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PANGASIWAAN NG TUBIG AT ALKANTARILYA SA METRO MANILA
Metropolitan Waterworks and Sewerage System

TA for the Strengthening of MWSS's Planning Capability in Water Supply, Sewerage and Sanitation Service Provision

IBRD Grant No. TF053321

WATER SUPPLY, SEWERAGE, AND SANITATION MASTER PLAN FOR METRO MANILA

VOLUME 1
SUMMARY

FINAL REPORT

November 2005

SINCLAIR KNIGHT MERZ (PHILIPPINES), INC.

in association with

DCCD ENGINEERING CORPORATION

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Acronyms, Abbreviations and Measurements

ACP	-	Asbestos Cement Pipe
ADB	-	Asian Development Bank
ADD	-	Average Day Demand
ADR	-	Appropriate Discount Rate
AIC	-	Average Incremental Cost
AO	-	Administrative Order
BOD	-	Biological Oxygen Demand
BOT	-	Build-Operate-Transfer (mode of project delivery)
BSWM	-	Bureau of Soil and Water Management
CA	-	Concession Agreement
CAS	-	Conventional Activated Sludge
CI	-	Cast Iron
CIP	-	Cast Iron Pipes
CO	-	Corporate Office
CWA	-	Clean Water Act
CWA-IRR	-	Clean Water Act-Implementing Rules and Regulations
DA	-	Department of Agriculture
DAO	-	Departmental Administrative Order
DBP	-	Development Bank of the Philippines
DCCD	-	Design Consultation Construction Management Engineering Corporation
DENR	-	Department of Environment and Natural Resources
DIP	-	Ductile Iron Pipes
DOE	-	Department of Energy
DOH	-	Department of Health
DPWH	-	Department of Public Works and Highways
EIRR	-	Economic Internal Rate Return
EIS	-	Environmental Impact Statement
EMB	-	Environmental Management Bureau
EPT	-	Enhanced Primary Treatment
EUFS	-	Environmental User Fee System
FIES	-	Family Income and Expenditure Survey
FIRR	-	Financial Internal Rate of Return
FTI	-	Food Terminal Inc.
GDP	-	Gross Domestic Product
GI	-	Galvanized Iron
GIS	-	Geographic Information System
HDI	-	Human Development Index
HEPP	-	Hydro-Electric Power Plant
HLURB	-	Housing and Land Use Regulatory Board
IEC	-	Information Education and Communication
IRR	-	Implementing Rules and Regulations
JICA	-	Japan International Cooperation Agency
JMM	-	James M. Montgomery
LGU	-	Local Government Unit
LLDA	-	Laguna Lake Development Authority

MCA	-	Multi-criteria Analysis
MCSS	-	Manila Central Sewerage System
MDU	-	Mobile Dewatering Units
MEERA	-	Modern Equivalent Engineering Reference Asset
METROSS	-	Metro Manila Sewerage and Sanitation
MM	-	Metro Manila
MMDA	-	Metro Manila Development Authority
MSSP	-	Manila Second Sewerage Project
MTSP	-	Manila Third Sewerage Project
MWCI	-	Manila Water Company, Inc.
MWSI	-	Maynilad Water Services, Inc.
MWSS	-	Metropolitan Waterworks and Sewerage System
NCR	-	National Capital Region
NEUFS	-	National Environmental Users Fee System
NGO	-	Non-Government Organization
NHA	-	National Housing Authority
NJS	-	Nippon Jogesuido Sekkei Co.
NPC	-	National Power Corporation
NPV	-	Net Present Value
NRW	-	Non Revenue Water
NSO	-	National Statistics Office
NSW	-	North South Wales
O&M	-	Operation and Maintenance
PD	-	Presidential Decree
PROGRESS	-	Program to Eliminate Sewage from the Streets
PRRC	-	Pasig River Rehabilitation Commission
PSALM	-	Power Sector Assets and Liabilities Management Commission
PVC	-	Polyvinyl Chloride
RO	-	Regulatory Office
ROW	-	Right-of-way
RR	-	Rate Rebasing
SAP	-	Strategic Action Paper
SBR	-	Sequencing Batch Reactor
SKM	-	Sinclair Knight Merz
SME	-	Small and Medium Enterprises
SpTP	-	Septage Treatment Plant
SSMP	-	Sewerage System Master Plan
STAMP	-	Septic Tank Management Program
STED	-	Septic Tank Effluent Disposal
STP	-	Sewerage Treatment Plant
TA	-	Technical Assistance
TF	-	Trickling Filter
UASB	-	Upflow Anaerobic Sludge Blanket
UATP	-	Umiray-Angat Transbasin Project
UNICEF	-	United Nations Children's Fund
USEPA	-	United States Environmental Protection Agency
WHO	-	World Health Organization

WTP	-	Water Treatment Plant
WWTP	-	Wastewater Treatment Plant

Units

g	-	gram
gpcd	-	grams per capita per day
GL	-	Gigaliters
GWH	-	Gigawatt-hour
ha	-	hectares
km	-	kilometers
km^2	-	square kilometers
kPa	-	kilo Pascal
kWH	-	kilowatt-hour
lpcd	-	liters per capita per day
m	-	meters
mg/L	-	milligram per liter
mm	-	millimeter
m^2	-	square meter
m^3	-	cubic meter
m^3/d	-	cubic meter per day
m^3/s	-	cubic meter per second
MCM	-	Million cubic meters
ML	-	Megaliters or Million Liters
MLD	-	Megaliters per Day (or Million Liters per Day)
MW	-	Megawatt
Php	-	Philippine peso
Php/ m^3	-	Philippine peso per cubic meter
psi	-	pounds per square inch
US$	-	United States Dollars
US$/ m^3	-	United States Dollars per cubic meter

1. Introduction and Background

1.1 Introduction

The delivery of an acceptable supply of safe, potable water to Metro Manila consumers has become increasingly constrained by the capacity of existing water sources and poor efficiency of existing infrastructure. Current source capacity is estimated to be 4,090 MLD, which draws primarily from the Angat-Umiray-Ipo River system, with augmentation from localized groundwater supplies. Potential water demand in the service area already exceeds this available source capacity, with high losses or non-revenue water (NRW) further compounding the supply difficulties.

The sewerage system in Metro Manila covers only about 15% of the population and 12% of the area. The remaining 85% of the population are either served by over 2 million, ill-maintained septic tanks that overflow to the storm drains, by pit latrines or not at all. Some have toilets simply connected directly to the storm drains. Most storm drains ultimately terminate into the Pasig River, which flows between Laguna de Bay, the largest freshwater lake in Asia, and Manila Bay. Significant sewage drainage also occurs within the catchments of Laguna de Bay, a potential future potable water source. It is estimated by World Bank that 60% of the households discharge sewage and solid wastes directly into the lake or into its tributary rivers. Domestic pollution accounts for about 70% of the organic load currently discharged into the lake. These three main receiving waters in Metro Manila exhibit varying degrees of environmental degradation in spite of being a source of food, livelihood, employment, and recreation to an estimated 23 million Filipinos within its 17,000 km^2 watershed (World Bank).

1.2 The Study

The Metropolitan Waterworks and Sewerage System (MWSS) received Technical Assistance (TA) financing from the World Bank (through the Japan Policy and Human Resources Development) toward the cost of the Strengthening of the Planning of Water Supply, Sewerage and Sanitation Services in Metro Manila under MWSS to meet an expanding population for the next 20 years. This involved a partial update of the Water Supply Master Plan and the preparation of a comprehensive Master Plan for Sewerage and Sanitation for the study area.

The Terms of Reference for the Study defined the time frame for the Master Plans to be up until 2020. However, there was also a requirement that Master Plans be prepared that would consider the requirements both up to and beyond the concession period which is 2022. Overall, it is considered that a timeframe of 20 years is reasonable, culminating at year 2025 as the target year.

The objectives of the water supply study are to (i) examine land use and demographic information to forecast long-term water demands for the Metro Manila area; (ii) identify the preferred long-term development program for source development and potential modes of program delivery; and (iii) identify the institutional improvements required to support this program.

The Sewerage and Sanitation Master Plan aims to analyze and identify least-cost and achievable options to address the environmental degradation in Metro Manila, conduct a willingness-to-pay survey of communities for sewerage and sanitation services, and determine the appropriate policy on sewer charges, including the extent of subsidy, as necessary.

Sinclair Knight Merz in association with DCCD Engineering Corporation won the international tender and commenced work in February 2005 on a nine-month contract.

1.3 Water Supply, Sewerage and Sanitation Service Provision in Metro Manila

The Metropolitan Water System was inaugurated in 1878 to supply water to the City of Manila, which then had a population of approximately 300,000 people. The service area and population was subsequently extended and expanded.

The Metropolitan Waterworks and Sewerage System, a Philippine government-owned and controlled corporation was established in 1971 and is responsible for the provision of water, sewerage and sanitation services in Metro Manila. MWSS had its operations privatized in 1997 to two concessionaires, viz. the Manila Water Company (MWCI, for the East Zone of Metro Manila) and Maynilad Water Services Inc. (MWSI for the West Zone of Metro Manila). The concessionaires agreed to provide defined water supply, sanitation and sewerage five year targets for each city and municipality in their respective service areas to the year 2022. The 2003 Rate Rebasing resulted in amendments to these targets, in particular a reduction in sewerage targets in favor of increased sanitation emphasis for MWCI and a five-year moving forward of sewerage targets for MWSI.

Following the privatization, the Regulatory Office was established as the representative of the customers and was created under provisions of the Concession Agreement. The MWSS Corporate Office was given responsibility for the retained functions, facilitating the performance of the concessionaires of their obligations, managing the Umiray-Angat Transbasin Project, managing the loans that are in the name of MWSS but serviced under the agreements by the concessionaires, and managing and where appropriate disposing of the ‘retained assets’, i.e. those assets not conceded for the duration of the concession agreement.

1.4 Study Area

The study area addressed by the water supply, sewerage and sanitation master plans for Metro Manila is shown in **Figure 1.1.** This is the MWSS service area that currently covers 16 cities and 21 municipalities within the National Capital Region, the Province of Rizal and the Province of Cavite with a total land area of 2,371 km^2. The area comprises the two concession areas defined for water, sewerage and sanitation service delivery in Metro Manila, which makes up the total MWSS service area. The study area is essentially defined based on municipal boundaries rather than geophysical or supply limiting borders.

The West Concession covers the cities of Manila, Pasay, Parañaque, Caloocan, Muntinlupa, Las Piñas, Valenzuela, Cavite City, parts of Makati and Quezon City and the municipalities of Malabon, Navotas, Bacoor, Imus, Kawit, Noveleta and Rosario. The East

Concession covers Makati, Mandaluyong, Marikina, Pasig, Pateros, San Juan, Taguig, and parts of Quezon City and Manila, Antipolo City and the towns of Angono, Baras, Binangonan, Cainta, Cardona, Jala-Jala, Morong, Pililla, Rodriguez, Tanay, Taytay and San Mateo, all in the Province of Rizal.

The areas covered by the East and West Concession Zones are shown in **Figure 1.2.**

1.5 Basis of Study

The partial update of the **Water Supply Master Plan** is based primarily on readily available information sourced from previous study reports for water source development in the Metro Manila region, with relevant updates applied where new or revised information has come to hand. Importantly, limited analysis has been conducted by the project team, as the focus of the study is sewerage and sanitation. Nonetheless, sufficient planning and engineering and financial assessment has been completed to confirm conclusions and recommendations of this report.

The partial update of the Water Supply Master Plan has essentially projected water demands for the master planning horizon until 2025 and in the context of proposed non-revenue water reductions and demand management measures, examined options for new water source development for the long term. The impact of the new water source development on water supply coverage in the service area has been projected for five yearly increments throughout the master planning period. The effect of water availability on the need for improved sewerage and sanitation facilities has also been a factor in the development of strategies for the Sewerage and Sanitation Master Plan.

The **Sewerage and Sanitation Master Plan** study examined the existing sewerage facilities as well as the targets, plans and programs of the concessionaires in the context of recommending least-cost technical and achievable solutions for sanitation, sewage collection (sewerage) and treatment. Issues that have constrained the development of sewerage and sanitation facilities in Metro Manila in the past were examined to guide the Master Plan strategy to allow addressing these constraints.

The 2003 Rate Rebasing targets of the concessionaires to 2022 for each of the cities and municipalities were taken as minimums for planning sewerage and sanitation activities to the year 2022 and were reflected in the Master Plan time horizons of 2005, 2010, 2015, and 2020. Logical extensions and achievability were used thereafter for the strategy between 2020 and 2025, when the concession agreements no longer exist. A further future probable scenario beyond 2025 was also included to show the ultimate conclusion of this proposed Master Plan.

Additional information and data from stakeholders such as the MWSS, MWCI, MWSI and various local government units (LGUs) are also acknowledged as key inputs to this study. In the case of MWCI and MWSI, water supply network-modeling support has also been provided to determine system improvements for the integration and transmission of new bulk water to demand centers.

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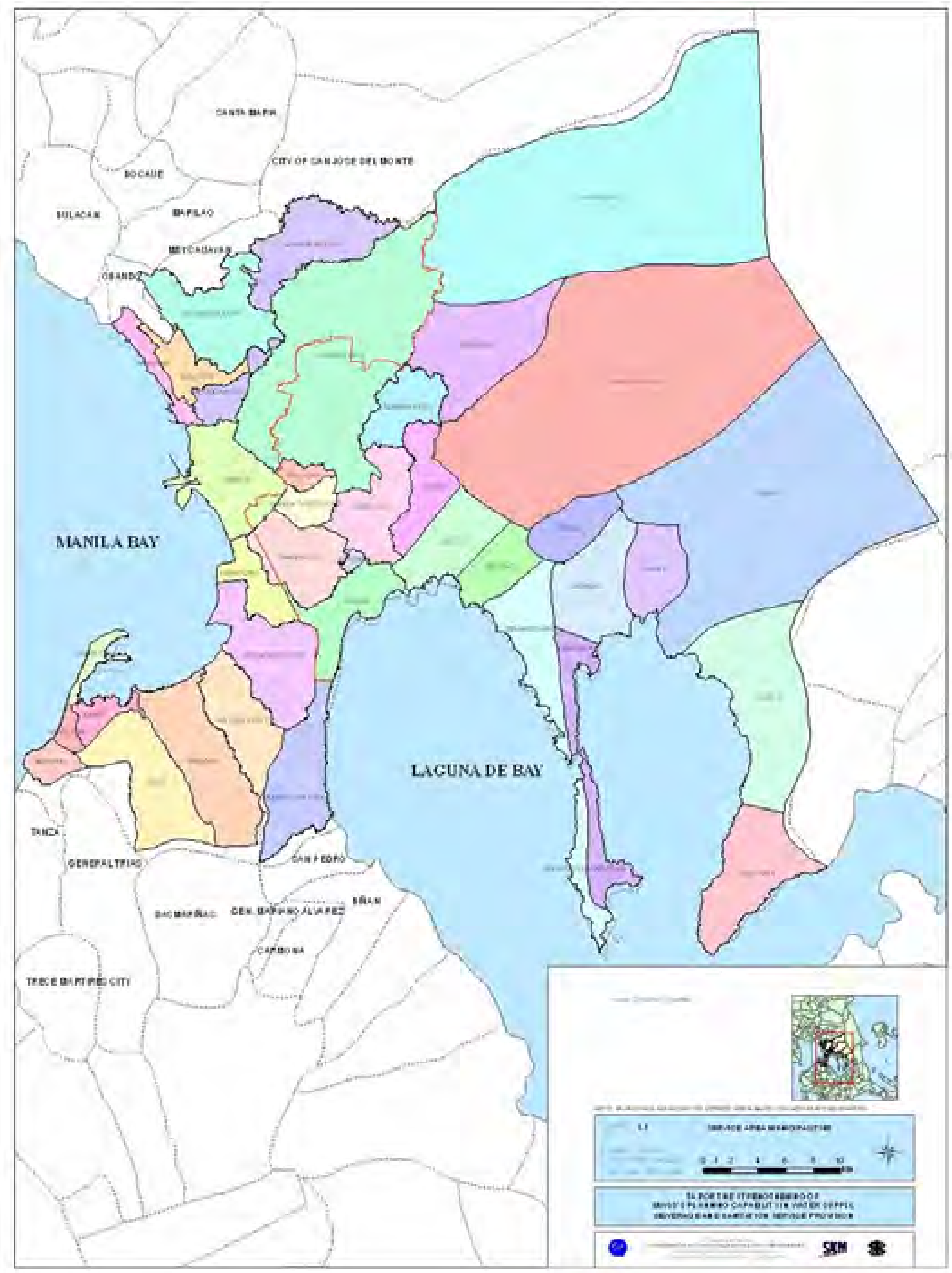

Figure 1.1 MWSS Service Area, 2000

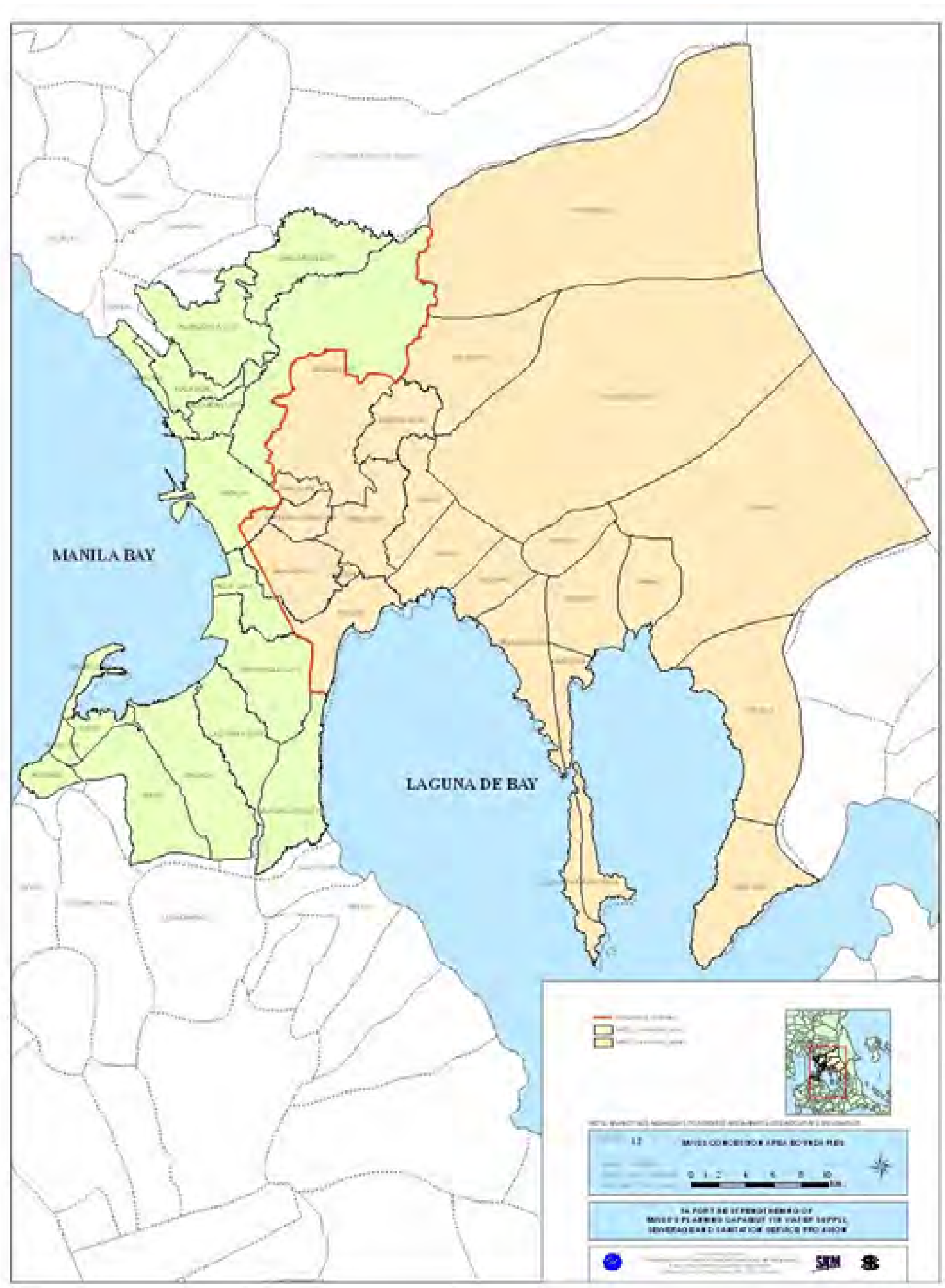

Figure 1.2 MWSS Concession Area Boundaries

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1.6 Previous Studies

1.6.1 Water Supply Studies

Water supply master planning for Metro Manila has been the subject of several key studies over the past 25-years. A summary of key outcomes from these studies follows:

1979

The 1979 Manila Water Supply lll Feasibility Report listed nine potential water sources for Metro Manila. Laiban Dam on the Kaliwa River was selected as the most economical source at that time.

1996

The 1996 Master Plan projected a maximum daily water demand of almost 6,000 MLD by 2015. This demand was to be satisfied through on-going augmentation of the Angat source under the Angat Water Supply Optimization Project and the Umiray-Angat Transbasin Project. The primary focus of new water source development, however, was to be the Kaliwa River (Laiban Dam) for which water rights to extract 1,950 MLD had been approved in 1979. Water rights for a further 3,200 MLD from the Kanan River were granted in 1981 to augment the proposed Laiban Dam development.

1997

The review of the Manila Water Supply Project III, or Laiban Dam, in 1997 concluded that this project continued to be the most viable option to meet water production requirements for the Metro Manila area up to 2015. Effectively, the Laiban Dam development was considered to be the only major water supply option to be fully identified, fully designed and without outstanding and unresolved technical issues at the time of the review.

2003

In 2003, the Study on Water Resources Development for Metro Manila projected an average daily water requirement of 6,980 MLD by 2025 and compared eight alternative combinations of new sources to meet this demand. The combinations considered alternative dams on the Kaliwa, Kanan and Agos Rivers. The recommended alternative was to initially construct a low dam on Kaliwa River to be augmented (and submerged) by a dam and reservoir on the Agos River. It was proposed that the development be constructed in three stages and it was estimated to provide an additional 3,000 MLD.

2004

In 2004, a steering committee comprising representatives of MWSS, MWCI and MWSI completed an assessment of new water sources and concluded on a prioritized source development timetable referred to as the “2004 Road Map”, as shown in **Table 1.1**.

Table 1.1 - New Water Sources Proposed in 2004 Road Map

Date		Proposed New Water Source	Additional Capacity	Total System Capacity
1	2005	Wawa River Project	50 MLD	4,140 MLD
2	2007	Angat Water Utilities & Aqueduct Improvement Project	750 MLD	4,890 MLD
3	2007	BOT Treated Bulk Water (Laguna Lake)	400 MLD	5,290 MLD
4	2013	Laiban Dam Project	1,900 MLD	7,190 MLD
5	2023	Agos Dam Project, Phase 1	1,500 MLD	8,690 MLD
6	2023	Agos Dam Project, Phase 2	1,500 MLD	10,190 MLD

Notably, missing from the Road Map is the development of Kanan River as a logical sequel to the Laiban Dam Project. This involves a storage dam and reservoir on the Kanan River and a transbasin tunnel from the Kanan Reservoir to the Kaliwa Reservoir (formed by Laiban Dam). The expected additional yield from Kanan is 37 m^3/s (3,200 MLD), which would increase the total Kaliwa-Kanan scheme yield to 5,000 MLD, thereby maximizing the potential yield of the total Agos basin resource.

1.6.2 Sewerage and Sanitation Studies

At least four (4) previous Sewerage and Sanitation Master Plans, starting in 1969, have been prepared for Metro Manila. Substantial implementation of one of them would have arrested the environmental degradation but all have been only been partially implemented or not implemented at all. The huge capital investment required for proposed conventional sewerage systems was the main deterrent, but there was also the likely traffic disruption during construction, unavailability of land, the low priority given to the management of dirty water by the government and the apparent unwillingness of consumers to pay for the service. A summary of the outcomes of these earlier studies and master plans follows:

1969

Black & Veatch in 1969 commenced a two-year Master Plan study. The Pasig River was even then measured with BOD concentrations of 2.5 to 10 mg/L and reported as “black and gaseous”. A centralized concept for a separate sewerage system for Metro Manila was proposed. Consideration was given to a combined sewerage system but not ultimately recommended due to the extent of the existing sewerage system, the high intensity rainfall in Manila and the consequent increased cost of a combined system. Collection of wastewater was to be by interceptor sewers (including one proposed along the bed of the Pasig River). Ultimate disposal was via three disposal points in Manila Bay. Inland treatment was not considered due to the negligible assimilative capacity of the streams. Sanitation was not considered in this Master Plan. The plan was not implemented due to its high cost.

1979

The next Master Plan was prepared by James Montgomery/Kampsax Kruger/DCCD in 1979. The 1969 plan was quickly discarded due to inaccuracies in its cost estimations. A sewerage expansion program involving rehabilitation of existing facilities and a monitoring system called METROSS (Metro Manila Sewerage and Sanitation) was proposed that would employ combined sewers with secondary treatment of sewage at four outfalls into Manila Bay. A sanitation program comprising minor drainage projects for the depressed areas (PROGRESS) and a septic tank desludging program (STAMP) was part of this Master Plan. Part of PROGRESS and STAMP were implemented as a component of METROSS – 1.

1994

The Manila Second Sewerage Project (MSSP) commenced with World Bank assistance in 1994 to begin addressing the increasing water pollution in Metro Manila. Programs included a (i) Septage Management Plan, (ii) Ayala Sewage Treatment and Sewerage System Rehabilitation, (iii) Manila Central Sewerage System Rehabilitation and (iv) Supply of Laboratory Equipment, Vacuum Trucks and Other Vehicles. The first SpTP in MM at Dagat-dagatan was implemented under this program.

1996

In 1996 a study on a Water Supply and Sewerage Master Plan for Metro Manila by Nippon Jogesuido Sekkei (NJS) commenced. The septage management plan in the 1996 MP was to include regular desludging, collection and disposal of septic tank septage. Construction 5 SpTPs were proposed to meet Sanitation target levels but ocean dumping of septage was suggested as an intermediate solution until the SpTPs were available. Since then this practice has been banned. Medium-scale inland treatment systems were recommended with the effluent quantity target to be less than 30 mg BOD/L. An Interceptor System (1st stage of combined) was recommended to help reduce the cost. Ten (10) sewerage systems were evaluated and prioritized to 2015. The target was around 30% of Metro Manila Region. Emphasis was placed on low cost technologies.

2000 – Post MWSS Privatization

A West Zone Sewerage Master Plan for MWSI by Philaqua Consultants, Inc. was proposed in October 2000. For the Sewerage Master Plan, the area of the West Zone was delineated into small catchments in the 11 cities and municipalities to correspond to contractual sewerage coverage. The Master Plan included four potential regional sewage treatment works and four regional sewerage catchments, all of which drain to Manila Bay (i) a coastal site in Navotas to Caloocan A City area, (ii) existing Dagat-Dagatan site, (iii) a coastal site adjacent to the City of Manila, and (iv) a coastal site in Pasay City to Parañaque area, drainage by gravity. Muntinlupa, where natural catchment flows drain inland to Laguna de Bay, and Caloocan B City, where the natural catchment flows drain northwest and subsequently towards the coast adjacent to MM, were not included. Coast sites for the STPs were proposed on existing or reclaimed land. This Master Plan was never formally presented to MWSS.

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2004

The Manila Third Sewerage Program Master Plan was developed to comply with the 2003 Rate Rebasing targets for sewerage and sanitation for the East Zone, in particular with the service targets for 2010. The plan was completed by late 2004, early 2005. The use of combined sewerage was emphasized with the use of the drains whenever possible. Riverbank STPs were proposed to treat combined flows at two underground plants at Mandaluyong and Pasig and one above the flood retention pond in Makati. Off-line primary STPs are to be constructed in the vicinity of the flood ponds in Taguig. The ponds would subsequently be used for secondary treatment during the dry season.

An underground STP on the bank of the Marikina River is also proposed with the upgrading of the existing drainage network, accompanying interceptor and pumping stations. Environmental discharge is to be into the Marikina River. Interceptor sewers adjacent to the Marikina River are to convey combined dry weather flow of sullage and stormwater to the STP. Existing outfalls from south Camp Atienza catchment, discharging to the Marikina River, would also be intercepted and conveyed to a STP through forced mains, parallel to the river. Some communal septic tanks will be upgraded to treatment plants as well as the construction of the Manggahan STP to service low income communities.

1.7 Organization of the Report

The approach to preparing the partial update of the Water Supply Master Plan and the full update of the Sewerage and Sanitation Master Plan has been the development of a series of Strategic Action Papers (SAPs) that have been discussed with the stakeholders during the course of preparation of the Plans. Following the consultations, the findings of the SAPs were consolidated into the Master Plan document. The Master Plan documents comprise five volumes in addition to the Strategic Action Papers.

Volume 1 – Summary Report for the Water Supply, Sewerage and Sanitation Master Plans

Volume 2 – Partial Update of the Water Supply Master Plan

Volume 3 – Sewerage and Sanitation Master Plan – Situation Analysis

Volume 4 – Sewerage and Sanitation Master Plan – Master Plan Strategy

Volume 5 – Sewerage and Sanitation Master Plan - Appendices

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2. Project Framework

2.1 National Economy

The Philippines has a diversified economy, with contributions of the key sectors to GDP in 2003 being: services 53%, industry 32%, and fishing 15%. Real GDP growth has strengthened over the past three years from 1.8% in 2001 to 4.3% in 2003 and about 6% in 2004. Inflation, which had been high in the past, appeared to have been well under control from mid-2001 until the end of 2003, when it averaged 2.5% per annum. Inflation, however, increased sharply in 2004 to a yearly average rate of about 8%. It is expected to decline to about 5% in the medium term.

A key issue in the Philippine economy is the level of unemployment, which is high and has been rising. In the second quarter of 2004, it was recorded at 13.7%, compared to 12.2% for the same quarter in 2003. A second problem in the economy is the fiscal deficit. This is running at 4 to 5% of GDP, and is an important reason for the relatively high interest rates in the Philippines.

Table 2.1 below gives an overview of the main economic indicators for 2003-2004 and projections for 2005-2006.

Table 2.1 – Actual and Projected National Economic Indicators

Description	In Percentage Terms			
	Actual		Projected	
	2003	2004	2005	2006
Real Gross Domestic Product Growth	4.7	5.6	4.6	4.2
Gross Agricultural Production Growth	3.8	5.5	3.7	3.6
Unemployment – Average	11.4	11.6	11.0	10.6
Inflation rate	2.9	5.6	5.3	5.2
91 day Treasury Bill rate	5.9	7.3	8.0	8.5
Fiscal Balance (% of GDP)	-4.6	-4.3	-3.8	-3.2
Current Account Balance (%GDP)	4.2	3.4	2.8	1.7

Source: EIU October 2004

2.2 Poverty

The 2003 Human Development Report ranks the Philippines 85th out of 175 countries based on the Human Development Index (HDI)[1]. In that report, the HDI has shown improvement over the past seven years from 0.735 in 1995 to 0.753 in 2002. There has also been progress in reducing the overall level of poverty in the Philippines, poverty incidence having declined from 44.2% in 1985 to 28.4% in 2000.

[1] The HDI is a measure of human development used by UNDP for the Human Development Report. The HDI considers indicators of life expectancy, literacy, educational levels and GDP. Countries are ranked as high development (HDI of 0.8 and above), medium development (HDI of 0.5 to 0.8) and low development (HDO less than 0.5).

The annual per capita poverty threshold in 2000 of the Philippines was PhP 13,913 (US$253), an increase of 22.9 % over the PhP 11,319 estimate in 1997. Based on the preliminary results of the 2000 Family Income and Expenditure Survey (FIES), the number of families below the poverty line of PhP 13,913 increased from 31.8 to 34.2 percent. Overall, the number of poor families reached 5.2 million up by 707,000 families or 16% higher than in 1997.

Because of the large disparity of poverty between rural and urban areas, many people from the rural areas migrate to urban areas, with the largest magnitude coming to Metro Manila. It is estimated that 36% of Metro Manila's population comprises informal settlers. This is about 432,450 families, as of 1996 (NHA-NCR). These informal settlers are distributed to about 276 major slum areas in Metro Manila.

2.3 Health

Diarrhea has been the leading cause of morbidity for the past 10 to 15 years in the Philippines, albeit at a declining rate. The impact of the lack of appropriate sanitation facilities in the country is evident in that diarrhea/gastroenteritis remains the major cause of child mortality in the 1 to 4 and 5 to 9 age brackets. The World Health Organization (WHO) has stated that improved sanitation/sewerage, i.e. human waste management, reduces the incidence of diarrhea by 32% and simple hand washing can reduce diarrhea cases by up to 45%.

Respondents from this study's Willingness-to-Pay Survey indicated that Filipinos in Metro Manila spend, on the average, PhP 3,180 per month on medical care, the second highest individual expense after food or about 15% of the average income.

2.4 Land Use Analysis

An analysis of existing and proposed land uses within the MWSS Service Area was made to determine the distribution of population and their activities and future trends or directions of expansion or contraction of specific land uses in each component city or municipality.

Existing Land Uses

A large portion of the MWSS service area is composed mainly of built up areas, specifically in the central and southern service area and some areas in the north. Built-up areas include residential, commercial, industrial, institutional and related infrastructure to make up about 40% of the MWSS service area. The rest, which lies mostly in the northeastern part of Rizal, is made up of agriculture, forest, open grassland and some mining and quarrying activities.

The land use trend in the National Capital Region (NCR) has largely been a response to socio-economic demands of a growing population and not necessarily according to plan. The area has a high density of informal settlements and much of the urban area has been infilled with high density housing. The Cavite Service Areas have become highly urbanized in the past 20 years because of their proximity to Metro Manila and due to resettlement of informal settlers in Metro Manila by the National Housing Authority (NHA) in the late

1980s. The largely agro-fishery base of the area has been lost to residential, commercial, industrial and institutional uses.

The province of Rizal has the largest land area in all the three provinces within the service area. However, most of this is predominated by grass and shrub lands, covering at least 53% of the provincial land area. Other dominant uses are agriculture (14%), forest (14%), built-up areas (12%), and some 2% are still unclassified. Rizal is an important catchment area for Laguna de Bay.

Urban Land Use Trends

Metro Manila studies show that, historically, the strongest directions of growth have been towards the northeast, or Quezon City and the south, or Muntinlupa. These growth directions, moreover, appear to be canceling each other out, thereby leaving what planners call a "net eastward" movement in the center of the metropolitan population.

Physical development will encroach and intensify potentially in the watershed areas in Quezon City and Marikina Valley, towards Rizal. Rizal province has been experiencing approximately 10 percent growth rate over the last decade and densities, particularly in the municipalities of Cainta and Taytay, are increasing.

The MMDA physical framework plan intends to decongest Metro Manila and re-distribute and link growth with the suburban centers of neighboring regions and provinces such as Rizal, Cavite, Laguna and Bulacan. The provinces of Rizal and Cavite will continue to receive and plan for the spillover of housing demand and supply in Metro Manila. A vast number of residents in these areas actually work in the inner and intermediate core of the metropolis. In anticipation of this trend, the LGUs in these provinces have already planned for increased built-up areas to accommodate the migration and increase of population from Metro Manila. **Figure 2.1** shows the predicted growth trends in the service area.

2.5 Demography and Population Growth to 2025

National and regional population and growth trends are important for predicting how much and where the water supply, sewerage and sanitation facilities will be most needed. The population of Philippines in 2000 was about 76.5 million, with an average growth rate of about 2.2%. The MWSS service area accounts for about 16% of the country's total population in 2000 estimated at 12.4 Million, with an average annual growth rate of 1.5 percent. The proportionate current (year 2000) distribution of population is approximately 60% West Service Area and 40% East Service Area.

The National Capital Region (NCR) comprises about 80% of the total population in the service area whilst the municipalities covered in Cavite comprise 6% and Rizal Province 14%. In the 2000 NSO Census, the biggest cities are the cities of Manila, Quezon and Caloocan, the combined population of which is 40% of the total population in NCR and already one-third of the entire service population.

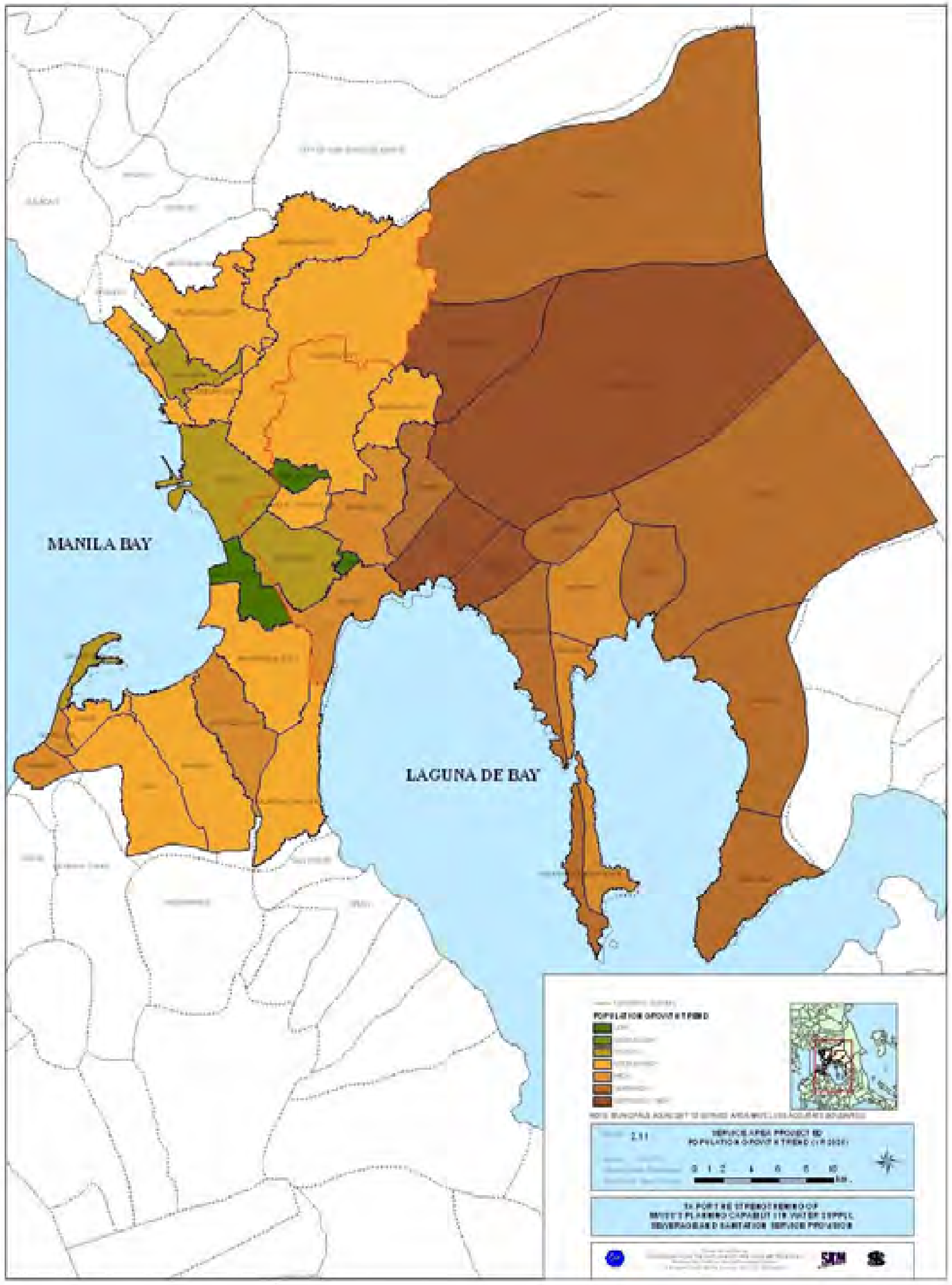

Figure 2.1 Service Area Projected Population Growth Trends, 2025

Generally, the NCR grew at a slower pace than the rest of the Philippines from 1980 to 2000 with an average growth rate of about 2.6%; Cavite and Rizal grew faster than the rest of the country with 4.4 and 5.8% growth rate, respectively. The NCR during the 5-year period between the years 1995-2000 had a growth rate less than 1%, while Cavite had 3.1% and Rizal had 5.4% growth rates during the same period.

The future population in the Service Area was projected for the planning period 2005 to 2025, using the NSO population census as base data. Population projections predict that by 2025, the approximate distribution between the East and West Service areas will be almost 50-50% due to the high growth rates in the East Service Area, especially in Rizal.

By the year 2025, about 19.4 Million persons or 4.3 Million families will need potable water supply and sewerage/sanitation services within the MWSS Service Area as shown in **Table 2.2** and **Figure 2.2.** This is an increase of about 57% or 7 Million persons from the NSO Census of 2000. The highest growth will be experienced by Rizal, which will more than triple, while Cavite will increase by 68% and NCR by 25%.

Table 2.2 – Service Area Population Projections

	Population (million people)				
Area	**2005**	**2010**	**2015**	**2020**	**2025**
NCR	10.58	11.14	11.65	12.07	12.40
Cavite	0.90	1.00	1.10	1.18	1.23
Rizal	2.23	2.88	3.69	4.67	5.86
TOTAL	**13.69**	**15.02**	**16.44**	**17.93**	**19.49**

The projected population will be housed in existing residential areas and in the development of new high density residential/commercial use spaces. Most of the LGUs are planning for medium-density socialized housing for low-income groups that will decide to stay within the region.

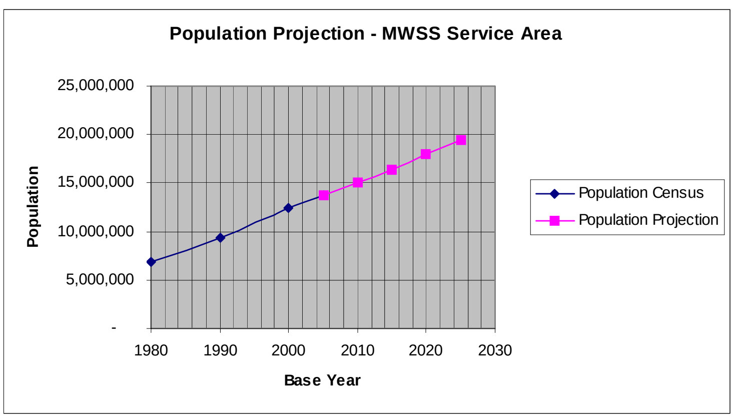

Figure 2.2 Projected Population, MWSS Service Area

The NCR population level has been stabilizing in the last ten years and negative population growth is likely -1.1 to -0.1%. Negative population growths were also projected for Makati (-1.5 to -0%), Malabon (-1.5 to -0.5%), Pateros (-1.0 to -0.3%) and San Juan (-0.7 to -0.03%). Large growths were projected for Las Piñas (2.4 to 3.4%), Taguig (2.4 to 3.4%), Pasig (1.7 to 2.7%), Parañaque (1.1 to 2.1%), Caloocan (1.1 to 2.1%) and Muntinlupa (0.8 to 1.8%).

In terms of land use and development, the NCR and the Cavite Service Areas will have a short supply of available land for their increasing population and economic activities. Vertical development is therefore likely to occur in these areas and water supply and sewerage services will need to cater for the increased density of development. Rizal, on the other hand, has a large expanse of open space/grasslands and is currently constrained by the lack of availability of water in the area. With the projected growth rate and development trends leading towards this area, new water sources should be given a priority for development.

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3. Water Demand/Sewage Generation Forecasts and Pollution Loads

3.1 Water Demand Projections

Water demand projections serve as the basis for decisions on the size and timing of the development of future sources, for the forecast for sales of water and tariff rates that will be required to meet financing and debt service requirements, and for predicting future sewage flows. For sizing and timing purposes, allowance is made for leaks and flushing (non revenue water) to determine the total system demand. Water demand is broken down into domestic, commercial and industrial demands. Unbilled consumption is included in water demand estimates.

The water supplied into the MWSS water system, which has always been less than the system demand, is broken down into billed consumption and non-revenue water (NRW). The NRW is composed of: (1) physical losses mainly from leaks and flushing operations and (2) non-physical losses or commercial losses referred to above as unbilled consumption, which are due to metering errors and illegal connections.

Projections for future domestic water demand will depend upon the service area coverage and the unit consumption which in turn depends upon water availability, household income and cost of water. Commercial and industrial water demand will tend to grow in accordance with the economic development of the service area.

The service area coverage for water supply required by the concessionaires as part of the Concession Agreement until 2020 and as projected by this Master Plan until 2025 is shown in **Table 3.1.**

Table 3.1 – Projected Water Supply Service Coverage

Service Area	2005	2010	2015	2020	2025
West	90%	97%	98%	98%	99%
East	67%	73%	81%	92%	98%
TOTAL	**81%**	**87%**	**90%**	**95%**	**98%**

The average unit consumption of water currently ranges from about 120 liters per person per day (lpcd) in the West Zone to 180 lpcd in the East Zone. The variation results from the lack of 24-hour water availability in most parts of the West Zone. This is unlikely to increase significantly even with increased household income until additional water is available after 2010. After 2015, the increase in per capita consumption is expected to be moderated or even neutralized by price elasticity and other demand management initiatives aimed at limiting consumption to sustainable levels. Projected per capita consumption is shown in **Table 3.2**.

The total water demand for the service area is the sum of the domestic, commercial and industrial water demands and the amount of physical losses in the water supply system.

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The physical losses are currently 52% of supply and are projected in this study to decrease to 26% by 2025. The projected total water demand for the service area is shown in **Table 3.3.**

Table 3.2 – Projected Per Capita Water Consumption (2005-2025)

	Per Capita Water Consumption (lpcd)			
	2005-2010		2015-2025	
	NCR	Rizal/Cavite	NCR	Rizal/Cavite
High Income	180	160	220	180
Middle Income	170	150	200	160
Low Income	140	140	160	140
Average	**160**		**180**	

Table 3.3 - Projected Total Water Demand (Million Liters per Day)

Water Demand	2005	2010	2015	2020	2025
Domestic (MLD)	1,767	2,078	2,736	3,119	3,465
Commercial (MLD)	636	889	1,048	1,244	1,438
Industrial (MLD)	121	172	204	242	281
Physical Losses (MLD)	2,769	1,948	1,632	1,639	1,774
Total	**5,294**	**5,088**	**5,619**	**6,244**	**6,958**

The system demand represents the amount of treated water to be produced by water sources on an *annual average daily* basis, i.e. the **average day demand (ADD)**. For water sources with storage capacity to balance out low and high demand periods, the ADD also represents the nominal source capacity needed to meet projected demand.

Given an existing source capacity of 4,090 MLD there is already a shortfall in water supply of over 1000 Million liters per day (1 GL/day) and new water sources will be required to contribute an additional 2,868 MLD of capacity by Year 2025 to match projected average day demand. Assuming optimization of existing sources is achieved and a BOT contract development is progressed in the immediate future to provide an additional 400 MLD in extra source capacity, the remaining capacity required by 2025 from other new sources is estimated to be approximately **2,500 MLD,** depending on actual NRW reductions.

A comparison of this study's system demand projections with the results of the previous studies is shown in **Figure 3.1**.

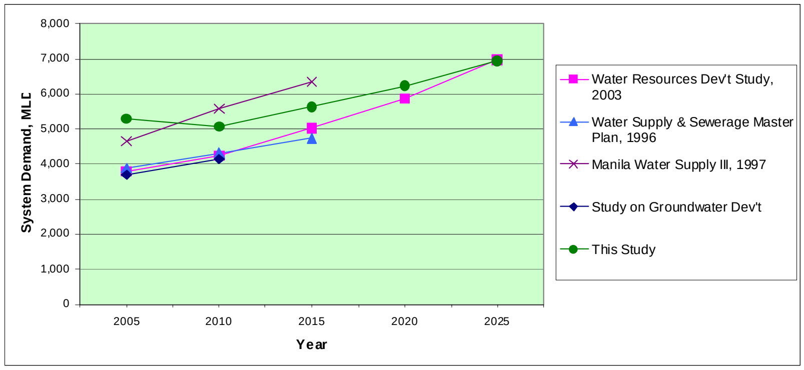

Figure 3.1 Comparison of System Demand with Previous Studies

3.2 Water Production

The projection of water production capacity to meet the maximum demands in the MWSS service area, obtained by applying the maximum day demand factor (1.25) to the total system demand, is shown in the **Table 3.4**.

Table 3.4 – Projected Water Production Capacity

Year	Required Water Production Capacity (MLD)
2005	6,617
2010	6,360
2015	7,024
2020	7,805
2025	8,698

A graph of existing supply versus the projected system demand is shown in **Figure 3.2.**

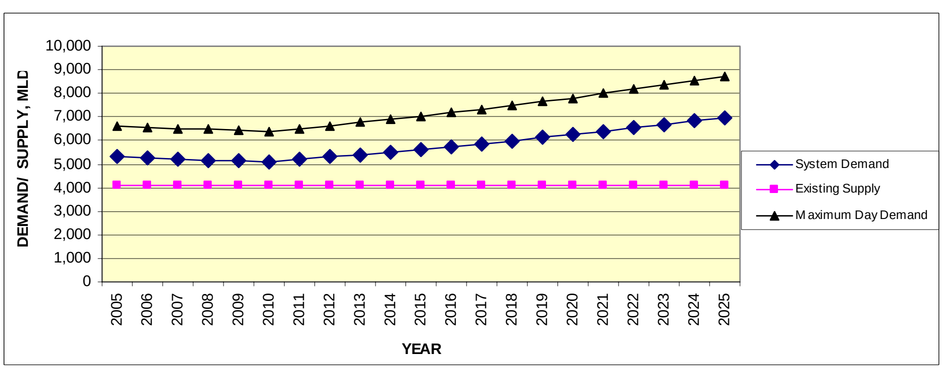

Figure 3.2 Projected Demand and Existing Supply Curve

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3.3 Sewage Generation Volumes and Quantities

Flows to the future sewerage systems were estimated from the projected water supply data, the total flow being composed of domestic, commercial and infiltration components. Industrial discharges were also estimated, based on the industrial potable water usage but it was assumed that these will not be connected to any proposed sewerage system.

The combined domestic and commercial dirty water flows for the 2005, 2010, 2015, 2020 and 2025 time horizons for each of the drainage catchments of interest were estimated at 80% of their metered potable water consumption (excluding water drawn from private wells). A constant daily infiltration flow rate of 7.5 m^3 per hectare per day was used for all the catchment areas.

Trunk main sewers, where required to transport sewage from the reticulated areas to the decentralized treatment plants, were ultimately sized by adjusting the estimated dirty water flows by a peaking factor that ranged from 1.4 to 2.5, depending on the size of the network (larger networks had lower peak factors). The infiltration rate was consequently added to the adjusted flow.

3.4 Pollution Load Analysis

The total pollution load of various water bodies within the MWSS service areas originates from domestic, commercial, and industrial sources. Each of the 31 drainage catchments delineated in this study had its pollution load individually estimated. The estimates accounted for any existing environmental infrastructure (i.e., sewerage and STPs) as well as the proposed sewerage and sanitation improvement projects (including MTSP) within the planning period of 2005 to 2025.

Domestic

- **1969 Sewerage Master Plan**: reported a wide range of potential per capita BOD loadings. It was eventually concluded that an average BOD loading of 45 g BOD per capita per day (gpcd) is relevant for the populace of MM.
- **1979 Sewerage Master Plan**: used a per capita BOD production of 50 gpcd for domestic wastewater.
- **1991 JMM Master Plan**: conducted sampling on sewage in the Central Sewerage System at the Tondo Pumping Station and on the Ayala system and deduced per capita BOD loadings of 38 gpcd and 37 gpcd, respectively.
- **1996 JICA Sewerage and Sanitation Master Plan**: used 40 gpcd for its 1995 load data, increasing to 50 gpcd by 2015.
- **2004 NJS MTSP Master Plan for the East Zone**: used the BOD per capita load presented in the **Table 3.5**. These values accord fairly well with the recommendations of previous studies and with the values used in other locations similar to Metro Manila. These were also adopted for this study.

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Table 3.5 - Domestic per capita Pollution Loads based on BOD (gpcd)

Household Profile	BOD load in 2005			BOD load in 2025		
	Toilet	Sullage	Total	Toilet	Sullage	Total
Low-income	20	16	36	20	23	43
Middle-income	20	30	50	20	30	50
High-income	20	30	50	20	30	50
Average	20	25.3	45.3	20	27.7	47.7

This 2005 Master Plan employed the 2005, 2015 and 2025 population projections of the MWSS service area and average per capita BOD allowances of 45.3 gpcd in 2005, 46.5 gpcd in 2015 and 47.7 gpcd in 2025 to calculate the BOD loads for each of the 31 catchments. The total BOD loads for each of these time horizons were 543 tons of generated BOD/day (198,000 tons BOD per year) in 2005, 603 tons BOD/day (220,000 tons BOD per year) in 2015 and 784 tons BOD/day (286,000 tons BOD per year) in 2025. These numbers did not account for any BOD reduction in the septic tanks.

The pollution load share of the West Zone is expected to decrease from 58% in year 2005 to 49% in year 2025. The load share of the East will conversely increase from 32% to 44%, respectively. The improved sanitation and sewerage programs to be implemented by MWSS through its concessionaires will have some effect on the net pollution load being discharged into the river systems in Metro Manila. The aforementioned BOD loads were subsequently adjusted to calculate the “net” pollution load. The existing septic tanks were estimated to conservatively remove only 10% of the pollution load being discharged by every household. This fraction would increase once the tanks are regularly desludged.

Commercial

The calculation of commercial loads utilized a “standard” BOD concentration of 500 mg/L, along with a flow deduced from assuming 80% of the water usage plus infiltration.

Industrial

Since 1998, an Environmental User Fee System (EUFS) has been actively implemented in LGUs under the jurisdiction of the LLDA with regard to effluent discharges. A similar effort was done in 2003 for a National Environmental Users Fee System (NEUFS) that would initially be implemented in the areas of NCR over which EMB has jurisdiction. A draft AO (DENR DAO 2003-39), work and financial plans, and community consultation activities were conducted in late 2003.

It was therefore assumed that industrial waste loading will continue to decrease as a result of these policies. Industrial activity within Metro Manila will not likely expand significantly in the future as more and more industries are choosing to relocate outside the capital. The program of the Development Bank of the Philippines (DBP), who is providing incentives and loan facilities for small and medium enterprises (SMEs) to install treatment facilities, is also expected to reduce industrial pollution levels.

Industrial pollution loads were also estimated for each of the drainage catchments. The assumed average percent compliance to existing effluent regulations (CWA and EUFS) in 2005 was 40%, with a linear increase to 60% in 2015 and 80% in 2025. Industrial water usage is projected to remain almost constant from 2015 to 2025, with the West Zone still carrying about 55 to 59% of the total industrial dirty water flow. The projected industrial dirty water flows in 2025 are 330,000 m^3/day or 8% of the total projected dirty water flow (assuming all industries connect).

For the short and medium term it is prudent to continue to disallow industrial effluent into the sewers and to concentrate on collecting and treating domestic waste, given the current legislation. The allowance of industrial wastewaters in domestic sewers can be given consideration in the future when a Trade Waste Group within MWSS and/or its concessionaires is available to monitor and control these discharges.

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4. Water Supply Master Plan to 2025

4.1 Water Supply Operations

4.1.1 Current Levels of Service

Table 4.1 summarizes the various service level indicators for the two concessions, which include coverage for water and wastewater services, continuity of supply, pressure, and advances in non-revenue water (NRW) programs.

Table 4.1 - Service Level Indicators for the Concessionaires

SERVICE INDICATORS	PRE-PRIVATIZATION	END OF 2004		
		MWCI	MWSI	SYSTEM-WIDE
Population Served in Millions	7.3M	3.4M	4.9M	8.3M
Official Number of Water Service connections	779,380	425,802	602,821	1,028,623
Annual Average Water Production (MLD)	2,800	1,518	2,276	3,793
Non-Revenue Water (NRW)	61%	47.5%	69%	60%
NRW Volume	1,708	632	1,599	2,231
Water Availability	17	21	21	21
Water Coverage	67%	78%	70%	73%

4.2 Water Supply System and Facilities

Water Source
Water supply to the current MWSS service area is sourced from the Angat-Umiray-Ipo system and local groundwater. Total raw water supply capacity of the existing water source infrastructure is estimated at **4,090 MLD**, of which approximately 98% (4,000 MLD) of the daily supply comes from the Angat-Umiray-Ipo source. A schematic diagram for the existing bulk water system is shown in **Figure 4.1**.

The system originates in the Angat River basin with a transbasin tunnel, adding yield from the Umiray River basin. Inflow is impounded at the Angat Dam. Discharge from the dam flows down to Ipo Dam. From Ipo Dam, raw water is conveyed thru three tunnels to the Bicti interconnection structure, thence via five raw water aqueducts to La Mesa. The conveyance from Ipo Dam to La Mesa involves some 20 km of tunnel/conveyance pipes. At La Mesa, part of the raw water feeds directly to the La Mesa Treatment Plants and the rest goes to Balara or to the La Mesa Reservoir. The La Mesa Reservoir also receives inflow from Alat Dam as well as from its own catchment area.

The sourcing of groundwater from deep wells to either fully meet local demands or augment supply capacity is widespread across Metro Manila, with significant competition existing for the use of this resource.

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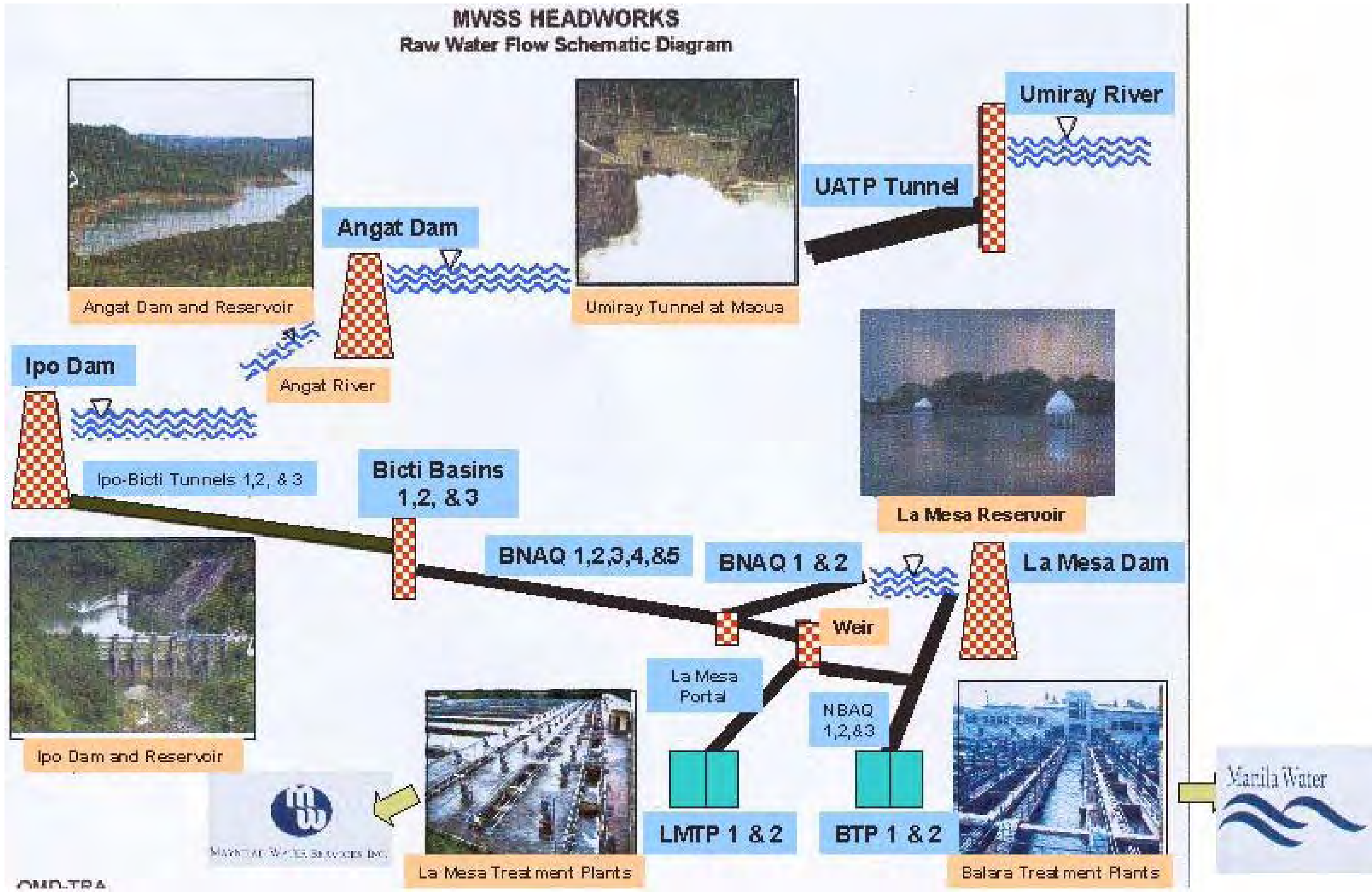

Figure 4.1 MWSS Headworks Raw Water Flow Schematic Diagram

Water Treatment
The West Concession has two water treatment plants, the La Mesa Treatment Plant 1 and La Mesa Treatment Plant 2, with a combined capacity of 2400 MLD, both located next to the La Mesa Dam and Reservoir. The East Concession has two water treatment plants, Balara Water Treatment Plants 1 and 2, with a combined capacity of 1600 MLD and located in Balara, Quezon City.

Water Distribution – West Zone
The West Zone distribution system was separated from the old MWSS system and generally covers the influence area of La Mesa Treatment Plants 1 and 2. The pipe network has a total length of about 2500 km, with sizes ranging from 3200 mm diameter to 50 mm. The primary distribution system, consisting of pipes 350 mm diameter and above, is about 220 km. The secondary distribution system, consisting of pipe diameters 200 mm to 300 mm, is approximately 290 km. The tertiary distribution system has pipes of up to 150 mm diameter, has a total length of around 2,000 km.

Within the distribution system there are eight large treated water reservoirs, ranging in storage capacity from 18.9 ML (5 million gallons) to 200 ML. The total storage capacity is 351 ML, representing less than 10% of average day demand. Security of supply is extremely limited under failure conditions.

Pipe materials range from asbestos cement pipes (ACP) to polyvinyl chloride (PVC), cast iron/ ductile iron pipes (CIP/DIP), and steel pipes. PVC accounts for about half of the tertiary distribution lines with a total length of about 1,000 km. It is noted that there are still over 450 km of ACP, mostly in the tertiary and secondary pipe network.

Water Distribution System - East Zone
The distribution network of the East Zone is generally the part of the MWSS network supplied by the Balara Water Treatment Plants 1 and 2. The total length of the pipes in the system is around 2,600 km. About 83.5 km of these have diameters of 750 mm and larger. It is estimated that 40% of the distribution system is served by gravity flow, while 60% requires pumping to maintain adequate pressure. Within the distribution system there are five major reservoirs and pump stations with a total storage capacity of 298 ML. This equates to approximately 20% of the average day demand and therefore offers limited security of supply under system failure conditions.

The pipe materials range from reinforced concrete to steel, cast iron (CI), polyvinyl chloride (PVC) and asbestos cement (ACP). PVC and ACP are mostly found in the secondary and tertiary network.

4.3 Water Supply Master Plan

4.3.1 Approach

The MWSS was solely responsible for future water sources planning and development before privatization in 1997. After privatization, it is currently unclear whether this responsibility was also delegated to the concessionaires, owing to the less than explicit provision on this issue in the concession agreement. This study has proceeded on the

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assumption that the future water sources options are not limited to those needing only short term repayment periods, and that an agreement can be forged between MWSS and the two concessionaires for the implementation of the best long term alternative water source.

4.3.2 Future Service Area and Levels of Service

The areas in the West Zone most in need of additional water supply are Valenzuela, Caloocan City, Cavite City, Parañaque, Muntinlupa, Las Piñas, Bacoor, Imus, Rosario, Kawit and Noveleta. Some areas of Parañaque, Las Piñas and the five towns in Cavite and Cavite City, are currently supplied from deepwells, which are showing increasing levels of chlorides, an indication of saltwater intrusion into the aquifers.

The main population and demand growth area in the East Zone will be in Antipolo City, Cainta, Taytay, San Mateo, Binangonan in the Province of Rizal. These areas currently rely mainly on ground water.

The concession agreement specifies a 24-hour water availability and 16-psi minimum pressure. The service coverage targets set forth in the Concession Agreement were revised in the 2003 Rate Rebasing for the East Zone, and soon after for the West zone.
The required minimum gauge pressure was also reduced from 16 psi (110 kPa) to 7 psi (48 kPa) for both the East and West concessions for the Rebasing period 2002 to 2007, but will revert back to 16 psi after 2007.

4.3.3 Potential Water Sources

For the purpose of this study, new water source options for Metro Manila have generally been divided into two categories – *interim* sources and *long-term* sources. The interim sources are those being considered for immediate implementation to gain additional source production capacity as quickly as possible. It was assumed that these sources have a high level of commitment already and are not subject to review.

The long-term source options on the other hand, are those sources that are available for inclusion in a development program to address the longer-term water needs of Metro Manila through to 2025 and beyond.

Interim Sources

Consultants are currently engaged (2005) by the MWSS to conduct a feasibility study and preliminary design for a 50 MLD Wawa Dam Project, with funding from the Asian Development Bank. In addition, a Treated Bulk Water Supply (possibly from Laguna de Bay) is currently being prepared by MWSS for tendering through a Build-Operate-Transfer (BOT) scheme.

Both MWCI and MWSI are also currently investing effort to explore opportunities to increase water source production levels in the interim period prior to the development of the next major water source for Manila.

MWCI have a range of water source options under review including:

- Laguna Lake infiltration wells (30 MLD)
- La Mesa watershed (10 MLD)
- Curayao wellfield (8 MLD)
- Nangka River (10 MLD)
- Rodriguez TP (100 MLD minimum)

The Rodriguez Water Treatment Plant, proposed for construction in the La Mesa area to service demands in municipality Rodriguez, represents the most significant opportunity to cut the short term deficit in source capacity. Selection of the plant capacity for this project will depend on the increased availability of raw water resulting from the AQ6 upgrade project and the split of this capacity between the concessionaires.

MWSI have commissioned a consultant to review opportunities to optimize production from the La Mesa water treatment plants. While the study is yet to be completed, early indications are that an additional 10-15% in capacity may be possible.

Long-term Source Options

The long-term sources are those that are available for inclusion in a development program to address the longer-term water needs of Metro Manila through to 2025 and beyond. These potential sources are centered on the Agos River basin and involve longer lead-time projects approaching a ten-year delivery timeframe. The identified sources are shown in **Figure 4.2** and include Laiban Dam, Agos Dam, Kaliwa Low Dam and Kanan No. 2 Dam. Combinations of these sources have been evaluated so as to provide the required 2,500 to 3,000 MLD by 2025 and additional water beyond 2025. A summary of the combinations is presented in **Table 4.2**. Importantly, while all options are capable of meeting the 2025 source capacity target (the primary concern identified for this study), the options are not equivalent in terms of the total yield, delivery pressure to the distribution network, current project status, level of flood protection offered, capacity for power generation, etc.

Table 4.2 - Water Source Combinations for Long-Term Water Supply

Option	Source Combination	Scheme Capacity (MLD)		
		Stage 1	Stage 2	Total
1	Laiban Dam + Kanan No.2 Dam	1,830	3,310	5,110
2	Kaliwa Low Dam + Agos Dam	(550)/0	3,000	3,000
3	Agos Dam (alone)	1,500	1,500	3,000
4	Laiban Dam + Agos Dam	1,830	1,500	3,330
5	Kaliwa Low Dam + Kanan No.2 Dam	(550)/290	3,310	3,600

Source – 2003 Study on Water Resources Development for Metro Manila (Nippon Koei and NJS)

It should be noted that while 5,210 MLD could be exploited from the Agos Dam source, there are economic benefits to be gained by allocating 2,000 MLD for hydropower generation. As a result the analysis for this option has been conducted on the basis that only 3,000 MLD will be allocated to water supply for Metro Manila.

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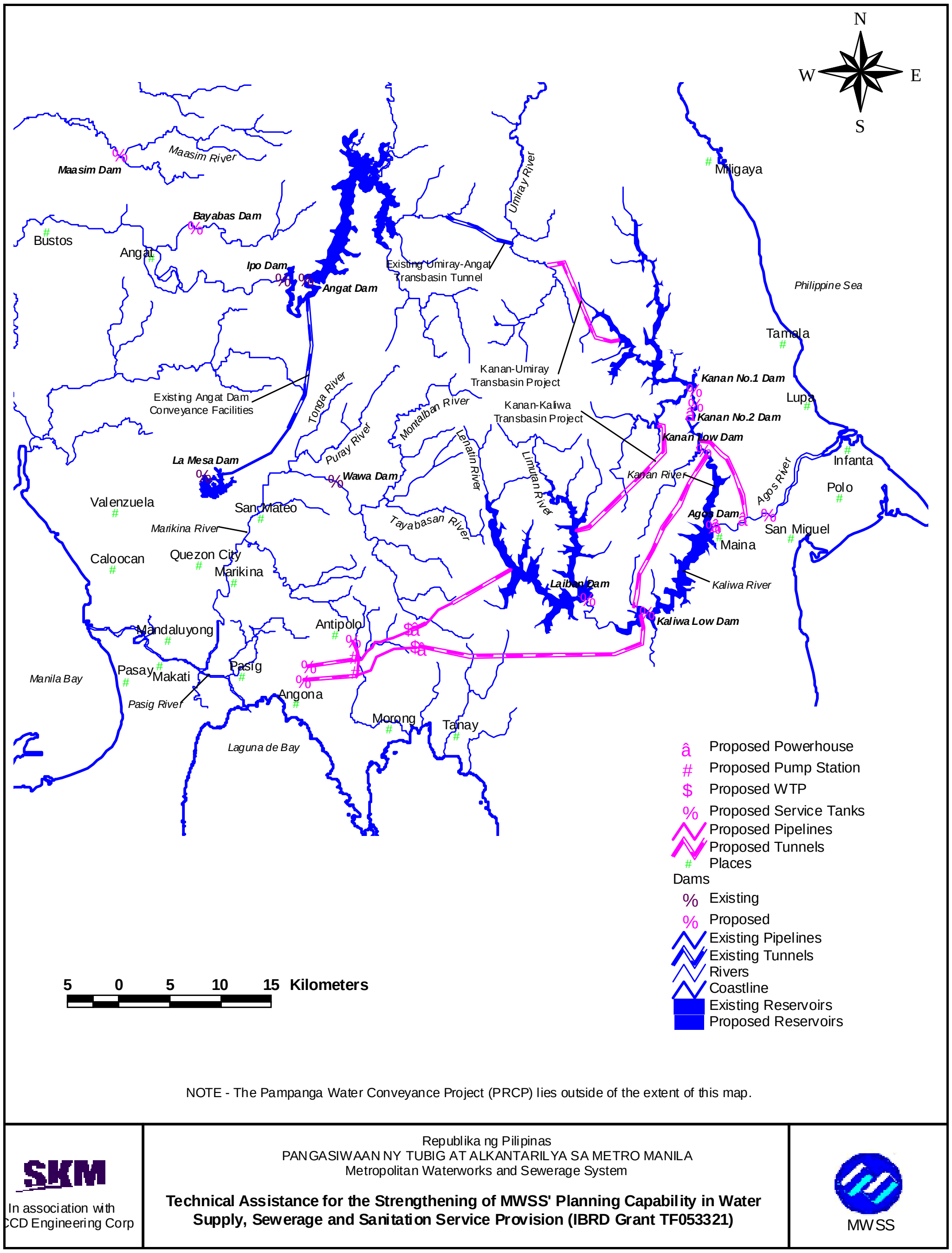

Figure 4.2 Potential Water Source Options

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4.3.4 Other Future Water Sources

A thorough investigation of all “conventional” water source options was made for the Metro Manila service area. The only other source options that remain to be explored, aside from reducing substantial NRW losses, are possibly reuse and desalination. Prospective desalination options would include Laguna Lake, brackish groundwater wells and seawater extracted from Manila Bay. Significant study will be required to fully explore the feasibility of these alternative water source options and address their fiscal, technical and environmental issues. Alternative sources would require tariffs in excess of PhP 30 per m^3 and were considered no further for this study.

4.3.5 Water Conservation and Re-Use

To solve the increasing supply-demand gap, an alternative approach focusing on the demand-side integrated with water conservation measures was studied. Water demand management is a management approach that aims to reduce or control water demand to conserve water. Some of the demand management approaches that can be adopted in Metro Manila are discussed below.

Water Pricing Reforms

Compared to other Asian cities in 2001, Manila has a relatively low water price but a high average per capita consumption, despite the shortage in supply. This suggests that a low water price undervalues water, leading to its excessive usage and misallocation.

The recommended strategy is to adopt an optimal water pricing policy to reflect the scarcity value of water and take account of the cost of production and distribution and the opportunity cost of water. The opportunity cost of water and the cost for its externalities can be recovered by: (i) bulk water pricing through raw water charges levied on the Concessionaires and taxation of effluents to firms in the MWSS service area; (ii) peak load pricing during low flow periods; and (iii) tariff restructuring.

Water-Efficient Plumbing Fixtures and Appliances

Some of the water-saving technologies that may minimize water use in the residential sector include dual flush or ultra low-flush toilets, low-flow showerheads, low-flow faucets and water efficient washing machines.

Dual/ultra flush toilets, low-flow showerheads and low-flow faucets all have payback periods of less than two years, making them cost effective and attractive to consumers. The payback period for water efficient washing machines is longer at 10 years, which may render them impractical for demand reduction until the period is shortened.

Public Education and Information

Any demand management activity should be integrated with an intensive public information program to ensure its success and sustainability. The information, education, and communication (IEC) program should raise awareness and encourage participation of the younger population, industrial and commercial customers, public sector, householders, etc. Key facilitators for the IEC may include the Water Conservation and Demand Management Committee, MWSS and the two Concessionaires, NGOs and community-based organizations, and community and religious leaders. It is noted that there exist a natural imbalance with asking those that derive revenue from the sale of water to reduce its consumption.

Water Audits

An option to achieve water use reduction, particularly in commercial buildings and large industries is the conduct of water audits, conducted by the concessionaires, that will identify all uses of MWSS and other water sources, leakages, and methods to eliminate these losses as well as identify water-efficiency and reuse options.

Legislation, Policies, and Regulation

There are already a number of existing laws and regulations that contain sections relevant to water conservation. These do not completely address key issues on water demand management. A national policy should, therefore, be formulated to support the implementation of the different strategies.

Rainwater Harvesting

Rainwater harvesting is being promoted in a number of countries for non-potable use and it is recommended that rainwater harvesting for MM, especially a simplified system which collects roof water and distributes it by gravity.

Recycling/ Reuse

The reuse of treated effluent, again for non-potable uses, is another way to reduce potable water demand. This can be a complex issue but the following simplified strategy is generally applicable:

- ***Short term.*** Reuse of treated water can be used for the cultivation of non-edible plants, e.g. for gardening, the watering of highway medium strips and parks, and golf courses to name a few.
- ***Medium term.*** As the recycle market is developed, industrial uses become more evident and more agricultural uses avail themselves. Establishment of recycled water return systems for toilets and other non-potable uses can expand recycled water demand.
- ***Long term.*** In the long term, recycled water quality will likely improve, thus expanding its reuse opportunities. To enhance the long term viability of the reuse of water, a recycled water management program is recommended.

Impact of Demand Management and Recycling Initiatives

The primary impact of demand management and recycling initiatives is a reduction in the per capita domestic water consumption. Currently, these have a minimal impact on water demand, but in the future it may be possible to effect a reduction of up to about 5 to 10% of the projected water demand by 2025 if effective programs are established. Potential demand management effects were, however, not factored into the master plan projections. To much uncertainty exists in the (i) the development of sewage treatment facilities to provide for recycled water; and (ii) the adoption by MWSS and the concessionaires of a water conservation and demand management policy with an accompanying public education program.

It is unlikely that significant reductions in per capita demand from demand management measures will occur until Laiban Dam is on-stream and water supplies are no longer constrained after 2015 when. Projected sewage treatment plant capacity will not be significant until after 2015, thus limiting the opportunities for recycling initiatives.

4.3.6 Evaluation of Long-Term Water Source Options

Project costs and benefits were evaluated for each of the alternative long-term water sources. Costs from previous reports were reviewed for each of the development options and escalated to a cost base of 2005 as shown in **Table 4.3**. In addition, unit costs were estimated for the source development options, taking into account the additional pumping cost to account for the 32.5 meters difference in elevation of the off-take points of the two basic schemes, (i.e. the Laiban Dam and the Agos Dam). These unit costs were computed assuming there will be no interim sources in the immediate future. Higher unit costs are expected if interim sources are developed because of reduced utilization of the more cost efficient long-term sources.

Table 4.3 - Cost Estimates for Water Source Combinations (at 2005)

Option	Source Combination	Capacity (MLD)	Estimated Project Cost (US $1000)	Ex-Plant Unit Cost (US $/m^3)
1	Laiban Dam + Kanan No.2 Dam	5,110	2,076,233	0.364
2	Kaliwa Low Dam + Agos Dam	3,000	1,740,872	0.393
3	Agos Dam (alone)	3,000	1,701,372	0.383
4	Laiban Dam + Agos Dam	3,330	1,913,387	0.372
5	Kaliwa Low Dam + Kanan No.2 Dam	3,600	1,676,882	0.396

Source: 2003 Study on Water Resources Development for Metro Manila (Nippon Koei and NJS) escalated to 2005 prices (4.7% per annum for local costs, 2.2% per annum for foreign costs)

The cost analysis shows that within the accuracy of the estimates there is negligible difference between the options, in terms of unit cost of water. Moreover, the lower cost projects are typically associated with lower total yields. These projects would need to be accompanied by further source development (at additional cost) to provide the same level of production as other options into the longer term future. Cost should therefore not be the sole criteria by which to evaluate source options.

The estimated project timeline for each development option is summarized at **Table 4.4**, based primarily on data from the 2003 Water Resources Master Plan updated to account for the projected water demand of this study. Timings listed will be highly dependent on the actual time required to resolve resettlement issues and secure environmental approvals. It is strongly recommended that these aspects be acted upon as soon as possible for the recommended development option.

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Table 4.4 - Project Timing for Source Development Options

Option	Source Combination	Stage 1		Stage 2	
		Duration* (yrs)	Commission Date	Duration* (yrs)	Commission Date
1	Laiban Dam + Kanan No.2 Dam	9	2015	15	2021
2	Kaliwa Low Dam + Agos Dam**	11	2017	11	2017
3	Agos Dam (alone)	11	2017	13	2019
4	Laiban Dam + Agos Dam	9	2015	15	2021
5	Kaliwa Low Dam + Kanan No.2 Dam***	11	2017	11	2017

*Duration refers to the number of years elapsed from 2005.

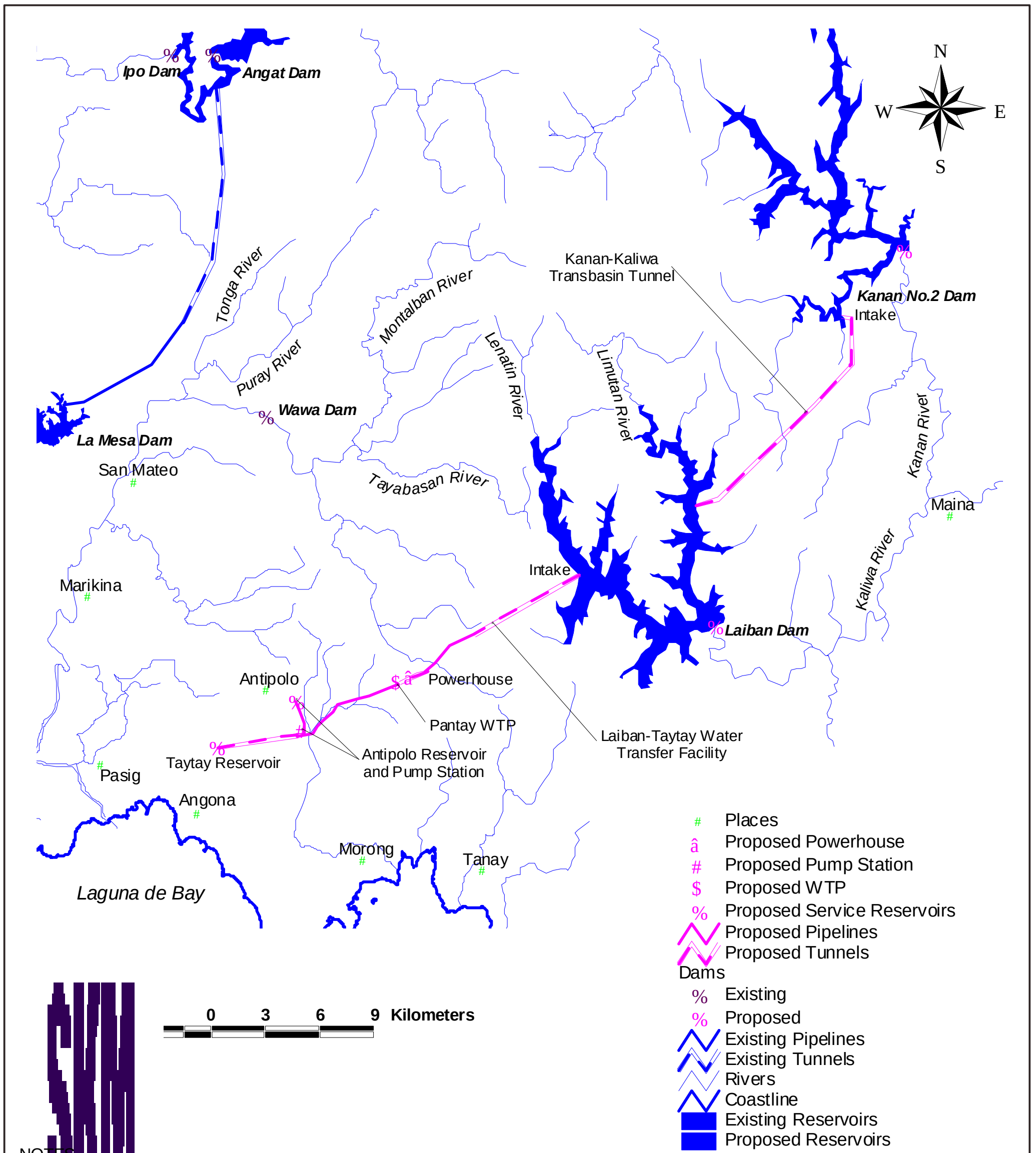
Based on the analysis, the recommended option for implementation is **Option 1 – Laiban Dam + Kanan No. 2 Dam**, based on the following rationale:

- It achieves the greatest level of long-term water resource utilization for municipal water supply purposes.
- It can be progressed as a priority with a higher level of confidence than other options, since the Laiban Dam project has already been developed through to detailed design status.
- It provides the greatest benefit towards MWSS demand in the shortest period of time.
- Previous investment on the diversion tunnel and resettlement payments for the Laiban Dam project will be utilized rather than wasted.
- It is likely to offer the least-cost approach to source development if the longer-term (beyond 2025 horizon) is taken into consideration, as other options still require investment on 1,500 to 2,000 MLD of source development to match the 5,110 MLD capacity delivered by Option 1.

The proposed Laiban/Kanan No. 2 development is shown on **Figure 4.3.** The 5,000 MLD total yield of the combined scheme will be sufficient to meet the projected water demand of Metro Manila beyond 2025, potentially up to year 2032.

As a significant lead-time is involved before the Laiban Dam can be brought on-line for Metro Manila supply, it is recommended that this strategy be endorsed forthwith and that progress be made to update designs and tender documentation as a matter of priority.

A graph of projected demand and supply is shown in **Figure 4.4** based on implementation of the Laiban/Kanan No. 2 development.



NOTES:
1. Stage 1 - Laiban Dam, Pantay WTP, Service Reservoirs plus single lane of Laiban-Taytay Transfer Facilities.
2. Stage 2 - Kanan No.2 Dam, Kanan-Kaliwa Transbasin Tunnel plus second lane of Laiban-Taytay Transfer Facilities.

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PANGASIWAAN NY TUBIG AT ALKANTARILYA SA METRO MANILA
Metropolitan Waterworks and Sewerage System

Technical Assistance for the Strengthening of MWSS' Planning Capability in Water Supply, Sewerage and Sanitation Service Provision (IBRD Grant TF053321)

MWSS

Figure 4.3 Option 1 - Laiban Dam + Kanan No. 2

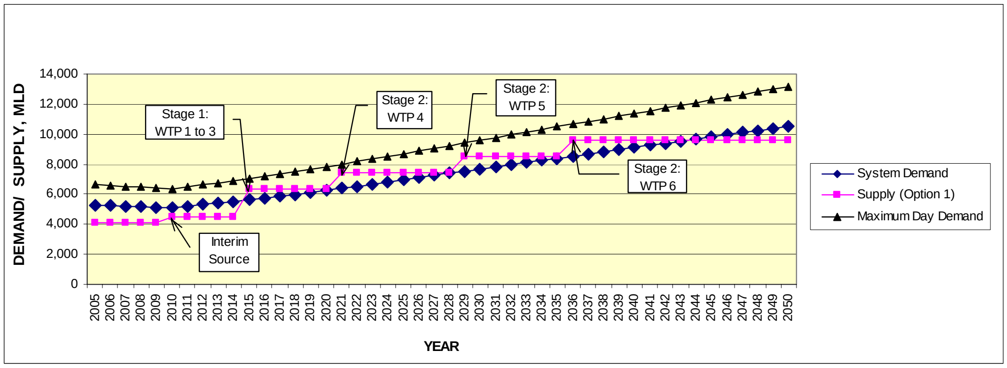


Figure 4.4 Projected Demand and Supply Curve for Laiban/Kanan No.2 Development

4.3.7 Water Supply Development Plan to 2025

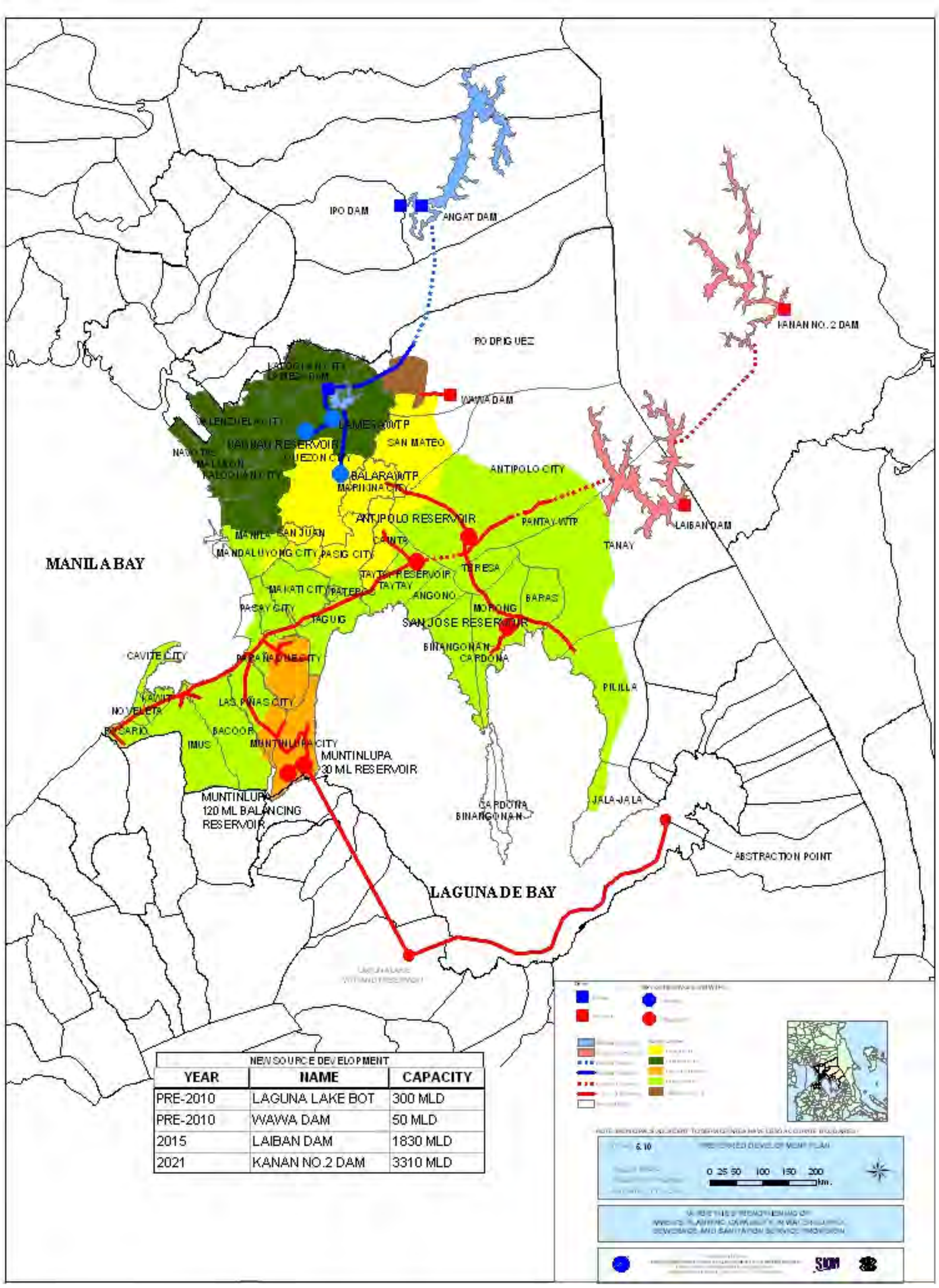
Figure 4.5 indicates the preferred development plan for expansion of the MWSS service area headworks, including raw water conveyance, water treatment plant, treated water conveyance and storage. Major trunk and primary mains to the off-take points of the two concessions are also shown.

Water Sources (Headworks)

The preferred scheme, the Laiban Dam + Kanan No. 2, is a two-stage development. Stage 1 involves the construction of Laiban Dam on the Kaliwa River and the second stage is the Kanan No. 2 Dam with a transbasin tunnel conveying water from the Kanan watershed to the Kaliwa reservoir (Laiban Dam).

The principal headworks features of Stage 1, Laiban Dam, include (i) a 113-m high concrete faced rockfill dam with 650-m crest length; (ii) raw water intake works and headrace comprising a three-level intake structure, two tunnels of 3.2-m and 2.7-m diameter with a total length of 9.3 km and a 3.2 m diameter, 4-km long pipeline connecting the tunnels; (iii) a 30-MW hydropower plant; and (iv) a treated waterway comprising a 5-km long 3.2-m diameter pipeline and a 4.9-km long 3.6-m diameter tunnel. The overall capacity of the Stage 1 conveyance facilities is 2,214 MLD.

The key headworks features of Stage 2, Kanan No.2 Dam, include (i) a 170-m high concrete faced rockfill dam with 700-m crest length; (ii) raw water intake works and a 3.7-m diameter, 14.5-km long tunnel (iii) an additional three-level intake structure at Laiban Dam; (iii) duplication of outlet works from Laiban Dam comprising two additional 4-m diameter tunnels 9.3 km long and a 4.21-m diameter pipeline 4 km long to connect the tunnels; (iv) upgrade of the Hydropower Plant to 54 MW capacity; and (v) augmentation of the treated waterway comprising a 4.21-m diameter pipeline, 5 km long and a 4.73-m diameter tunnel, 4.9 km long. The overall capacity of the Stage 2 conveyance facilities is 4,005 MLD.



NEW SOURCE DEVELOPMENT		
YEAR	NAME	CAPACITY
PRE-2010	LAGUNA LAKE BOT	300 MLD
PRE-2010	WAWA DAM	50 MLD
2015	LAIBAN DAM	1830 MLD
2021	KANAN NO.2 DAM	3310 MLD

Figure 4.5 Preferred Water Supply Development Plan

Water Treatment Facilities

A water treatment plant, with Stage 1 capacity of 2,400 MLD, will be developed in a single phase to meet the estimated water demand by 2015. The treatment plant will be located at a 32-ha site near barrio Pantay, about 30 km east of Manila. The base design treatment processes include screening, chemical coagulation, rapid mixing, flocculation, horizontal flow sedimentation, filtration, chlorination, fluoridation, and ph correction.

The expansion of the Pantay WTP to accommodate the integration of Kanan No. 2 Dam requires further review and progress on land acquisition to ensure feasibility of this key project. Process selection is consistent with Stage 1 treatment works.

Water Distribution Facilities

The Phase 1 water distribution works shall consist of (i) Taytay, Antipolo and San Jose reservoirs with capacities of 120 ML, 20 ML, and 15 ML respectively; (ii) Antipolo Pumping Station with a capacity 100 MLD; (iii) Taytay Pressure Control Station; (iv) 4 km of 2800-mm diameter trunk main, 3 km of 2500-mm diameter trunk main, and 2 km of 1500-mm trunk main to supply the East Zone including Cainta, Antipolo and other towns of Rizal; and (v) 14.5 km of 2800-mm diameter trunk main to supply the West Zone, including Cavite City and the towns of Noveleta, Imus, Bacoor, Kawit, and Rosario.

4.3.8 Staged Development Plan

The staged development of the MWSS system is described in five-year increments through to the horizon of the Master Plan period (2025).

2005-2010
During this period, it is assumed that interim water source proposals at Wawa Dam and Laguna Lake (300 MLD BOT) will be completed. The Laguna Lake BOT development will service all or part of Muntinlupa, Parañaque City, Las Piñas City and Bacoor as shown in **Figure 4.6**. A separate supply enclave is to be created for this source, which will extend into the existing Villamor Pumping Station zone, thereby reducing pumping requirements. As demand from these municipalities is shifted to the Laguna Lake supply, displaced supply from La Mesa WTP will be re-directed further south through to the areas of Cavite.

The Wawa Dam supply will service areas of municipality Rodriguez only, as demand in this municipality is expected to exceed the limited capacity (50 MLD) of the proposed development.

With reductions in NRW levels, it is expected that expansion of the primary distribution will also take place during this period to service additional consumers within the concession areas particularly to the east through the San Mateo and Antipolo City municipalities. Additional groundwater development in fringe areas outside of the current supply zone will also support service growth.

During this period, all existing deep well groundwater supplies operated by MWCI and MWSI are assumed to be continued to augment the main surface water supplies from the Angat-Umiray system and the new Wawa Dam and Laguna Lake BOT. These wells can be used to provide much needed peaking capacity during summer periods if operation year round will lead to water quality issues.

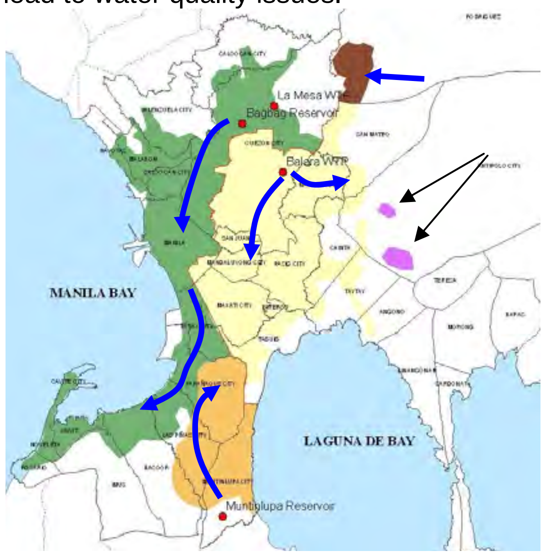


Figure 4.6 Staged Development Plan, 2005-2010

2011-2015

The key development will be Laiban Dam, with associated bulk water conveyance and water treatment infrastructure. Significant investment in primary distribution mains will form part of the development plan to link new supply capacity to expansion areas and to improve levels of service in existing zones. Shown in **Figure 4.7** is the staged development plan for 2011-2015. The Laiban Dam supply via Taytay Reservoir will take control of supply along the south-west coastal corridor of the service area from Manila to Cavite City, freeing capacity at La Mesa WTP to improve supply to the north-western parts of the MWSS service area, namely the municipalities of Malabon and Navotas, Valenzuela City, and northwards to Caloocan City.

Supply from the Balara WTP will also be extended further eastwards into San Mateo, Antipolo City (lower elevation areas) and through to Rodriguez. The existing Balara supply zone will retract from Makati City and areas in Taguig, Taytay, Cainta and Angono, to create the necessary surplus capacity for re-direction to these new areas.

A new supply corridor via the proposed San Jose Reservoir (supplied from Laiban Dam) will be created through municipalities of Teresa, Morong, and Baras. The new Antipolo Reservoir will service only the higher elevation areas of Antipolo City (in order to minimize pumping costs).

Again, existing groundwater assets may continue to be operated to provide needed peaking capacity in localized areas.

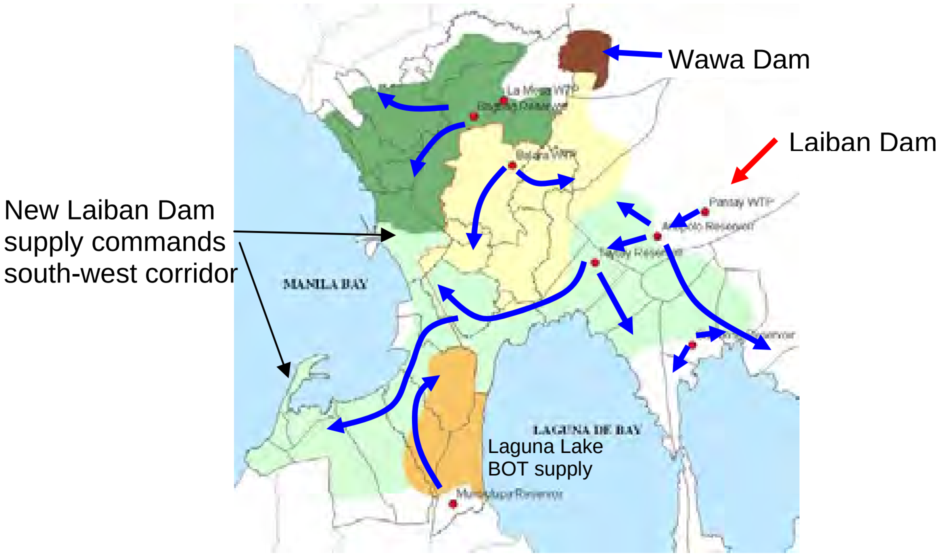


Figure 4.7 Staged Development Plan, 2011-2015

2016-2020

The focus of the development during this period is the expansion of the primary distribution network to take advantage of gains made in water availability from NRW reduction activities. No new water sources are proposed for this period, other than localized deep well groundwater augmentation, unless the concessionaires make progress with other interim source options as presented in **Figure 4.8**.

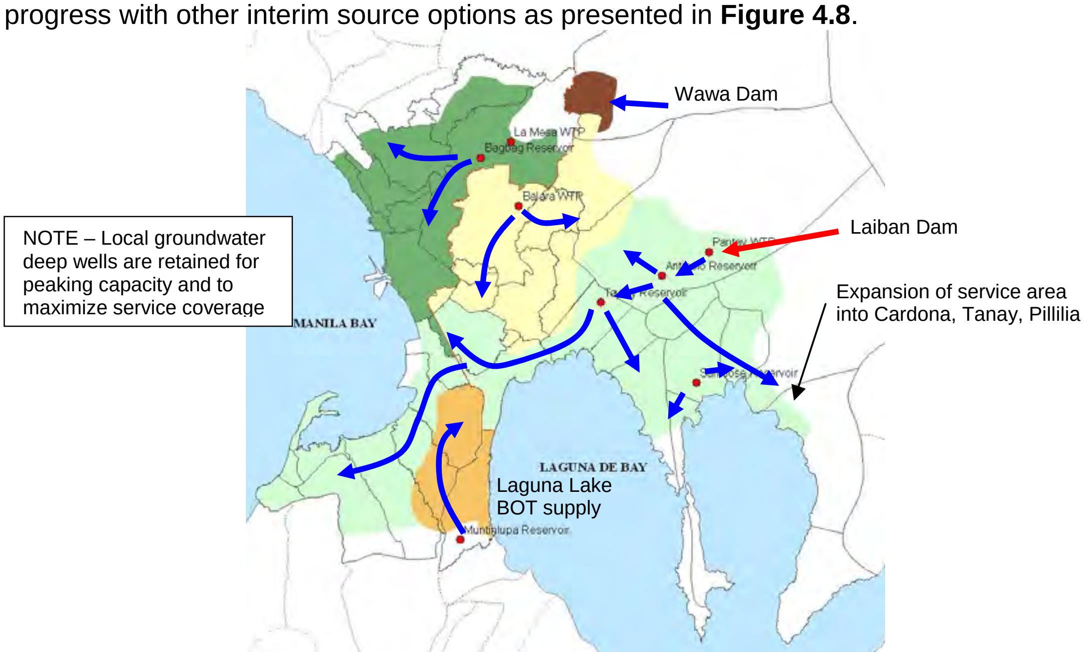


Figure 4.8 Staged Development Plan, 2016-2020

The extension of Laiban supply to municipalities Cardona, Tanay, and Pililla is made possible if NRW Reduction Programs have been successful. Municipalities in Rizal along the eastern border of the service area such as San Mateo, Rodriguez and Antipolo City will also benefit from further service coverage.

It is noted that peaking capacity in the scheme will be limited during this period. Current projects examining capacity optimization on the Angat-Umiray system will be beneficial to address this issue. It is not considered appropriate to advance construction of the next major water source (Kanan River) as the solution to peaking capacity shortfalls, since this strategy is not considered affordable.

2021-2025

Figure 4.9 presents the staged development plan for 2021 to 2025. To meet growing demand levels and facilitate the further expansion of the service area, Kanan No.2 Dam is scheduled for completion in 2021. This will include all associated water conveyance and treatment infrastructure. The total capacity of the Kaliwa-Kanan System will be in excess of 3000 MLD, totally relieving the constraint on supply, which in turn will permit the de-commissioning of local groundwater assets.

With the integration of the new source, the full extent of the MWSI service area will experience water supply coverage. The service coverage of MWCI will continue to expand into the eastern municipalities of its allocated service area and extend southwards to Jala-Jala.

By 2025, the projections for this study assume that NRW Reduction Programs will have achieved a target level of 30%. Maintenance of this target will however require ongoing upgrades to the system as part of the post-rehabilitation program discussed in later sections of this report.

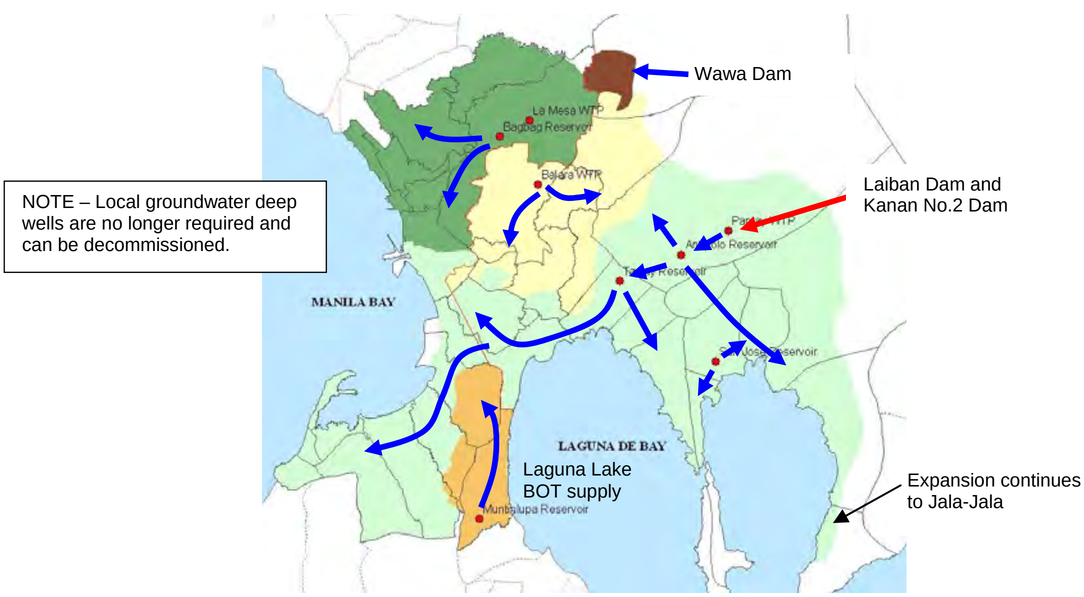


Figure 4.9 Staged Development Plan, 2021-2025

4.3.9 Capital Works Program

Master Plan Study

The summary of the implementation schedule and capital expenditures program is presented in **Table 4.5**. Allowing for a one-year tendering period, the earliest start for Stage 1 works is 2007 and Phase 1 of Stage 1 will be completed by 2014. The trunk and primary mains included in this program is only up to the off-take points of the two concessions and does not include additional primary and reinforcing water mains required in their respective distribution systems.

Stage 2 works are scheduled to be commissioned around 2021. Earlier development of these works is not recommended as affordability of the supply will become an issue.

The system rehabilitation and non revenue water (NRW) capital expenditure program is mainly based on the current and planned programs of the Concessionaires. Furthermore, the higher pressure of the supply from Laiban will require the replacement of additional old and substandard water mains beyond what is needed and currently planned, given the prevailing low pressures. Failure to replace or repair these lines and tighten the distribution system will most likely result in an abrupt increase in NRW after the commissioning of the Laiban source.

4.3.10 Operation and Maintenance Plan

Water Source Operations

Dam operation and control can either be placed under MWSS or the Common Facilities Group. Intimately associated with dam operations is the management and protection of the watershed, which must be viewed from a very long-term perspective extending beyond the concession period. This consideration alone points to MWSS as the most logical entity principally responsible for both dam operations and watershed management.

Water Treatment and Distribution Operations

The Stage 1- Pantay Water Treatment Plant will have a capacity of 2400 MLD corresponding to maximum day demand or 1.25 times the average day yield from the Kaliwa River Basin (Laiban Dam). Since the two concessionaires will share the production from the treatment plant, operation of the Water Treatment Plant in Pantay as well as the Treated Water Reservoir and the Pressure Control Station both located in Taytay is best placed under the Common Purpose Facilities Group.

The Concessionaires, on the other hand, may be in the best position to separately operate and maintain the trunk and primary distribution mains coming out of the Taytay Reservoir to deliver water to strategic points of their concessions, including the 1500-mm pipeline and pumping station drawing directly from pipeline no.2 (upstream of the Taytay Reservoir).

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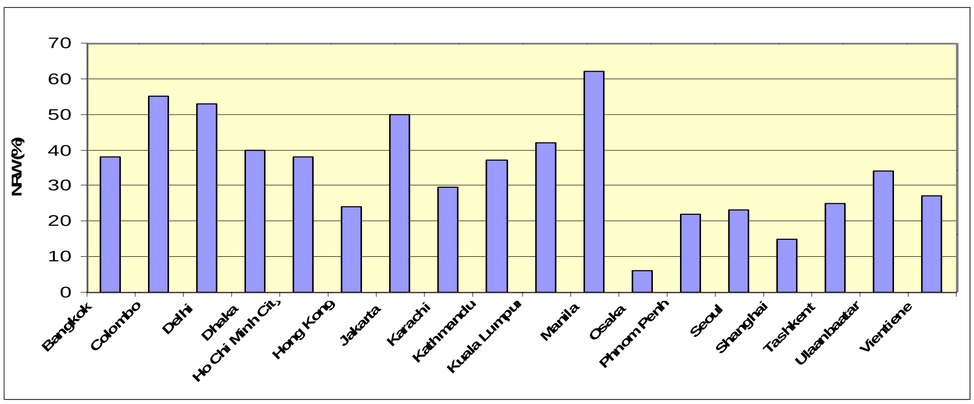
Table 4.5 - Implementation Schedule and Cost Summary

STAGE	ACTIVITY	IMPLEMENTATION PERIOD	COST @ 2005 PRICES US$'000
1	Laiban Dam with Laiban-Taytay 1st Waterway		
	Land Acquisition and Resettlement	2007 - 2009	115,427
	Local Component in US$		115,427
	Laiban Dam	2010 - 2014	201,227
	Local Component in US$		85,009
	Foreign Component		116,218
	1st Waterway	2010 - 2014	455,535
	Local Component in US$		145,695
	Foreign Component		309,840
	Pantay Water Treatment Plant #1 & 2	2010 - 2014	192,552
	Local Component in US$		41,448
	Foreign Component		151,104
	Pantay Water Treatment Plant #3	2014 - 2016	83,129
	Local Component in US$		17,894
	Foreign Component		65,235
	Sub-total		**1,047,870**
	Trunk and Primary Distribution Mains		
	Phase 1	2012 - 2014	193,724
	Local Component in US$		99,023
	Foreign Component		94,701
	Phase 2	2014 - 2015	67,141
	Local Component in US$		34,260
	Foreign Component		32,881
	Phase 3	2015 - 2016	35,940
	Local Component in US$		20,160
	Foreign Component		15,780
	Sub - total, trunk and primary mains		**296,805**
	Total Cost, Stage 1		**1,344,675**
	Local Component in US$		558,916
	Foreign Component		785,759
2	Kanan No. 2 with Laiban - Taytay 2nd Waterway		
	Land Acquisition and Resettlement	2013 - 2016	66,211
	Local Component in US$		66,211
	Access Road via Laiban Damsite	2014 - 2015	52,577
	Local Component in US$		22,211
	Foreign Component		30,366
	Kanan Dam	2016 - 2020	256,700
	Local Component in US$		108,444
	Foreign Component		148,256
	Kanan No. 2 - Laiban Interbasin Tunnel	2016 - 2020	170,626
	Local Component in US$		54,572
	Foreign Component		116,054
	2nd Waterway	2016 - 2020	656,944
	Local Component in US$		210,112
	Foreign Component		446,832
	Water Treatment Plant # 4	2018 - 2020	194,078
	Local Component in US$		41,776
	Foreign Component		152,302
	Water Treatment Plant # 5	2026 - 2028	150,532
	Local Component in US$		32,403
	Foreign Component		118,129
	Water Treatment Plant # 6	2033 - 2035	150,532
	Local Component in US$		32,403
	Foreign Component		118,129
	Total Cost, Stage 2		**1,698,200**
	Local Component in US$		568,132
	Foreign Component		1,130,068
	Total Cost of Stage 1 and Stage 2		**3,042,875**
	Local Component in US$		1,127,048
	Foreign Component		1,915,827
	Pipe Replacement and NRW Reduction Progra	2006 - 2022	**1,306,400**
	Grand Total		**4,349,275**
	Local Component in US$		2,433,448
	Foreign Component		1,915,827

System Rehabilitation and NRW Reduction

The size of the required new water source development is dependent on reducing physical losses in the system from a current 52% to 26% in 2025. Without this reduction significantly more water than 2,500 to 3,000 MLD will be required in 2025 to meet the system demand. The consequence will be significant additional cost or a continued water shortage.

Reduction in water losses (or non revenue water) is the responsibility of the concessionaires. The Non Revenue Water level in 1997 at the time of turn over from MWSS was 66% in the West Concession area and 59% in the East Concession Area. Nevertheless, by 2001 the extent of non revenue water in Metro Manila was still the highest of major cities in Asia (see **Figure 4.10).** By 2004, the NRW in the West was 69% and in the East 47.5% or 60% for the entire MWSS service area. (The East Zone NRW is now estimated to be reduced to 37% as of June 2005). This means that if non-revenue water could be reduced to an acceptable level of 30% by 2025, this would be equivalent to developing a new water source with a capacity of about 1400 MLD.



Source: Asian Water Supplies, Reaching the Urban Poor, by Arthur C. McIntosh

Figure 4.10 NRW in Asian Cities (2001)

The need to reduce NRW and rehabilitate the pipe network gains added urgency when a new major source is to be introduced into the existing distribution system for the following reasons:

- In a system with physical losses at 50%, one needs to produce 2 MLD for every 1 MLD actual demand. This entails huge additional treatment and delivery costs on top of the incremental development cost to provide the higher capacity required of the new sources.

- The introduction of the Laiban supply will add about 50% more water into the distribution network and will result in higher pressures not only because of the improved demand and supply balance but also by the fact that the new supply will be entering the system at a hydraulic grade 34.5 m (about 50 psi) higher than the present Angat-Ipo-La Mesa supply.

- Particular attention should be focused on older portions of the distribution network that have been operating at very low pressures for a long period of time prior to the commissioning of the new water source. Subjecting this part of the pipe network to a sudden and big incremental increase in pressure will result in several new breakages and increased discharges from old leaks.

In reducing non revenue water, while the ultimate aim is to reduce the losses for the whole system, the best returns are realized by first addressing the areas with the highest level of losses, both physical and non-physical. A logical first step is a NRW survey of the system to identify the areas with very high NRW. This is done by dividing the network into zones and the NRW for each zone is determined. The NRW is then addressed in a systematic manner, concentrating initially on areas with high NRW. However, physical losses saved in a given zone will be converted to actual revenue only when it is channeled to new paying customers or when it can be sent to areas with suppressed demand because of low pressures or unavailability of water on a 24 hour basis.

It is important also to understand that once the NRW has been brought down to a desired level, an active monitoring of the district meters and a distribution system maintenance program is necessary to maintain NRW levels. A Zone Manager or caretaker should be given charge of the rehabilitated zone or district metering area, taking responsibility for the overall performance of the zone with emphasis on revenues and customer care.

By adopting these procedures, it is estimated that non revenue water (non-physical and physical) can be reduced to 30% by 2025 in both concession areas as shown in **Figure 4.11**.

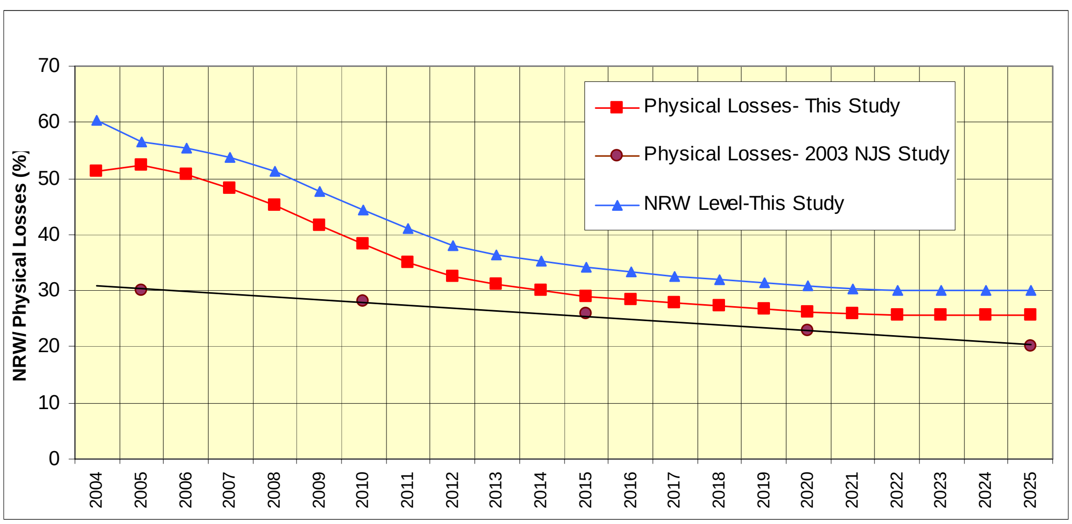


Figure 4.11 Projected NRW for MWSS Service Area

The estimated billed volume from NRW reduction during the period 2004 to 2025 is 1,445 MLD for the MWSS Service Area comprising 396 MLD and 1,132 MLD for the East and West Zones respectively.

Based on the estimated cost of NRW reduction programs being planned by the concessionaires and the expected revenue from the additional billed volume recovered, payback period have been estimated at 12 and 13 years for MWCI and MWSI, respectively as shown in **Figures 4.12** and **4.13**.

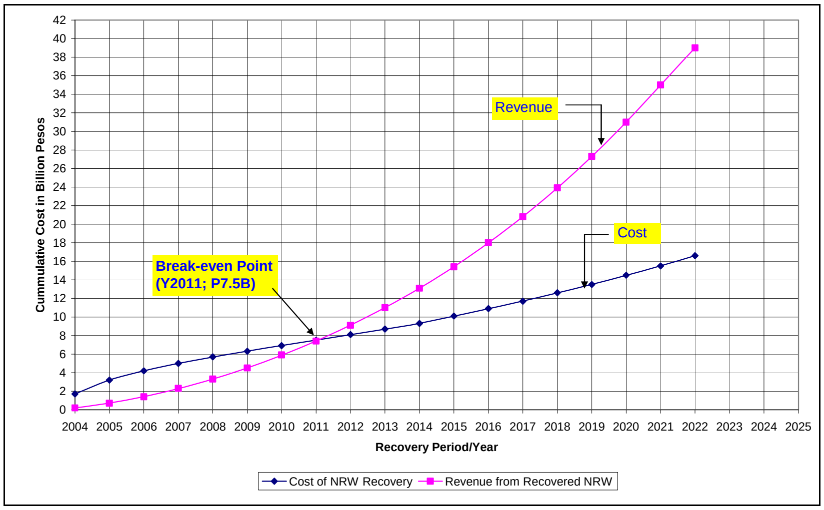


Figure 4.12 Estimated Cost and Revenue from Recovered NRW, East Zone

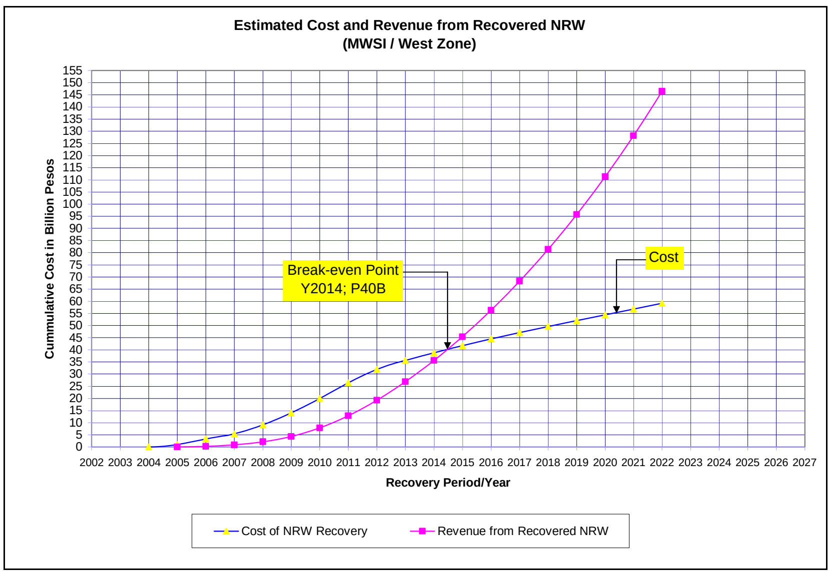


Figure 4.13 Estimated Cost and Revenue from Recovered NRW, West Zone

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4.3.11 Water Supply Master Plan Implementation

Project Implementation Schemes

Traditionally, major water supply development projects in the MWSS were funded by borrowings from international and local banking institutions and the debt servicing requirements taken out of MWSS revenues. Concessionary loans from international financing institutions were easily accessed because of the sovereign guarantee normally provided by the Philippine Government. The privatization of MWSS operations transferred the MWSS income base to the concessionaires and current Philippine Government policy does not encourage government corporations seeking sovereign guarantees for loans.

A number of design, finance and build BOT proposals have been received by MWSS and clearly this is an option that should be given serious consideration as an alternative to direct borrowing by MWSS.

Project Proponent Options

The long-term nature of major water supply projects, the limited term of the concession, and MWSS being the ultimate owners of the utility and its assets suggest that the lead role in the water source developments outlined in Section 6.5.5, should be assumed by MWSS. This will ensure that consumers of Metro Manila are not disadvantaged by short-term expedient decisions.

Two options could be considered:

Option 1: MWSS as Main Proponent: The MWSS is the borrower of record in the case of a loan with a take or pay agreement established with the two concessionaires to buy water. If a BOT scheme is adopted, a similar take or pay agreement will be required with MWSS on selling, to the concessionaires, water which is bought from the BOT operators.

Option 2: The Concessionaires Enter into a Joint Venture: The concessionaires may enter into a joint venture to develop and undertake the construction and supply project. MWSS participation will principally be in the resettlement of settlers affected by the project and the acquisition of rights-of-way for conveyance and treatment facilities.

Project Implementation Issues

- *Land and ROW Acquisition*

As recommended in past reports, a strong preference exists for the MWSS to take a lead role in the acquisition of land and ROWs for proposed water supply assets, to limit the extent of private sector involvement in this sensitive area.

- *Securing Environmental Approvals*

An Environmental Compliance Certificate (ECC) will be required as the final approving document for the proposed projects, given that these developments will occur within a national park.

- *Resolving Resettlement Plans*

The Laiban Dam and Kanan No. 2 Dam had its resettlement program already in progress since the early 1980's up to around 1996. This activity was authorized under Memorandum Circular No. 725 issued by the Office of the President on May 19, 1981, creating an Inter-Agency Committee for the relocation of families affected by the Laiban Dam Project. In 1986, Presidential Proclamation No. 2480 was issued reserving a relocation site of 4,424 hectares in San Isidro Valley in Antipolo, Rizal.

While the latest survey commissioned by MWSS in 2001 showed that majority of the respondents agreed to the choice of relocation site (San Ysiro), the area appeared not to be attractive to prospective relocatees for a combination of reasons. It was recommended that MWSS ensure availability of funds to effect improvements to the site to make San Ysiro an attractive place for the Laiban families. This will include the provision of facilities for roads, transportation, electricity, water supply, health, education and livelihood opportunities.

- *MWSS Resources for Project Implementation*

Significant MWSS resources will be required to manage and support the implementation of a major water source development program. Some of the activities involved include:

a. Project management responsibilities;
b. Assistance in acquiring land and rights-of-way for project structures;
c. Leadership and coordination of resettlement programs for families living in proposed reservoir areas; and,
d. Addressing the long-term financial issues, which will include debt-servicing costs, commitments to both supply and purchase water; cost pass through and ultimate tariff impacts.

5. Sewerage and Sanitation Master Plan to 2025

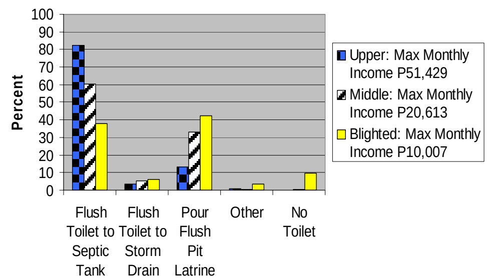
5.1 Present Situation

5.1.1 Sewerage

The sewerage system in Metro Manila currently covers only about 15 % of the population and 12 % of the area. The remaining 85 % of the population is served by on-site sanitation, primarily septic tanks or pit latrines, or not at all.

Income level usually dictates what each family has for the management of their personal wastes. The willingness-to-pay survey conducted as part of this study provided the following breakdown of sewerage and sanitation facilities at the household level:

Connected directly to sewerage system	5%
Septic tank connected to sewerage system	6%
Septic tank discharging directly to drain	60%
Toilet discharging directly to drain/canal/creek	8%
Pit latrines	15%
No toilet	5%



At the time of privatization, the existing sewerage systems comprised only the four shown in **Table 5.1**:

Table 5.1 – Existing Sewerage Systems in Metro Manila

System	City / Municipality	Service Area (ha)	Details
Central System	Manila City	2,620	325 km of sewer and 7 lift stations with no treatment beyond screening and an outfall to Manila Bay. Latest renovation occurred in 2005. Only secured 730 out of proposed 10,000 new connections under MSSP 4.
Ayala System	Makati City	600	40 MLD STP is in SW Magallanes Village and services 120,000 people.
Dagat-Dagatan System	Caloocan, Malabon, Navotas Manila	333	Covers reclaimed land with 67 km of sewers. Uses 5 ha of lagoons for treatment; converted by 2005 to accept 300 m^3 / d of septage, the first SpTP. Upgraded under MSSP.
Separate Systems	Quezon City, Karangalan Village (Pasig/Canta), Filinvest Alabang in Muntinlupa	1000	There are a variety of sewerage systems, serving residential & commercial developments.
Total		**4,553**	

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5.1.2 Sanitation

There are an estimated 2.2 million septic tanks in Metro Manila comprising 84% of the households (NSO 2000); most do not have appropriate leaching fields and overflow into the storm drains. Mostly, the septic tanks are almost never desludged, thus rendering them ineffective. Storm drains in Metro Manila are, in practice, a combined sewer whose termini are adjacent rivers and esteros that eventually drain into either Manila Bay or Laguna de Bay. There are in addition communal septic tanks in Quezon City, a number of communal septic tanks that service NHA developments in the West and East Zones, as well as other communal septic tanks operated by other government agencies.

It was estimated (James Montgomery 1991) that 26 % of existing septic tanks in Metro Manila are inaccessible due to being located under buildings and roadways, the absence of manholes, and access roads that are too narrow for tankers. In the willingness-to-pay survey conducted as part of this study, only 32% of respondents could recall having had their septic tank emptied.

Limited septic tank desludging services are currently available. The World Bank funded Manila Second Sewerage Project (MSSP) originally had the provision for ocean dumping of septage until septage treatment plants could be established. This was eventually discontinued. Dagat-Dagatan has recently been rehabilitated (2005) for treating up to 300 m^3/d of septage (including trucks) for MWSI. Prior to completion of the septage treatment plant at Dagat-Dagatan, MWSI continued its collection, treatment, and disposal of septage using Mobile Dewatering Units (MDU). Private contractors transported the dewatered sludge to lahar areas in Pampanga and Tarlac.

MWCI currently collects between 80 and 150 m^3 / d of septage and discharges it to an Imhoff tank in Phil-Am Village, Quezon City. Private haulers subsequently transport to lahar areas in Pampanga and Tarlac. This practice will soon cease due to the cost of transport, in particular the cost of fuel and road tolls. Three new SpTPs (plus trucks) will be constructed for MWCI in 2006 / 2007 at Antipolo (600 m^3/d), the South Septage Treatment Plant at Taguig (814 m^3/d septage and 2 MLD of sewage) and the North Septage Treatment Plant at San Mateo (586 m^3/d).

5.1.3 Drainage

The topography of much of the Metro Manila area is generally flat and stormwater drains slowly during rainfall. Stormwater, septic tank overflow and sewage gravitates through the drains toward the esteros and rivers. The esteros resemble open canals with variable cross-sections, frequently clogged with silt, sediments, solid waste and water hyacinths. Informal settlers often build over or into the esteros. In many instances, inadequate or clogged drainage facilities aggravate flooding problems, particularly in the low-lying and low-income areas. All drains are owned and maintained by the LGUs. This study has delineated thirty-one drainage catchments in Metro Manila.

5.1.4 Willingness to Pay for Dirty Water (Sewage) Management

Only 5 % of respondents in the Willingness-to-Pay Survey reported that they did not have a toilet in their house, but almost 80 % of these expressed a wish to have their own toilet facility and 60% were willing to pay. About 90 % of respondents were aware that improperly disposed of sewage can be responsible for variety of diseases in the community as well as contribute to the pollution of river systems, groundwater and waterways. They also identified the need to improve and maintain drainage systems and to prevent waste from entering the drains as the highest priorities for improving the waste disposal system. About 70 % of respondents were willing to pay on average 20% of their water bill for improvement in their wastewater disposal systems.

5.1.5 Organizational

The main government entities currently involved in sewerage and sanitation for Metro Manila include:

- *Department of Health (DOH):* is the principal government organization responsible for planning, implementation, and coordination of the policies and programs for public health protection and sanitation;
- *Department of Environment and Natural Resources (DENR*): is the primary government agency responsible for the promulgation of rules and regulations for the control of water, air, and land pollution in the Philippines;
- *Laguna Lake Development Authority (LLDA):* is a quasi-government agency empowered to provide regulatory and proprietary functions. The LLDA is mandated to lead, promote and accelerate the development and balanced growth of the Laguna de Bay Region within the context of national and regional plans and policies. LLDA operates an Environmental User's Fee (EUF) system in the cities and towns in its jurisdiction;
- *Department of Public Works and Highways (DPWH):* is the government agency that is in-charge of infrastructure construction. The agency is responsible for the planning, design, construction and maintenance of infrastructure facilities, including water resources development systems, flood control and water supply;
- *Pasig River Rehabilitation Commission* (PRRC): is tasked for activities associated with the rehabilitation of the Pasig River system. Its plans and programs include sanitation improvement components especially within the easement areas along Pasig River presently occupied by informal settlers;
- *Housing and Land Use Regulatory Board* (HLURB): is the government's regulatory body responsible for land use and housing. These functions are complementary with the mandate of all LGUs under RA 7160, the Local Government Code, to prepare their land use plans;
- *Local Government Units (LGUs):* are part of the Philippine decentralized form of government. As such, there are two main levels of government: central or national government and LGUs. The policy described in the Local Government Code is to devolve authority to LGUs who will operate autonomously under the regulatory supervision of the National Government; and
- *Department of Agriculture (DA):* Under the Clean Water Act (CWA), the DA is tasked to coordinate with DENR in the formulation of guidelines for the reuse of wastewater

for irrigation and other agricultural purposes and for the prevention, control, and abatement of pollution from agricultural and aquaculture activities. The DA is also tasked to review and propose guidelines for domestic sludge and septage management particularly on land application of bio-solids.

5.1.6 Legislation

Recently passed laws and administrative orders that may have impacts on the design and implementation of existing and future sanitation and sewerage projects of the MWSS and its concessionaires can be summarized as follows.

- *PD 856 or the Code on Sanitation of the Philippines (1975):* has been the basis of rules and regulations imposed for health and sanitation. It covers collection, handling, transport, treatment and disposal of sewage, domestic sludge and septage as well as requirements for sewerage and treatment. This law was added to by Implementing Rules and Regulations (IRR) of 1995 and the supplemental IRR of 2004;
- *PD 984 or the Pollution Control Law*: sets up the administrative and regulatory mechanisms for pollution control and establishes air and water quality standards that define maximum allowable limits of emissions and effluents from domestic, commercial and industrial activities;
- *PD 1151 or the Philippine Environmental Policy*: defines the general state policy on the pursuit of a better quality of life without degrading the environment. One of the most important provisions of PD 1151 was the requirement for all agencies and corporations to prepare an Environmental Impact Statement (EIS) for every project or undertaking which significantly affects the quality of the environment. The law was subsequently strengthened by PD 1586 or the Environmental Impact Statement System; and
- *RA 9275 or the Clean Water Act of 2004 (CWA), IRR 2005:* provides a comprehensive national water quality program to protect, preserve, and revive the quality of the country's fresh, brackish, and marine waters. Provisions of PD 984 relative to wastewater discharges were subsumed by the CWA. Under the CWA, development projects including subdivisions, commercial establishments and manufacturing plants (which generate and discharge dirty water into the environment) are required to secure from the DENR the Discharge Permit and pay the corresponding load based fees to DENR.
- Under the CWA, the MWSS through its concessionaires should provide the sewerage and sanitation facilities and enforce the mandatory connection of sewage lines from domestic, commercial or industrial establishments to an available sewerage system. The sewage treatment facilities of MWCI/MWSI are required to comply with the guidelines on sanitation of the DOH and the Effluent Standards of DENR. The LGUs are to share the responsibility in the management and improvement of water quality within their territorial jurisdictions. LGUs may enact ordinances to impose a service fee system, which may, however, conflict with the role of the concessionaires in Metro Manila.

These main laws are further supported by a number of Presidential Decrees, Republic Acts, and Administrative Orders. Enforcement of these laws rests with government agencies such as the Environmental Management Bureau (EMB) of the DENR, DOH, DPWH, and the LGUs.

5.1.7 Environmental

The study's primary receiving waters include rivers, Laguna de Bay, Manila Bay and numerous esteros or creeks. The major rivers that form the catchments in the MWSS service area are Pasig-Napindan River, Marikina River, San Juan River, Tullahan-Tenejeros River, Parañaque River, Zapote River and Imus River. All are substantially (i.e. greater than 50 %) polluted by human liquid waste and some by solid waste; all mostly fail the DENR Class C water criteria for dissolved oxygen of 5 mg/L and for a BOD concentration of between 7 to 10 mg/L. An updated 2004 copy of the World Bank Environmental Monitor 2003 that included water quality data of 2002 to 2004 showed that the BOD in most stations had increased between 2001 and 2004.

Manila Bay is roughly 1,800 km^2 in area, with a coastline of about 190 km. The eastern shore of Manila Bay adjacent to Metro Manila shows signs of significant pollution, especially in the vicinity of the mouths of rivers and the openings of major storm drains. Manila Bay has its own water quality monitoring program under the Manila Bay Improvement Project of the EMB. Spot total coliform levels can reach over 300,000 CFU/100 mL.

Laguna de Bay is estimated to have a total volume of 3.2 billion cubic meters of water, with an average depth of 2.8 meters. The lake receives flow from 21 rivers that meander through five provinces. It is estimated that industrial pollution accounts for only about 30% of the deterioration in the water quality of the lake. This figure is less than the contribution of agricultural activities (40%) but equals the pollution from domestic sources also estimated at 30%. The Environmental User Fee System (EUFS) for industrial pollution contributors has contributed significantly to the cleanup of the lake since its implementation. Laguna de Bay has been identified as a future potable water source for Metro Manila.

5.2 Constraints for Sewerage and Sanitation in Metro Manila

On a global level, it has been reported (DFID 2005) that the major constraint for general sanitation is the lack of political will: "activities that fail to establish sustainable and hygienic facilities and behavior, a high rate of abandonment of existing infrastructure, and clear linkages with illness rates."

All previous Metro Manila Sewerage and Sanitation Master Plans have recognized that a centralized sewerage system would eventually solve most of the environmental degradation and health issues caused by polluted waters in the MWSS service area. A review of previous sewerage and sanitation master plans, of past and current projects of

MWSS, MWCI and MWSI, as well as observations from site visits have identified issues that have constrained the development of the sewerage and sanitation infrastructure in Metro Manila. These are discussed briefly in this section.

Disease Prevention

Poor water supply and sanitation-related diarrhea cause the deaths of 3,900 children globally every day (UNICEF-WHO JMP 2004). The chief purpose of sanitation, sewerage and treatment is to prevent the spread of diseases from human waste, particularly from dense concentrations of human habitation. The spread of water-borne diseases is brought about by human contact with sewage or dirty water. Diarrhea was the 2nd and 3rd cause of morbidity in Metro Manila for the 5-year average period of 1996 to 2000 and in 2001, respectively (DOH 2005). Better sanitation and sewerage translates into benefits for the community, which result in real economic return (DFID 2005). The lack of maintenance of septic tanks all over Metro Manila inadvertently releases raw sewage into the drainage system.

Environmental Protection

The quality of the environment and the state of the human condition, both health wise and from a quality of life perspective, have always been directly related. The adverse environmental effects of the discharge of sewage, either directly to the creeks, esteros and rivers or through the approximately 2.2 million septic tanks, significantly contributes to the degradation of the water systems in Metro Manila. The failure to desludge the septic tanks is tantamount to not having them and simply discharging untreated sewage into the drainage system.

Land Availability

Land availability for sewerage and sewage / septage treatment plants is a major restriction in Metro Manila for the implementation of sewerage and sanitation programs. Most available areas in Metro Manila are already heavily inhabited by formal and/or informal settlers and large open areas are scarce.

Traffic Disruption

The works required to install a centralized sewerage network would involve excavation of major and minor thoroughfares. Many of the Metro Manila roads are narrow or heavily congested. Conventional methods of trench digging for large-bore gravity sewerage would be chaotic and would take decades to implement.

Existing Utilities in Roadways

In the planning of a centralized sewerage system, a major constraint would be the existence of utility infrastructure for water supply, storm drainage and outfalls, electricity distribution, gas, and telecommunications. Sewer pipes are installed deeper than other utilities, but they may still intercept these utilities.

Cultural Preferences

A project may be technically and financially feasible, but if the project is not socially acceptable, it will not be implemented.

Inaccessible Septic Tanks

The Second Manila Sewerage Project Feasibility Report (JMM 1991) cited a 1980 survey, which estimated that only about 50 % of the septic tanks within four cities (Manila, Quezon City, Caloocan and Pasay) and about 80 % of the septic tanks in the remaining municipalities are fully accessible. The average of 30% of possible inaccessible septic tanks will need a special program to identify and bring them into a working condition.

Financial Constraints

- *Lack of National Government Support*

Since 1970, for every PhP 97 spent on water, only PhP 3 has been spent on sanitation and sewerage.

- *Willingness to Pay by the Public for Dirty Water Services*

In a survey conducted as part of the 2005 Master Plan study, sixty eight percent (68%) of those willing to pay for dirty water services were prepared to pay 20 to 40% of their water bill for the service, with most willing to pay around 20%. Most of those unwilling to pay believed that MWSS should bear the entire cost, others believed the cost was too high or they did not believe MWSS can make any improvements. Sixty-eight percent (68%) of respondents without toilets (about 5% of the total) who preferred to use a public toilet were willing to pay about PhP 2 for the use of such a facility.

Technology Constraints

Only the least-cost options for sanitation, sewerage and dirty water stand any chance of being implemented in the current Philippine financial climate.

Management of Flow / Pollution Load

The use of combined drainage for stormwater and sewage for conveying the pollution to a treatment facility will have to cope with rainfall events that will greatly increase flows.

Management / Recycle / Disposal of Residuals

Management of residuals is currently not a significant problem as there are few biological solid residuals (sludges) generated by the present treatment plants. However, as the number of SpTPs and STPs increase in the future, management and reuse of biological solids will become an important and potentially expensive issue.

Consistency with the Plans of Concessionaires

This 2005 Master Plan has to address ongoing programs such as MSSP and MTSP when forwarding its proposals for the five-year planning time horizons within 2005 to 2025.

Public Education

The willingness-to-pay survey study showed that people educated about the choices they are given are more willing to pay for services that will positively impact on their lives, their environment and their city as a whole.

5.3 Review of Relevant Technical Options

5.3.1 Multi-criteria Analysis (MCA)

Technical options for Metro Manila were evaluated against the aforementioned constraints using a MCA process. Those constraints relevant to a particular group of options (e.g. sanitation, sewerage or treatment) were "*weighted*" to reflect their perceived importance. Weightings and constraints changed from one group of technical options to another, depending on their perceived importance. The total weighting for any group of options has sum to 100%. Weightings for a MCA are often a group decision and changing the weightings can greatly affect the MCA scores and outcome.

Each option within a group was then judged against its rivals, and a "*judgment ranking*" (on a scale of 0 to 10 from worst to best) assigned. Judgment rankings are usually assigned by a single professional and are often subjective. Where possible, such as costing for example, the rankings can be quantifiable such as lowest cost can be assigned a judgment ranking of "10" and the other options proportionally discounted.

Judgment rankings multiplied by the weightings for each constraint resulted in a score for each option within a technical group. The highest score identified the preferred option(s) within a particular group. A single preferred option in any one group may not be universally applicable throughout all of Metro Manila. In this case, the top two (2) or three (3) options were taken as "preferred".

5.3.2 Sanitation Facilities

Sanitation is defined as those "on-site" facilities utilized for the purpose of receiving and disposing of human excreta and urine. Examples are pit latrines, pour flush toilets, septic tanks, soakage pits and field absorption systems or leaching fields. Sanitation practices promoted today fall into one of two broad types:

- "Flush-and-discharge" (for example the flush toilet), and
- "Drop-and-store" (for example the pit toilet).

Since the last century, the Flush-and-Discharge method has been regarded as the ideal management approach, particularly for urban areas. Filipinos from the willingness-to-pay survey prefer to have a flush toilet.

For informal settlements it may be preferable at least to have Drop-and-Store sanitation available as opposed to open defecation. The MCA considered 6 options against 10 constraints as presented in **Table 5.2**.

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Table 5.2 - Multi-Criteria Analysis of Drop-and-Store Sanitation

No.	SANTIATION: DROP & STORE Multi-criteria Analysis of Constraints	Selected Weighting (x / 100)	Judgement Ranking Dehydration Toilets (1 to 10)	Ventilated Pit Latrine (1 to 10)	Composting Toilet (1 to 10)	Pit Privy (1 to 10)	Aqua Privy (1 to 10)	Pail System/Vault Toilet (1 to 10)
1	Cultural Acceptability in MM	10	2	2	2	2	8	1
2	Affordability (Capital Requirement)	10	2.4	5	1.1	4	3.3	10
3	Disease Prevention	15	9	6	8	6	4	3
4	Protection of the Environment	10	9	5	8	5	5	3
5	Consistency with MWCI and/or MWSI Plans	10	5	4	5	4	10	10
6	Land Availability	10	9	9	9	9	9	10
7	Traffic Disruption	10	10	10	10	10	10	10
8	System Design & Complexity	10	5	7	5	8	6	10
9	Operations & Maintenance	10	7	9	6	4	9	2
10	Management/Recycle of Residuals	5	10	4	10	4	6	2
	TOTAL WEIGHTING (should be 100):	**100**						
	INDIVIDUAL SCORES (x / 1000 max):		**679**	**620**	**631**	**570**	**693**	**615**
	HIGHEST SCORE:			**Aqua Privy**				

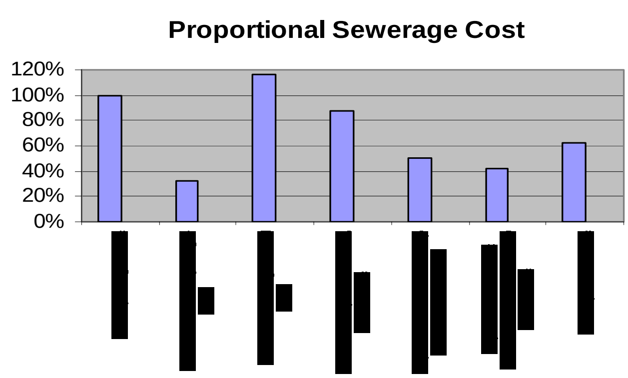
For the most part, all the constraints were equally weighted. The Aqua Privy and the Dehydration Toilet had the two highest scores in the MCA.

Three technical options were considered for Flush-and-Discharge sanitation as shown in **Table 5.3**. The same previous constraints and weightings were used. Even though the multi-baffled septic tank gives better BOD removal than the traditional two-chamber septic tank, it is more costly and takes up more land area. The septic tank-anaerobic filter is more vertical than horizontal and may be useful for those sites where space is restricted. Otherwise, the two chamber septic tank was identified as the preferred option for use with the flush toilet.

Table 5.3 - Multi-Criteria Analysis of Flush and Discharge Sanitation

No.	SANTIATION: FLUSH AND DISCHARGE Multi-criteria Analysis of Constraints	Selected Weighting (x / 100)	Judgement Ranking Traditional Septic Tank (1 to 10)	Septic Tank / Anaerobic Filter (1 to 10)	Multi-Baffled Septic Tank (1 to 10)
1	Cultural Acceptability in MM	10	10	10	10
2	Affordability (Capital Requirement)	10	10	4.3	8
3	Disease Prevention	15	5	6	6
4	Protection of the Environment	10	5	7.5	7.5
5	Consistency with MWCI and/or MWSI Plans	10	10	10	10
6	Land Availability	10	7	8	5
7	Traffic Disruption	10	10	10	10
8	System Design & Complexity	10	10	8	8
9	Operations & Maintenance	10	7	8	7
10	Management/Recycle of Residuals	5	6	6	6
	TOTAL WEIGHTING (should be 100):	**100**			
	INDIVIDUAL SCORES (x / 1000 max):		**795**	**778**	**770**
	HIGHEST SCORE: Traditional Septic Tank				

5.3.3 Sewerage



Pipes and other conduits are used for conveying human waste away from their living spaces. There are a number of different sewerage methodologies, ranging from conventional large-bore gravity sewerage to a small-bore vacuum system. All have their place, depending on the constraints of the area they are to be applied. Considerable cost lies within a sewerage system. A conventional, large-bore is only surpassed in unit cost (estimated at PhP 203,000 per household) by vacuum sewerage.

Seven alternative sewerage systems were taken through a MCA, from which it can be seen that three options emerged as the most preferred for Metro Manila, viz. Combined Large-Bore Gravity, Separate Small-Bore (Condominial), and STED. The top three

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options were selected as preferred to fit all the scenarios in the MWSS service area as shown in **Table 5.4**.

Table 5.4 - Multi-Criteria Analysis of Sewerage Alternatives

SEWERAGE for Metro Manila		Selected Weighting	Judgement Rankings						
No.	Multi-criteria Analysis of Constraints	Selected Weighting (x / 100)	Conventional Sewerage: Separate (1 to 10)	Conventional Sewerage: Combined (1 to 10)	Vacuum Sewerage (1 to 10)	Pressure Sewerage: GP (1 to 10)	Pressure Sewerage: STEP (1 to 10)	Simplified Sewerage: STED / STEP (1 to 10)	Simplified Sewerage: Condominial (1 to 10)
1	Cultural Acceptability in MM	0	10	10	10	10	10	10	10
2	Affordability (Capital Requirement)	25	3.2	10	2.8	3.6	6.4	7.6	5.2
3	Disease Prevention	10	9	6	9	9	9	9	9
4	Protection of the Environment	10	7	5	9	9	8	8	9
5	Consistency with MWCI and/or MWSI Plans	10	5	9	4	4	4	4	9
6	Land Availability	5	6	9	7	7	7	7	7
7	Traffic Disruption	10	3	9	8	8	8	8	8
8	System Design & Complexity	5	7	8	5	6	6	7	7
9	Operations & Maintenance	10	9	9	6	6	6	7	7
10	Management of Flow / Pollution Loads	10	7	5	8	8	9	9	9
11	Management/Recycle of Residuals	5	9	6	9	9	6	6	9
	TOTAL WEIGHTING (should be 100):	**100**							
	INDIVIDUAL SCORES (x / 1000 max):		**590**	**795**	**614**	**641**	**695**	**740**	**754**
	HIGHEST SCORE:		Conventional Sewerage: Combined						

5.3.4 Dirty Water Treatment

The principal objective of dirty water treatment is generally to detoxify/remove anthropogenic, commercial and industrial impurities to allow the water to be environmentally disposed and / or reused without danger to human health or unacceptable risk to the environment.

Treatment is composed of a number of unit operations but biological treatment is by far the most expensive. Five biological treatment systems were analyzed (i) continuous conventional activated sludge (CAS), (ii) sequencing batch reactor (SBR) activated sludge, (iii) trickling filter with plastic media (TF), (iv) Upflow Anaerobic Sludge Blanket (UASB) – SBR combination, and (v) UASB – TF combination. The first three processes have 100% aerobic biological treatment, the last two processes have anaerobic – aerobic biological treatments. An anaerobic biological treatment process can offer a number of advantages in operating costs over an aerobic process but cannot achieve DENR Class C effluent by itself.

The aforementioned treatment process options were designed and costed (capital and operating) for 10 MLD treatment plants for this study. The aerobic processes were initially less expensive to construct but were eventually overtaken in an NPV analysis by lower operating costs of the anaerobic-aerobic treatment option (see **Figure 5.1**).

The UASB-TF option suffered from the high price of plastic packing as it is imported and derived from oil-chemical stocks. The best treatment option for its cost was the UASB-SBR. Operating costs were reduced a further 3% if the biogas is used to generate the electricity for the whole treatment process.

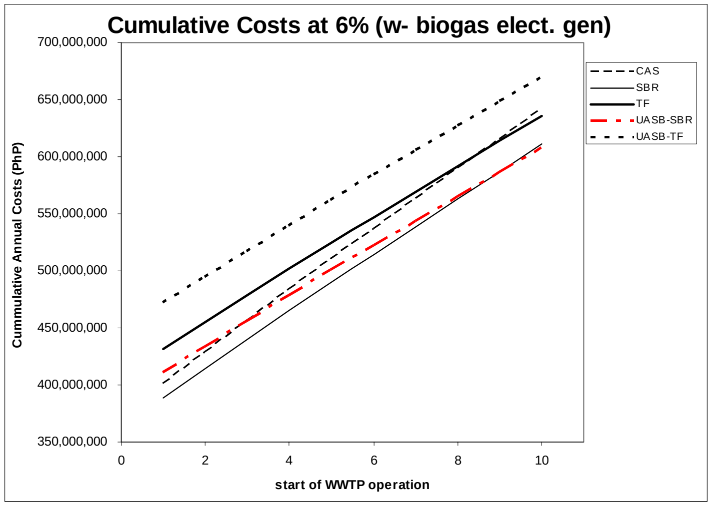

Figure 5.1 NPV Analysis for Dirty Water Treatment Options

The MCA of dirty water treatment options is presented in **Table 5.5.** The MCA also preferred the UASB-SBR treatment process combination and the SBR by itself proved the second choice. In some catchments in Metro Manila with dilute dirty water, it may be better to employ the SBR.

5.3.5 Strategy for Metro Manila

As a general planning approach for the 20 year planning time line (2005 to 2025), the aforementioned recommendations can be simply stated as:

- Keep existing septic tanks (over 2.2 m already) but pump them out regularly and catch their overflow for treatment.
- Initiate a program to bring the estimated 30% of inaccessible septic tanks into working order.
- New developments should utilize traditional gravity sewerage and treatment as much as possible.
- Drop-and-Store sanitation applications should use the Aqua Privy.
- Use combined drainage and decentralized [small-bore sewerage] approaches to sewer the existing population, gradually phase out higher-risk combined systems and
- Generally, move dirty water from East to West (away from Laguna Lake as a potential water source) in continually more centralized treatment plants.

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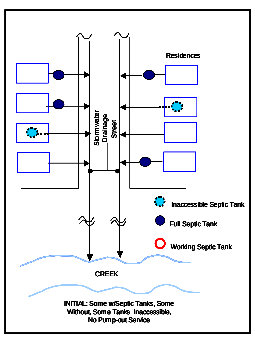
Table 5.5 – MCA of Dirty Water Treatment Options for Metro Manila

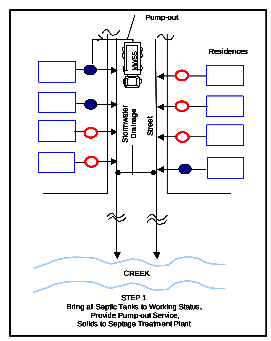
No.	Dirty Water Treatment for Metro Manila Multi-criteria Analysis of Constraints	Selected Weighting (x / 100)	Judgement Rankings Continuous Activated Sludge (1 to 10)	Sequencing Batch Reactor (SBR) (1 to 10)	Trickling Filter w- Plastic Media (TF) (1 to 10)	Anaerobic (UASB) - SBR (1 to 10)	Anaerobic (UASB) - TF (1 to 10)
1	Cultural Acceptability in MM	0					
2	Affordability (NPV @ end of 10yr @ 6%)	25	9.2	9.6	9.3	10.0	9.0
3	Disease Prevention	10	10	10	10	10	10
4	Protection of the Environment	10	8	8	9	9.5	10
5	Consistency with MWCI and/or MWSI Plans	10	10	10	10	9	9
6	Land Take	20	8.5	9.2	7.6	10	7.0
7	Traffic Disruption	0					
8	System Design & Complexity	5	7	7	8	6	6
9	Operations & Maintenance Costs	10	8.1	8.8	9.6	10.0	10.0
10	Management of Flow / Pollution Loads	5	10	10	10	10	10
11	Management/Recycle of Residuals	5	8.5	8.5	9	9.5	10.0
	TOTAL WEIGHTING (should be 100):	100					
	INDIVIDUAL SCORES (x / 1000 max):		888	920	904	963	885
	HIGHEST SCORE:		Anaerobic (UASB) - SBR				



EXISTING MM
"TYPICAL" STREET

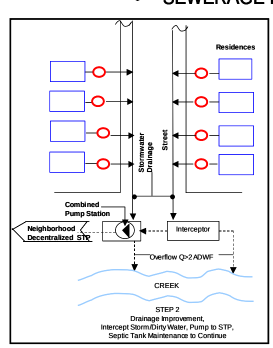
The transition process will take place over the course of the 2005 Master Plan and beyond such that the existing situation will gradually be replaced with a "sanitation" phase or STEP 1.

SANITATION PHASE

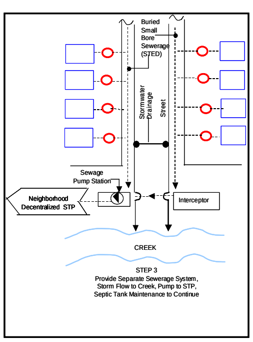


COMBINED
SEWERAGE PHASE

All existing septic tanks will be brought into working condition through regular solids pump-out and refurbishment and / or replacement of those tanks considered "inaccessible". The next two steps involve moving into sewerage, first combined and then a separate system.



SEPARATE SEWERAGE
PHASE



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5.4 Strategies for Sewerage and Sanitation for 2005 to 2025

5.4.1 Sanitation Strategy

The 2003 Rate Rebasing converted much of the MWCI contractual requirements for sewerage to sanitation. Reduction of sewerage coverage was compensated by higher sanitation coverage. MWSI under the 2003 Rate Rebasing moved forward its sewerage contractual coverages as set in the 1997 CA by five years, starting 2006. However, no change was made to the sanitation targets to compensate for the reduction in sewerage coverage, which for several LGUs has resulted in an overall reduction in the service provided. In this 2005 Master Plan, the lower-cost sewerage systems proposed (such as Septic Tank Effluent Disposal or STED) requires the continued operation of the septic tanks. Septage collection facilities have been proposed to accommodate these pump-out requirements, even where it exceeds the concessionaire contractual targets.

MWCI has recently started implementation of the Manila Third Sewerage Project (MTSP) to meet their concession contractual requirements. The current investment projects being undertaken by MWSI are parts of the implementation of the Manila Second Sewerage Project. No other investment project intended for achieving the sewerage and sanitation targets in the 1997 CA is currently proposed by MWSI.

Inaccessible Septic Tanks

NSO estimated that in 2000, eight-two percent (82%) of households in the MWSS service area including 84% of the number of households in the National Capital Region (NCR) had a total of 2.17 million septic tanks. The number of septic tanks is expected to increase to 1.30 million and 1.75 million by years 2015 and 2025, respectively, for the East Concession and to 1.67 million and 1.81 million in the same years for the West Concession.

Many septic tanks in the NCR were found to be inaccessible for desludging, either because the tanks have no access manholes, or structures have been built over them, or the septic tanks are located in areas with roads that are very narrow or impassable by any type of vehicle. It was assumed that septic tank accessibility is around 80 % for the whole of the MWSS service area.

An average septic tank volume 5.0 m^3 was assumed for this study. However, as a result of reports by the concessionaires that many tanks have a lower volume, a sensitivity analysis on septage volumes produced was conducted for tank volumes ranging from 3 to 5 $m^{3.}$ A desludging interval of 6 years (calculated from 32 L septage generation/capita/year, one-third of septic tank for solids, 8 people per septic tank) and 300 collection days per year was assumed that put the potential total daily septage collection by 2015 and 2025 at around 6,603 m^3 (2,900 m^3 in the East) and 7,922 m^3 (3,899 m^3 in the East), respectively.

No Units	Capacity, m^3	Status
14	10	Existing
1	5	Existing
30	10	Awarded, delivery 2006-7 (Antipolo SpTP)
6	5	Awarded, delivery 2006-7 (Antipolo SpTP)
60	10	To award in 2008 (North/South SpTP)
10	5	To award in 2008 (North/South SpTP)
121		**TOTAL**

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Currently MWCI has 15 vacuum tankers, with more planned for 2006 to 2008. MWSI currently has 32 trucks, including the 7 Mobile Dewatering Units.

Type of Unit	No of Units
Mobile Dewatering	7
10 m3 Vacuum Tankers	19
4 m3 Vacuum Tankers	6
TOTAL:	**32**

Proposed New SpTps

It is proposed to construct a new SpTP (1,600 m^3/day) for Rizal Province at the Binangonan or Cardona area for MWCI to meet the expected backlog by the year 2025. These areas will remain agricultural up to 2025 onwards. The option for natural system processes for treating septage can be seriously considered such as drying beds for sludge dewatering and stabilization ponds for treating filtrate. It is not anticipated that sewerage will be available in Rizal Province during the Master Plan period so the treatment facility would be designed for septage alone. Vacuum trucks will have to be purchased and operated to meet the septage pump-out demand. Procurement of vacuum tankers should be staggered as shown in **Table 5.6**. It was presumed that there will be two trips/vacuum tanker/day.

Table 5.6 – Proposed Number of Vacuum Tankers

Concessionaire	No. of Tanks		Procured by Year
	5 m^3	10 m^3	
MWCI		2	2015
	31	110	2020
	5	33	2025
sub-total	*36*	*145*	
MWSI	6	40	2010
	5	42	2015
	4	20	2020
	11	54	2025
sub-total	*26*	*156*	
Total	**62**	**301**	

Note: About 10 % of the requirement is assumed to be handled by private contractors.

MWSI will likely comply with their contractual sanitation coverage by the end of 2006, but in some cases for this Master Plan these contractual targets will need to be exceeded for the sewerage systems proposed to function effectively. Additional SpTP capacity of 1,131 m^3/day is however required by year 2010 and 1,573 m^3/day by 2015 as presented in **Table 5.7**.

To meet the treatment capacity shortfalls, septage treatment plants are proposed to be constructed as presented in **Table 5.8**.

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Table 5.7 – Combined MWCI and MWSI Septage Treatment

Location	Septage Treatment Capacity (m^3/day)				
	Year 2005	Year 2010	Year 2015	Year 2020	Year 2025
MWCI					
Excess/(Backlog)	(1264)	495	(162)	(867)	(1582)
Prop. Plant Capacity at Rizal	-	-	*800*	*800*	*1600*
MWSI					
Excess/(Backlog)	(1047)	(1131)	(1573)	(1123)	(1490)
Prop. Plant Capacity at Dagat-dagatan & Parañaque		*600*	*1000*	*1200*	*1500*
Combined					
Total Excess/(Backlog)		(636)	(1735)	(1990)	(3072)
Total Prop. Plant Capacity		**600**	**1800**	**2000**	**3100**

Table 5.8 – Septage Treatment Plants for MWCI and MWSI

Location	Septage Treatment Capacity (m^3/day)			
	Year 2010	Year 2015	Year 2020	Year 2025
MWCI				
Plant Capacity (Rizal)		*800*	*800*	*1600*
MWSI				
Plant Capacity (Dagat-dagatan)	*400*	*600*	*800*	*1000*
Plant Capacity (Parañaque)	*200*	*400*	*400*	*500*
Combined				
Total Plant Capacity	**600**	**1800**	**2000**	**3100**

Overall Septage Collection Plan

The proposed overall septage collection plan in **Figure 5.2** shows that the proposed *San Mateo SpTP* will serve Quezon City, Marikina and San Juan; the Food Terminal Inc. *(FTI) SpTP* will serve Mandaluyong, Pasig, Makati, Pateros, Taguig and most towns of Rizal; the *Antipolo SpTP*, while proposed to serve Makati, Mandaluyong, Pateros, San Juan and Taguig will also serve some areas in Rizal; in the West Zone, the proposed Parañaque SpTP will serve the south, including Cavite, and an expanded Dagat-Dagatan will serve the northern towns of the West Zone. The septage treatment requirements for MWCI will increase whilst MWSI requirements will decrease from 2005 to 2020. If the excess capacity of MWCI can be utilized by MWSI between the years 2010 to 2015, it would be unnecessary for MWSI to construct the 1,600 m^3/day septage treatment plant in 2015. MWCI can utilize the excess capacity of MWSI in 2020.

Short Term Strategy

As a priority the accessibility of septic tanks will need to be improved to bring all into a working condition. LGUs can conduct surveys to identify and verify locations of inaccessible septic tanks and formulate strategies to make tanks accessible or replace inaccessible tanks. Notices should be sent to households with offending tanks as well as assigning special desludging team(s) to identify problem areas and consult with homeowners. It is recommended that the vacuum tankers be equipped with extended suction hoses and high power pumps to reach the septic tanks which cannot be accessed due to the narrow alleys/roads. In some cases replacement of the septic tank is likely and that should be made as inexpensive to the householder as is reasonable.

Other recommendations include the constant review of septic tank designs to identify and verify improved models, the reconsideration of the sea disposal of septage, and the future design of STPs that have septage receival ability.

Medium Term Strategy

Section 6 of the supplemental IRR of the Code of Sanitation does not specify pertinent standard limits for the characteristics of sludge prior to disposal. Section 8 of the CWA also tasked the DOH to develop standards and guidelines for the disposal of septage and domestic sludge. For land application, the DA is tasked to develop necessary standards prior to land application of the bio-solids.

The Bureau of Soil and Water Management (BSWM) of the Department of Agriculture has yet to establish allowable and acceptable limits for bio-solids characteristics for the purpose of agricultural productivity enhancement. The DOH is also mandated to develop similar limits (both for sludge and bio-solids) for protection of public health and the receiving water environment. It is important that standards be developed and adopted for sludges similar to USEPA codes or even those in NSW, Australia. This will open a greater number of sustainable disposal options such as to the lahar areas. There appears to be a local demand by the farmers in lahar for the septage.

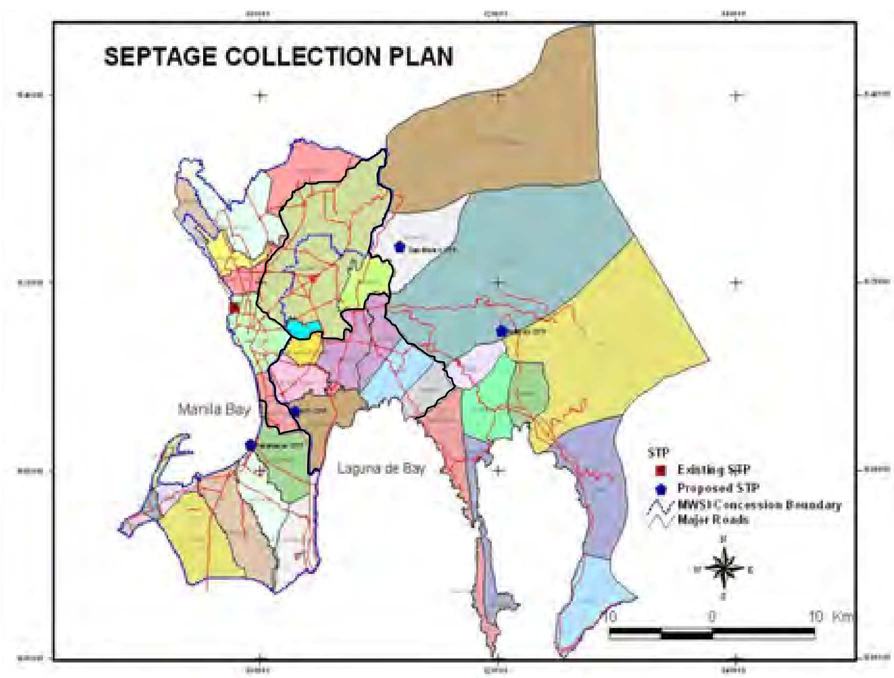

Figure 5.2 Septage Collection Plan

Medium to Long Term Strategy

As evidenced by the previous discussion significant septage treatment backlogs will develop during the 2005 Master Plan planning period of 2005 to 2025. Additional SpTPs or STPs with septage acceptance will need to be brought on line to meet the time horizon deficits. Concomitantly, with new septage treatment capacity is the need for additional vacuum pump out trucks.

It is proposed that long-term use of septage on the lahar areas be explored. The program will require continued monitoring to eventually decide the overall sustainability of this disposal option. The existing barge loading stations may be considered in the transport of the sludge/septage to the lahar areas.

Estimated Costs

The estimated investment cost for sanitation considering STED systems can be seen in **Table 5.9**.

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Table 5.9 - Estimated Investment Cost for Sanitation Master Plan (2005 to 2025)

	2005	2010	2015	2020	2025	Total (PhP million)	With 30 % Contingencies
MWCI							
o Rizal							
SpTP (m^3/d)			800		800		
Land (ha)			4.00				
Amount (PhP million)			*973*		*941*	***1,914***	2,488
MWSI							
o Dagat-dagatan							
SpTP (m^3/d)		400	200	200	200		
Amount (PhP million)		*470*	*235*	*235*	*235*	***1,176***	1,529
o Paranaque							
SpTP (m^3/d)		200	200		100		
Land (ha)		3.00					
Amount (PhP million)		*475*	*235*		*118*	***828***	1,076
Sub-total (SpTP)		**946**	**1,443**	**235**	**1,294**	**3,918**	5,093
MWCI							
o Vacuum Tankers							
5 m3				31	5		
10 m3			2	110	33		
Amount (PhP million)			*9*	*606*	*166*	***781***	1,015
MWSI							
o Vacuum Tankers							
5 m3		6	5	4	11		
10 m3		40	42	20	54		
Amount (PhP million)		*201*	*206*	*104*	*282*	***794***	1,032
Sub-total (Tankers)		**201**	**215**	**710**	**448**	**1,574**	2,046
Total		**1,147**	**1,659**	**945**	**1,742**	**5,492**	**7,139**
Grand Total (with 30 % contingencies)						**7,139**	
Cost of sludge disposal (PhP million)							
MWCI		6.77	9.73	12.90	16.12		
MWSI		6.28	8.43	6.40	8.05		
Total		*13.05*	*18.16*	*19.30*	*24.17*		

Note:

Unit Price of SpTP ($/$m^3$/d) =	21,000.00	
Conversion of $ to PhP	56.00	
Land (ha) =	3.00	
Cost of Land in Rizal (PhP/ m^2) =	800.00	
Cost of Land in Paranaque (PhP/m^2)		8,000.00
Cost of 5 m^3 tanker ($/unit)=		65,000.00
Cost of 10 m^3 tanker ($/unit) =		80,000.00

Only 90 % of vacuum tankers are assumed to be purchased by concessionaire, rest by private contractors
Cost of sludge disposal to lahar areas = PhP 300/m^3

5.4.2 Sewerage Strategy

Low-cost Sewerage Proposed

Of the seven sewerage approaches analyzed for cost and through a Multi-criteria Analysis, three approaches were shown as preferred, viz.

- Combined Drainage,
- Separate Small-Bore (Condominial), and
- Septic Tank Effluent Disposal (STED) system.

Condominial sewerage was not proposed in this study because of the predominance of existing septic tanks, where STED systems are more appropriate. In some drainage catchments, conditions were such that combined drainage offered the least cost approach. New developments should have their own conventional gravity sewerage and treatment.

Concessionaire Targets Treated as Minimums

The plans of the Concessionaires are driven by their contractual requirements to provide specified sewerage coverage for nominated cities and municipalities according to five-year time lines. In the 2003 Rate Rebasing, MWCI had a significant portion of their 1997 CA sewerage requirements converted into increased sanitation targets, whilst MWSI had their 1997 CA sewerage targets delayed by five years, starting in 2006.

This Master Plan interpolated between the 2003 Rate Rebasing targets as necessary to extract those sewerage coverage for our planning time horizons of 2005 to 2010, 2010 to 2015, and 2015 to 2020 as they did not correspond directly to the Concessionaire target years. Our last planning time horizon for the period 2020 to 2025 did take into account the final Concessionaire 2021 targets, but to 2025, sewerage coverage decisions were based on population densities, affordability and achievability.

Thirty-one Catchments Analyzed

Figure 5.3 shows the proposed trunk sewer backbone for the 31 catchments analyzed. Each of the assigned thirty-one catchments was individually analyzed to determine its preferred sewerage approach. Catchments with good drainage were naturally inclined towards the lowest cost of the alternatives, viz. Combined Drainage. Unfavorable hydraulics in some catchments dictated the use of both Combined Drainage and STED systems. The drains currently are unintentionally used as Combined Drainage and in many areas this can be used for a workable environmental system. Other areas will require some rehabilitation of their drains. The drains are owned by the LGUs and their use for combined drainage remains unclear from an institutional viewpoint. The Master Plan for MWCI placed significant emphasis on the use of the drains for sewerage.

STED systems were the most dominant sewerage proposed throughout the MWSS Service Area, simply due to the predominance of septic tanks. STED requires that small-bore piping be connected to each septic tank to catch its liquid overflow. It is likely that a

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portion of the existing septic tanks (ca. 10 to 20%) cannot accommodate this arrangement (for a variety of reasons) and will have to be replaced.

Both Combined and STED reticulation systems at some point require the means of focusing the flow towards the treatment plant. A section of gravity trunk main was therefore used for this purpose in each catchment as shown in **Figure 5.3**. Not all of these trunk systems are proposed for the planning period of 2005 to 2025. The use of trunk main gravity sewers was minimized as much as possible because of cost. All trunk main sewers were designed using the hydraulic modeling software SewerCAD©.

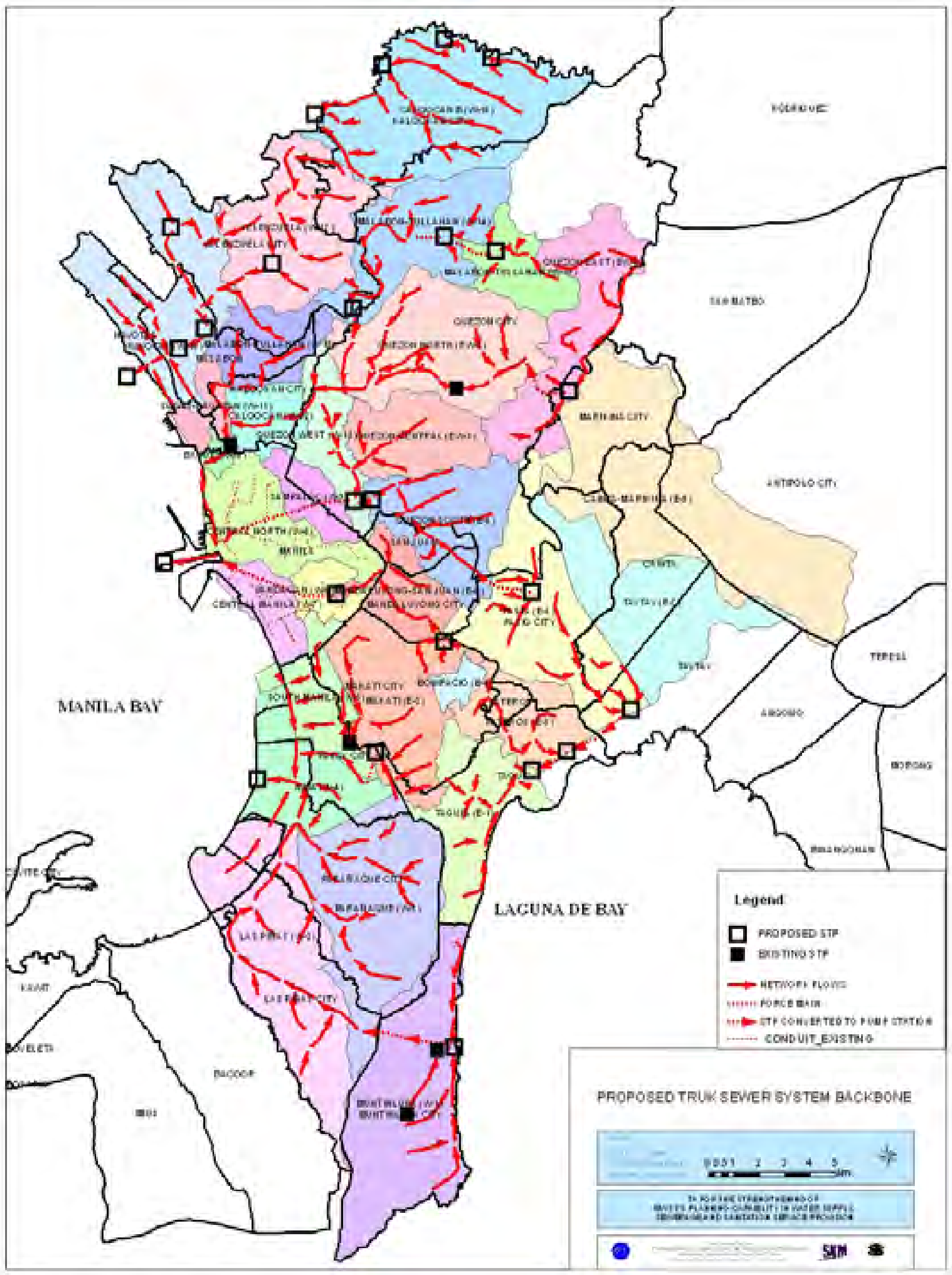

Figure 5.3 Proposed Trunk Sewer Backbone for the 31 Sewerage Catchments

5.4.3 Proposed Sewerage with Treatment

Figures 5.4 to **5.7** present the proposed sewerage master plan for time horizons 2005 to 2025.

Time Horizon 2005 to 2010 (Figure 5.4)

MWCI in late 2005 started to implement the MTSP to meet their sanitation and sewerage targets as part of the 2003 Rate Rebasing requirements.

MTSP Provided Areas: The pink cross-hatched areas shown in the sewerage plan for 2010 are proposed MTSP coverage, the darker cross-hatched areas are existing sewerage coverage, and the yellow areas (no cross hatching) are the proposed coverage by this study to enable the Concessionaires to fulfill their contractual sewerage coverage. The largest MTSP area (1,766 ha) to come on line during this planning period is that of the *Taguig Sewerage System*.

Taguig floods for three months when Laguna de Bay swells during the rainy season. DPWH is undertaking construction of Major Flood Control Project, involving construction of 10.9 km lakeshore dike and four drainage/flood retentions ponds. The drainage and ponds will catch flows from the rivers of Hagonoy, Taguig, Labasan and Tapayan that drain to Laguna Lake to mitigate inundation in Taytay, Pateros, Taguig and Pasig cities.

The MTSP *Taguig Sewerage System* will employ combined drainage and off-line primary STPs in the vicinity of each of the ponds. The ponds will subsequently be used for secondary treatment during the dry season, when ponds can retain flows.

The smaller pink cross-hatched areas along the Pasig River are catchments with combined drainage to serve the three proposed *Riverbank STPs* in Mandaluyong (2.33 MLD, underground), Pasig (3.95 MLD, underground), and Makati (5.35 MLD, on a platform above an existing flood retention pond). These plants are to be eventually replaced with regional STPs.

Another scheduled MTSP project includes the *Quezon City – Marikina Sewerage System*. This will include the construction of an underground STP on the bank of the Marikina River, served with combined drainage (with accompanying interceptor and pumping stations and upgrading of the existing drainage network). *Sewerage for Low-income Communities* along the Manggahan Floodway East Bank is also scheduled to be provided with a combined drainage system.

Muntinlupa: Sewerage coverage targets for Muntinlupa were specified in the Concession Agreements for as early as 2001, and increasing towards the end of the concession period in 2021. The early targets for sewerage are justified by the need to protect the freshwater Laguna Lake, considered as a source of potable water for Metro Manila. The interpolated 2003 Rate Rebasing contractual sewerage requirement for Muntinlupa (MWSI) is 35 % by 2010. For this time horizon two options were considered; (i) maintaining the two existing sewerage systems and their STPs and build a new STP or (ii) decommission the existing STPs and centralize to a new STP. The least-cost option (i) was selected. The required reticulation area for this development would be 269 ha of combined drainage (use of the drains for sewerage) and 235 ha of STED (Septic Tank Effluent Disposal, catch septic tank overflow in small bore sewerage) systems to a 3.74 km trunk main and then to a 40 MLD UASB-SBR STP (combination anaerobic-aerobic for the biological treatment process). The existing 22 MLD STPs serving a 850 ha separate systems will continue to operate.

Pasig: The proposed development in the southern part of Quezon City is adjoined by San Juan and includes Mandaluyong and the west part of Pasig City. The area is predominantly residential and commercial development. The area is well drained by various creeks and waterways.

The interpolated 2003 Rate Rebasing MWCI sewerage coverage requirement for the Pasig catchment for 2010 is 10%. This Master Plan proposes that this be met with 60 ha from Pasig and 59 ha from Quezon City of combined reticulation drainage to an existing lined canal leading to the 8 MLD UASB-SBR STP at the eastern extent of the system.

Time Horizon 2010 to 2015 (Figure 5.5)

During this time period additional sewerage is added to allow the concessionaires to keep pace with the 2003 Rate Rebasing targets as indicated in yellow.

Muntinlupa: During this time horizon this catchment will have 500 ha of additional STED reticulation to feed its existing 40 MLD UASB-SBR STP. This will provide needed protection for Laguna de Bay.

Pasig: The interpolated 2003 Rate Rebasing MWCI sewerage coverage requirement for the Pasig catchment for 2015 is 12%. During this time horizon an additional 61 ha of STED reticulation will be added, bringing the existing STP to full capacity.

San Juan: The interpolated 2003 Rate Rebasing sewerage coverage is required to be 14% in the San Juan catchment by 2015. The general approach for San Juan is to employ combined drainage and STED sewerage. The reticulation would drain to a 1.9 km trunk main leading to STP No. 1, a 5 MLD UASB-SBR to be constructed for 2015.

East Manila: The required sewerage for this catchment amounts to about 80 ha. STED reticulation is proposed, leading to a trunk main and subsequently to a 30 MLD UASB-SBR STP that is adequate to meet the 2020 capacity requirements

Time Horizon 2015 to 2020 (Figure 5.6)

New systems as well as system expansions are proposed during this time period to keep pace with concessionaire sewerage targets.

Muntinlupa: During this time horizon, this catchment will have its existing 40 MLD UASB-SBR STP expanded by another 20 MLD to accommodate a proposed expansion of the STED reticulation by 40 ha.

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Pasig: The Pasig catchment system expands to 14 % coverage with an additional 61 ha of reticulation added during this time horizon. The STP will increase in size by 50% by 2020 to 12 MLD. A suitable STP site with sufficient area is currently available.

San Juan: The combined drainage and STED sewerage approach remains in San Juan and will be augmented by an additional 58 ha of combined drainage and 71 ha of STED reticulation. STP No. 1 will be expanded by another 5 MLD by 2020. STP No. 2 will also be included by 2020, a 6 MLD UASB-SBR STP, that will also accommodate 2025 sewage flows.

Pasay: The required sewerage coverage for the Pasay catchment by 2020 is about 13%. A STED system is proposed with a 15 MLD UASB-SBR treatment plant to treat the flow from 230 ha of reticulation via a 3.3 km trunk main.

Caoocan-Navotas-Malabon-Valenzuela: This area (5,965 ha) has 2003 Rate Rebasing sewerage coverage targets by 2021 of 36%, 38%, 24% sewerage coverage for Navotas, Malabon and Valenzuela respectively. This 2005 Master Plan has allowed for these targets. The area is a low-lying flat terrain that is often flooded, in particular l the Navotas-Malabon area (catchment W-16). The Valenzuela area (catchment W-17) has a flat terrain but relatively higher elevations. STED reticulation is proposed. Valenzuela and Navotas would have UASB-SBRs STPs, whilst the Malabon STED reticulation would drain to an updated / augmented Dagat-dagatan STP.

Caloocan B (Novaliches): This northern (W18) catchment has a 2021 sewerage coverage target of 32% that is to be addressed in this time horizon. The proposed system will consist of a 36 MLD UASB-SBR STP serving a STED reticulation area of 629 ha. A 7.82 km trunk main conveys the sewage to the STP.

Navotas: The west part of catchment 16 covers Navotas, which has a required sewerage coverage of 36% in 2021 and is addressed in this time horizon. The proposed system will consist of a 17 MLD UASB-SBR STP that provides treatment to collected sewage conveyed by 3.11 km trunk from a 425 ha STED reticulation area.

Malabon: Like its neighbor Navotas, Malabon has a required sewerage coverage of 38% in 2021 that is similarly addressed by facilities installed in 2020. These facilities will cover the south part of Malabon and consist of a 93 MLD STP and a 6.7 km of trunk main conveying sewage from 368 and 624 ha of reticulation area respectively at Malabon and Caloocan including about 700 ha of existing Dagat-dagatan system.

Valenzuela: The required 24% sewerage coverage in 2021 is planned to be met by facilities installed in 2020. These facilities will cover 1011 ha of STED reticulation whose sewage flow will be conveyed by 7.8 km of trunk main to a 32 MLD STP.

East Manila: An expansion of sewerage in East Manila (catchment W-9) is proposed during this time horizon. The selected option was STED reticulation of 399 ha, leading to a 4 km trunk main to an expanded 62 MLD UASB-SBR STP (from 30 MLD). This option was preferred to that of augmenting the Central Sewerage System due to the difficulty of constructing large trunk sewers in the congested Manila area.

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Time Horizon 2020 to 2025 (Figure 5.7)

The concession period ends by 2021 and hence their targets would have been met. What is proposed from 2021 to 2025 are new systems and augmentations that focus on “pollution hot spots”, where there is a higher ability to pay.

Muntinlupa: The Muntinlupa 60 MLD UASB-SBR STP will have sufficient capacity to accommodate a proposed expansion of the STED reticulation by 170 ha.

Pasig: The Pasig catchment system expands to 16% coverage with the sewer-served area at 569 ha by 2025. The STP will be further expanded by 22 MLD to 34 MLD by 2025. A suitable STP site with sufficient area is currently available. The southern area of Pasig City, due to the increasing population density, is recommended for sewerage through expanding the MTSP system. This proposed expansion by 2025 will cover 375 ha of combined reticulation area, served by a 5.5-km trunk main, leading to the MTSP STP, along San Doval Avenue. This treatment facility is proposed to be expanded by 32 MLD. The storm drains are to be improved / rehabilitated to provide combined flow.

San Juan: STP treatment capacity is sufficient in San Juan to include a proposed addition of 135 ha of combined drainage and STED sewerage.

Pasay: The Pasay system by 2025 is recommended for expansion by including a 425-hectare low-lying area, where STED reticulation is proposed. The trunk main will be expanded by 4.4 km. In 2025, the existing UASB-SBR treatment plant will be expanded by 27 MLD, bringing its total capacity to 42 MLD.

Caloocan-Navotas-Malabon-Valenzuela: This area (5,965 ha) is proposed by the 2025 time horizon to have additional STED reticulation installed, which would put the areas above their 2003 Rate Rebasing targets. Sewerage coverage for Navotas, Malabon and Valenzuela would still be 36%, 38%, 24%, respectively, by the end of this period. STPs constructed from the previous time horizon will have sufficient capacity.

Caloocan B: All requirements to meet the 2021 Rate Rebasing targets are to be implemented by 2020.

East Manila: A further expansion of about 147 ha of STED sewerage in East Manila (Catchment W-9) is proposed during this time horizon. The previously constructed STP will be able to accommodate the additional flow.

Quezon: The sewerage plan for Quezon City West by 2025 is proposed to serve a significant population. The proposed area covers 541 ha that will generate a sewerage coverage of 44% for the catchment area or equivalent to an incremental 6% coverage for Quezon City. The plan consists of a 32 MLD UASB-SBR STP located at the southern end of the 3.3 km trunkmain. Proposed reticulation is by STED.

Taguig-Pateros: The sewerage of the area is to be covered by the MTSP. However, it is proposed to expand this system by 2025 to cover fully the densely populated Pateros area. This will involve a sewerage coverage of 400 ha of combined drainage, served by

14.9 km of trunk main, leading to the MTSP STP, near the Tipas River. This plant will be expanded by 26 MLD to accommodate the increased sewage flows.

Marikina: No sewerage coverage was specified for in the 2003 Rate Rebasing for Marikina, although there is a significant population density therein. By 2025, a combined drainage system is proposed to cover part of Marikina City, bordering the Marikina River. The combined drainage will require a 17 MLD UASB-SBR STP to treat the sewage flow from 320 ha with 3.2 km of trunk mains. Combined drainage for the reticulation network is less expensive and the land area for the STP appears to be no constraint.

Parañaque: The sewerage plan for 2025 targeted a sub-catchment incorporating a community with a large capacity to pay. This sub-catchment will require a 32 MLD UASB-SBR STP to treat the sewage flow from 961 ha of STED reticulation. A total of 9.4 km of sewer trunk mains (375 to 750 mm diameter) will be laid to the STP located at the west end of the catchment.

Las Piñas: The sewerage planned for this catchment by 2025 will focus on 1,250 ha of developed residential subdivisions with peripheral commercial establishments. These communities are considered to have a high ability to pay for the services STED reticulation will be used, with a 4.8 km trunk main leading to an 80 MLD UASB-SBR treatment plant at the west end of the catchment.

Time Horizon Beyond 2025+

The extension of planning beyond the 2025 time horizon would eventually involve proposing a complete sewerage coverage and treatment for the MWSS service area.

The decentralized approach commencing in the first time horizon of this study would become more centralized as sewage is moved from the East to the West, away from Laguna de Bay.

Existing septic tanks would be maintained with regular pump-outs and their overflows caught in STED/STEP (small bore) reticulation systems. The installation of areas with new septic tanks would have to be discouraged but if necessary, the two-chamber tank is the preferred design. Combined drainage is to be initially used around the service area where they are appropriate. Areas that pose higher risk to human health should be those prioritized for replacement by STED systems. All new developments should be encouraged to install traditional gravity sewerage and treatment.

Dirty water treatment should be preferably by anaerobic – aerobic biological treatment (UASB – SBR) combinations to minimize energy use and sludge production. The second preferred biological treatment option was the use of only an SBR. This should be applied where the advantages of the UASB – SBR cannot be realized. Treatment standards will undoubtedly tighten as time passes. Focus should, however, remain on providing collection systems and treatment for the most populated areas.

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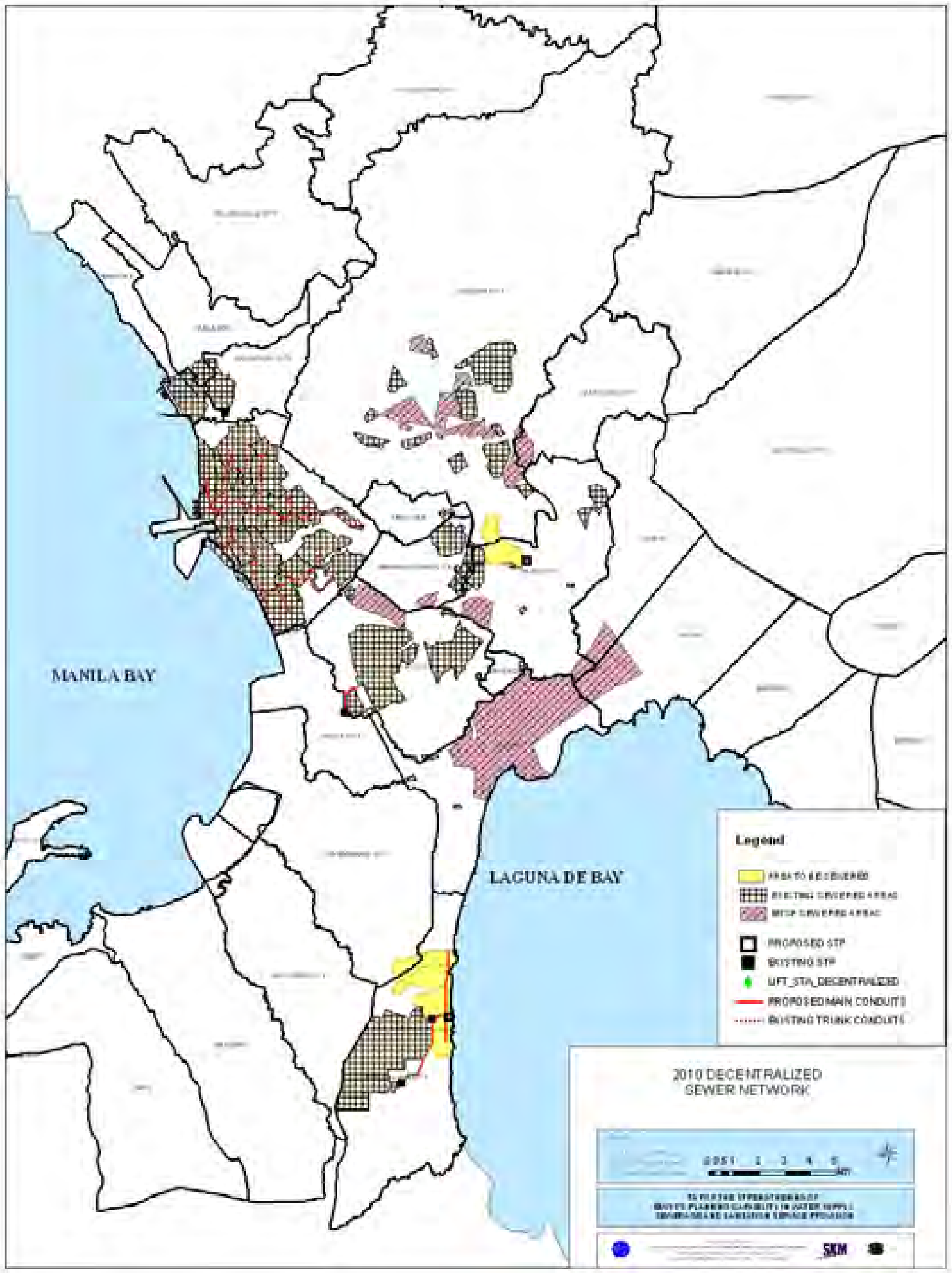

Figure 5.4 Proposed Sewerage Master Plan for Year 2010

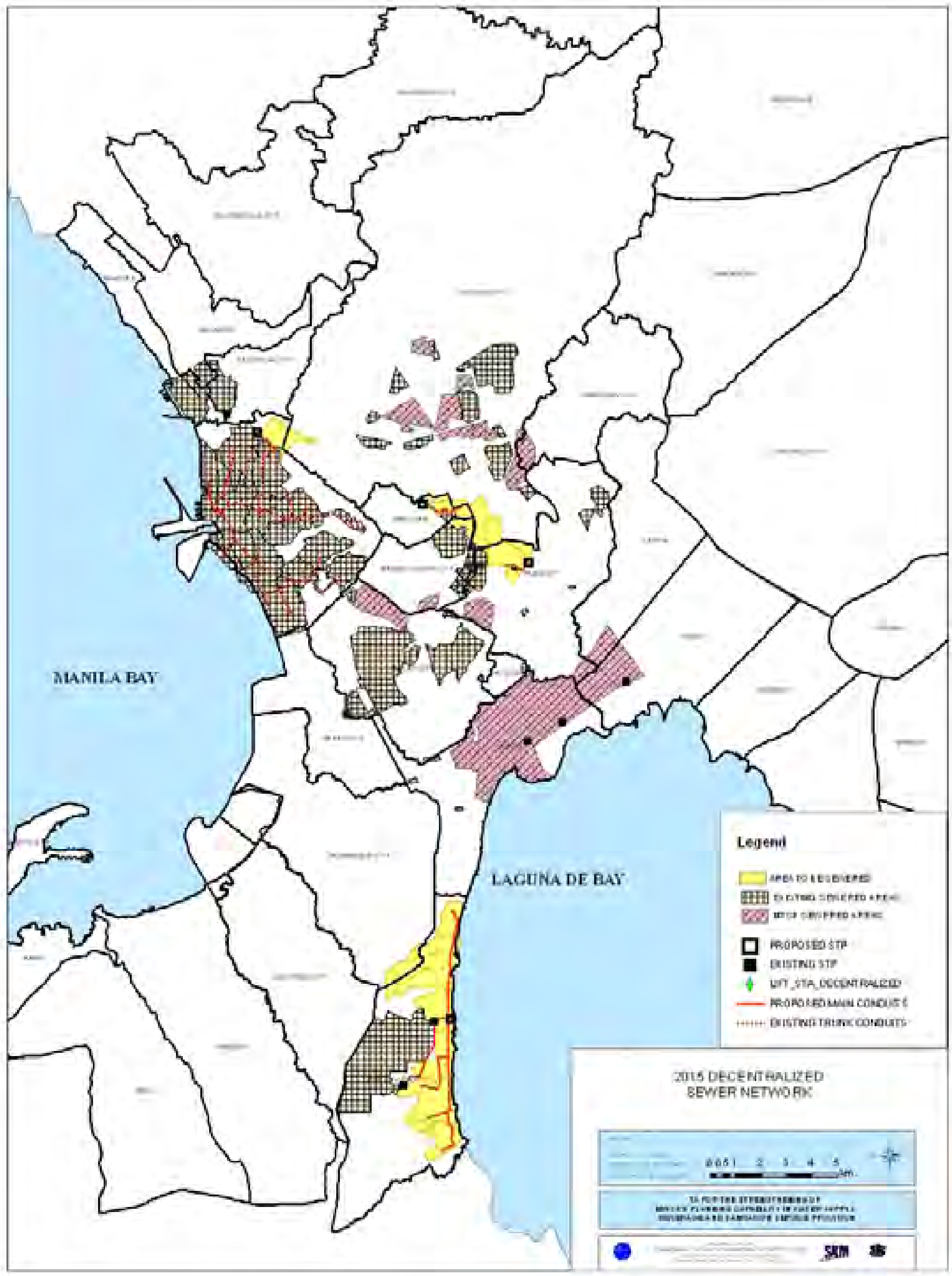

Figure 5.5 Proposed Sewerage Master Plan for Year 2015

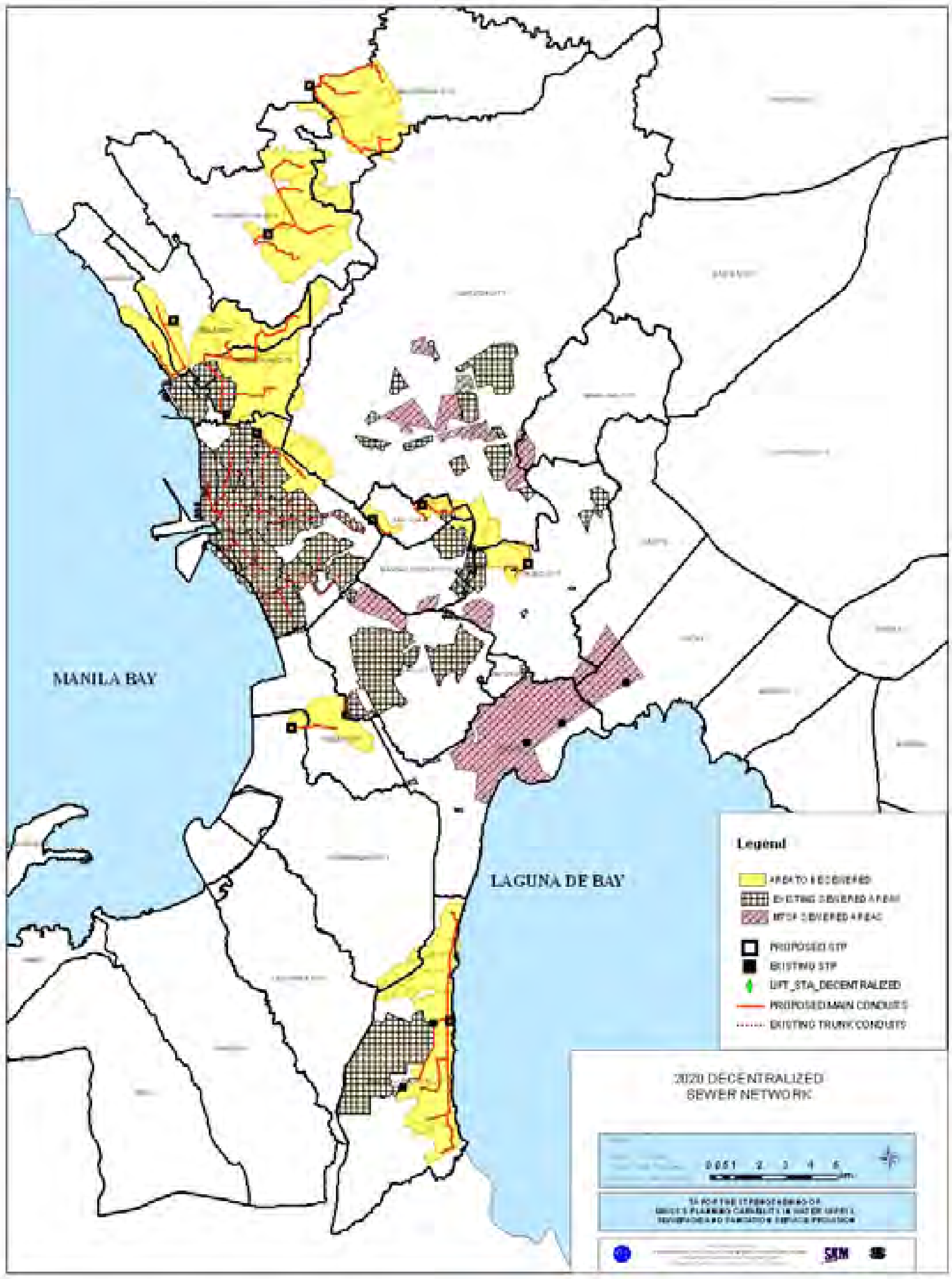

Figure 5.6 Proposed Sewerage Master Plan for Year 2020

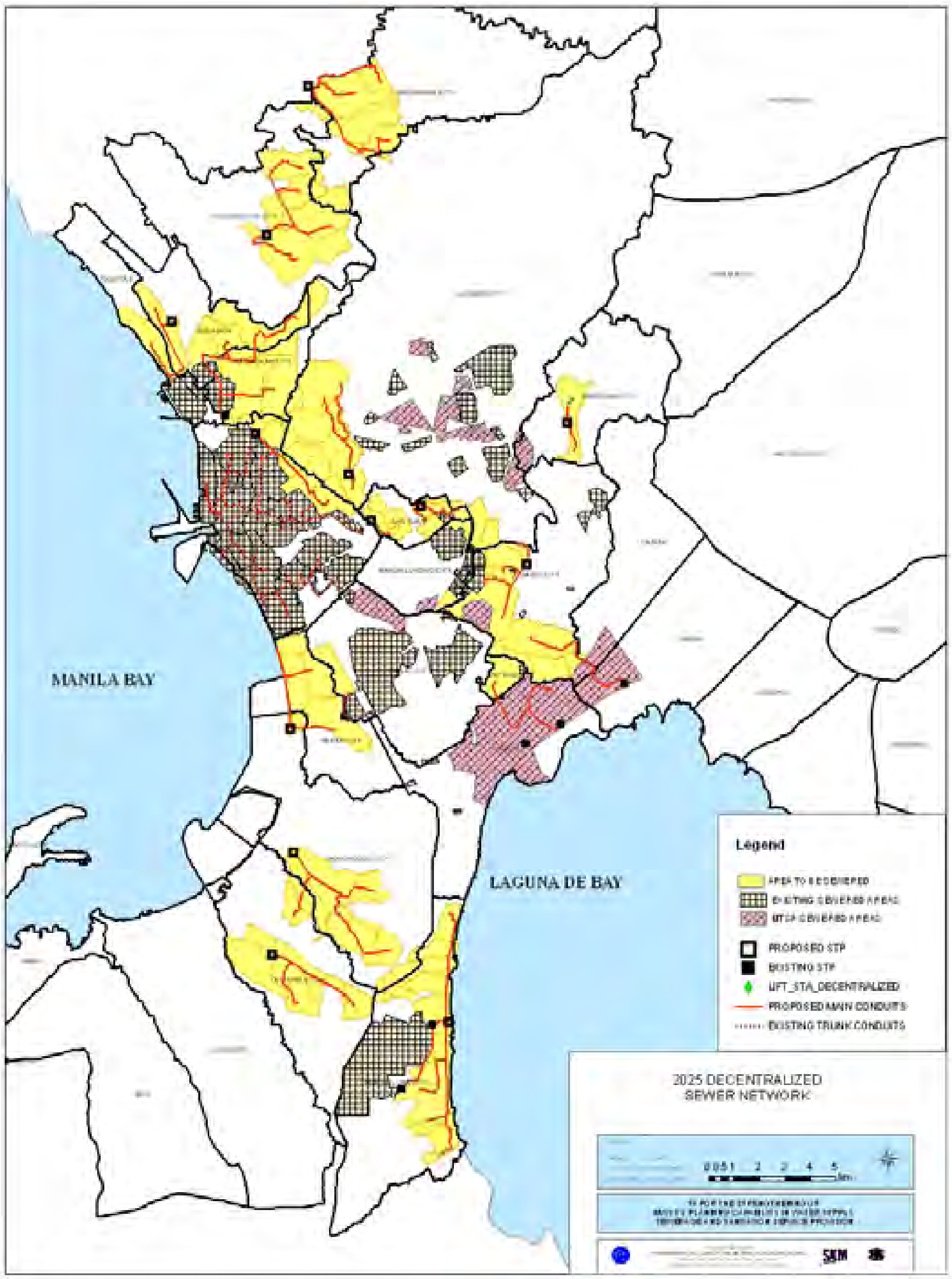

Figure 5.7 Proposed Sewerage Master Plan for Year 2025

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5.4.4 Dirty Water Treatment and Biosolids Production

Summary of STPs

Table 5.10 summarizes the STPs and their implementation time horizon. The production of biosolids will steadily increase as more STPs are brought on line:

- 89,060 m^3 per year during the 2005 to 2010 time horizon,
- 163,885 m^3 per year during the 2010 to 2015 time horizon,
- 645,503 m^3 per year during the 2015 to 2020 time horizon, and
- 870,087 m^3 per year during the 2020 to 2025 time horizon.

These biosolids will also require management schemes.

5.4.5 Costing of Sewerage Systems

The sixteen new sewerage systems proposed by the Master Plan for the twenty-year period beginning in 2005 has the following highlights:

- Sewage reticulation covers a total area of 11,757 hectares at a cost of PhP 16 billion in 2025;
- By 2025, a total of 99.9 km of new trunk mains with 250 to 1350 diameter is installed at a cost of PhP 3.15 billion;
- Sixteen new UASB-SBR STPs are proposed with a combined capacity of 612 MLD and total cost of PhP15.55 billion;
- A total land area of 34.04 hectares is required for the sixteen STPs, with a land cost of PhP 5.0 billion;
- The total cost of the new systems including land costs and a 30% contingency is PhP 51.66 billion; and
- A unit cost of sewerage development of PhP 4.4 million per ha, including land or PhP 3.84 million per ha, excluding land.

The distribution of the capital costs for the proposed Metro Manila Sewerage Master Plan is as follows: Reticulation system - 40.3%, Trunk mains – 7.9%, STP – 39.1% and Land – 12.7%.

The present sewerage coverage is 8,226 ha or about 14% of the NCR or Metro Manila. With the implementation of the SMP, the coverage is projected to increase to 33% in 2025.

Table 5.11 summarizes the details.

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Table 5.10 – Summary of Proposed STP Construction and Production of Biosolids

Item #	Location	City Municipality	Type of Improvement	Treatment Process	STP Area Requirement (Ha)	2010			2015			2020			2025		
						Type of Reticulation	STP Capacity (MLD)[2]	Sludge Generation (m³/yr)	Type of Reticulation	STP Capacity (MLD)	Sludge Generation (m³/yr)	Type of Reticulation	STP Capacity (MLD)	Sludge Generation (m³/yr)	Type of Reticulation	STP Capacity (MLD)	Sludge Generation (m³/yr)
1	Kaunlaran St. adjacent to Dampalit River, Concepcion	Malabon	New	UASB - SBR	0.95							S	17 (17)	34,310			
2	Maysan Road near Sampaguita St., Bahayang Pag-asa Subd.	Valenzuela	New	UASB - SBR	1.60							S	32 (32)	64,240			
3	Dagat-Dagatan Ave., MWSI STP site	Caloocan	Existing - with extension	UASB - SBR	4.72							S	93 (93)	186,696			
4	Cabatuhan St. near Bignay-Llano Road, Llano	Caloocan (No	New	UASB - SBR	1.80							S	36 (36)	72,270			
5	PCSO Compound (formerly Quezon Institute) E. Rodriguez Sr. Ave.	QC	New	UASB - SBR	0.90										S	15 (16)	32,120
6	Bagong Farmers Avenue, Near Marikina River (Tumana)	Marikina	New	UASB - SBR	0.95										S	17 (17)	34,310
7	Manila North Cemetery	Manila	New	UASB - SBR	3.21				S	30 (11)	22,265	S	30 (38)	77,015	C	62 (62)	124,465
8	Ortigas Ave. near Xavier St., Green Hills	San Juan	New	UASB - SBR	0.65				S	5 (4)	8,030	S	10 (8)	16,060	C	10 (10)	20,075
9	F. Manalo St. corner Valenzuela St., San Perfecto	San Juan	New	UASB - SBR	0.35							C	6 (4)	8,030	C	6 (6)	12,045
10	General Mills Compound, Eagle St., Ugong, near Marikina River	Pasig	New	UASB - SBR	2.53	C[3]	8 (8)	16,060	C	8 (9)	18,250	C	16 (13)	26,280	C	35 (35)	70,263
11	Hon. Sandoval Ave. near Manggahan Floodway & Laguna de Bay	Taytay	MTSP - with extension	UASB - SBR	1.68										C	32 (32)	64,240
12	F. Manalo St. near. Tipas River and Laguna de Bay	Taguig	MTSP - with extension	UASB - SBR	1.39										C	26 (26)	52,670
13	D. Macapagal highway near corner NAIA Road	Pasay	New	UASB - SBR	2.10							S	15 (15)	30,660	S	27 (27)	85,045
14	Sucat Road corner Bernabe St., Bernabe Subd. (near EVACOM)	Parañaque	New	UASB - SBR	1.68										S	32 (32)	64,970
15	Alabang-Zapote Road beside Uniwide Sales Metromall	Las Piñas	New	UASB - SBR	4.03										S[4] & C	80 (80)	162,060
16	San Guillermo St. adjacent to Alabang River and Laguna de Bay	Muntinlupa	New	UASB - SBR	3.53	S[4] & C	50 (17)	73,000	S	50 (24)	115,340	S	70 (61)	129,940	S	70 (70)	147,825
TOTAL							25	89,060		48	163,885		317	645,503		413	870,087

[1] UASB-SBR - Upflow Anaerobic Sewage Blanket - Sequencing Batch Reactor
[2] Values in () represent actual flows to the STP
[3] Combined Sewerage System
[4] Septic Tank Effluent Disposal (STED) System

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Table 5.11 – Summary of Sewerage Facilities and Costs for Metro Manila

	Total Summary of Facilities		2010	2015	2020	2025	TOTAL
	(1) Trunk Main Areas, (m),(∅250mm -∅1350mm)		7,235	14,418	34,062	44,192	99,907
	(2) Reticulation Areas, (ha.):*includes existing sewered area						
	Total sewered area (ha.)		1,613	704	4,389	5,051	11,757
	(3) UASB-SBR Capacity, (Mld)		48	36	228	300	612
	Total Costs in P million						
	(1) STP Area & Land Cost						
	(a) Required STP Area (ha)		2.46	1.88	12.51	17.19	34.04
	(b) STP Land Cost		465	498	1,565	2,508	5,036
	(2) STP Cost		1,618	867	5,735	7,329	15,549
	(3) Sewer Trunks Costs		117	386	931	1,715	3,148
	(4) Reticulation Costs		1,075	1,197	6,705	7,026	16,003
	Total Cost of Facilities & Land (MPhp):		3,276	2,948	14,936	18,577	39,736
	30% Contingency:	30%					*51,657*
	Total Cost per Hectare(MPhp)						4.39

5.4.6 Treatment of Manila Central Sewerage System (MCSS) Flow

There have been no recent thorough studies conducted to ascertain the assimilative capacity of Manila Bay, particularly in receiving domestic wastewater discharges from the MCSS outfall. But there are a number of reports and studies that infer to the deteriorating conditions of water quality of the bay. A thorough study is needed to define whether the discharge from MCSS (a point source) is actually contributing to continued degradation of the water quality of the Bay. Only then, can recommendations be made regarding the need for a MCSS treatment plant.

A treatment plant, if required for the MCSS, would come at considerable cost and would likely subtract from sewerage efforts around the rest of the MWSS Service Area. This 2005 Master Plan did not consider the current information of sufficient overview and depth to warrant recommending a MCSS treatment plant.

An Enhanced Primary Treatment (EPT) was nevertheless costed as a potential option for a MCSS treatment plant at PhP 3.2 billion (year 2000). This treatment process does not provide biological treatment but focuses on removal of solids to reduce the BOD by up to about 40%. The potential MCSS EPT plant would be located at the bay shores of Manila Bay (on reclaimed land of about 5 ha), near the line of sight for current outfall diffuser. The downside of this system is the great volume of solids (estimated below at over 500 tons per day) it produces, which will require land disposal. At a disposal cost of PhP 400 per ton, just the disposal cost (no chemicals) would amount to PhP 75 million (US$ 1.4 million) per annum.

5.4.7 Overall Approach of Concessionaires

The 2003 Rate Rebasing converted many of the sewerage targets for MWCI into increased sanitation targets. MWSI sewerage targets remained as per the 1997 Concession Agreement but were moved forward by five years, starting in 2006. No change was made to the MWSI sanitation targets to compensate for the delays in sewerage coverage.

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MWCI

The meeting by MWCI of their 2003 Rate Rebasing targets for sanitation and sewerage is mostly tied to implementation of the MTSP. Achieving contractual targets does not necessary promote those design options that provide the lowest cost sewerage per unit area. Lower costs are often achieved by approaching the design from a wider drainage catchment perspective.

The below excerpt from *Strategic Action Paper 11* of this study illustrates that small STPs and catchments are only implemented at considerably higher per capita costs, particularly if little or no space is available (see the underground Riverbank STPs - Poblacion STPs with a catchment of 30 ha; Ilaya STP with a catchment of 49 ha; Capitolyo STP with a catchment of 100 ha).

Table 5.12 – Comparison of Dirty Water Treatment Technologies§

Dirty Water Treatment System	Dirty Water Flow Range	Dirty Water Flow BOD	Estimated Const.Cost[1] per kg BOD Rem. per Year		Estimated Annual O&M Cost[1] per kg BOD Rem	
	(MLD)	(kg/d)	($US)	(PhP)	($US)	(PhP)
Sequencing Batch Reactors						
Foess (2003)	0.4	102	$18.71	P1,029	$3.23	177.65
MTSP: Poblacion Riverbank STP[2]	1.5	142	$14.01	P771	$1.06	58.46
MTSP: Ilaya Riverbank STP[2]	2.3	266	$7.10	P391	$0.87	47.84
MTSP: Capitolyo Riverbank STP[2]	3.9	693	$3.17	P175	$0.56	30.67
MTSP: Taguig Low Income Scheme[2]	6.1	1,775	$2.81	P155	$0.36	19.55
Cost Estimate 2005 MP Study	10.0	3,000	$6.82	P375	$0.56	30.93
MTSP: Quezon City – Marikina sewerage system[2]	10.4	3,120	$5.73	P174	$0.29	15.97
Bradford, California[3]	27.0	3,436	$5.73	P267	$1.03	56.65
MTSP: Alternative Option of Stand-along SBRs for Treating Pollution from Hagonoy, Taguig, Labasan and Tapayan Rivers into Laguna Lake (alternative to conjunctive use of flood ponds); for 2025 flows[4]	151.9	34,411	$2.56	P141	$0.38	21.12

The Riverbank STPs may meet contractual targets, but in a short time (i.e. fifteen years or just beyond the concession period) these plants will be beyond their economic service life. The STPs will have to be decommissioned in favor of an interceptor leading to a larger STP. Sites for this larger STP are likely more scarce than present due to increasing population pressures.

Much of the analyses in this 2005 Master Plan concurred with what was done in the 2004 NJS Master Plan for the East Concession. Combined drainage was selected as the least cost / preferred option in both studies. This study proposes to use combined drainage (i.e. the use of the storm drains) where it is appropriate but proposes to decommission those systems on a "greatest human risk" basis when the financial ability is available to do

§
1 All costs have been escalated to 2005.
2 NJS et al (2004)
3 http://www.town.bradfordwestgwillimbury.on.ca/articles/MasterServicingStudy
4 MTSP Feasibility Study by NJS et al (2004); flow represents a population of 732,411; assumes 80% H20 use, 7.3 m3/ha/d infiltration, 47g BOD/p/d by 2025.

so. STED reticulation was selected mostly throughout the service area due to the large number of septic tanks already in existence and the fact that combined drainage cannot be employed in every catchment. STED reticulation has its own disadvantages but represents the least cost and lowest risk sewerage methodology for Metro Manila.

The selection of treatment systems by this study and the East Zone Master Plan also preferred the use of Sequencing Batch Reactor over other aerobic biotreatment technologies. This study went further by preferring an anaerobic – aerobic biotreatment process (UASB-SBR) combinations (over a simple SBR) when appropriate to reduce overall treatment costs and sludge production. There is enough evidence available from India and Brazil to support this selection, particularly for this tropical climate.

The use of the low-cost methodologies for sewerage adopted in this study (i.e. combined drainage and STED systems) requires a strong sanitation program to keep the existing septic tanks in working order. New septage treatment plants and truck fleets are proposed to meet this demand. Moreover, new sewage treatment facilities should be capable of treating not only sewage but also septage. There are too many septic tanks to decommission in favor of pure gravity sewerage. The approach is pragmatic and economically sound.

MWSI

The effect of moving sewerage targets five years forward without moving sanitation will adversely affect the management of pollution as illustrated by the examples in **Figures 5.8**, **5.9** and **5.10** for the municipalities of Pasay, Quezon and Caloocan, respectively.

The total sanitation and sewerage coverage for Caloocan City in the original concession agreement by 2021 was 100%. The 2003 Rate Rebasing reduced this 2021 total to 53% or a decrease of 47% (**Figure 5.8**).

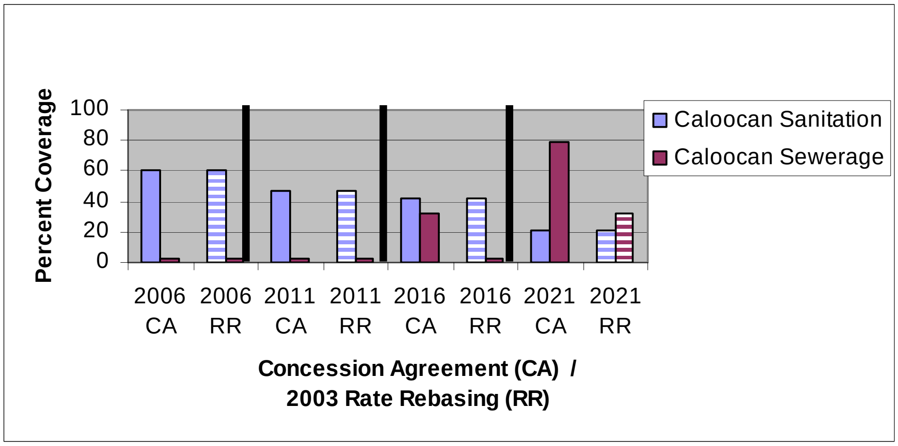

Figure 5.8 Sewerage and Sanitation Targets for Caloocan

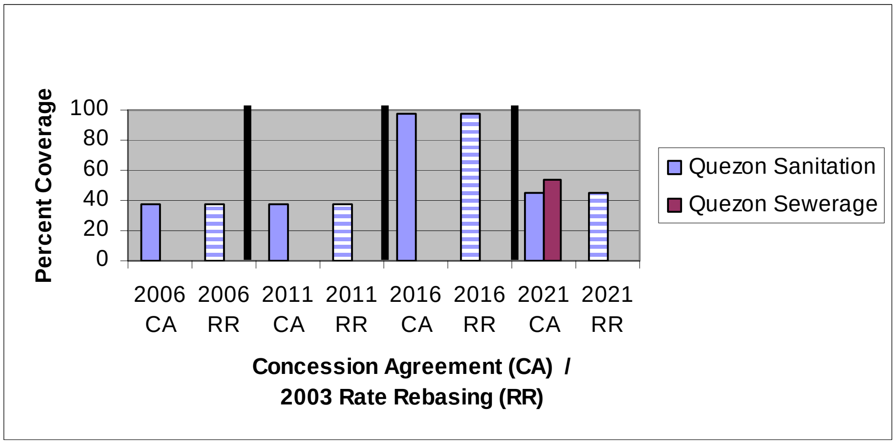

Figure 5.9 Sewerage and Sanitation Targets for Quezon

This coverage is worse for that portion of Quezon City in the West. The total sanitation and sewerage coverage in the original concession agreement by 2021 was 99%. The 2003 Rate Rebasing reduced the 2021 total to 45%. By 2021 there will be no sewerage coverage, yet reduced sanitation coverage from 2016 to 2021 of 54% (**Figure 5.9**).

Another example is the case of Pasay City. The total sanitation and sewerage coverage in the original concession agreement by 2021 was 95% sewerage. The 2003 Rate Rebasing reduced this by 2021 to 16% sewerage; at the same time, sanitation coverage disappears entirely from 2016 to 2021 (**Figure 5.10**).

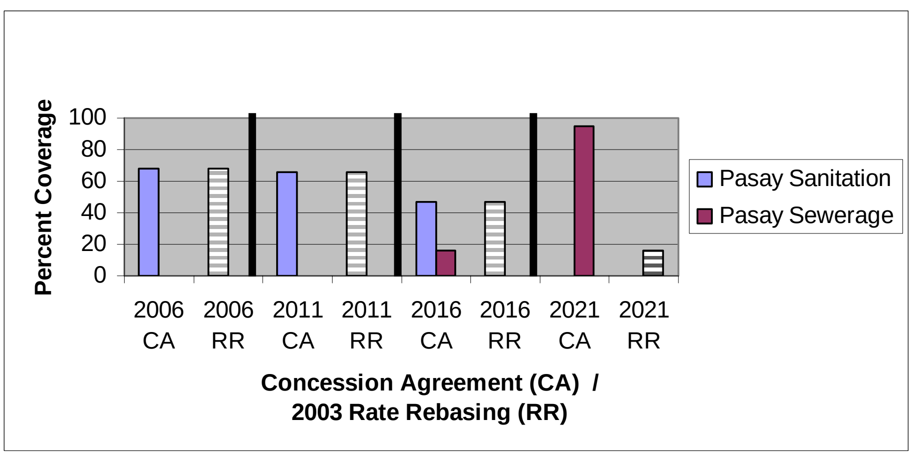

Figure 5.10 Sewerage and Sanitation Targets for Pasay

Sanitation and sewerage were taken as inseparable in the original 1997 CA but considered separately in the 2003 Rate Rebasing. As a result some areas were greatly disadvantaged.

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6. Economic and Financial Studies

6.1 Tariff Implication of Developing New Water Sources

Approach

The Concession Agreements between MWSS and the two Concessionaires provide for the bases in changes in tariff.

The key elements in the conduct of rate rebasing are:

1. Examination of the concessionaire's cash position;
2. Determination of appropriate discount rate (i.e. commencement ADR and future ADR);
3. Evaluation of past and future service obligation targets; and
4. Evaluation of future capital and operating expenditures.

For this study, a limited financial evaluation is conducted. In relation to the rate rebasing exercise, this evaluation will focus only on future capital and operating expenditures, the last key element listed above.

FIRR is calculated for a period of 30 years (in recognition of the long asset lives of the projects) after the inception of projects using the cash flow based on constant price (i.e. inflation not considered). For this Master Plan study, it is calculated for the study period of 2007 to 2036.

Financial Costs

The capital investments of the recommended option in this Master Plan are summarized in **Table 6.1**.

Financial Benefits

The financial benefits of the proposed projects will be realized as an increase in revenue resulting from increased water supply to target end users.

Three scenarios in the implementation of revenue water rates are evaluated in this study. First, the current average water charge (2005) is used as the base scenario. Two levels of possible increases in water charge are then analyzed as to their affordability and viability. **Table 6.2** briefly describes the three scenarios.

The annual financial benefits (in million m^3 per year) of the proposed projects are presented in **Table 6.3**.

Financial Internal Rate of Return (FIRR) and Affordability Analysis

Based upon the net cash flows of the incremental revenue and costs, the financial internal rate of return and affordability results are shown in **Table 6.4**.

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Table 6.1 - Summary Cost of Investments (US$ 103)

Component/Stage	Land Acquisition /Resettlement ($x10^3$ US $)	Construction Cost ($x10^3$ US $)			Total Local Currency ($x10^3$ US $)	TOTAL Cost ($x10^3$ US $)
		Total	Foreign	Local		
Water Source Development						
1st Stage- Laiban Dam						
Laiban Dam	86,366.2	201,227.3	116,218.0	85,009.2	171,375.5	287,593.5
1st Waterway	15,075.4	455,535.1	309,840.0	145,695.1	160,770.5	470,610.4
WTP # 1 and # 2	13,985.2	192,551.0	151,103.5	41,447.5	55,432.7	206,536.2
WTP # 3	0.0	83,129.1	65,235.2	17,893.9	17,893.9	83,129.1
Sub-total...1st Stage	*115,426.8*	*932,442.4*	*642,396.7*	*290,045.7*	*405,472.5*	*1,047,869.2*
2nd Stage- Kanan Dam						
Kanan Dam	18,238.5	256,699.5	148,255.8	108,443.7	126,682.3	274,938.1
Kanan - Laiban Tunnel	489.9	170,625.8	116,054.1	54,571.7	55,061.7	171,115.7
Access Road	0.0	52,577.0	30,365.6	22,211.4	22,211.4	52,577.0
2nd Waterway	28,622.1	656,944.4	446,832.0	210,112.4	238,734.4	685,566.5
WTP #4	18,860.2	194,078.0	152,301.8	41,776.2	60,636.3	212,938.1
WTP # 5	0.0	150,531.1	118,128.6	32,402.5	32,402.5	150,531.1
WTP # 6	0.0	150,531.1	118,128.6	32,402.5	32,402.5	150,531.1
Sub-total...2nd Stage	*66,210.7*	*1,631,986.9*	*1,130,066.5*	*501,920.4*	*568,131.1*	*1,698,197.6*
Total Cost	181,637.5	2,564,429.4	1,772,463.2	791,966.1	973,603.6	2,746,066.9
Districution Trunk and Primary Mains						
Phase 1 - Maynilad & Manila Water						
General		5,409.5	1,081.9	4,327.6	4,327.6	5,409.5
Pipe mains, supply		72,062.7	56,132.1	15,930.6	15,930.6	72,062.7
Pipe laying		27,744.1	5,548.8	22,195.3	22,195.3	27,744.1
Valves and appurtenances		9,980.7	1,996.1	7,984.5	7,984.5	9,980.7
Pipework ancillaries		13,473.9	2,694.8	10,779.1	10,779.1	13,473.9
Provisional item		11,976.8	2,395.4	9,581.5	9,581.5	11,976.8
Crossing Mangahan floodway, 2800mm		1,901.0	830.8	1,070.2	1,070.2	1,901.0
Crossing Pasig River, 2800mm		950.5	415.4	535.1	535.1	950.5
Indirect Costs, 35%		50,224.7	23,605.6	26,619.1	26,619.1	50,224.7
Sub-total...Phase 1		*193,724.0*	*94,700.9*	*99,023.1*	*99,023.1*	*193,724.0*
Phase 2 - Maynilad Water						
General		1,912.9	382.6	1,530.3	1,530.3	1,912.9
Pipe mains, supply		25,481.9	19,849.5	5,632.4	5,632.4	25,481.9
Pipe laying		9,810.5	1,962.1	7,848.4	7,848.4	9,810.5
Valves and appurtenances		3,529.2	705.8	2,823.4	2,823.4	3,529.2
Pipework ancillaries		4,764.5	952.9	3,811.6	3,811.6	4,764.5
Provisional item		4,235.1	847.0	3,388.1	3,388.1	4,235.1
Indirect Costs, 35%		17,406.9	8,181.3	9,225.7	9,225.7	17,406.9
Sub-total...Phase 2		*67,141.1*	*32,881.2*	*34,259.8*	*34,259.8*	*67,141.1*
Phase 3 - Maynilad Water						
General		6,902.1	1,380.4	5,521.6	5,521.6	6,902.1
Pipe mains, supply		10,508.0	8,178.2	2,329.9	2,329.9	10,508.0
Pipe laying		4,045.6	809.1	3,236.5	3,236.5	4,045.6
Valves and appurtenances		1,455.4	291.1	1,164.3	1,164.3	1,455.4
Pipework ancillaries		1,964.7	392.9	1,571.8	1,571.8	1,964.7
Provisional item		1,746.4	349.3	1,397.1	1,397.1	1,746.4
Indirect Costs, 35%		9,317.8	4,379.4	4,938.4	4,938.4	9,317.8
Sub-total...Phase 3		*35,940.0*	*15,780.3*	*20,159.6*	*20,159.6*	*35,940.0*
Total Cost		296,805.0	143,362.5	153,442.5	153,442.5	296,805.0
GRAND TOTAL COST	181,637.50	2,861,234.37	1,915,825.75	945,408.62	1,127,046.12	3,042,871.87

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Table 6.2 - Possible Water Charges

	Average Water Charge		Possible Increase in Water Charge
	PhP/m^3	US$/m^3	
Scenario 1	16.83	0.306	2005 Average Charge
Scenario 2	22.38	0.407	33%
Scenario 3	26.25	0.477	56%

Exchange Rate: US$1.00=PhP 55.00

Table 6.3 - Summary of Annual Financial Benefits

Year	Water Production				Electric Energy Production	
	Volume (MCM)	Income (US$)			Capacity (GWH)	Income (US$)
		Scenario 1	Scenario 2	Scenario 3		
2015	393	120,194	159,858	187,503	179	14,096
2016	435	133,107	177,033	207,647	179	14,096
2017	481	147,060	195,590	229,414	179	14,096
2018	526	161,013	214,147	251,180	179	14,096
2019	572	174,966	232,705	272,947	179	14,096
2020	617	188,919	251,262	294,714	179	14,096
2021	666	203,876	271,156	318,047	179	14,096
2022	718	219,839	292,385	342,948	418	32,910
2023	771	235,801	313,615	367,849	418	32,910
2024	823	251,763	334,845	392,750	418	32,910
2025	875	267,725	356,074	417,651	418	32,910
2026	927	283,687	377,304	442,552	418	32,910
2027	979	299,649	398,534	467,453	418	32,910
2028	1,031	315,612	419,763	492,354	418	32,910
2029	1,084	331,574	440,993	517,255	418	32,910
2030	1,136	347,536	462,223	542,156	418	32,910
2031	1,188	363,498	483,452	567,057	418	32,910
2032	1,240	379,460	504,682	591,958	418	32,910
2033	1,292	395,422	525,912	616,859	418	32,910
2034	1,344	411,385	547,142	641,760	418	32,910
2035	1,397	427,347	568,371	666,661	418	32,910
2036	1,449	443,309	589,601	691,562	418	32,910

Notes: Unit Cost of Water (US$/m^3)
Scenario 1 = US$0.306
Scenario 2 = US$0.407
Scenario 3 = US$0.474
Unit Cost of Energy = US$0.08/kWH

Table 6.4 - Summary Result of Financial Evaluation

Scenario	2005 Average Tariff		Possible Tariff Increase	% of Household Income	FIRR	NPV
	Php/m^3	US$/m^3				
1	16.83	0.306	-	3.2%	7.6%	(279,288)
2	22.38	0.407	33%	4.3%	10.4%	1,579
3	26.25	0.477	56%	5.0%	12.1%	197,334

6.2 Sewerage Tariffs and Subsidies

Proposed Subsidy

At the lowest level, households place a high value on sanitation services that provide a private, convenient and odor-free facility that removes excreta and dirty water from the property or confines it appropriately on-site. However, there are clearly benefits, which accrue at a more aggregate level and are therefore externalities from the point of view of the household. Willingness-to-pay surveys have shown that households are willing to pay for the first category of service benefits, but their interest in paying for external (environmental) benefits that they consider beyond their concern is questionable. The fundamental principle of public finance is that costs should be assigned to different levels in a typical modern hierarchy, according to the benefits accruing at the different levels from households to blocks to neighborhood to drainage catchment to city or municipality to national.

Current Tariff Structure

The current tariff structure for sewerage and sanitation allows the concessionaires to charge (i) an Environmental Charge, amounting to 10% of the water charge that is levied on all customers where the current average charges (January 2005) are PhP 2.50 per m^3 of water consumed (West Zone) and PhP 1.53 per m^3 of water consumed (East Zone) and (ii) Sewerage Charge equivalent to 50% of the Water Charge to cover the cost of sewage treatment and expansion of sewerage services; this is levied on customers who are connected to the sewerage system and the current average charges are PhP 12.50 per m^3 of water consumed (West Zone) and PhP 7.66 per m^3 of water consumed (East Zone).

Under the terms of the Concession Agreements, project capital expenditures are allowed to be recovered through tariff adjustments, i.e. through increased prices to customers. This provision allows for cost recovery through cross-subsidy, as the cost of a project is passed on to all customers in the concession area, whether or not they are directly benefiting from the project.

The provision of sewerage and sanitation services in urban areas is important for the protection of the environment and the maintenance of public health. The benefits from these projects can be shared by all or a large proportion of the entire community.

The components of cost sharing framework are shown in **Figure 6.1**. The existing situation in Metro Manila is that the customers connected to the sewerage system pay a Sewerage Charge while all customers, whether connected or not, pay an Environmental Charge (or Common Charge).

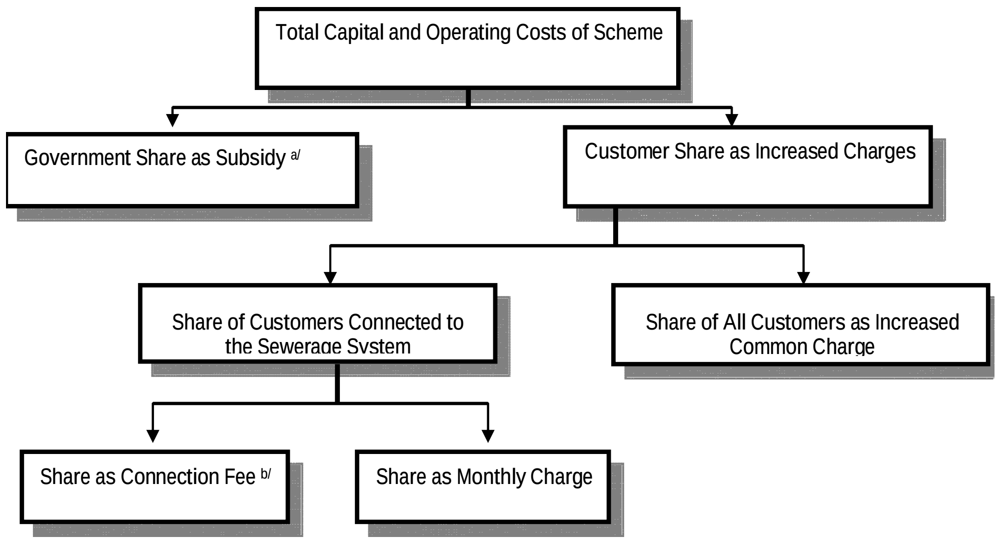

Figure 6.1 Cost Sharing Framework

User Pays

The general principle for economic pricing of infrastructure services is that the users of the services or those who benefit from the provision of the services, should pay for the resources consumed in providing the services – commonly referred to as the 'user pays' or 'beneficiary pays' approach. However, everyone benefits from an improved environment and cost sharing between the wider community and local residents is therefore appropriate in this case. Moreover, the levying of uniform service (fixed) or usage (variable) charges for services that provide similar outcomes across the same service area is an administratively efficient and equitable means of charging for sewerage and sanitation services to residential customers. However, it does result in some customers cross-subsidizing others and is not entirely consistent with a strict 'user pays' view of charging.

Willingness to Pay

Cost recovery strategies need to have regard to customer willingness to pay and affordability. This study's willingness-to-pay survey found that 75% of respondents were willing to pay an additional 20% on top of their water bill for improved sewerage or sanitation services. The generally accepted guideline by international funding agencies for household expenditure on water supply, sewerage and sanitation services is no more than 5% of average household income. The survey found that households in Metro Manila are willing to pay, on average, less than this threshold level, many because of the belief that MWSS should be responsible for paying for the improved services.

Cost Recovery Strategies

In terms of the cost recovery strategies shown herein, it is appropriate to allocate these costs to all customers, not just those receiving the improved services, via a common sewerage/sanitation charge. This charge can be levied through the monthly water bill as a usage charge per m^3 of water consumed (the current arrangement for charging for sewerage and sanitation services) or as a uniform service (or access) charge per household connection. Capital expenditure could also be funded from National Government subsidy in the form of direct budgetary outlay or other forms of grant. However, based on discussions with MWSS officials, the subsidy option is currently unlikely.

The current water charges for the low income group are already approaching the same level as the generally acceptable percentage of household income. The scope for increasing charges is greater for the high-income group current charges are only equivalent to about 2.0% of their disposable household income. One option to maximize the cost sharing ability of the high-income group is by implementing progressive charging. Progressive charging implies a higher charge for higher water usage and sewage discharge. This can be achieved through an increasing block tariff structure, like the existing water charges structure. A minimum charge may be retained, so as not to further burden the low-income group.

6.3 Financial Analysis for Sewerage and Sanitation Master Plan

6.3.1 Introduction to Financial Analysis

In accordance with the Terms of Reference of the TA for Strengthening MWSS' Planning Capability, the financial analysis of the proposed sewerage and sanitation improvement plans is undertaken. The focus of this financial study is on the impact of the cost of the Master Plan on the tariff being charged by the concessionaires to their customers. Financial parameters of the projects are identified and financial impact evaluated.

In analyzing the Plan's financial viability, the discounted cash flow technique was used in determining the Average Incremental Cost (AIC) and the Financial Internal Rate of Return (FIRR). Cash flows were projected over the concession period and also over a 40-year period from year 2006 to 2045. The latter approach would remove the bias from residual values that might be derived if the projection period were limited to the concession period (2021). Furthermore, the operations and maintenance costs for each program would have fully worked out their cost implications with the use of longer term projection period.

The financial evaluation is done separately for the sanitation and sewerage components. Likewise, separate evaluation is conducted for the two concession areas, East Zone and West Zone since the existing tariff differs between the two concession areas.

Since the cost of the project can be passed on to the household consumers, viability were looked at from the point of view of the affordability of the sanitation and sewerage charges and the willingness and the ability of the consumers to pay the adjusted rates.

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6.3.2 Financial Costs

Sanitation

Assumptions used are as follows:

- Capital cost includes cost for land acquisition, construction of Septage Treatment Plant and acquisition of vacuum tankers. These are presented in **Table 6.5.**
- Contingency of 30 % is added to basic cost.
- Prices are at 2005 level.
- Exchange rate at US$1 = PhP 56.00
- Implementation schedule follows the targets set in the engineering study.
- Operation and maintenance costs and disposal of sludge are as estimated by the Engineers and discussed in this Plan. These are summarized in **Table 6.6**.

Table 6.5 - Summary of Proposed Capital Investment Costs for Sanitation (PhP Million)

		Total	2010	2015	2020	2025
Septage Treatment Plant	**Capacity**					
Rizal	800 m^3/day	973		973		
Rizal (Expansion)	800 m^3/day	941				941
Dagat-dagatan	400 m^3/day	470.4	470.4			
Dagat-dagatan (Expansion)	600 m^3/day	705.6		235.2	235.2	235.2
Paranaque/Las Pinas	500 m^3/day	827.8	475	235.2		117.6
Total		***3,917.80***	***945.4***	***1,443.40***	***235.2***	***1,293.80***
Vacuum Tanker	**Unit**					
MWCI		780.6				
	31	112.8			112.8	
	5	18.2				18.2
Vacuum Tanker (5 m^3)	0	0				0
	2	9		9		
	110	492.8			492.8	
Vacuum Tanker (10 m^3)	33	147.8				147.8
MWSI		793.5				
	6	21.8	21.8			
	5	18.2		18.2		
	4	14.6			14.6	
Vacuum Tanker (5 m^3)	11	40				40
	40	179.2	179.2			
	42	188.2		188.2		
	20	89.6			89.6	
Vacuum Tanker (10 m^3)	54	241.9				241.9
Total		***1,574.20***	***201***	***215.3***	***709.8***	***448***
T O T A L		***5,492.00***	***1,146.40***	***1,658.70***	***945***	***1,741.80***
T O T A L (With Contingency)		***7,139.50***	***1,490.40***	***2,156.30***	***1,228.50***	***2,264.30***

NOTES:
Exchange Rate US$1 = Php56.00
Cost of Tankers
Vacuum Tanker (5 m^3)
Php3,640,000.00
Vacuum Tanker (10 m^3)
Php4,480,000.00

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Table 6.6 – Operation and Maintenance Costs for Sanitation Facilities

Septage Treatment Plant	PhP 0.082 million/m3/year
Vacuum Tanker (5 m^3)	PhP 0.92 million/tanker/year
Vacuum Tanker (10 m^3)	PhP 1.05 million/tanker/year
Sludge Disposal	As estimated by Engineers

Sewerage

Assumptions used are as follows:

- Capital cost includes cost for land acquisition, construction of Sewage Treatment Plant, construction of main trunks and reticulation. Details are shown in **Table 6.7.**
- Contingency of 30 percent is added to basic cost.
- Prices are at 2005 level.
- Exchange rate at US$1 = PhP 56.00
- Implementation schedule follows the targets set in the engineering study.
- Operation and maintenance costs are as estimated by the Engineers.

Table 6.7 - Summary of Proposed Capital Investment Costs for Sewerage

Component	Year of Implementation	Project Cost (PhP million)	
		West Zone	East Zone
Phase 1	2010		
Land Acquisition		402	63
Sewerage Treatment Plant		1,408.00	210
Trunk Sewer Pipe		117	-
Reticulation		998	77
Sub-Total Cost		***2,925.00***	***350***
Phase 2	2015		
Land Acquisition		428	70
Sewerage Treatment Plant		732	135
Trunk Sewer Pipe		341	45
Reticulation		1,044.00	153
Sub-Total Cost		***2,545.00***	***403***
Phase 3	2020		
Land Acquisition		1,329.00	236
Sewerage Treatment Plant		5,041.00	695
Trunk Sewer Pipe		912	19
Reticulation		6,574.00	131
Sub-Total Cost		***13,856.00***	***1,081.00***
Phase 4	2025		
Land Acquisition		1,884.00	624
Sewerage Treatment Plant		4,949.00	2,380.00
Trunk Sewer Pipe		1,108.00	606
Reticulation		5,580.00	1,309.00
Sub-Total Cost		***13,521.00***	4,919.00
Total Capital Costs (All Stages)		**32,847.00**	***6,753.00***
Total Capital Costs (With Contingencies)		**42,701.10**	***8,778.90***

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6.3.3 Financial Revenues

Incremental revenue is computed in this study to determine the level of tariff that would generate recovery of the capital expenditure and operating costs of the Master Plan. The incremental tariff is multiplied by the projected capacity of the facilities to derive incremental revenue. For the purpose of this financial analysis, the incremental revenues are likewise expressed in 2005 prices.

Sanitation

The financial benefits of the proposed Plan will be materialized as an increase in revenue resulting from increased number of septic tanks that will be desludged. The increase in septic tanks desludged will be made possible by the two components of the Proposed Plan, the construction of Septage Treatment Plants and the acquisition of vacuum tankers.

It is further assumed that there will be additional income from private collection tankers that will service the desludging of individual septic tanks. They are expected to dispose of their collected septage in the Septage Treatment Plants. This could be regulated by the Local Government Units concerned who will require the use of the SpTPs and monitor the operations of these private collection tankers. As per the engineering design, a remaining 10 percent will be serviced by these private collection tankers.

Three scenarios of tariff levels were analyzed. The scenarios are:

- Tariff based on calculated AIC with discount rate of 10.4 percent;
- Tariff based on WTP rate computed from the Survey Results; and
- Tariff based on affordability of consumers (total tariff assumed to be not more than 5 percent of household income).

The following table summarizes the proposed tariff for each scenario.

Table 6.8 - Tariff Rates for Sanitation

	WEST ZONE	EAST ZONE
Water consumed (m^3/mth)	37	37
Water charge (P/m^3) [a/]	15.88	9.91
Sanitation charge (P/m^3)		
Based on AIC [b/]	1.69	2.67
Based on WTP rate [c/]	3.67	2.94
Based on affordable rate [d/]	12.47	18.37

a/ As at January 2005 excluding Environmental Charge. Includes 10% VAT.

b/ Based on Average Incremental Cost computation with discount rate of 10.4%.

c/ From WTP Survey (results tabulated separately for East and West Zone).

d/ Average mid range of affordability from each household type .

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Sewerage

For sewerage, the financial benefits of the proposed Plan will come from the increase in sewerage connections made possible by the two components of the proposed Plan, the construction of Sewage Treatment Plants and the laying out of trunk mains and reticulation to connect individual households. **Table 6.9** summarizes the tariff for Sewerage.

Table 6.9 – Tariff Rates for Sewerage

	WEST ZONE	EAST ZONE
Water consumed (m^3/month)	37	37
Water charge (PhP/m^3)	23.09	14.42
Sewerage charge (PhP/m^3)		
Based on AIC	26.27	17.63
Based on WTP rate	3.51	2.45
Based on affordable rate	11.72	18.28

6.3.4 Result of Financial Analysis

Average Incremental Cost

The annual stream of costs and benefits are discounted using a discount rate of 10.4 percent. From the summary tables presented above, it is shown that for sanitation, the tariff based on AIC is lower compared to WTP and Affordability rates. Significantly, this is not true for the case of Sewerage where the AIC rates for both West Zone and East Zone are much higher than the WTP and Affordability rates.

Financial Internal Rate of Return

The incremental tariff that would give a Financial Internal Rate of Return equal to the Weighted Average Cost of Capital or give a net present value of zero to the net financial benefits using the WACC as the discount rate. The WACC has been set at 10.4 percent in the last rate rebasing and was also used in this Study. The following table presents a summary of FIRR given various levels of tariff – based on AIC, WTP and Affordability rates.

Table 6.10 – Summary Result of Financial Internal Rates of Return

Sanitation		
Based on AIC [b/]	11.9%	26.3%
Based on WTP rate [c/]	47.8%	17.9%
Based on affordable rate [d/]	130.0%	130.3%
Sewerage		
Based on AIC	10.4%	10.4%
Based on WTP rate [c/]	-	-
Based on affordable rate [d/]	-	-0.6%

Affordability of Tariff Rates

The Concession Agreement between MWSS and the two concessionaires, MWCI and MWSI, allows the concessionaires to recover all costs related to the project through the rate rebasing mechanism. The proposed investment plans can be considered financially viable if the resulting incremental charges remain acceptable to the consumers. A study of the impact of the Plan to existing tariffs, therefore, becomes a crucial determinant of financial viability from the point of view of consumers, MWSS and the two Concessionaires.

One significant aspect for MWSS is the provision that allows for cross-subsidy, wherein the cost of the project is passed on to all customers, whether or not they are directly benefiting from the improvement. Cross subsidy may be necessary specifically for the Sewerage Component. From **Tables 6.11 and 6.12**, a number of significant points can be noted.

For Sanitation:

- The AIC rates for both West Zone and East Zone are within the consumers' willingness to pay for increased charges and their affordability to pay for such increases.
- In both Zones, while some level of increases in charges are acceptable to the consumers, these willingness are way below their computed affordability.
- Based on AIC, sanitation charges are about 11 percent and 27 percent of water tariff for the West Zone and East Zone, respectively. This compares with the existing Environmental Charge of 10 percent of Water Tariff.
- The total water bill will be about 2.2 percent to 3.1 percent of the household mean income of PhP 20,856 per month.

For Sewerage:

- The AIC rates for both West Zone and East Zone are way above the consumers' willingness to pay for increased charges and their affordability to pay for such increases.
- In both Zones, while some level of increases in charges are acceptable to the consumers, these willingness are much lower than their computed affordability.
- Based on AIC, sanitation charges are 165 percent and 178 percent of water tariff for the West Zone and East Zone, respectively. Compared with the existing Environmental Charge of 50 percent of Water Tariff, these again are significantly high.
- The total water bill will be about 6 percent to 9 percent of the household mean income of PhP 20,856 per month.

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Table 6.11 – Affordability Analysis for Improved Sanitation Services

	WEST ZONE	EAST ZONE
Water consumed (m^3/mth)	37	37
Water charge (PhP/m^3)	15.88	9.91
Sanitation charge (PhP/m^3)		
Based on AIC	1.69	2.67
Based on WTP rate	3.67	2.94
Based on affordable rate	12.47	18.37
Financial Internal Rate of Return		
Based on AIC b/	11.90%	26.30%
Based on WTP rate c/	47.80%	17.90%
Based on affordable rate d/	130.00%	130.30%
Sanitation Charge as % of Water Charge		
Based on AIC b/	11%	27%
Based on WTP rate c/	23%	30%
Based on affordable rate d/	79%	185%
Total water bill (PhP/month)		
Based on AIC	650	465
Based on WTP rate	723	476
Based on affordable rate	1,049	1,046
Household Mean Income (PhP/month)	20,856	20,856
Water bill as % of income		
Based on AIC	3.10%	2.20%
Based on WTP rate c/	3.50%	2.30%
Based on affordable rate d/	5.00%	5.00%

Table 6.12 – Affordability Analysis for Improved Sewerage Facilities

	WEST ZONE	EAST ZONE
Water consumed (m^3/month)	37	37
Water charge (PhP/ m^3) a/	23.09	14.42
Sewerage charge (PhP/m^3)		
Based on AIC	26.27	17.63
Based on WTP rate c/	3.51	2.45
Based on affordable rate d/	11.72	18.28
Financial Internal Rate of Return		
Based on AIC	10.40%	10.40%
Based on WTP rate c/	-	-
Based on affordable rate d/	-	-0.60%
Sewerage Charge as % of Water Charge		
Based on AIC b/	165%	178%
Based on WTP rate c/	22%	25%
Based on affordable rate d/	74%	184%
Total water bill (PhP/month)		
Based on AIC	1,826	1,186
Based on WTP rate c/	984	624
Based on affordable rate	1,288	1,210
Household Mean Income (PhP/month)	20,856	20,856
Water bill as % of income		
Based on AIC	8.80%	5.70%
Based on WTP rate c/	4.70%	3.00%
Based on affordable rate d/	6.20%	5.80%

a/ As at January 2005 including Environmental Charge. Includes 10% VAT.
b/ Based on Average Incremental Cost computation with discount rate of 10.4%.
c/ From WTP Survey (results tabulated separately for East and West Zone).
d/ Average mid range of affordability from each household type .

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6.3.5 Conclusion

The computed AIC for the Sanitation Component is still within the willingness to pay and affordability of consumers. However, this is not true for the Sewerage Component since the willingness to pay and affordability of consumers would only cover the operations and maintenance but not the recovery of capital investment.

MWSS is considering the revision of the existing tariff structure by eliminating the 50 percent charge on sewerage and increasing the environmental charge of 10 percent, to say, 15 percent. This would in a way resolve this problem since there would be cross-subsidy among consumer groups like those not connected to the sewerage system will subsidize those connected to the system. This would likewise lower the tariff to a more affordable level since the cost will be passed on to other consumers. This can be justified by the fact that benefits from these projects are shared by all or a large proportion of the entire community, not just in the local community concerned. This would likewise eliminate the reaction of the consumers of not wanting to connect to the sewerage system due to increased cost on their part.

6.4 Economic Analyses for Sewerage and Sanitation Master Plan

The assessment was undertaken using conventional cost-benefit analysis and the discounted cash flow technique. A 40-year evaluation period was adopted, recognizing that many of the SSMP projects are proposed to be implemented beyond the current concession period, which is up to 2022.

6.4.1 Economic Costs

The economic costs of capital works and annual operation and maintenance are calculated from the financial cost estimates on the following basis:

- Price contingencies are excluded but physical contingencies are included because they represent real consumption of resources; a contingency allowance of 30% has been added to the base cost estimates.
- Import duties and taxes are excluded because they represent transfer payments; they have been estimated at 33% of foreign costs and 10% of local costs.
- The existence of unemployment and under-employment for unskilled workers within the Manila economy means that the opportunity cost of unskilled labor can be considered to be lower than its wage rate – a conversion factor of 0.6 of the market wage rate is used to estimate the shadow wage rate; the unskilled labor component is estimated at 40% of local capital costs and 50% of local O&M costs.
- The market wage rate for skilled labor and the acquisition cost of land are considered to represent opportunity costs, as both factors are in demand.
- All costs are valued using the domestic price numeraire, to enable an easier comparison with the information used to measure benefits (e.g. a significant component of benefit is the willingness to pay of households for the improved services). Foreign costs net of duties and taxes are adjusted by the shadow exchange

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rate factor of 1.2; foreign costs as a percentage of capital costs are estimated at 65% for sanitation services and 30% for sewerage services; and as a percentage of O&M costs at 20% for both options.

The effects of loss of access and other types of disruption to residents due to works during the construction phase have been excluded because of the difficulties of measurement. However, the selected option in an area has been chosen to minimize disruption wherever possible.

Tables 6.13 & 6.14 present the economic costs used in the cost-benefit analyses and the flows of expenditure in five-year intervals, for sanitation services and sewerage services respectively. Costs for the former are based on adjusted rate rebasing to consider STED system; costs for the latter exclude proposed expansions of STPs that serve existing or MTSP sewered areas.[3]

Incremental O&M cost represents the increase in annual O&M expenditure compared to the 'base case' situation, i.e. without implementation of the SSMP. It has been estimated by applying the following percentages to capital costs: 7% for septage treatment plants,10% for sewerage treatment plants,[4] 7% for trunk mains, 3% for reticulation pipes and 25% for vacuum tankers[5](with tanker replacement assumed every ten years).

Table 6.13 - Cost Estimates for Sanitation Services Option Economic Analysis [a]/ (PhP Million in 2005 Prices)

	Five Years to				
	2010	**2015**	**2020**	**2025**	**Total [b/]**
Base Cost [c/]					
Septage Treatment Plants	946	1,443	235	1,294	**3,918**
Tankers	201	215	710	448	**1,574**
Total [b/]	1,147	1,533	945	1,742	**5,492**
Economic Cost	1,174	1,697	967	1,783	**5,621**
Incremental O&M Cost	116	429	674	1,047	
As % of economic cost [d/]	*10%*	*15%*	*18%*	*19%*	

Notes:
a/ Based on adjusted rate rebasing to consider STED system.
b/ Totals may not sum exactly due to rounding.
c/ Excludes allowance for planning contingency of 30%.
d/ Expressed as percentage of cumulative economic cost.

[3] These expansions are for STPs in the following schemes in the East CA: Pasig-Taytay (32 MLD) and Taguig-Pateros (25 MLD), both in 2025; and in the West CA: Dagat-Dagatan (91 MLD) and Pasay (15 MLD), both in 2020.
[4] Refer Figures 10.21 & 10.22.
[5] Allows for cost of sludge disposal.

Table 6.14 - Cost Estimates for Sewerage Services Option Economic Analysis
(PhP **M**illion in 2005 **P**rices)

	Five Years to				
	2010	**2015**	**2020**	**2025**	**Total [a]**
Base Cost [b]					
Land for STPs	465	488	1,585	2,688	**5,226**
STPs [c]	1,618	867	5,736	7,729	**11,939**
Trunk Mains	117	386	931	1,817	**3,251**
Reticulation	1,075	1,197	6,705	7,864	**16,841**
Total [a]	3,275	2,938	12,336	18,708	**37,257**
Economic Cost	3,345	3,024	12,547	19,120	**38,036**
Incremental O&M Cost	191	332	876	1,816	
As % of economic cost [d]	*6%*	*5%*	*5%*	*5%*	

STPs – Sewerage Treatment Plants
Notes:
a/ Totals may not sum exactly due to rounding.
b/ Excludes allowance for planning contingency of 30%.
c/ Excludes cost of STP expansions that will benefit existing or MTSP sewered areas (base cost of Php 4.0 million).
d/ Expressed as percentage of cumulative economic cost.

6.4.2 Valuing Economic Benefits

The benefits of improved sewerage or sanitation services will be the improved environmental and living conditions and public health that a better functioning system of sewage and wastewater collection and treatment provides. This will be achieved through the more effective removal of sewage and wastewater from in and around living areas and prevention of sewage and wastewater from entering drains, canals and natural water bodies (streams and rivers) and, in some areas, broken water supply pipelines. Improved disposal of sewage and wastewater will result also in more pleasant surroundings through a reduction in odor and an improvement in the aesthetic quality of drains, canals, natural water bodies, low-lying areas and other areas where wastewater is disposed of.

However, quantifying environmental and health benefits is difficult because of the need for data to establish the magnitude of the impacts of the improvements and to separate out the effects of an improved sewerage system from other factors such as personal hygiene habits, housing standards, water quality, etc.

Difficulties in estimation have meant that benefits which are more readily valued generally have been used in the economic evaluation of environmental improvements – for example, stated willingness to pay for improved services; increased property values; avoided economic costs for households or businesses from not having to undertake certain activities necessitated by the poor delivery of environmental sanitation services. Revenues from service tariffs or charges also have been used but these are generally not good indicators of willingness to pay for improved sewerage and sanitation services because they do not reflect the costs of such services; also, often there has been no history of paying explicitly for environmental services and many people consider that such services should be provided by the government from general taxation revenue.

Willingness to Pay

Information on willingness to pay for improved sewerage and sanitation facilities and services was collected in the WTP Survey of 2,000 households in the MWSS service area

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conducted during June 2005 as part of this TA. The survey methodology and results are discussed in detail in a separate report, *Report on Willingness to Pay Survey* (June 2005). Responses were generally favorable towards willingness to pay, with the majority of respondents stating a relatively high willingness to pay for different options of sewerage and sanitation services. This positive attitude may be attributed to the following key factors:

- the significant value accorded by respondents to the importance of sewerage and sanitation for them to sustain health and cleanliness;
- the respondents' recognition of the need to improve the sanitation and sewerage systems for them to sustain health and cleanliness.

Table 6.15 derives the per household WTP values used as measures of economic benefit in the cost-benefit analyses of the sanitation and sewerage services options. It has been assumed that households have a time frame of about six years when considering WTP for the perceived benefits of improved services, rather than an unlimited time frame – six years is consistent with the average frequency of households' emptying their septic tanks.

Table 6.15 - Derivation of Household WTP Values as Measures of Economic Benefit

	Sanitation Services Option		Sewerage Services Option	
	East CA	West CA	East CA	West CA
% of households stating WTP [a/]	85%	68%	86%	55%
% of monthly water bill				
- for households stating WTP [a/]	20%	20%	20%	20%
- for all households [a/]	17%	14%	17%	11%
Per household WTP amount				
Php per month [b/]	125	140	125	180
Present value [c/]	7,500	8,400	7,500	10,700

Notes:
a/ From *Report on Willingness to Pay Survey*, June 2005, Table 3.
b/ From SAP No.12, *Draft Policy on Sewer Charges*, November 2005, Table 5.3.
c/ Derived using PV factor of 5.6 assuming real interest rate of 2% over six years.

Changes in Property Values

The improvement in the environment, together with some perception of health benefits, may be reflected in the amounts people are willing to pay for property either in terms of rent or the purchase price of the house. The environmental characteristics of the area in which a property is located are sources of variations in property values between different locations.[6]

For example, improved sewage disposal may be part of a range of characteristics associated with a particular property option; individuals who value a new or upgraded sewerage system may be willing to pay more for property with "good" disposal than for a property with "bad" disposal. Following the same reasoning, people may be willing to pay more for housing in areas where they are "less exposed" to environmental degradation and unpleasant surroundings caused by sewage odor, dumped sewage/septage, stagnant wastewater, etc.

[6] Other sources include the attributes of the building itself (e.g. amount and quality of accommodation available) and access to places of work and to commercial, institutional and recreational facilities.

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Quantification of the benefits associated with environmental improvements can be done by comparing property values in areas which are "less exposed" to environmental degradation and unpleasant surroundings with property values in those areas which are "more exposed" to environmental degradation and unpleasant surroundings. It may be sometimes necessary to attribute a portion of the difference in property values to the effects of an improved sanitation or sewerage system alone, as the complementary investments in other environmental sanitation components (such as the drainage or solid waste collection system) may not be being made.

It was not possible to undertake a detailed comparative survey of property values in this TA, so the following conservative assumptions have been made of the property value differentials due to a particular environmental difference between properties:[7]

- Sewerage (combined) system – 3% increase in property values;
- Effective septic tank cleaning/sludge disposal services – 1% increase in property values.

These differentials apply to properties within system catchment or service areas. Existing property values have been estimated from data collected in the WTP Survey of households on monthly rental or housing loan payments, together with assumptions on property market parameters. The assumptions and results are shown in **Table 6.16**.

Table 6.16 Derivation of Average Market Value of Housing, Both Concession Areas

Average monthly payment (Php/month) [a/]	Php 3,700
% of average household expenses	*31%*
% of average household income	*18%*
Estimated market value (Php in 2005 prices) [b/]	Php 932,400

Notes:
a/ From *Report on Willingness to Pay Survey*, June 2005, Figures IV-4 & IV-5 and Annex A.
b/ Assumes a 2.5% real rate of return from rental of residential property over 30 years (present value factor of 21). Taken together with capital value growth of 2.5% per year in real terms, this equates to a total real rate of return on residential property investment of 5% per year (or about 12% in nominal terms).

Avoided Health Care Costs

The WTP Survey collected information on the total medical care expenses of households. Drawing on statistics presented in Section 2.8, it was assumed that:

- 25% of these expenses comprised the costs of treating environmental sanitation diseases;
- Improved sewerage system reduces the incidence of these diseases by one-third; and
- Effective septic tank cleaning/sludge disposal services reduce the incidence of these diseases by one-sixth.

[7] The assumed differentials in property value may also include some perception of health costs but it is felt that the degree of double counting would be minor. Sensitivity analysis showed that the EIRR is very insensitive to changes in the property value increase assumptions.

The derivation of per household avoided health care costs using these assumptions is shown in **Table 6.17**.

Table 6.17 Derivation of Household Avoided Health Care Costs, Both Concession Areas

	Sanitation Services Option	Sewerage Services Option
Average monthly medical care (Php/month) [a/]	PhP 3,200	
% of average household expenses	*27%*	
% of average household income	*15%*	
% on environmental sanitation diseases [b/]	25%	
% reduction in incidence of env'tl sanitation diseases [b/]	33%	16.5%
Per household avoided health care costs (Php/month)	PhP 264	PhP 132

Notes:
a/ From *Report on Willingness to Pay Survey*, June 2005, Figures IV-4 & IV-5 and Annex A.
b/ Drawing on statistics presented in Section 2.8.

Septage Treatment Plant Capacity

For the sanitation services option, there is an additional economic benefit associated with the construction of the septage treatment plants – the capacity that is to be utilized by private septic tank cleaning contractors. It is proposed that 10% of the septic tanks will be serviced by private contractors who will be required to transport the septage to the treatment plants operated by the concessionaires.

For the purpose of measuring economic benefits, it is assumed that private contractors will be charged a treatment fee equivalent to 90% of the average incremental economic cost of treatment (that is approximately Php 560/m^3 in the East CA and Php 780/m^3 in the West CA).[8]

Exclusions

The following benefits of improved environmental sanitation, a cleaner city and better waterway environment have not been quantified:

- Private and public costs of flooding due to canals and drains clogged with sewage/wastewater, including traffic disruption, road repair and building repair;
- Private costs of cleaning homes after sewerage system overflows/backflows;
- Public cost of treating diseases due to poor environmental sanitation;
- Private and public costs of mosquito control;
- Effects on businesses and industries, such as aquaculture and fisheries and agriculture; and
- Effects on tourism and tourist-related businesses.

[8] 90% converts the AIC in economic prices to financial prices, assuming a weighted average financial cost of capital of 10.4% for the concessionaires.

6.4.3 Economic Cost-Benefit Analysis

This section summarizes the results of both the main cost-benefit analysis and the sensitivity analysis. Each SSMP option was compared to the situation without implementation of the Master Plan, using the discounted cash flow technique and an economic opportunity cost of capital of 12%. The evaluation period allowed for 40 years from 2005, with costs and benefits during the SSMP implementation period being determined from an indicative implementation schedule for each investment component. The discount year was taken as 2005 and all values in the following tables are expressed in 2005 prices.

To avoid potential double-counting of the benefits measured by willingness to pay, the per household benefit measures of increased property values and avoided health care costs were applied only to the proportion of households who stated that they would not be willing to pay for improved services.[9] For the proportion of households expressing willingness to pay, it is likely that the WTP amount may include some perception of improved environmental conditions and reduced medical expenses – to include increased property values and avoided health care costs may result in double-counting of benefits for these households.

Main Cost-Benefit Analysis

Table 6.18 presents the results of the main cost-benefit analysis. The table shows that the overall EIRR of the sanitation services option is estimated to be 24% and that of the sewerage services option is 26%. Individual concessionaire area EIRRs for the sanitation services option are 23% (East) and 24% (West) and, for the sewerage services option, 33% (East) and 22% (West). All options have EIRR values exceeding the economic opportunity cost of capital of 12% and can be considered economically viable.

The sewerage services option is preferable to the sanitation services option in terms of maximizing the economic contribution of the capital expenditure involved, because of its higher net present value for each concessionaire area and overall.

Sensitivity Analysis

Sensitivity analysis of the overall options was undertaken in order to assess the robustness of the economic results to changes in benefit and cost variables. The following changes were analyzed:

- Capital cost overrun of 10%;
- 10% increase in annual O&M costs;
- 10% reduction in benefits;
- Combination of the above changes.

The results are summarized in **Table 6.19**. The table shows that the EIRR is more sensitive to a reduction in benefits than increases in capital or recurrent costs; however,

[9] In the East CA, 14% for sanitation and 15% for sewerage; in the West CA, 45% for sanitation and 32% for sewerage.

the outcome is the same as for the main cost-benefit analysis, with all options being economically viable.

Table 6.18 Cost-Benefit Analysis of SSMP Options [a]/

	Sanitation Services			Sewerage Services		
	East CA	West CA	Overall b/	East CA	West CA	Overall b/
Present Value (PhP million) [c/]						
Costs						
Capital costs	581	1,064	1,644	1,361	7,643	9,004
O&M costs	208	708	916	443	2,316	2,758
Total costs [b/]	789	1,772	2,561	1,803	9,959	11,762
Benefits						
Willingness to pay	1,053	2,548	3,601	3,226	14,393	17,619
Increased property value	22	13	35	97	142	239
Avoided health care costs	89	60	149	388	566	954
Septage treatment capacity	131	131	263			
Total benefits [b/]	1,296	2,752	4,048	3,711	15,101	18,812
Economic Return Measures						
Net present value (PhP million) [b/]	507	980	1,487	1,907	5,142	7,049
EIRR (%) [d/]	23%	24%	24%	33%	22%	26%

Notes:
a/ From Annex A & B.
b/ Totals may not sum exactly due to rounding.
c/ In 2005 prices. Discounted to 2005 at 12% real discount rate.
d/ EIRR for Sewerage Services East CA is imputed using benefit-cost ratio relativities.

Table 6.19 Results of Sensitivity Analysis of SSMP Options (EIRR)

	Sanitation Services			Sewerage Services		
	East CA	West CA	Overall [b/]	East CA	West CA	Overall [b/]
Main cost-benefit analysis [a/]	**23%**	**24%**	**24%**	**33%**	**22%**	**26%**
Capital cost overrun [b/]	22%	22%	22%	29%	19%	23%
Increased O&M costs [c/]	23%	23%	23%	32%	21%	25%
Reduced benefits [d/]	21%	21%	21%	28%	19%	22%
Combination of above	19%	18%	18%	24%	17%	19%

Notes:
a/ From Table 12.14.
b/ 10% increase in capital costs.
c/ 10% increase in annual O&M costs.
d/ 10% reduction in benefits.

6.4.4 Conclusion on Economic Analysis

The main cost-benefit analysis has shown that all options are economically viable, with the calculated EIRR values exceeding the economic opportunity cost of capital. The sensitivity analysis has demonstrated the robustness of these results with respect to variations in benefit or cost parameter values, with all options remaining economically viable in the tests undertaken.

For both options, the calculated EIRR values are considered to be minimum estimates of economic return - there are a number of economic benefits of reduced pollution, a cleaner city and improved waterway environment that have not been quantified.

7. Institutional Analysis

The institutional component of the water supply, sewerage and sanitation master plans addressed the role of the MWSS Corporate Office and the Regulatory Office in the context of the concession framework. It also considered the manner in which each of the concessionaires' implement their responsibilities with regard to water supply, sewerage and sanitation, although these were not discussed in detail. In addition, strategic longer term planning was addressed in terms of any institutional considerations that may emerge.

7.1 Privatization of MWSS

In 1997, as part of the Government's policy on private sector involvement in public utility service delivery, water and wastewater services to the MWSS service area were privatised for twenty-five years in two concession contracts. At the time, it was the largest ever private sector participation project in the water and sanitation sector in the world and was carried out within the constraints of urgency and limitations in regard to the legislative capability available. In addition, the concessions involved multinational participation and substantial debt.

Metro Manila was subsequently split between an East (MWCI) and a West (MWSI) concession. The successful bidders were required to assume the existing debt of MWSS and to service it during the period of the concession. The debt however was disproportionately (approximately 90%) held in one concession area (the West Zone). The Regulatory Office was established under provisions of the concession agreements as the representative of the customers. It is established to be responsible for monitoring the concession agreements generally and to monitor specifically the performance of the concessionaires, including sponsoring technical and financial audits. The Regulatory Office also has the role of facilitating and implementing changes to rates and charges.

7.2 MWSS Corporate Office

The MWSS Corporate Office assumed/retained functional responsibility for facilitating the performance by the concessionaires of their obligations, managing the Umiray-Angat Transbasin Project (UATP), managing the loans which are in the name of MWSS but serviced under the agreements by the concessionaires, and managing and, where appropriate, disposing of those "retained assets" not conceded for the duration of the agreement. Notably the Corporate Office takes responsibility in some respect for supply of bulk raw water and generally acts on behalf of the concessionaires for Raw Water Access management.

The two MWSS entities and the concessionaires formally relate through the concession agreements and through an annual review. There is substantial day-to-day liaison between the Corporate Office and the Regulatory Office. All entities are located within the same building compound.

7.3 Significant Events since Privatization

Since commencement of the concessions there have been several significant events which have impacted on the concept, in particular the devaluation of the Philippine Peso in late 1997 which coincided with the El Nino based severe drought. The MWSI concession claimed substantial hardship as a result of the devaluation and other causes and submitted a case for adjustment of rates as well as other issues.

MWSI in 2005 underwent a capital rehabilitation that resulted in 84% of the equity in the company being held by MWSS. This was a swap of debt for equity and creates a significant issue in regard to the appropriateness of the Regulatory Office remaining within the MWSS corporate framework. The remaining equity will be held by an existing minority shareholder, the Suez group. It is the intent of MWSS that its majority ownership of MWSI will be temporary, i.e. for a maximum of approximately two years, with the ownership returning to the private sector by sale of its holding or by a comprehensive sale of the company.

7.4 Recommendations

Recommendations that came out of the analyses of the current institutional arrangements are given below. Additional discussions on the costs, personnel, and functionality changes for MWSS are included in the body of the main report.

1) **Skill Base of MWSS**. The MWSS needs to retain within the organization a strong competence level based on a small core of professionals in the fields of water resources planning, sewerage planning, engineering and project management to determine the need for and oversee the conduct of outsourced services for major water sources development and address the many strategic cross concession issues in regard to sewerage and sanitation.

2) **Assets**. There is a need to provide more detailed asset condition data to the Corporate Office and for the Office to be strengthened to manage and use the data in decision making.

   Decisions on repair or replacement of assets in the water and sanitation sector are a major component of asset management. Failure of assets will generally have a strong impact on customers and the environment. At the current time, decision-making is the sole right and responsibility of the concessionaires, with the Regulatory Office taking a role through the review process associated with Rate Rebasing. This results in the decisions being generally taken in consideration of the business considerations of the concessionaires (modified by the customer focused regulatory concerns). There is no direct input on behalf of the long-term asset owners.

   There arises during the middle term of the concession (2008 to 2012) scope for decisions to be made based on the remaining period of the concession rather than on the very long term associated with asset lives. A possible solution would be for the Regulatory Office to continue in its review role but to take advice from the Asset Management group of the MWSS Corporate Office in relation to decisions taken.

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In the fourth and fifth terms (2013 to 2022), the Corporate Office as representatives of the Asset Owners should participate in any decision-making, which involves assets where lives will directly extend beyond the concession period.

It is recommended that the Corporate Office establish an **Asset Management Group** within the Corporate Planning Department under the Office of the Senior Deputy Administrator.

3) **Concession planning**. There is an emerging requirement for active concession planning by MWSS. The need is moderate currently as the concession period is now approaching the tenth year but will become critical by 2010. It is recommended that the MWSS Corporate Office include a **Concession Planning Group** within the Corporate Planning Department under the Office of the Senior Deputy Administrator.

4) **Regulatory Office**. The establishment of clear and effective regulatory systems is critical to the autonomy of water service providers. The concession agreements do not *per se* demand a totally independent Regulatory Office in that there is an acceptance of reliance on MWSS being the ultimate controller of the Regulatory Office, albeit with defined independence requirements in regard to location and staffing.

   It is reported that this association of the Regulatory Office with MWSS was necessary due to the urgency with which the overall privatization process took place and the possible cost burden (which is borne by the concessionaires) of total independence. This is acceptable currently although it is noted that the 2003 ADB TA project made a recommendation to relocate the Regulatory Office physically away from MWSS and to provide greater emphasis on independence.

   The impending possibility that MWSS will take a significant and perhaps majority shareholding in MWSI changes the situation. Having a Regulator which is a functioning arm of the owner of one of the concessionaires will create tensions which must be avoided.

   It is recommended that legislation be developed (based on the current concession agreement provisions), which will totally separate the Regulatory Office both geographically and conceptually from the other participants in the framework.

5) **Long term planning**. The current framework for long term planning which relies primarily on the plans developed by the concessionaires has consequently significant risks in terms of loss of synergy and of deriving solutions, which are sub optimal.

   To adequately perform long-term strategic planning and project management for water supply, sewerage and sanitation services in the Metro Manila area, MWSS would need to reinforce its present staff. It is proposed that long term strategic planning be undertaken by an additional department/function group, the **Master Plan and Lender Liaison Division** under the Engineering and Project Management Department within the MWSS Corporate Office.

6) **Drawings**. It is understood that drawings exist of most of the water system and all of the sewerage system in 1:2000 scale on a work-as executed basis. Some of these drawings are retained in the MWSS vault while one or other of the concessionaires have borrowed others. The drawings generally indicate materials used e.g. pipe material and date of installation. They are thus vital to the asset management process.

   The drawings that have been borrowed by concessionaires should be immediately returned and physical security of these drawings should be assigned to a senior manager in the MWSS Corporate Office who should take responsibility for copying them in a secure manner and making them available to appropriate stakeholders.

7) **MWSS GIS**. This master planning project includes in the methodology the intent to create a **Geographic Information System** which can contain spatial data on both the water and sewerage systems which are maintained by the concessionaires. The system will be established using the ArcView Mapping Package.

   ArcView has the capability of establishing quantitative (attribute) data alongside the spatial data set and the establishment of the data is discussed in *Strategic Action Paper No.5 – Use of GIS and Modeling*.

   It is recommended that the data collection for each system asset node and segment should include specific asset data including:

   a. Installation Date
   b. Historical Cost (actual or estimate)
   c. MEERA Cost
   d. Condition
   e. Remaining Life
   f. Residual Value

   This data collection should be based on copies of the drawings noted above and on concessionaire data, which should be reconciled against records of capital expenditure, which has been included in rate rebasing submissions.

   The data collection project should be undertaken by the Concessionaires and should be controlled by the Corporate Office who should employ a rigorous audit process. Alternately, the data collection should be undertaken by a joint group or by contractors but in all cases with a rigorous audit/ quality assurance process.

   The development of the asset based registers would be in conjunction with the establishment of a GIS function within the Corporate Office.

   Initially the GIS function would be housed within the asset management group in Corporate Planning.

8) **MWSS personnel**. It is apparent that MWSS will need to take a greater role in the planning, lender liaison and management of the implementation of major water source development programs. Significant MWSS resources will be required to manage and support the implementation activities. Based on an assessment of

current resources, additional personnel with considerable project management experience in major water supply developments will be required.

Formation of a dedicated taskforce led by MWSS and involving relevant government agencies, NGOs and community representation under a participatory approach is recommended to promote a successful outcome on resettlement issues in a reasonable period of time.

9) **Structure of MWSS Corporate Office**.

Recommendations for institutional strengthening in the areas of Corporate Planning and in the Engineering and Project Management Departments are summarized in **Figure 7.1** and **Table 7.1** below.

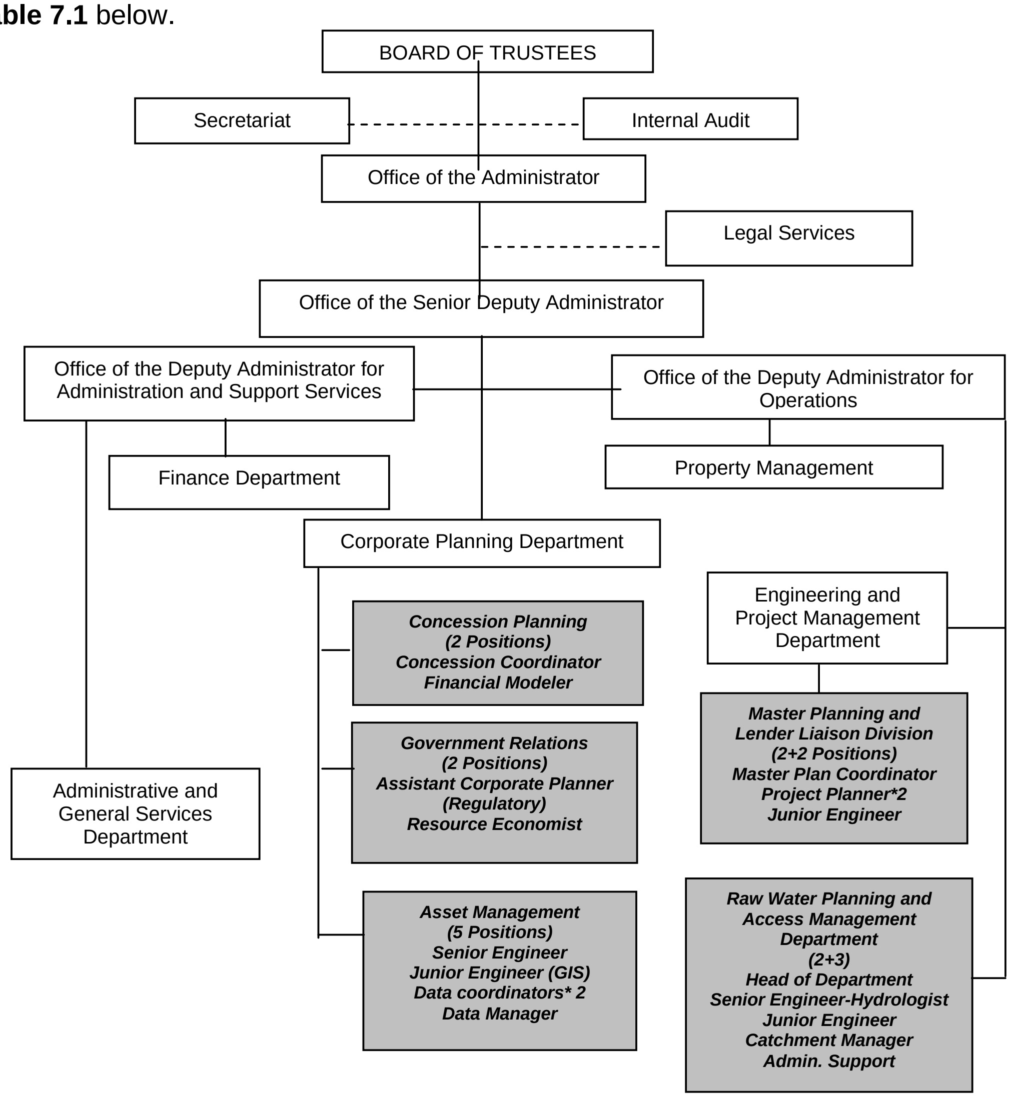

Figure 7.1 Proposed Functional Structure

Table 7.1 - Institutional Development Recommendation Summary

Action	Urgency	Priority
Organizational		
Establish Raw Water Planning and Access Management Department under the Office of the Deputy Administrator for Operations within the MWSS Corporate Office	Immediate	High
Establish Master Plan and Lender Liaison Division under the Engineering and Project Management Department within the MWSS Corporate Office.	Immediate	High
Corporate Planning be restructured as a Line Department with clear responsibility for • Creation of an Asset Management System • Concession Planning • Government Relations	Within 6 months	Very High
Establish an Asset Management Group within the Corporate Planning Department under the Office of the Senior Deputy Administrator. Commence centralized development of a comprehensive Asset Register for system assets.	Within 6 months	Very High
Establish a Concession Planning Group within the Corporate Planning Department under the Office of the Senior Deputy Administrator.	Within the next two years	Extreme
Establish a GIS Facility within the Asset management Group of the Corporate Planning Department. GIS to be primarily used as an asset management tool.	Within 6 months	Very High
Establish an Enterprise wide GIS within the Corporate Planning Department to provide support all functions within the MWSS Corporate Office.	After 3 years	Moderate
Privatization of Angat Dam Power Generating Facilities		
MWSS to seek appointment as the successor to NPC as manager of Angat.	Immediate	High
MWSS make representations to the DoE, PSALM/NPC so that it can actively participate in watershed management through membership of a committee responsible for the formulation and implementation of the watershed rehabilitation management program	Within next 6 months	High
MWSS make representations with the PSALM/HEPP Sales Committee of the inclusion in the bidding documents of an approved Water Protocol that safeguards the water supply for Metro Manila in the interest of national security	Immediate	High
Management		
The 1:2000 drawings that have been borrowed by concessionaires should be immediately returned and physical security of these drawings should be assigned to a senior manager in the MWSS Corporate Office who should take responsibility for copying them in a secure manner and making them available to appropriate stakeholders.	Immediate	Extreme

Other recommendations include:

a. **Septage management**.
Septage management will need to be given an increasing focus given the significant projected increase in septage volumes to be collected and treated during the Master Plan planning time horizons. Currently, even with the relatively small quantities of septage being collected and treated, logistical problems are apparent with the desludging and collection processes. There are also unregulated private operators in the market that may result in improper disposal of septage. With the importance of septage collection in the sewerage and sanitation strategy developed by this Master Plan, it is important that suitable monitoring systems are in place to ensure that the concessionaires not only meet their contractual requirements in this regard, but actively promote improved sanitation. The following options were studied to improve the operational efficiency of septage collection.

- Systems to enable stronger regulation by the Regulatory Office to audit revenues and expenditures on sanitation and efficiency of service provision
- Outsourcing of septage collection (but not treatment) by the concessionaires to the private sector
- Transfer of responsibilities and revenues for septage collection to LGUs, MMDA or a separate sanitation agency.

Limited support was found either with MWSS, MWCI, MWSI or with any of the line agencies for a transfer of responsibilities for septage collection from the concessionaires. This approach was therefore not considered further. However, it is recommended that further consideration by given to the first two options of strengthening the RO monitoring of the concessionaires' performance is septage management and in the outsourcing by the concessionaires to the private sector of septic tank desludging and transport of septage to the treatment facility..

b. **Developer charges**. A developer charges regime should be established for Manila to operate in conjunction with current regulations (such as Batas Pambansa 220) in regard to property development.

c. **CWA IRR**. Plans should be developed as a priority, with consultation from MWSS, the concessionaires, the LGUs and MMDA. The action plans will include establishing a discharge license framework which is based on load based licensing for non domestic waste content and a trade waste inspection program.

d. **Trade waste**. Following development of the action plans for CWA implementation, a trade waste management and tariff framework should be developed by the concessionaires as the operators of approved treatment plants.

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Metropolitan Waterworks and Sewerage System

TA for the Strengthening of MWSS's Planning Capability in Water Supply, Sewerage and Sanitation Service Provision
IBRD Grant No. TF053321

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VOLUME 2
PARTIAL UPDATE OF THE WATER SUPPLY MASTER PLAN

FINAL REPORT

November 2005

SINCLAIR KNIGHT MERZ (PHILIPPINES), INC.

in association with

DCCD ENGINEERING CORPORATION

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Acronyms, Abbreviations and Measurements

ABC	-	Association of Barangay Captains
ACP	-	Asbestos Cement Pipe
ADB	-	Asian Development Bank
ADD	-	Average Day Demand
ADR	-	Appropriate Discount Rate
AMRIS	-	Angat-Maasim River Irrigation System
AO	-	Administrative Order
ARBA	-	Agrarian Reform Beneficiaries Association
AWUAIP	-	Angat Water Utilities and Aqueduct Improvement Project
AWSOP	-	Angat Water Supply Optimization Project
BOT	-	Build-Operate-Transfer (mode of project delivery)
BRL	-	Bureau of Research Laboratories
BMG	-	Bureau of Mines and Geosciences
BSWM	-	Bureau of Soils and Water Management
CALABARZON	-	Cavite, Laguna, Batangas, Rizal, Quezon
CAPEX	-	Capital Expenditures
CARP	-	Comprehensive Agrarian Reform Program
CBFMA	-	Community-Based Forest Management Agreement
CI	-	Cast Iron
CIP	-	Cast Iron Pipes
CFRD	-	Concrete-Faced Rockfill Dam
CLUP	-	Comprehensive Land Use Plan
CO	-	Corporate Office
CWA	-	Clean Water Act
DA	-	Department of Agriculture
DAR	-	Department of Agrarian Reform
DCCD	-	Design Consultation Construction Management Engineering Corporation
DCRA	-	Debt and Capital Restructuring Agreement
DENR	-	Department of Environment and Natural Resources
DIP	-	Ductile Iron Pipes
DOE	-	Department of Energy
DOF	-	Department of Finance
DOH	-	Department of Health
DOJ	-	Department of Justice
DPWH	-	Department of Public Works and Highways
DTI	-	Department of Trade and Industry
ECC	-	Environmental Compliance Certificate
EDSA	-	Epifanio Delos Santos Avenue
EGF	-	Environmental Guarantee Fund
EGGAR	-	Engineering Geological and Geohazard Assessment Report
EIA	-	Environmental Impact Assessment
EIS	-	Environmental Impact Statement

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EMB	-	Environmental Management Bureau
EMP	-	Environmental Management Plan
EO	-	Executive Order
ERDB	-	Ecosystems Research and Development Bureau
FIRR	-	Financial Internal Rate of Return
FMB	-	Forest Management Bureau
FSL	-	Full Supply Level
GDP	-	Gross Domestic Product
GI	-	Galvanized Iron
GIS	-	Geographic Information System
GRDP	-	Gross Regional Domestic Product
HEP	-	Hydro-Electric Plant
HLURB	-	Housing and Land Use Regulatory Board
HWL	-	High Water Level
IEE	-	Initial Environmental Examination
IFC	-	International Finance Corporation
IP	-	Indigenous People
IPO	-	Initial Public Offering
IRR	-	Implementing Rules and Regulations
JICA	-	Japan International Cooperation Agency
KCWSP	-	Kanan-Cogeo Water Supply Project
KUTP	-	Kanan-Umiray Transbasin Project
LGU	-	Local Government Unit
LLDA	-	Laguna Lake Development Authority
LMB	-	Land Management Bureau
LWUA	-	Local Water Utilities Administration
mllw	-	Mean lower low water
MDD	-	Maximum Day Demand
MEERA	-	Modern Equivalent Engineering Reference Asset
MMDA	-	Metro Manila Development Authority
MMWDP	-	Metro Manila Water Distribution Project (MMWDP)
MMT	-	Multi-Partite Monitoring Team
MOA	-	Memorandum of Agreement
MOL	-	Minimum Operating Level
MSWDP	-	Manila South Water Distribution Project
MWCI	-	Manila Water Company, Inc.
MWSI	-	Maynilad Water Services, Inc.
MWSP III	-	Manila Water Supply Project III
MWSS	-	Metropolitan Waterworks and Sewerage System
NAWAPCO	-	National Water and Air Pollution Commission
NEDA	-	National Economic Development Authority
NEPC	-	National Environmental Protection Council
NIA	-	National Irrigation Administration
NIPAS	-	National Integrated Protected Areas System
NCR	-	National Capital Region
NGO	-	Non-Government Organization
NJS	-	Nippon Jogesuido Sekkei Co.
NPC	-	National Power Corporation

NPCC	-	National Pollution Control Commission
NPV	-	Net Present Value
NRW	-	Non Revenue Water
NSCB	-	National Statistics Coordination Board
NSO	-	National Statistics Office
NWRB	-	National Water Resources Board
ODA	-	Overseas Development Assistance
PAGASA	-	Philippine Atmospheric, Geophysical, & Astronomical Services Administration
PAMB	-	Protected Area Management Board
PAWB	-	Parks and Wildlife Bureau
PAWS	-	Public Assessment of Water Services
PD	-	Presidential Decree
PDS	-	Primary Distribution System
PO	-	People's Organizations
PNSDW	-	Philippine National Standards for Drinking Water
PSALM	-	Power Sector Assets and Liabilities Management Commission
PSE	-	Philippine Stock Exchange
PSP	-	Private Sector Participation
PVC	-	Polyvinyl Chloride
PWCP	-	Pampanga Water Conveyance Project
QS	-	Qualification Standards
RAP	-	Resettlement Action Plan
ROP	-	Republic of the Philippines
ROW	-	Right-of-way
RPWSIP	-	Rizal Province Water Supply Improvement Project
SAP	-	Strategic Action Paper
SDS	-	Secondary Distribution System
SKM	-	Sinclair Knight Merz
SWOT	-	Strength Weakness Opportunity Threat
TA	-	Technical Assistance
TDS	-	Tertiary Distribution System
TOR	-	Terms of Reference
TWL	-	Top Water Level
UATP	-	Umiray-Angat Transbasin Project
UPSARDF	-	University of the Philippines Social Action and Research for Development Foundation, Inc.
USAID	-	United States Agency International Development
WACC	-	Weighted Average Cost of Capital
WQMA	-	Water Quality Management Area
WTP	-	Water Treatment Plant

Units of Measurement

^{o}C	-	Degrees Celsius
GWH	-	Gigawatt-hour
ha	-	hectares
HP	-	Horsepower

hrs/day	-	hours per day
km	-	kilometers
km^2	-	square kilometers
kWH	-	kilowatt-hour
lpcd	-	liters per capita per day
m	-	meter
mm	-	millimeter
m^3	-	cubic meter
m^3/s	-	cubic meters per second
m EL	-	meters, elevation (referenced to height datum)
MCM	-	Million cubic meters
ML	-	Megaliters or Million Liters
MLD	-	Megaliters per Day (or Million Liters per Day)
MW	-	Megawatt
PhP	-	Philippine peso
PhP/ m^3	-	Philippine peso per cubic meter
psi	-	pounds per square inch
sq m	-	square meter
sq km	-	square kilometer
US$	-	United States Dollars

1. Introduction and Background

1.1 Introduction

The delivery of an acceptable supply of safe, potable water to Metro Manila consumers has become increasingly constrained by the capacity of existing water sources and poor efficiency of existing infrastructure. Current source capacity is estimated to be 4,090 MLD, which draws primarily from the Angat-Umiray-Ipo River system, with augmentation from localized groundwater supplies. Potential water demand in the service area already exceeds this available source capacity, with high losses or non revenue water (NRW) further compounding the supply difficulties.

Various projections suggest that bulk water demand in the MWSS service area will increase to more than 5,000 MLD by the Year 2010 and further to 8,000 MLD by 2025. Given that major water source development typically has a lead-time of between 5-10 years for completion, resolution of a recommended program of water source development and associated supply infrastructure is now critical to ensure that future demands of Metro Manila can be met.

1.2 Scope of Report

This report presents a **partial update** only of the Water Supply Master Plan for Metro Manila, to serve as a key input to the development of a comprehensive Master Plan for Sewerage and Sanitation for the study area.

The scope of the report is to establish and evaluate the current costs, constraints and issues associated with future water source options and identify the least-cost long-term development strategy recommended for water source implementation, complete with the associated water transmission and distribution infrastructure needed to integrate these sources with the existing supply system and connect new water to areas of demand growth.

It is highlighted that this is not a comprehensive study intended to verify all technical and financial information reported in prior studies, but rather utilizes and reviews this information under current prevailing conditions to derive its conclusions. The study also draws heavily on the plans and knowledge of the two concessionaires Manila Water Company, Inc. (MWCI) and Maynilad Water Services, Inc. (MWSI), whose assistance in the preparation of this study is acknowledged and has been greatly appreciated.

The report also examines the institutional framework needed to support future planning and implementation of water infrastructure development in Metro Manila, to effectively deliver the Master Plan. Recommendations on strategies to strengthen the MWSS's capability and capacity are made and, where applicable, suggested changes to the roles and responsibilities of other stakeholders and agencies involved in water services delivery are identified.

1.3 Study Objectives

The objectives of the study are to:

1. Examine land use and demographic information to forecast long-term water demands for the Metro Manila area;
2. Review known water source development options for Metro Manila supply;
3. Establish updated cost estimates and identify current issues and constraints for these water source options;
4. Perform a comparative evaluation of water source options;
5. Identify the preferred long-term development program for source development and potential modes of program delivery;
6. Identify the water transmission and distribution infrastructure needed to integrate the preferred source development program with the existing water supply system; and,
7. Identify the institutional improvements required to support this program.

1.4 Overall Framework for Sewerage and Sanitation Service Provision in Metro Manila

1.4.1 General

The Metropolitan Water System was inaugurated in 1878 to supply water to the City of Manila, which then had a population of approximately 300,000 people. The service area and population was subsequently extended and expanded.

Manila as a city was substantially destroyed in the closing stages of World War II and was subject to major reconstruction in the 1950's and 60's.

The Metropolitan Waterworks and Sewerage System (MWSS), a Philippine government owned and controlled corporation, was established in 1971 and is responsible for the provision of water, sewerage and sanitation services in Metro Manila. In 1997, MWSS was a very large government owned company with almost 8,000 employees. Water supply services were being provided to approximately 70% of the potential population with availability of supply being approximately 16 hours per day. There were frequent system failures and water system leakages, which with other causes resulted in a non- revenue water level of over 60%.

Consideration of private sector participation (PSP) in the water supply to Manila initially arose out of a change in national government in 1986, the creation of a Government Committee on Privatization in the same year and the subsequent privatization of many government-owned businesses.

The award in 1997 of two concurrent concession contracts for water supply and sewerage in Manila has been widely publicized. The concession agreements have resulted in four entities being directly involved in water and sewerage service provision in the city:

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Two concessionaires were awarded contracts, **Maynilad Water Services Inc. (MWSI)** which is the service provider in the west of the city and **Manila Water Company (MWCI)** which operates in the east of the city. The **Regulatory Office** is established as the representative of the customers and is created under provisions of the concession agreements. The **MWSS Corporate Office** has the responsibility for the retained functions, those not passed to the concessionaires such as: facilitating the performance of the concessionaires of their obligations, managing the Umiray-Angat Transbasin Project, managing the loans that are in the name of MWSS but serviced under the agreements by the concessionaires, and managing and where appropriate disposing of the 'retained assets', i.e. those assets not conceded for the duration of the concession agreement.

1.4.2 Manila Water Company Inc. (MWCI)

MWCI is a joint venture of three companies, namely, Ayala Corporation, United Utilities Pacific Holdings B.V. a subsidiary wholly owned and controlled by United Utilities PLC of the United Kingdom and Mitsubishi Corporation of Japan, with Ayala Corporation holding majority control. The concession contract is for 25 years commencing on August 1, 1997 and to end in July 31, 2022. The total population in the East Zone at the start of the concession period was about 4.5 million.

1.4.3 Maynilad Water Services Inc (MWSI)

MWSI was a joint venture between Benpres Holdings Corporation and Lyonnais des Eaux of France. This concession contract was also for 25 years commencing on August 1, 1997 and ending on July 31, 2022. The total population in the West Zone at the start of the concession period was about 7.2 million. MWSI has suffered from financial problems for several years and as from July, 2005 is subject to restructure due to previous insolvency. A Rehabilitation Plan has been submitted by the company and approved by its creditors. The rehabilitation results in 84% of the equity in the company being held by MWSS. The remaining equity will be held by the Suez group (Lyonnaise des Eaux), which is an existing minority shareholder.

It is the intent of MWSS that its majority ownership of MWSI will be interim, i.e. for a maximum of approximately 2 years with the ownership returning to the private sector by sale of its holding or by comprehensive sale of the company.

1.5 Study Area

The study area addressed by the partial update of the water supply master plan for Metro Manila is shown at **Figure 1.1.** This is the MWSS service area that currently covers 16 cities and 21 municipalities within the National Capital Region, the Province of Rizal and the Province of Cavite with a total land area of approximately 2,371 square kilometers.

The area comprises the two concession areas defined for water services delivery in Metro Manila, which makes up the total MWSS service area. The study area is essentially defined based on municipal boundaries rather than geophysical or supply limiting borders.

The West Concession covers the cities of Manila, Pasay, Paranaque, Caloocan, Muntinlupa, Las Pinas, Valenzuela, Cavite City, parts of Makati and Quezon City and the municipalities of Malabon, Navotas, Bacoor, Imus, Kawit, Noveleta and Rosario. The Regulatory Office places the total number of water service connections in 2004 at 602,821 corresponding to a population of 4.9 million out of the total population in the service area of 7.9 million; a service coverage of 70%.

The East Concession covers Makati, Mandaluyong, Marikina, Pasig, Pateros, San Juan, Taguig, and parts of Quezon City and Manila, Antipolo City and the towns of Angono, Baras, Binangonan, Cainta, Cardona, Jalajala, Morong, Pililia, Rodriguez, Tanay, Taytay and San Mateo all in the Province of Rizal. The total number of connections in the East Zone per Regulatory Office records in 2004 is 425,802 corresponding to a population served of 3.45 million out of a total service area population of 5.4 million, a coverage of 78%.

The areas covered by the East and West Concession Zones are shown in **Figure 1.2.**

Further detailed description of the study area is found at Chapter 3.

Figure 1.1 MWSS Service Area, 2000

Figure 1.2 MWSS Concession Areas Boundaries

1.6 Target Year

The Terms of Reference for the Study defined the time frame for the Master Plan to be up until 2020. However, there was also a requirement that a Master Plan be prepared that would consider the requirements both up to and beyond the concession period which is 2022. At the same time, there are risks in accurately planning for an excessive period due to changes in social, economic and environmental conditions over time that can impact on many of the assumptions made with regard to variables such as population projections, water demand and affordability of services.

The National Government agencies and the LGUs also limit their planning and population projections to in the order of 20 years. This is a reasonable approach given the current residential growth rates in Metro Manila. Future population projections can be influenced by changes in government policies such as family planning and birth control programs. The spatial allocation of population may vary depending on future transportation and land development programs that cannot be foreseen at the present time.

Overall, it is considered that a timeframe of 20 years is reasonable for this partial update of the water supply master plan for Metro Manila, culminating at Year 2025 as the target year. This takes it beyond the end of the current concessions in Year 2022.

1.7 Basis of Study

This study is based primarily on readily available information sourced from previous study reports for water source development in the Metro Manila region, with relevant updates applied where new or revised information has come to hand.

Key documents used for reference on this study include:

- *The Study on Water Resources Development for Metro Manila in the ROP, Draft Final Report, Volumes I, II and III* (February 2003), Nippon Koei Co., Ltd and NJS Consultants
- *Manila Water Supply III Project Review, Laiban Dam, Volume 1: Feasibility Review* (February 1997), Electrowatt Engineering and Renardet S.A.
- *Master Plan Study on Water Resources Management in ROP, Final Report, Volume II* (August 1998), Nippon Koei Co., Ltd and NJS Consultants
- *Study on Water Supply and Sewerage Master Plan of Metro Manila in the ROP* (February 1996), Nippon Jogesuido Sekkei Co. Ltd and Tohmatsu Co.
- *Comprehensive land use plans* for each of the local government units within the study area.

Additional information and data from stakeholders such as the MWSS, MWCI, MWSI and various local government units (LGUs) is also acknowledged as a key input to this study. In the case of MWCI and MWSI, network-modeling support has also been provided to determine system improvements for the integration and transmission of new bulk water to demand centers.

Importantly, limited analysis has been conducted by the project team for the partial update of the Water Supply Master Plan, as the focus of the current institutional strengthening project is sewerage and sanitation. Nonetheless, sufficient planning and engineering and financial assessment has been completed to confirm conclusions and recommendations of this report.

1.8 Previous Studies

Water supply master planning for Metro Manila has been the subject of several key studies over the past 25-years. A summary of key outcomes from these studies follows.

1979 Manila Water Supply Project III Feasibility Report

The 1979 Manila Water Supply lll Feasibility Report listed nine potential water sources for Metro Manila as shown in **Table 1.1**, while **Figure 1.3** is a location map of the different schemes. Laiban Dam on the Kaliwa River was selected as the most economical source at the time, followed closely by the Marikina River. Marikina River was not pursued further and was deemed socially unacceptable because of the proximity of the dam site to the active Marikina fault and the densely populated areas of Metro Manila that may be affected in the event of dam failure.

The Umiray River source option was developed through the Umiray-Angat Transbasin Project that was completed in June 2000 with only one diversion dam constructed as opposed to the five originally proposed in the 1979 study.

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Table 1.1 - Potential Water Sources for Metro Manila as Proposed in 1979

Ref. No.	Source	Estimated Yield (MLD)	Cost of Water (PhP / m^3)	Remarks and Earliest Date of Commissioning in Year
1	Kaliwa	1909	0.69	Most economic source (1987).
2	Marikina	1280	0.82	Dam is socially unacceptable (1987)
3	Kanan	3170	0.94	Development possible only as second stage to Kaliwa (1994).
4	Umiray	777	0.76	Construction will disrupt supplies of water and electricity from Angat; other major sources will have to be implemented first (1994).
5	Laguna de Bay (Entire Lake)	2592	0.98	Prosecution of pollution control measures required before exploitation for water supply (2000).
6	Laguna de Bay (Eastern Part)	1728	1.04	Requires 9.5 km dike in the Bay (1992).
7	Pampanga	2592	1.08	Cost is highly sensitive to cost of energy for pumping (1986).
8	Taal Lake	864	0.95	Not recommended owing to hazards of volcanic activity (1986).
9	Calamba-Santa Rosa	190	0.69	Recommended for local supply only (1983).
10	Lower Marikina Valley	130	0.73	Recommended for local supply only (1983).

Source: 1979 Manila Water Supply Project III Feasibility Report, Electrowatt Engineering in association with Renardet S. A.

Note that all costs referred to in **Table 1.1** are 1979 costs.

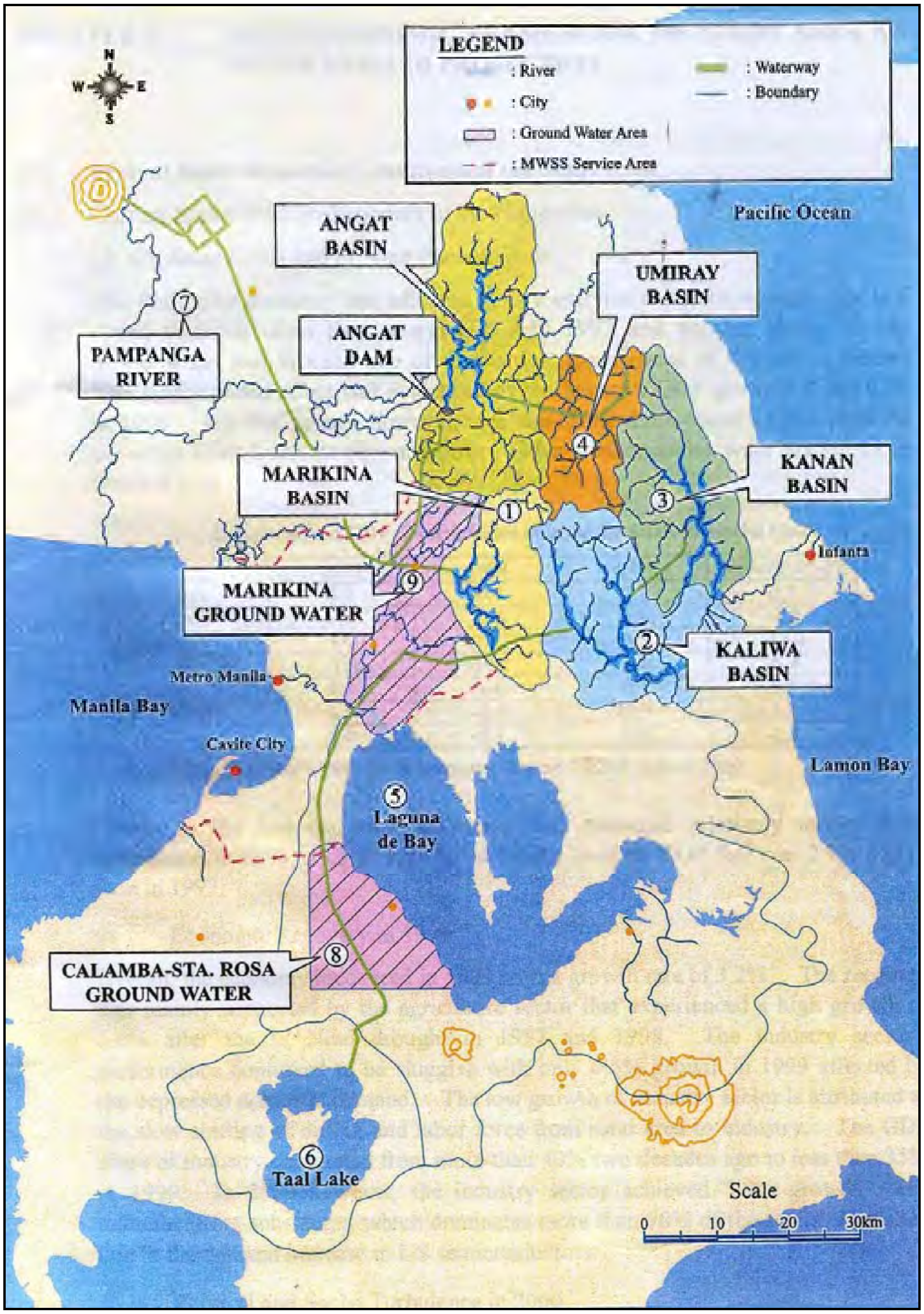

Figure 1.3 Potential Water Sources for Metro Manila (1979 Study)

1996 Master Plan for MWSS

The 1996 Master Plan projected a maximum daily water demand of almost 6,000 MLD by 2015 (the study timeframe). This demand was to be satisfied through on-going augmentation of the Angat source under the Angat Water Supply Optimization Project (AWSOP) and the Umiray-Angat Transbasin Project (UATP) together with projects such as the Rizal Province Water Supply Improvement Project (RPWSIP), which would extract water from Laguna Lake. The primary focus of new water source development however, was to be the Kaliwa River (Laiban Dam) for which water rights to extract 1,950 MLD had been approved in 1979. Water rights for a further 3,200 MLD from the Kanan River were granted in 1981 to augment the proposed Laiban Dam development.

1997 Review of the Manila Water Supply Project III (Laiban Dam)

The review of the Manila Water Supply Project III (MWSP III), or Laiban Dam, in 1997 concluded that this project continued to be the most viable option to meet water production requirements for the Metro Manila area up to 2015. Effectively, the Laiban Dam development was considered to be the only major water supply option to be fully identified, fully designed (including system improvements) and without outstanding and unresolved technical issues at the time of the review.

In the 1997 review, design updates were completed for the MWSP III proposal to allow its implementation by the BOT process. These updates were associated with treated water pipeline and tunnel routes, and design of downstream storage and distribution facilities. No significant changes were made to the earlier proposed water source infrastructure.

1998 Master Plan on Water Resources Management in ROP

A nation-wide plan for water resource development and management in the ROP was completed in 1998 with a target year of 2025, examining water supply for a range of sectors including municipal water supply, hydropower generation and irrigation. For the Metro Manila area, the projected requirement for surface water capacity was estimated at 6,313 MLD by the Year 2025. To meet this demand, three development scenarios were considered involving a combination of the following projects:

- Kaliwa (Laiban) Dam Project and Kaliwa-Kanan Transbasin Project
- Kanan-Umiray Transbasin Project (KUTP)
- Kanan-Cogeo Water Supply Project (KCWSP)
- Pampanga Water Conveyance Project (PWCP)

The latter three projects in this list were conceived as part of the 1998 Master Plan and as such were subject to further investigation into the detailed feasibility of these proposals.

The 1998 study raised concern over the presence of significant limestone in the proposed reservoir area for Laiban Dam, implying that seepage losses could be a major issue with this development option. It was recommended that the technical viability of the Laiban Dam option should be verified through geological investigation within the reservoir area. This concern was subsequently dismissed in the 2003 Study on Water Resources Development by the same consultant (NJS).

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2003 Study on Water Resources Development for Metro Manila

In 2003, the Study on Water Resources Development for Metro Manila projected an average daily water requirement of 6,980 MLD by 2025 and compared eight alternative combinations of new sources to meet this demand. The combinations considered alternative dams on the Kaliwa, Kanan and Agos Rivers. The recommended alternative was to initially construct a low dam on Kaliwa River to be augmented (and submerged) by a dam and reservoir on the Agos River. It was proposed that the development be constructed in three stages and it was estimated to provide an additional 3,000 MLD.

The Laiban Dam and Kanan River development recommended in the 1996 Master Plan study was not recommended due to its higher unit cost of water, but more importantly due to concerns with the resettlement of up to 3,000 families that may be affected with the Laiban Dam development. Discussion on these observations follows later in this report.

2004 Source Development "Road Map"

In 2004, a steering committee comprising representatives of MWSS, MWCI and MWSI completed an assessment of new water sources and concluded on a prioritized source development timetable referred to as the "2004 Road Map", as shown in **Table 1.2.**

Table 1.2 - New Water Sources Proposed in 2004 Road Map

Date		Proposed New Water Source	Additional Capacity	Total System Capacity
1	2005	Wawa River Project	50 MLD	4,140 MLD
2	2007	Angat Water Utilities & Aqueduct Improvement Project	750 MLD	4,890 MLD
3	2007	BOT Treated Bulk Water (Laguna Lake)	400 MLD	5,290 MLD
4	2013	Laiban Dam Project	1,900 MLD	7,190 MLD
5	2023	Agos Dam Project, Phase 1	1,500 MLD	8,690 MLD
6	2023	Agos Dam Project, Phase 2	1,500 MLD	10,190 MLD

The 750 MLD Angat Water Utilities and Aqueduct Improvement Project is currently being implemented with the ongoing construction of AQ-6. To realize the full benefit of this project, a formal agreement with the National Power Corporation (NPC) and the National Irrigation Administration (NIA) for additional allocation from Angat is needed and is yet to be perfected. Further, the current treatment capacity of the La Mesa and Balara treatment plants is only 4000 MLD, which must be augmented to realize any major increase in available water source capacity. It is therefore possible that the incremental capacity of this scheme upgrade will fall to only 100 MLD.

The 400 MLD Treated Bulk Water Project from Laguna Lake has now been downgraded to a 300 MLD project. This project was recently tendered as a Build Operate Transfer (BOT) scheme and bids have been received. Due to the current rehabilitation plan existing over MWSI however, this project has been placed on hold.

Notably missing from the Road Map is the development of Kanan River as a logical sequel to the Laiban Dam Project. This involves a storage dam and reservoir on the

Kanan River and a transbasin tunnel from the Kanan Reservoir to the Kaliwa Reservoir (formed by Laiban Dam). The expected additional yield from Kanan is 37 m^3/s (3,200 MLD), which would increase the total Kaliwa-Kanan scheme yield to 5,000 MLD, thereby maximizing the potential yield of the total Agos basin resource.

1.9 Organization of the Report

The approach to preparing this Master Plan update has been the development of a series of Strategic Action Papers (SAPs) that have been discussed with the stakeholders during the course of preparation of the Plan. Following the consultations, the findings of the SAPs were consolidated into the Master Plan document. The SAPs and Working Papers prepared (which form as attachments to the Master Plan) are as follows:

a. Strategic Action Paper No. 1 (Volume 1): Land Use, Demography, and Water Demands

b. Strategic Action Paper No. 1 (Volume 2): Institutional Review

c. Strategic Action Paper No. 1 (Volume 3): Review of Relevant Regulations Relating to Water Supply

d. Strategic Action Paper No. 2: Future Water Sources

e. Strategic Action Paper No. 3: NRW & Suggested System Improvements

f. Strategic Action Paper No. 4: Water Demand Management and Reuse Options

g. Strategic Action Paper No. 5: The Use of GIS and Modeling

h. Strategic Action Paper No. 6: Turnover of Angat Dam and Reservoir

i. Working Paper No.1: The Role of MWSS

j. Working Paper No.2: Asset Management Issues

k. Working Paper No.3: Key Performance Indicators and Business Efficiency Measures

2. Description of the Study Area

2.1 Physical Conditions

2.1.1 Topography

The total area of Metro Manila is expanding due to reclamation works being done on Manila Bay. The topography of the study area is characterized as the *Coastal Plain*, *Guadalupe Plateau* and the *Marikina-Laguna Valley*.

The Coastal Plain includes the western areas of Metro Manila. Intramuros, Fort Santiago and Fort San Antonio Abad were originally constructed along the shorelines prior to the extensive reclamation of the bay. Only a series of canals are left of the once low sandy islands found at the Pasig River delta. Most of the areas in Manila and Pasay are situated at elevations about two meters above sea level.

Guadalupe Plateau rises above the coastal lowlands with summits reaching 90 to 100 m above sea level north of the Pasig River and 30 to 40 m due south. Drainage is directed westward to the San Juan River in the north and directly westward to the Manila Bay down south.

The Marikina-Laguna Valley is relatively flat having a narrow north area, which becomes wider towards the south near Laguna de Bay. The flow of the Marikina River takes on a meandering course and the flow becomes slow and the cross-section becomes wider from the Sierra Madre foothills.

The topography of Rizal can be characterized by a combination of valleys and mountains. Flat low-lying areas are found on the western section of the province. To the east, rolling hills and rugged ridges form the southern foothills of the Sierra Madre Mountain Ranges. Elevations can exceed 600 m above mean sea level.

Cavite is considered flat being part of the coastal plains. Cavite City extends outwards to the Manila Bay. River systems include Imus River, Julian River and Ilang-ilang River.

In the proposed area for new water source development, namely the Agos River basin, the terrain is typically mountainous country, dropping to a coastal plain along the lowermost reach of the Agos River in the east. Elevations rise to more than 700 m above mean sea level.

Slope

The slopes found within Metro Manila vary from the topographic areas mentioned above. Slopes for the Coastal Plain are relatively flat (zero to one percent) with elevations ranging from zero to two meters. A one to three percent rise can be seen from the Coastal Plain to the Guadalupe Ridge. Slope drops of 20 percent and greater can be seen towards the Marikina Fault. Moving towards the Marikina-Laguna Valley, slopes become flat.

About 34.5% and 2.5% of the land area in Rizal is situated on slopes ranging from zero to eight percent and eight to eighteen percent, respectively. More than half (51%) of Rizal land area falls under the slope classification of 18 to 50 percent. A substantial percentage of 12% of the Rizal province have slopes of 50 percent and up. Steep slopes can be attributed to the topography of the mountainous regions of the Rizal province.

Slopes near the coastal plains of Cavite do not exceed three percent and elevation is about sea level. The slope slightly increases to about 5 percent along the south-east with elevations rising to about 70 m above sea level.

In the proposed water source catchment area, significant variation in slope is recorded. In the Kanan River sub-basin, extreme slopes characterize the extreme terrain, which has generally hampered access to the area and allowed a large portion of the catchment area to remain under virgin forest. In the Kaliwa River sub-basin, the slope of the terrain is more moderate allowing the area to be developed through logging and farming activities.

2.1.2 Meteorology

Meteorology in the study area is characterized by distinct wet and dry seasons. The dry season falls on the months of November to April during the northeast monsoon. The wet season occurs from the months of May to October coinciding with the southwest monsoon. In Metro Manila, the annual average rainfall is 2164.5 mm, with an average number of rainy days of 133 per year.[1] **Figure 2.1** shows the graph of monthly average rainfall and number of rainy days in Metro Manila.

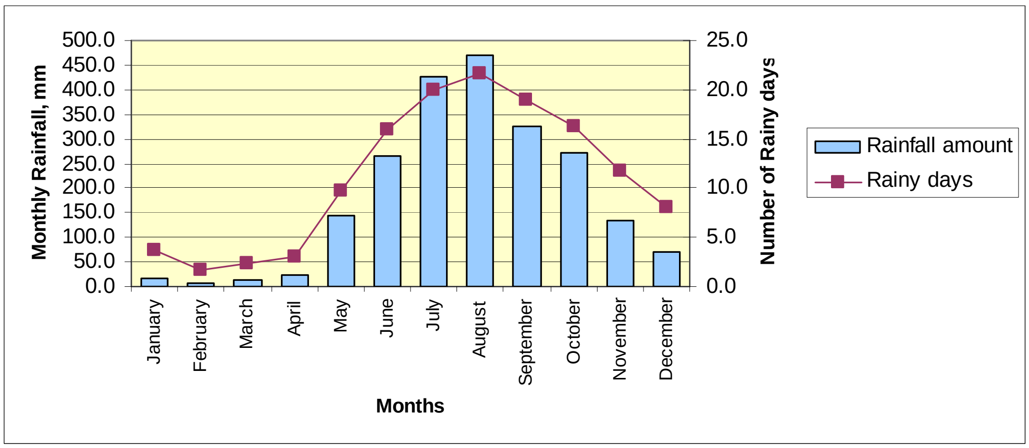

Figure 2.1 Monthly Average Rainfall and Number of Rainy Days in Metro Manila

The overall monthly temperature is about 27.7 ºC. Warmest days occur during the summer months of April and May with an average high temperature of 29.6ºC, while the

[1] Derived by averaging the annual average rainfall data recorded in three PAGASA weather stations: Port Area, Manila, Science Garden, Quezon City, and NAIA, Pasay City.

coolest month is January with low average temperature of 25.9 ºC.[2] **Figure 2.2** presents the monthly average temperatures in Metro Manila.

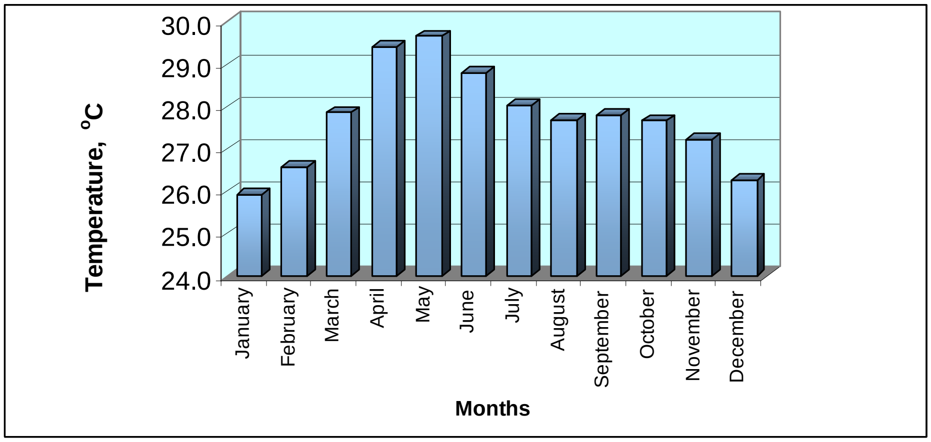

Figure 2.2 Monthly Average Temperature in Metro Manila, ºC

The area covered by the Sierra Madre Mountain in Rizal is an exception as even rainfall is experienced throughout the year.

Climatic data for the new water source development area indicates high annual rainfall of up to 6000mm (in the Kanan River sub-basin).

2.1.3 Geology and Hydrogeology

Geology

In the Metro Manila area, the underlying rock strata are composed of three types of sedimentary rock sequentially layered as: Miocene rocks, “Alata” Conglomerate and Guadalupe Tuff. Guadalupe Tuff is the overlaying stratum from the Marikina Valley until Quezon City where layer thickness is about 300 to 2,000 m. A change in overlaying alluvium stratum with a depth of about 25 to 50 m is seen along the coastal plains. Alluvial sediments also overlay the Marikina Valley but the depth varies greatly. A simplified geological cross-section of Metro Manila is presented in **Figure 2.3**.

The Guadalupe tuff is understood to be water-laid, most probably in a shallow sea during the late Tertiary or early Quaternary age. Beds of the tuff are clearly stratified and are composed mostly of comminuted, somewhat altered, vitric volcanic ash although certain layers are composed of rather coarse fragments of volcanic pumice. The tuff layers, which are normally fine-grained and gray to brownish-gray in color, are often separated by brownish or yellowish soil, which is indicative of weathering. Also gravel and sand layers have been found between tuff strata. It would seem, therefore, that deposition of these tuff

[2] Derived by averaging the mean monthly temperatures recorded in three PAGASA weather stations: Port Area, Manila, Science Garden, Quezon City, and NAIA, Pasay City.

layers was not a continuous process but rather may have been cycles of deposition. Uplift, weathering and erosion rather than submergence and deposition.

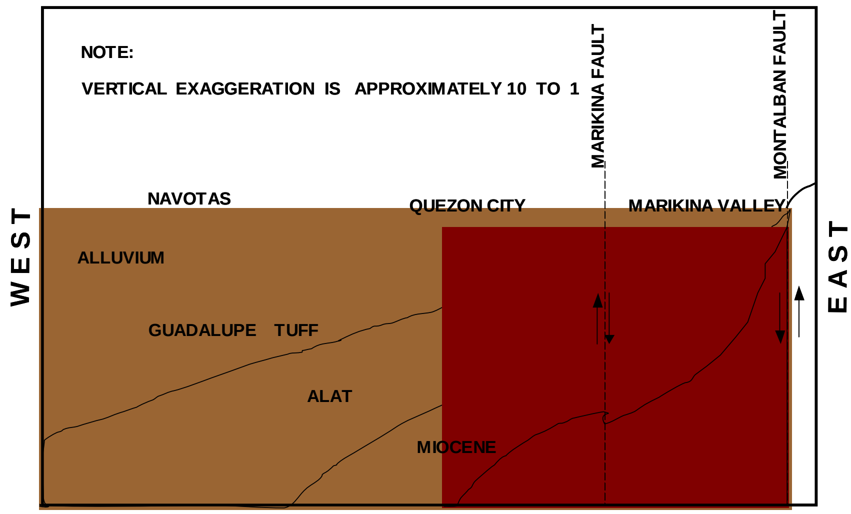

Figure 2.3 Simplified Geological Cross-Section of Metro Manila

Hydrogeology

The hydrogeologic structure in the MWSS service area was formed due to tectonic and volcanic events during the Late Tertiary and Quaternary periods, along with sea level changes.

In the coastal areas of Manila Bay, Laguna de Bay, and Marikina Valley, the groundwater systems mainly consist of alluvial sediments, while the rest of the areas are underlain by pyroclastic Guadalupe Formation. These aquifer systems extend from 1400 to 1800 sq. km.

The major aquifer systems underlying Metro Manila are as follows:

- Manila Bay Alluvium – found in Caloocan City, Manila, Pasay City, Makati City, Valenzuela, Navotas, Malabon, Parañaque, Las Piñas, Bacoor, Imus, Kawit, Noveleta, and Rosario. The Manila Bay Aquifer System is anisotropic and semi-confined with vertical permeability that is much lower than the horizontal permeability.
- Marikina Valley Alluvium – exposed in the municipalities of San Mateo, Montalban, Marikina, Pasig, Cainta, Taytay, Pateros, and Taguig.
- Guadalupe Formation – underlies Quezon City, San Juan, Mandaluyong, part of Makati, and Muntinlupa. The transmissivity coefficient in the Guadalupe Formation ranges from 50 to 100 sq m/ day, with an average of 58 sq m/ day, which means that the aquifer system has slightly moderate water transmitting properties.
- Laguna Formation and Pre-Quaternary Formations – deposited in Antipolo City, Angono, Baras, Binangonan, Cardona, Jala-jala, Morong, Pililia, Tanay, and Teresa.

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The aquifer systems generally have an upper water table aquifer of up to 30 m deep. A semi-confining layer with thickness of up to 45 meters separates this upper water table aquifer from the lower artesian aquifer of more than 500 m thickness. Ground water velocity within the confined aquifers averages 0.6 m/day, flowing generally from Quezon City toward Caloocan and Manila and from Laguna Lake and Las Piñas toward Makati and Parañaque.

Confined aquifers within the Guadalupe tuff are the source of groundwater for the service area. It is believed that withdrawal of groundwater from the aquifer is in excess of the recharge resulting in the following externalities:

- Aquifer depletion;
- Groundwater pollution;
- Land subsidence; and,
- Saline intrusion.

An indicator of groundwater over-abstraction is the drawdown of piezometric heads. The piezometric heads in the northeast of Manila has gone down from +180 m in 1955 to only +120 m in 1994. At the coastal areas, the piezometric heads fell from –10 m to –100 m within about four decades.

Earthquakes

Several hundred tremors are recorded annually in the Philippines. Two sources of structural movement are the Philippine Deep whose axis lies 80 km off the east cost of Luzon and Samar. And the Philippine Rift, which runs from Lingayen Gulf through Polillo Island, Sorsogon, Leyte and Eastern Mindanao. Three active volcanoes (Taal, Makiling and Banahaw) lie within 80 km of Manila.

Construction in the coastal plain alluvium is especially susceptible to seismic damage because of the soft foundation materials and the almost universal use of friction piles. No major pipeline damage has been attributed to earthquakes in the Metro Manila area, although it is possible that seismic action has damaged sewer pipes without external indication.

2.2 Land Use Analysis

An analysis of existing and proposed land uses within the MWSS Service Area was made to determine the distribution of population and their activities and future trends or directions of expansion or contraction of specific land uses in each component city or municipality. A more detailed discussion can be found in *SAP 1, Volume 1: Land Use, Demographic and Water Demand Study.*

2.2.1 Land Use Types and Maps

The land use maps used in this Study were compiled from the individual Comprehensive Land Use Plans (CLUP) of each city/municipality within the Service Area. The CLUPs had different base years and time frame of planning. The earliest existing map available was 1980 and the most current existing map was 1996. This means that the existing land use maps might have considerably changed at the time of this report particularly for the NCR, which exhibited very rapid urban transformations.

The proposed land use maps have a time frame between 7 and 20 years from the time they were prepared which translates to between year 2010 and 2016. Hence, a projection for up to the Master Plan timeframe of 2025 was extrapolated based on projected populations and densities. A more detailed discussion of the land use analysis is found in *Strategic Action Paper 1: Volume 1*. Land use maps are annexed in the same document.

This study uses the standard Housing and Land Use Regulatory Board (HLURB) classification of urban uses such as Residential, Commercial, Industrial, Institutional and Open Spaces. For summary purposes, other specific land uses identified in the individual CLUPs were included in the major land use classifications used below based on the predominant type of uses as discussed above (e.g. cemeteries, cultural heritage were included in Institutional, etc.)

2.2.2 Existing Land Use

A large portion of the MWSS service area is composed mainly of built-up areas specifically in the central and southern service area and some areas in the north. The built-up areas that include residential, commercial, industrial, institutional and related infrastructure make up about 40% of MWSS Service area. The rest, which lies mostly in the northeastern portion of Rizal is made up of agricultural land, forest, open grassland and some mining/quarrying activities.

Almost half of the existing land area of the NCR is devoted to residential land use. The combined area for commercial and industrial land uses is less than one-third of the total area. Parks and open spaces comprise about 25 percent of the total existing land uses and the rest are devoted to other land uses. **Table 2.1** and **Figure 2.4** show the summary of existing land uses in the NCR. Four trends have been identified to characterize land use in the region:

- Increased density and size of squatter settlements in city centers;
- Development of medium-scale residential subdivisions for the upper and upper-middle income markets up to the peripheries of the inner and intermediate cores; while low-cost housing has moved to the outer core in the provinces of Rizal, Bulacan, Cavite and Laguna;
- The growth of big commercial centers along EDSA and other major thoroughfares; and
- Infilling of the urban area with high-density housing.

Table 2.1 - Existing Land Uses in the NCR

Land Use Category	Existing Land Use Area (hectares)	%
Residential	29,842.91	49.38
Commercial	5,222.98	8.64
Industrial	5,480.84	9.07
Institutional	3,150.89	5.21
Parks/Open Spaces	15,548.67	25.73
Agricultural	1,077.97	1.78
Military Area	113.01	0.19
Total Land Area	**60,437.26**	**100.00**

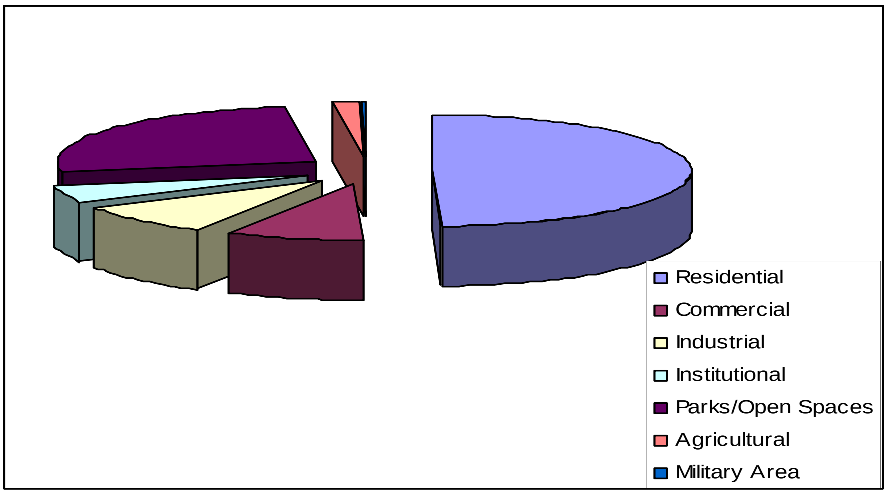

Figure 2.4 Existing Land Uses in the NCR

The Cavite service areas and Rizal province has a combined total existing built-up area of approximately 214 hectares or about 13 percent of its combined total land area of about 1,652 sq km as shown in **Table 2.2.**

Table 2.2 - Existing Built-up Areas of Rizal Province and Cavite Service Areas

	Rizal	Percent	Cavite	Percent
Built-Up Area (ha)	162.59	11.3	86.76	40.8
Other Land Uses (ha)	1,277.89	88.7	125.82	59.2
Total Area (ha)	1,440.48	100.0	212.58	100.0

The Cavite Service Areas have become highly urbanized in the past 20 years because of the proximity to Metro Manila. The largely agro-fishery base of the area was lost to residential, commercial, industrial and institutional uses. The rapid urbanization was also due to the resettlement of squatters in Metro Manila by the National Housing Authority in Cavite in the late 1980s.

The same phenomena can be observed in Rizal province. Its proximity to Metro Manila has greatly influenced its rapid urbanization. This high rate of urbanization is concentrated mostly in the municipalities near Metro Manila. The municipalities of Antipolo, Cainta, Taytay and Tanay are considered the urban centers of the province where most of the economic activities are located.

2.2.3 Proposed Land Use

The NCR will have increased allocation for residential, commercial, and industrial uses in view of increasing population and increased economic activities. These will be taken from previously classified agricultural lands that are now idle and no longer serving that function and from converted military reserved areas planned for mixed-use development.

The differences between the existing and proposed land uses in Metro Manila as reflected in the CLUPs of the LGUs are shown in **Figure 2.5.**

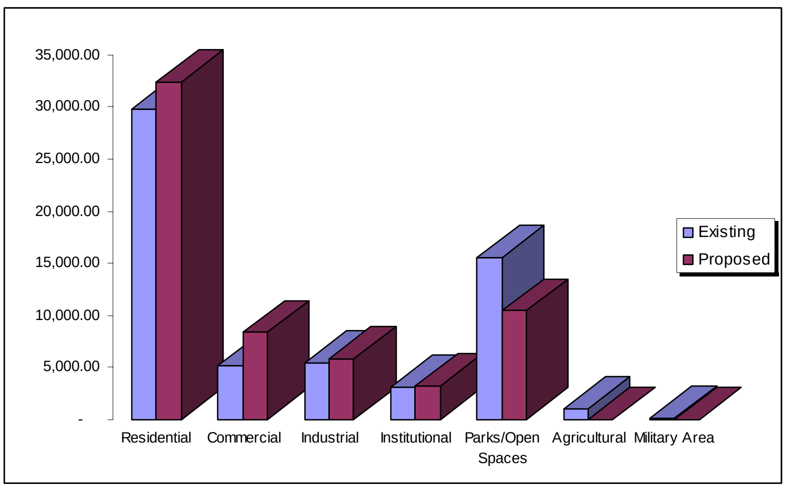

Figure 2.5 Difference between Existing and Proposed Land Uses (in hectares)

The CLUPs of the Cavite Service Areas are proposing further expansion of the built-up areas except for Kawit, Rosario and Noveleta, which up to the time of preparation of this Master Plan have not yet prepared their CLUPs. However, based on the increasing trend of population in these areas and their adjoining LGUs, it is projected that their built-up areas will likewise increase.

Rizal province is also anticipating continued development particularly the service centers of Antipolo, Cainta and Taytay. Growth corridors are being planned in various strategic locations around the province. The Rodriguez-San Mateo-Antipolo growth corridor, which includes the proposal for the establishment of San Mateo Industrial Estate, will link it with

Quezon City and the northeastern part of Metro Manila. A planned Antipolo-Sampaloc, Tanay growth area, on the other hand, will focus on the development of a grand industrial estate project that is expected to hasten the eastern province's industrialization.

The difference between the existing and proposed built-up areas in Rizal and the Cavite service area is shown in **Table 2.3.**

Table 2.3 - Percentage Change Between Existing and Proposed Built-up Areas of Rizal Province and Cavite Service Areas

Service Areas	Existing (hectares)	Proposed (hectares)	% Change
Cavite Service Areas*	8345.52	9898.58	15.69
Rizal Province**	16,259	40,440	59.79

Note: * includes only Bacoor, Cavite City and Imus
** excluding Baras

2.2.4 Urban Development Trends

Metro Manila studies show that, historically, the strongest directions of growth have been towards the northeast, or Quezon City and the south, or Muntinlupa. These growth directions, moreover, appear to be canceling each other out, thereby leaving what planners call a "net eastward" movement in the center of the metropolitan population.

Physical development will encroach and intensify potentially in the watershed areas in Quezon City and Marikina Valley, towards Rizal. Rizal province has been experiencing approximately 10 percent growth rate over the last decade and densities, particularly in the municipalities of Cainta and Taytay are increasing.

The approved/proposed land uses within the service area are developing towards increased residential, commercial and industrial activities with corresponding increases in land allocation. The NCR is going towards mixed use high residential/commercial developments to cater to its increasing population and higher level of commercial activities in the future.

The MMDA physical framework plan intends to decongest Metro Manila and re-distribute and link growth with the suburban centers of neighboring regions and provinces such as Rizal, Cavite, Laguna and Bulacan. This is supported by specific policy areas and applicable strategies such as permitted developments and transport systems. One of the policies is the relocation of squatters in suburban resettlement areas or sites outside the region specially those living in environmentally constrained areas. This supports the continued growth of population in Rizal.

There are also plans for the development of transport exchange centers where people living outside the NCR can be dropped off and commute from there to their place of work or destination in the region. This is reinforced by the promotion of mass transit systems including other transport modes such as skyways, subterranean railways or roads.

For land use and development, the emerging trend is that land value within the NCR, particularly in the regeneration and urban control policy areas, is rapidly rising thereby leading to changes in land using activities in order to meet demand for specific purposes, be they residential or service-oriented commercial uses. In other words, manufacturing entities will find it more practical and less costly to relocate to areas outside the inner and intermediate cores of Metro Manila. Add to this the fact that installation of anti-pollution treatment facilities will add to operating costs of industries, which may opt to transfer to industrial enclaves already equipped with such facilities. The provinces of Rizal and Cavite will continue to receive and plan for the spillover of housing demand and supply in Metro Manila. A vast number of residents in these areas actually work in the inner and intermediate core of the metropolis. In anticipation of this trend, the LGUs in these provinces have already planned for increased built-up areas to accommodate the migration and increase of population from Metro Manila.

2.3 Population and Social Base Analysis

It is essential to establish accurate information about the existing population, which will be the basis for formulating reasonable projections in the light of predictable influences within the Study Area. These include growth trends at the national, regional and provincial levels that set the growth trend of the component cities and municipalities within the Service Area.

2.3.1 Existing Population and Densities

The national and regional population and growth trends are important in this study as they are the basis for predicting the behavior or their component cities/municipalities. The population of the country in 2000 was about 76.5 Million with an average growth rate of about 2.2 percent. The ratio of NCR and Region IV with respect to the total population of the country is about 13 and 15 percent respectively. The ratios of the Province of Cavite and Rizal are 17 and 14 percent, respectively, out of the 10 provinces within Region IV.

The MWSS Service Area accounts for 16.2 percent of the country's total population in 2000 estimated at 12.4 Million, with an average annual growth rate of 1.5 percent in 2000. The proportionate current (Yr 2000) distribution of population is approximately 60% West Service Area and 40% East Service Area. The National Capital Region comprises about 80% of the total population in the service area; the municipalities covered in Cavite comprise 6% and Rizal Province 14%.

In the 2000 NSO Census, the biggest cities are the cities of Manila, Quezon, and Caloocan the combined population of which is 40% of the total population in NCR and already one-third of the entire service area population. Meanwhile, the towns with the smallest number of population are Baras, Jala-jala, and Teresa in Rizal Province where the combined population is less than 100,000 or 4.5% of the total population in Rizal or less than 1% of the total population in the service area.

The average density within the Service Area is about 6,000 persons or about 1,300 households/km^2. The City of Manila registered the highest population density at about 39,000 persons/km^2 followed by Caloocan City. The least dense municipality is Tanay, Rizal with only about 234 persons/ km^2 or inhabited only by about 47 families/km^2.

It is estimated that 28 percent of the households in the service area are informal settlers, which are approximately 814,000 families. These informal settlers are distributed to about 600[3] major slum areas in the service area.

Figure 2.6 indicates the population densities in the service area at the time of the 2000 census.

[3] Based on NHA reports

Figure 2.6 Service Area Population Densities, 2000

2.3.2 Growth Trends

The population growth is the change in the population size between two points in time. Generally, NCR is growing at a slower pace than the rest of the Philippines from 1980 to 2000 with an average growth rate of about 2.6 %, while Cavite and Rizal grew faster than the rest of the country with 4.4 and 5.8 percent growth rate, respectively. NCR during the 5-year period between the years 1995-2000 had a growth rate less than 1 percent, while Cavite had 3.14 percent and Rizal had 5.4 percent growth rates during the same period.

2.3.3 Population Projections

The future population in the Service Areas was projected for the planning period (2005 to 2025) using the NSO population census of 2000 as base data. The projection aims at providing data for the estimate of future water demand at city/municipal level.

To project populations of cities and municipalities in the coverage area, the ratio method rather than the cohort component method was utilized because of the unavailability of data on fertility, mortality and migration at the city/municipal level. The ratio method of estimating the future population of the MWSS service areas makes use of the levels and trends in the ratios of the population of cities and municipalities to the population of their respective provinces observed in previous censuses. These ratios are then projected on the assumption that after some time stability will be attained

The 2000 to 2040 NSO projection of Philippine population was used as a basis for projecting the population of NCR and the provinces of Cavite and Rizal (based on their ratio with Region IV) using the ratio method.

The results of the projection are presented in **Table 2.4 and in Figures 2.7 to 2.10.**

By the year 2025, the projected population within the MWSS service area is 19.4 million. This is an increase of about 57 percent or 7 Million persons from the NSO Census of 2000. The highest growth will be experienced by Rizal, which will more than triple by 2025, while Cavite will increase by 68 percent and NCR by 25 percent.

The projected growth and distribution in Rizal is strongly influenced by its proximity to Metro Manila. The more densely populated municipalities are those located or close to Metro Manila. The high population growth rate is largely attributed to in-migration from the other regions of the country, which results mainly from the perceived economic opportunities in Metro Manila.

Because NCR and Cavite Service Areas are highly urbanized, population growth has more or less stabilized and their development strategies focus now on mixed use and high-density residential development.

By 2025, the approximate distribution between the East and West Service Areas will be almost 50-50 percent because of the high growth rates in the East Service Area. The projected population in each of the LGUs in the service area for the years 2000, 2005, 2010, 2015, 2020 and 2025 is shown in **Table 2.4.** The growth trends are shown in **Figure 2.11.**

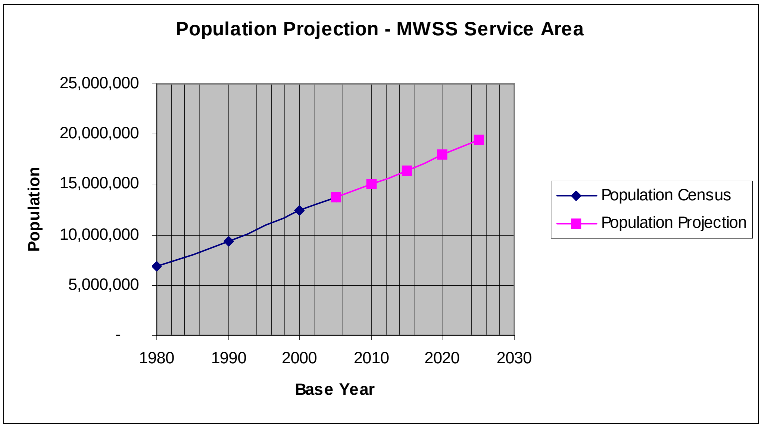

Figure 2.7 Population Projection, MWSS Service Area

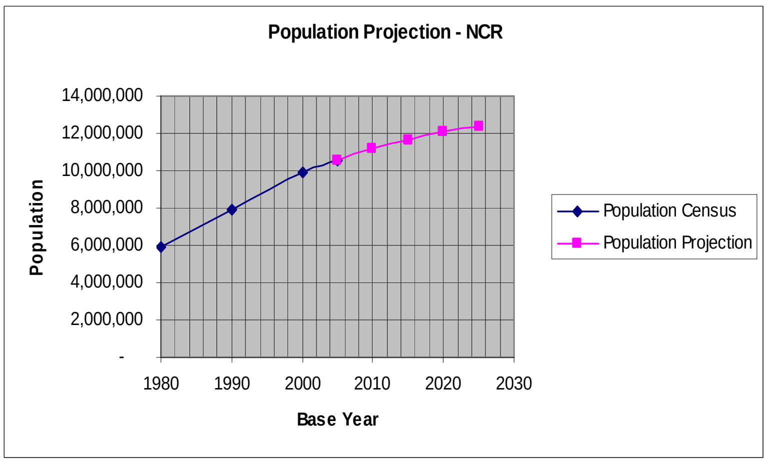

Figure 2.8 Population Projection, NCR

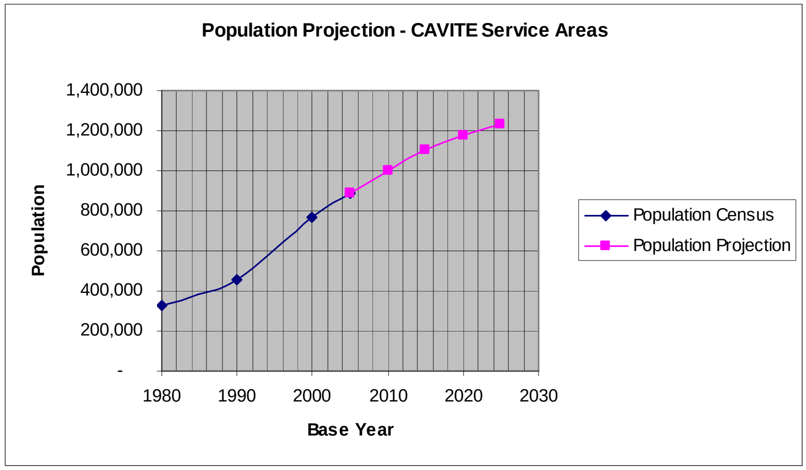

Figure 2.9 Population Projection, Cavite Service Areas

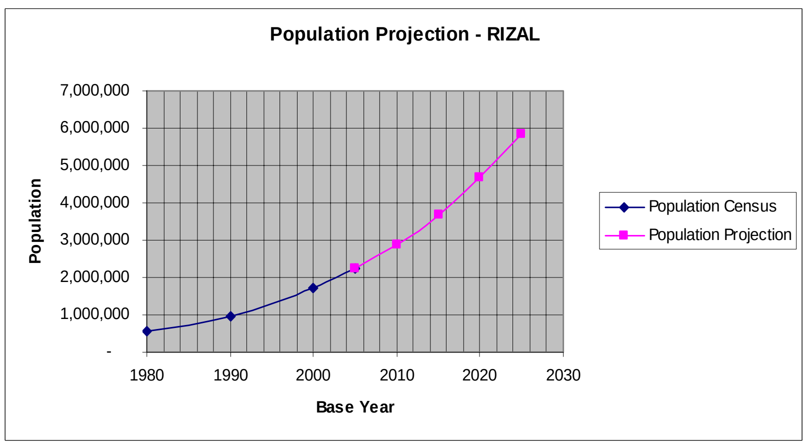

Figure 2.10 Population Projection, Rizal Province

Table 2.4 - Projected Population and Growth Rates, MWSS Service Area

	City/Municipality	Population Projection					Projected Growth Rates (%)				
		2005	2010	2015	2020	2025	'00-'05	'05-'10	'10-'15	'15-'20	'20-'25
	NCR	**10,575,188**	**11,137,443**	**11,649,493**	**12,077,301**	**12,402,857**	1.26	1.04	0.90	0.72	0.53
1	Manila	1,572,788	1,542,856	1,498,306	1,437,495	1,361,717	(0.11)	(0.38)	(0.58)	(0.83)	(1.08)
2	Pasay	355,122	350,412	342,295	330,334	314,760	0.01	(0.27)	(0.47)	(0.71)	(0.96)
3	Quezon	2,288,816	2,376,485	2,442,754	2,480,588	2,487,164	1.04	0.75	0.55	0.31	0.05
4	Caloocan	1,305,994	1,428,308	1,546,404	1,654,073	1,746,872	2.09	1.81	1.60	1.36	1.10
5	Mandaluyong	296,293	310,882	322,918	331,374	335,752	1.25	0.97	0.76	0.52	0.26
6	Las Pinas	559,481	652,906	754,286	860,899	970,158	3.42	3.14	2.93	2.68	2.42
7	Makati	461,480	444,207	423,290	398,494	370,408	(0.48)	(0.76)	(0.96)	(1.20)	(1.45)
8	Malabon	330,538	317,956	302,785	284,860	264,608	(0.50)	(0.77)	(0.97)	(1.21)	(1.46)
9	Marikina	412,731	429,446	442,354	450,155	452,302	1.08	0.80	0.59	0.35	0.10
10	Muntinlupa	415,098	447,968	478,589	505,137	526,418	1.82	1.54	1.33	1.09	0.83
11	Navotas	245,524	258,011	268,413	275,867	279,944	1.28	1.00	0.79	0.55	0.29
12	Paranaque	498,242	544,239	588,518	628,723	663,185	2.07	1.78	1.58	1.33	1.07
13	Pasig	576,228	648,316	722,104	794,589	863,297	2.67	2.39	2.18	1.93	1.67
14	Pateros	57,438	56,673	55,357	53,419	50,897	0.01	(0.27)	(0.47)	(0.71)	(0.96)
15	San Juan	119,133	118,932	117,541	114,765	110,638	0.25	(0.03)	(0.24)	(0.48)	(0.73)
16	Taguig	551,941	642,775	741,048	844,040	949,194	3.38	3.09	2.89	2.64	2.38
17	Valenzuela	528,340	567,069	602,531	632,489	655,543	1.71	1.42	1.22	0.98	0.72
	Cavite	**889,204**	**1,001,005**	**1,100,829**	**1,179,874**	**1,231,998**	2.95	2.40	1.92	1.40	0.87
18	Cavite City	103,976	105,650	104,612	100,701	94,199	0.91	0.32	(0.20)	(0.76)	(1.33)
19	Bacoor	352,753	395,270	431,607	458,171	472,635	2.90	2.30	1.77	1.20	0.62
20	Imus	226,717	255,332	280,220	298,977	309,981	3.01	2.41	1.88	1.30	0.73
21	Kawit	72,750	81,901	89,850	95,828	99,318	3.00	2.40	1.87	1.30	0.72
22	Noveleta	38,068	44,032	49,631	54,385	57,911	3.56	2.95	2.42	1.85	1.26
23	Rosario	94,941	118,820	144,910	171,812	197,955	5.21	4.59	4.05	3.46	2.87
	Rizal	**2,230,624**	**2,878,932**	**3,686,046**	**4,672,308**	**5,859,922**	5.49	5.24	5.07	4.86	4.63
24	Angono	100,496	133,373	175,297	227,726	292,250	6.12	5.82	5.62	5.37	5.12
25	Antipolo City	639,804	857,242	1,137,491	1,491,840	1,932,861	6.32	6.03	5.82	5.57	5.32
26	Baras	31,018	38,701	47,820	58,403	70,463	4.82	4.53	4.32	4.08	3.83
27	Binangonan	237,025	295,155	363,995	443,681	534,256	4.78	4.48	4.28	4.04	3.79
28	Cainta	308,654	387,364	481,453	591,452	717,776	4.94	4.65	4.44	4.20	3.95
29	Cardona	45,233	51,727	58,582	65,576	72,515	3.01	2.72	2.52	2.28	2.03
30	Jala-jala	28,724	34,948	42,110	50,151	59,003	4.29	4.00	3.80	3.56	3.30
31	Morong	50,832	59,966	70,059	80,900	92,286	3.65	3.36	3.16	2.92	2.67
32	Pillila	56,027	68,367	82,620	98,685	116,446	4.35	4.06	3.86	3.62	3.37
33	Rodriguez	149,087	190,309	240,584	300,610	371,061	5.30	5.00	4.80	4.56	4.30
34	San Mateo	183,874	245,853	325,552	426,083	550,900	6.28	5.98	5.78	5.53	5.27
35	Tanay	95,441	114,826	136,816	161,125	187,452	4.06	3.77	3.57	3.32	3.07
36	Taytay	267,047	354,825	466,906	607,260	780,232	6.15	5.85	5.64	5.40	5.14
37	Teresa	37,362	46,275	56,761	68,816	82,420	4.67	4.37	4.17	3.93	3.67
	Grand Total	**13,695,016**	**15,017,380**	**16,436,369**	**17,929,483**	**19,494,777**		1.86	1.82	1.75	1.69

Figure 2.11 Service Area Projected Population Growth Trends, 2025

2.3.4 Population Density Projections

The average density of population within the MWSS Service Area by 2025 is about 10,216 persons/km^2, an increase of 30 percent from the 2000 density. The highest densities can still be found within NCR with the cities of Taguig, Manila and Caloocan achieving densities over 30,000 persons/km^2. Taguig became highly dense because it lost some of its lands to Makati City, particularly the Fort Bonifacio development. The least dense is Tanay in Rizal province with about 560 persons or about 112 families/km^2. **Figure 2.12** presents the density projection within the service area.

The growth trend continues to draw eastward with the core of Manila extending to the peripheries of Rizal and Cavite.

2.4 Economic Base Analysis

2.4.1 General Economy

In terms of economic output, selected economic indicators reveal that the MWSS service area continued to occupy a large sector of the country's economy, particularly NCR which contributed 30.5 percent share to the total and the sub-region of CALABARZON (where Rizal and Cavite had a large contribution) with 13 percent. Both regions were also among the top two highest contributors to the GDP growth rate (NSCB Sectoral Performance Report, 2004). All these factors lead to the indication of further expansion within the area in the future.

NCR remains as the region with the highest per capita index at 235.7 based on the national index set at 100.00. The CALABARZON to which Cavite and Rizal belong also achieved a high index of 103.4 while the rest of the regions had lower per capita indices than the national average.

2.4.2 Household Income and Expenditure Distribution

Based on the 2000 NSO Family Income and Expenditures Survey, the average annual family income in the service area ranges from PhP 270,000 to about PhP 300,000. The average annual family income in the service area is significantly higher than the national average of PhP 145,121, which means that Metro Manila households have more disposable income than the rest of the country.

Figure 2.12 Service Area Projected Population Density, 2025

SKM

2.4.3 Poverty Statistics

The country's annual per capita poverty threshold (also called the poverty line or the annual per capita income required to satisfy nutritional requirements and other basic needs) is PhP 13,313 for urban areas in 2002. The NCR posted the highest poverty threshold at PhP 15,975 per person, 25 percent higher than it was in 1997[4]. Cavite and Rizal had a poverty threshold of PhP 14,965 and PhP 14,787 respectively in the same period. The number of poor families within the Service Area reached over 380,000 families.

2.5 Issues and Opportunities for Water Sector Development

Approximately 19.4 Million persons or approximately 4.3 Million families will need potable water supply services within the MWSS Service Area by 2025. At present, the level of population served by water is about 8.3 Million[5] with total service connections of about 1,028,623 as of 2004.

The projected population will be housed in existing residential areas and in the development of new high-density residential/commercial use spaces. Most of the LGUs are planning for medium-density socialized housing for low-income groups that will decide to stay within the region.

There will also be a general increase in commercial and industrial uses that will be requiring new water supply and sewerage systems. Industrial activities within the NCR will likely be of the small and light industries and the large, heavy industries will be relocating outside the region, most likely towards Rizal, Cavite and the adjoining provinces.

Transport projects that will link NCR with Cavite and Rizal are already underway. This will increase the movement and flow of people and goods within the Service Area and will likely promote more development within the planning period. The approved/proposed land uses within the MWSS service area provides for a general increase in residential, commercial and industrial areas with the residential area increasing at a higher rate than the other two uses. This implies increased water needs in all three major activities. It is estimated that domestic water supply will have a higher proportion than industrial water supply requirements not only because of the high growth rate in residential areas but also because most LGUs in NCR are also limiting their industrial development to light industries which have limited water consumption. In certain areas of the NCR, particularly the cities of Manila, Quezon, Makati, Pasig, Mandaluyong and Las Piñas as well as the municipality of San Juan, industrial activities will be reduced to pave way for the creation of new residential/commercial developments.

Certain issues should be considered though in the light of the proposed developments in the service area and the increasing population.

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[4] The NSO Family Income and Expenditure Survey is being conducted every 3 years only,
[5] Based on 2003 MWSS Regulatory Office Annual Report

In terms of land use and development, the NCR and Cavite Service Areas will have a short supply of available land for their increasing population and economic activities. Hence, development will likely be vertical rather than horizontal. The existing systems should be assessed if they can still accommodate the additional load coming from these developments.

Rizal, on the other hand, has a large expanse of open space/grasslands but is constrained by the availability of water in the area. With the projected growth rate and development trends leading towards this area, new water sources should be given priority for development.

In terms of developing new systems, there are several factors to be considered relative to the projected land uses within the service area:

- It is likely that developments will be scattered all over the region and will not likely be developing in scheduled phases as it is mostly private sector led. Hence, careful consideration should be given to designing system requirements for specific sector areas.

- The changing advocacies and short term tenures of Chief Executives affect the ability of LGUs to implement CLUPs and enforce zoning ordinances within the plan period. Hence, in the design of new systems, approved/projected land uses should be treated only as indication. It is unlikely that these areas will be transformed within the time frame prescribed by the plans.

- There are also external and macro-economic factors affecting the rate of development in the NCR and the rest of the country. Historically, the NCR consistently produced the highest output in the country while Cavite and Rizal are closely followed because of their proximity to the NCR.

3. Water Demand and Production Forecasts

3.1 Introduction

The water demand projection will serve as the basis for decisions on the size and timing of the development of future sources, as well as the forecast for sales of water and tariff rates that will be required to meet financing and debt service requirements.

For sizing and timing purposes, allowance is made for leaks and flushing (non revenue water) to determine the total system demand.

In this study, water demand is broken down into domestic, commercial and industrial demands. Semi-business category is included in the domestic category while government and private institutions are included in the commercial category. Unbilled consumption is included in water demand estimates.

The water supplied into the MWSS water system, which has always been less than the system demand, is broken down into billed consumption and non-revenue water (NRW). The NRW is composed of: (1) physical losses mainly from leaks and flushing operations and (2) non-physical losses or commercial losses referred to above as unbilled consumption, which are due to metering errors and illegal connections.

3.2 Water Demand Projection

In this study, non-physical losses are considered to satisfy part of the demand and only physical losses are applied as a correction factor to total demand to determine the required system capacity.

Future water demand estimates are mainly dependent on past consumption trends and other factors such as water tariff and the socio-economic condition of the community. In the present case, complete reliance on past consumption trends is inappropriate as these are affected by:

- Low pressures
- Supply interruptions (intermittent water availability)
- Metering errors
- Unauthorized connections
- Use of sources other than from MWSI or MWCI (private wells)
- Tariff increases

The factors enumerated above will result in an underestimation of future demand. The forecast of future consumption rates has therefore been based on best estimates of sustainable demand for domestic and other purposes. Unit consumption projections are in-line with standards set for comparable Asian cities sharing similar socio-economic conditions.

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3.3 Domestic Water Demand

A reasonably accurate correlation between per capita consumption and per capita income or family income can be established from past consumption trends in an unconstrained supply setting. This was the methodology used in the 1997 Manila Water Supply III Project Review of the Laiban Dam Project.

In view of the constrained supply situation and the factors enumerated in the preceding section, which affected the normal growth of domestic water demand, this study adopted a methodology similar to that used in the Study of Water Resources Development for Metro Manila commissioned by the NWRB and JICA and prepared by Nippon Koei Co., Ltd. and NJS Consultants in 2003.

Domestic Water Demand is estimated as follows:

a. Service Coverage

The service coverage targets are taken from the Rate Rebasing Submission of the two concessionaires. However, these were updated considering the actual service coverage per municipality for Year 2004 as presented in **Appendix A (Table A-1 and Figures A-1 to A-5)**.

It is assumed that the service coverage targets per municipality vary linearly. Since the planning milestones in the Rate Rebasing Submission of MWCI (i.e. five-year interval from 2006 to 2021) are not the same as in this study (i.e. five-year interval from 2005 to 2025), linear interpolation is applied to obtain coverage targets for the intermediate years and for years beyond 2021. A summary is shown in **Table 3.1** below.

Table 3.1 - Service Coverage Targets

Service Area	2005	2010	2015	2020	2025
West	90%	97%	98%	98%	99%
East	67%	73%	81%	92%	98%
TOTAL	81%	87%	90%	95%	98%

The projected population served is obtained by applying these service coverage targets to the projected population developed for this study (refer to **Appendix A**, **Table A-2)** and *Strategic Action Paper No.1: Volume 1* for further details).

b. Household Distribution by Income Level

It is also assumed that water demand is related to household income. **Appendix A (Table A-3)** shows the total number of families in each city/municipality, categorized into three income groups: high, middle, and low using the 2000 Family Income and Expenditures Survey by the National Statistics Office (NSO).

In the absence of a similar detailed survey for the cities/municipalities of the provinces of Rizal and Cavite, the provincial household income percent distribution was adopted commonly for each city/municipality.

c. Number of Individuals per Connection

According to the Consumer Survey prepared by the Public Assessment of Water Services (PAWS) in 2003, the number of individuals sharing one connection is significantly lower than 9.2. This figure has been used by the two concessionaires in computing the total population served for the past years. However, in some cases, using this value gives percentage coverage exceeding 100%. Hence, this study adopted the results indicated in the Consumer Survey that are deemed more realistic, i.e. 8.1 persons per connection served by MWCI and 7.26 persons per connection for MWSI. These new figures were used in computing the historical domestic per capita billed volume.

3.3.1 Domestic per Capita Water Demand for Year 2005

Taking into account the current limitation on supply, the following consumption rates or per capita demand (constrained) were used: 180 lpcd for the high income group, 170 lpcd for middle, and 140 lpcd for low.

A lower set of per capita demand were adopted for selected and less urbanized towns in Rizal and Cavite, i.e. 160 lpcd for high, 150 for middle and 140 for the low income group.

Using the household distribution by income level from **Appendix A (Table A-3)** and the per capita demand above, the weighted average per capita demand were obtained per city/ municipality. The domestic demand projection for Year 2005 was obtained by applying these average per capita demands to the population served as shown in **Appendix A (Table A-2)**, resulting in a system-wide average per capita demand of about 160 lpcd. (See **Appendix A**, **Table A-4**)**.**

3.3.2 Domestic per Capita Water Demand for Year 2010

While the current and planned NRW reduction programs of the concessionaires and the expected recovery of physical losses will lead to more water becoming available, the lack of a new major source development by Year 2010 and increased service numbers is expected to keep unit demand levels constrained. Hence, the 2005 demand levels have been applied up to Year 2010. The following consumption rates or per capita demand (constrained) were used: 180 lpcd for the high-income group, 170 lpcd for middle, and 140 lpcd for low.

Similar to Year 2005, a lower set of per capita demand was adopted for selected and less urbanized towns in Rizal and Cavite: 160 lpcd for high, 150 lpcd for middle, and 140 lpcd for the low income group. The resulting system-wide average per capita demand was also roughly 160 lpcd. (See **Appendix A**, **Table A-4**)

3.3.3 Domestic per Capita Water Demand from 2015 to 2025

With the likely development of a major source prior to Year 2015 and continued benefits of planned NRW reduction programs of the concessionaires, it is expected that more water will become available from Year 2015 leading to an increase in unit consumption rates. The increase in per capita consumption during this period is, however, expected to be moderated or even neutralized by price elasticity and other demand management initiatives aimed at limiting consumption to sustainable levels. There are indications that price elasticity may have been the reason for the decline in billed volumes in both concessions from 2001 to 2004, when water rates were raised. The historical domestic per capita-billed volumes for the West and East Concessions are presented in **Appendix A (Tables A- 6.1 and A- 6.2)**.

The following per capita demands were used for the period 2015-2025: 220 lpcd for the high-income group, 200 lpcd for middle, and 160 lpcd for low. Once again, a lower set of per capita demand was adopted for selected and less urbanized towns in Rizal and Cavite: 180 lpcd for high, 160 for middle, and 140 for the low income group.

From this new set of per capita demands by income level, the domestic demand projection for Year 2015 onwards results in a system-wide average per capita demand of about 180 lpcd. **(See Appendix A, Table A-5).** This level of consumption correlates well with the present level of consumption, specifically, in some areas in the East Zone where there is 24-hour supply and adequate pressures **(See Appendix A, Table A-6.2).**

3.3.4 Domestic Water Demand from 2005 to 2025

The domestic water demand as calculated above is summarized in **Table 3.2**. It is projected that the total domestic water demand will increase from 1,767 MLD in 2005 to 3,465 MLD in 2025. The details per city/municipality are presented in **Appendix A (Tables A-4 and A-5)**.

Table 3.2 - Projected Domestic Water Demand (MLD)

Service Area	2005	2010	2015	2020	2025
East	599	734	1,071	1,372	1,653
West	1,168	1,344	1,665	1,747	1,812
TOTAL	1,767	2,078	2,736	3,119	3,465

3.3.5 Comparison of Results with Previous Studies

The results of this study fall within the range of previous projections as shown in the **Table 3.3** and **Figure 3.1**. This study's domestic water demands are slightly higher than those of the 2003 Water Resources Development Study and 1996 Water Supply & Sewerage Master Plan, but lower than those of the 1997 Manila Water Supply III Project Review. Overall, the domestic water demand projections of this study are within 30% of values being used by the concessionaires for the purpose of future supply planning.

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Table 3.3 - Comparison of Domestic Water Demand Projections with Previous Studies

Previous Studies	Projected Domestic Water Demand, MLD					
	2000	2005	2010	2015	2020	2025
2003 Water Resources Dev't Study	919	1,213	1,565	2,116	2,742	3,596
1996 Water Supply & Sewerage Master Plan	1,201	1,585	2,090	2,635		
1992 Study on Groundwater Dev't	1,902	2,145	2,382			
1997 Manila Water Supply III	2,064	2,630	3,220	3,788		
This Study	**1,111***	**1,767**	**2,078**	**2,736**	**3,119**	**3,465**

*From historical data provided by MWCI and MWSI plus commercial losses

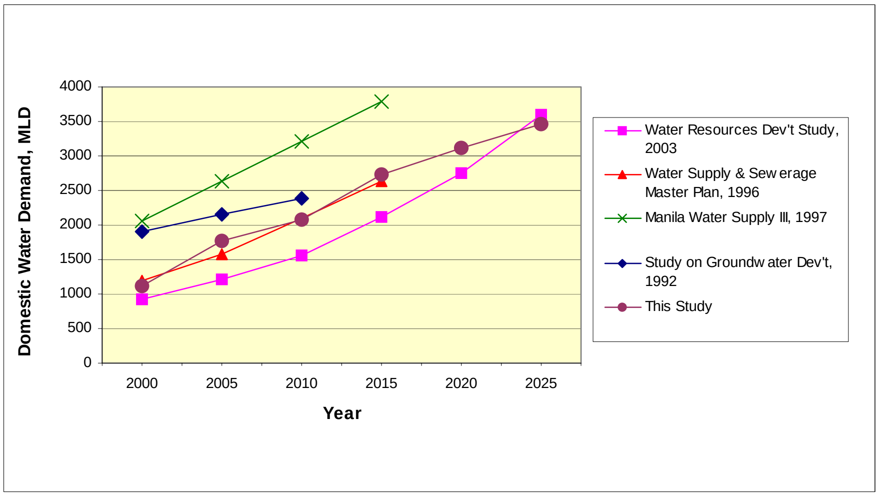

Figure 3.1 Comparison of Domestic Water Demand Projections with Previous Studies

3.4 Commercial and Industrial Water Demand

Two methodologies were considered for projecting commercial and industrial water demand:

- **Method 1**

  This is an adaptation of the 1996 NJS Master Plan methodology, which uses a time series trend analysis for commercial water demand projections and an exponential curve trend analysis for industrial water demand.

- **Method 2**

  This method seeks to establish a relationship between Gross Regional Domestic Product (GRDP) and commercial and industrial water consumption as used in the 2003 Water Resources Development Study.

Both of these methodologies rely on the past consumption trends to project future consumption, assuming normal consumption growth is reflected therein.

When the past consumption rates are affected by supply constraints like low pressures and water supply interruptions, the resulting demand projection may not reflect the true demand growth rate.

Hence, to mitigate the effects of constrained supply, this study examined billed volume records in the East Zone, where some areas have uninterrupted supply and relatively good water pressures compared to the West Zone as shown in **Appendix A (Tables A-7.1 and A-7.2)**.

The average historical commercial and industrial per capita-billed volume of the East Zone was used in computing future commercial and industrial billed volumes for both concessions.

3.4.1 Commercial Water Demand

Details of the application and comparison of the two demand forecasting methodologies for commercial demand projections are found in *Strategic Action Paper No.1 Volume 1*.

For this study, Method 2 for demand forecasting, based on GRDP, was selected as the preferred methodology as it presents a more logical way of calculating billed water for commercial use. The projected commercial billed volumes were then used to obtain the commercial water demand by applying a correction for commercial losses, which was estimated at 15% of NRW. (*See Strategic Action Paper No. 3, Section 4.3*)

A comparison of this study's commercial water demand with those of the previous studies is shown in **Table 3.4** and **Figure 3.2**.

Table 3.4 - Comparison of Commercial Water Demand Projections with Previous Studies

Previous Studies	Projected Commercial Water Demand, MLD					
	2000	2005	2010	2015	2020	2025
2003 Water Resources Dev't Study	418	428	528	662	842	1,082
1996 Water Supply & Sewerage Master Plan	349	385	397	409		
1992 Study on Groundwater Dev't	697	822	948			
1997 Manila Water Supply III	815	1,008	1,159	1,311		
This Study (Method 2)	**569***	**636**	**889**	**1,048**	**1,244**	**1,438**

* From the historical data provided by MWCI & MWSI plus commercial losses

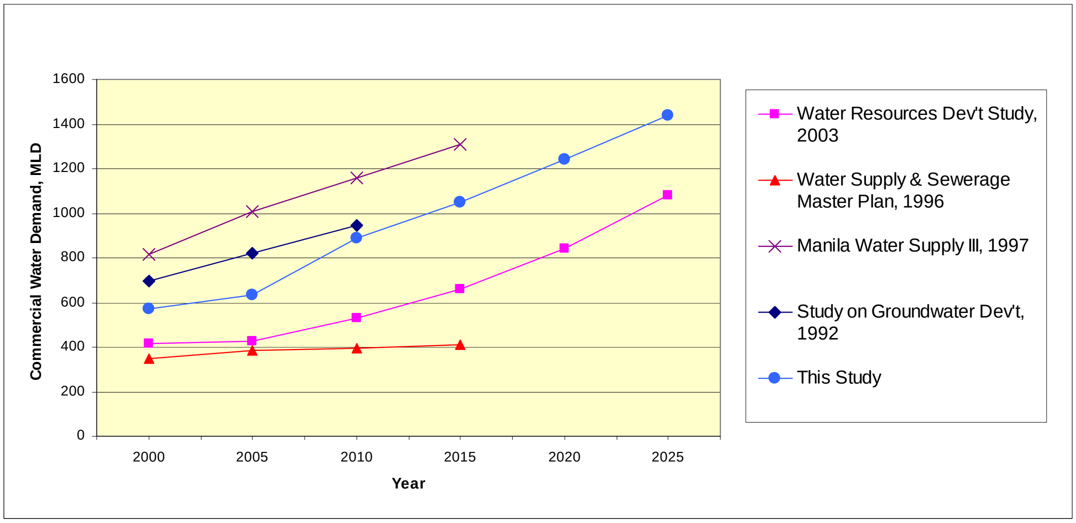

Figure 3.2 Comparison of Commercial Water Demand Projections with Previous Studies

3.4.2 Industrial Water Demand

Details of the application and comparison of the two demand forecasting methodologies for industrial demand projections are found in *Strategic Action Paper No.1 Volume 1*.

Similar to commercial demand, the results of Method 2 are adopted for this study and are projected with the addition of a correction factor to the computed industrial billed volume to account for commercial losses. The correction is also estimated at 15% of NRW. (See *Strategic Action Paper No. 3, Section 4.3*)

When compared with the projections of the previous studies, the computed industrial water demand for this study falls within the range of previous projections as shown in **Table 3.5 and Figure 3.3**.

Table 3.5 - Comparison of Industrial Water Demand Projections with Previous Studies

Previous Studies	Projected Industrial Water Demand, MLD					
	2000	2005	2010	2015	2020	2025
2003 Water Resources Dev't Study	94	99	117	141	170	208
1996 Water Supply & Sewerage Master Plan	173	266	272	278		
1992 Study on Groundwater Dev't	626	715	800			
1997 Manila Water Supply III	725	1,003	1,190	1,247		
This Study (Method 2)	**125***	**121**	**172**	**204**	**242**	**281**

* From the historical data provided by MWCI & MWSI plus commercial losses

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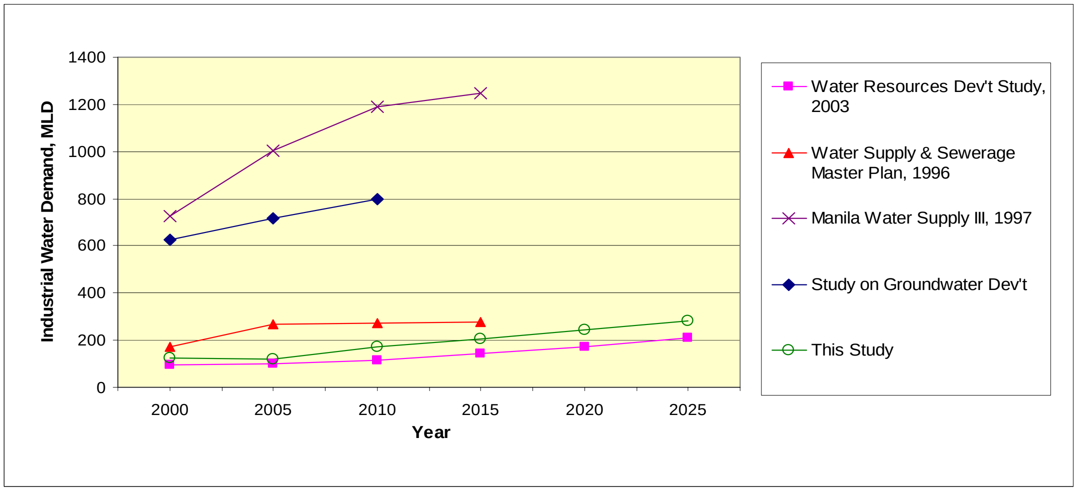

Figure 3.3 Comparison of Industrial Water Demand Projections with Previous Studies

3.5 Total Water Demand

The projected total water demand for 2005 to 2025, which is referred to in this study as the sum of domestic, commercial, and industrial water demands, is summarized in **Table 4.6** below.

Table 3.6 - Projected Total Water Demand

Water Demand	2005	2010	2015	2020	2025
Domestic (MLD)	1,767	2,078	2,736	3,119	3,465
Commercial (MLD)	636	889	1,048	1,244	1,438
Industrial (MLD)	121	172	204	242	281
Total	**2,525**	**3,139**	**3,988**	**4,605**	**5,184**

The total water demand also represents the amount of water supplied by the system for beneficial use, whether the consumption is billed or not. In cases where the consumption has not been accurately metered and billed, this portion is referred to as commercial loss.

3.6 Non Revenue Water

With the existing and planned non-revenue water (NRW) reduction programs by the East and West Concessionaires, it is projected in this study that the NRW ratios will be further decreased from 62%[6] in 2005 to as low as 30% in 2025.

The average projected NRW levels and physical losses are presented in **Table 3.7**. It is noted, however, that different values have been applied to the two concession areas at

[6] NRW ratio of 62% will occur if projected system demand is applied. If supply is limited to the existing system capacity, NRW ratio is 57%.

the detailed level of computation. The decision to adopt different values for NRW and physical losses for the two concession areas is to ensure that current differences between the two areas are actually reflected in the projections.

NRW is divided into two components: non-physical losses or commercial losses and physical losses. Non-physical losses or commercial losses, which are about 15% of the total NRW, are directly applied to the billed volumes to obtain the total water demand. On the other hand, physical losses (estimated to be 85% of the total NRW) are applied to the total water demand to derive the system demand.

Table 3.7 - Projected NRW Levels and Physical Losses

	2005	2010	2015	2020	2025
NRW Ratio (%)	62%	45%	34%	31%	30%
NRW Level (MLD)	3,258	2,292	1,920	1,928	2,088
Physical Losses Ratio (%)	52%	38%	29%	26%	26%
Physical Losses (MLD)	2,769	1,948	1,632	1,639	1,774

Table 3.8 and Figure 3.4 present the comparison of the NRW reduction targets with those of the 2003 Water Resources Development Study and 1996 Water and Sewerage System Master Plan. When plotted, the NRW ratios of this study form an asymptotic curve, whereas those of the previous studies are in linear form.

Table 3.8 - Comparison of NRW Reduction Targets with Previous Studies

Previous Studies	2005	2010	2015	2020	2025
2003 Water Resources Dev't Study	54%	48%	42%	36%	30%
1996 Water Supply & Sewerage Master Plan	42.5%	36%	30%		
This Study	**62%**	**45%**	**34%**	**31%**	**30%**

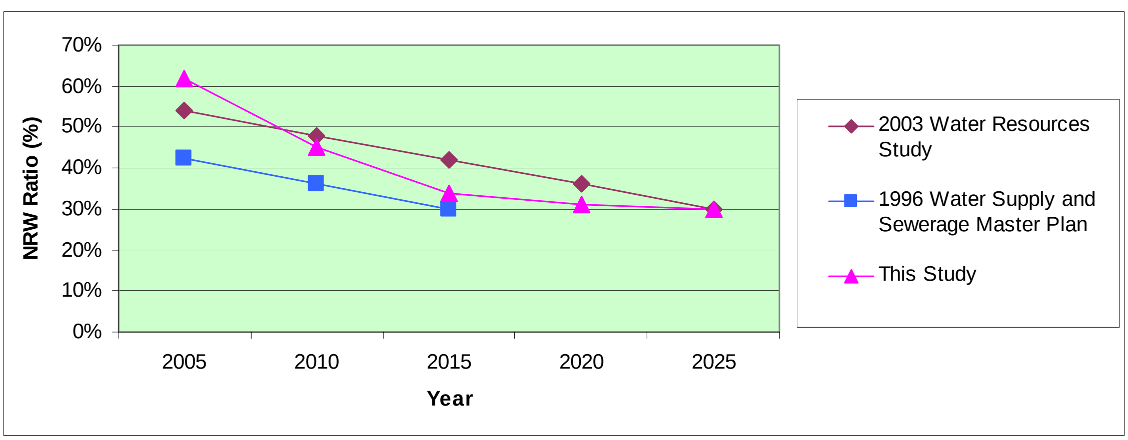

Figure 3.4 Comparison of NRW Reduction Targets with Previous Studies

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3.7 System Demand

Shown in the table below is the system demand, which was obtained by applying the correction due to physical losses to the total water demand.

Projected System Demand

Year	System Demand (MLD)
2005	5,294
2010	5,088
2015	5,619
2020	6,244
2025	6,958

The system demand represents the amount of treated water to be produced by water sources on an *annual average daily* basis, i.e. the **average day demand (ADD)**. For water sources with storage capacity to balance out low and high demand periods, the ADD also represents the nominal source capacity needed to meet projected demand.

Interestingly, in the forecasts presented the system demand for Year 2010 is lower than the estimate for Year 2005 due to the assumed impacts of NRW reduction programs being undertaken by the two Concessionaires. If NRW reduction targets are not met by the Concessionaires however, the Year 2010 system demand is more likely to approach 5,500 MLD.

A comparison of this study's system demand projections with the results of the previous studies is shown in **Table 3.9 and Figure 3.5**.

Table 3.9 - Comparison of System Demand with Previous Studies

Previous Studies	Projected System Demand, MLD				
	2005	2010	2015	2020	2025
2003 Water Resources Dev't Study	3,783	4,250	5,033	5,866	6,980
1996 Water Supply & Sewerage Master Plan	3,889	4,324	4,746		
1992 Study on Groundwater Dev't	3,682	4,130			
1997 Manila Water Supply III	4,650	5,571	6,346		
This Study	5,294	5,088	5,619	6,244	6,958

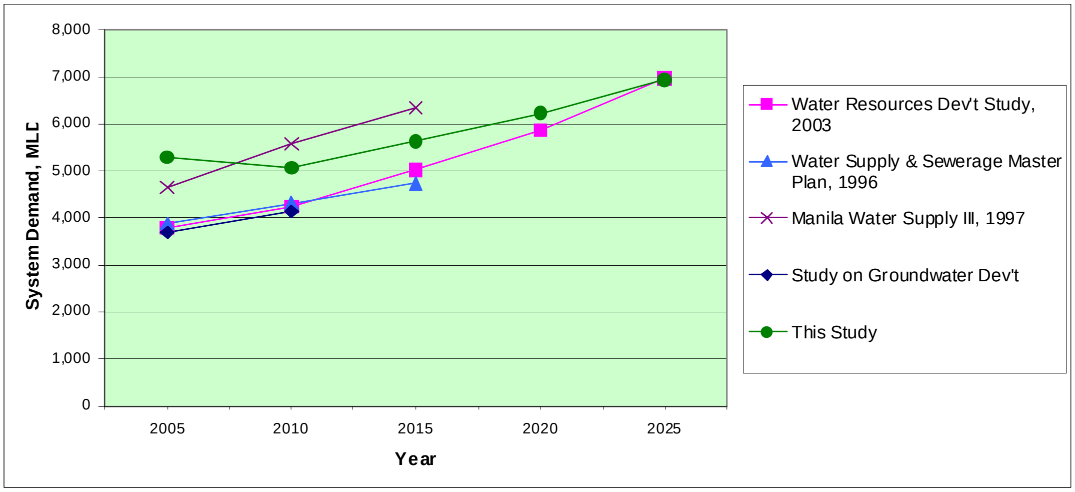

Figure 3.5 Comparison of System Demand with Previous Studies

The projected domestic, commercial, and industrial water demand for 2005, 2010, 2015, and 2025 per city/ municipality and for the East and West Zones is shown in **Appendix A (Tables A-8.1 to A-8.5)**.

From the projected system demand estimates two key observations may be made:

1. Given an existing source capacity of 4,090 MLD, new water sources will be required to contribute an additional 2,868 MLD of water by Year 2025 to match projected system demand. Assuming optimization of existing sources is achieved and a 300 MLD BOT development is progressed in the immediate future to provide an additional 400 MLD in extra source capacity, the remaining capacity required by 2025 from other new sources is estimated to be approximately **2,500 MLD** depending on actual NRW reductions.

2. The Year 2015 system demand forecast of approximately 5,600 MLD is also significant in terms of early water source development, as the time interval of 10-years (from now) is close to the lead-time for delivery of a major dam construction project. This suggests that the next source to be progressed after the system optimization and interim source BOT project are completed must be capable of producing **~1,100 MLD** (minimum) to match the projected system demand at the date of commissioning. This effectively rules out a run-of-river type scheme unless it is coupled with a major dam and reservoir option to be implemented in parallel.

A graph of existing supply versus the projected system demand is shown in **Figure 3.6.**

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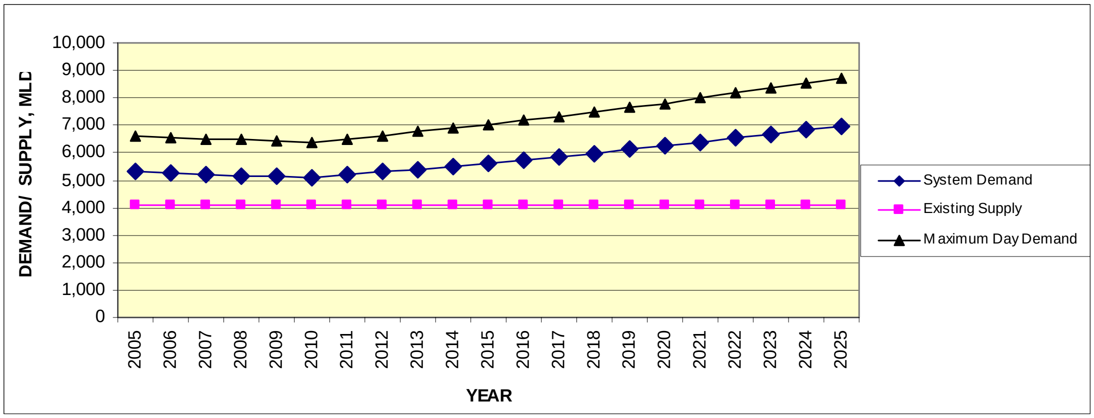

Figure 3.6 Projected Demand and Existing Supply Curve

3.8 Water Production

Water production capacity refers to the capacity of infrastructure downstream of the dams, such as water treatment and conveyance infrastructure, which are operated to supply the system demands at all times. Water production must be capable of meeting the maximum day demand (MDD) of the system. The MDD is determined by applying a factor of 1.25 to the average day demand (ADD). It is assumed that adequate balancing storage will exist within the water distribution system to meet peak hour demands if upstream facilities have capacity to deliver treated water at the MDD rate.

The table below outlines the projection of water production capacity that will be required to meet maximum demands in the MWSS service area, which was obtained by applying the MDD factor (1.25) to the total system demand. As the MDD factor has been applied to the NRW component of total system demand, these estimates are considered to be conservative.

Projected Water Production Requirements

Year	Water Production Requirements (MLD)
2005	6,617
2010	6,360
2015	7,024
2020	7,805
2025	8,698

Further details of the MDD breakdown across the two concession areas are included at **Appendix A (Tables A-8.1 to 8.5)**.

3.9 Water Demand Management

To solve the increasing supply-demand gap, an alternative approach focusing on the demand-side integrated with water conservation measures, may be employed. Water demand management is a management approach that aims to reduce or control water demand to conserve water.

There is no single strategy that can completely reduce or control demand. A holistic approach usually involves a combination of options for the different water users.

Having carefully studied the different demand management options, the following conclusions are derived for the MWSS service area (see *Strategic Action Paper No. 4: Water Demand Management and Reuse Options* for more details):

a. NRW reduction has been recognized as the biggest opportunity to conserve water in Metro Manila. If reduced to 30%, the 2,400 MLD of water that can be recovered, reallocated, and resold may generate additional income to the Concessionaires and improve social equity. This volume is adequate to meet un-served demands until 2015, thus deferring the construction of proposed interim sources.

b. Water pricing reforms provide additional incentives for the efficient use of water. By optimal pricing, the practicality of water-efficient technologies, rainwater harvesting, and water recycling is enhanced, when compared to available potable sources, i.e. MWSS piped water and groundwater. Any of these strategies must therefore be complemented with water pricing reforms.

c. Most of the water-efficient plumbing fixtures (i.e. dual flush toilets and ultra low-flush toilets, low-flow showerheads, and low-flow faucets) available in the market are economically attractive and practical.

d. Public education and information and legislative measures enhance the viability and ensures sustainability of a demand management activity. The different strategies, when employed, should be coupled with an IEC program and a national water demand management policy.

e. The infrastructure options to reduce pressure and control flow are impractical because in general, the service area is already experiencing low pressures.

f. For small houses with low consumption and even for public buildings, the payback period of a sophisticated rainwater harvesting system is so long that it becomes impractical. A simplified rainwater harvesting system is more likely to be attractive particularly for houses with small roof areas.

g. There is limited opportunity for a centralized reuse scheme using a secondary pipe distribution system because of the absence of a major industrial node in

Metro Manila. However, limited amount of reused effluent could be applied for irrigation and other municipal and city uses.

h. There is a need for MWSS to take an active role in the Water Conservation and Demand Management Committee to promote more efficient use of water resources.

i. It may be appropriate for the MWSS Regulatory Office to set performance targets on water-use efficiency.

The primary impact of demand management and recycling initiatives is a reduction in per capita domestic water consumption from water conservation measures and in municipal and industrial water consumption from the use of treated effluent. Currently, these have a minimal impact on water demand, but in the future, provided effective programs are established, it may be possible to effect a reduction of up to about 5-10% of the projected water demand by 2025. These reductions, however, have not been factored into the master plan projections as it is highly dependent upon: (i) the development of wastewater treatment facilities to provide for recycled water; and (ii) the adoption by MWSS and the concessionaires of a water conservation and demand management policy with an accompanying public education program.

It is unlikely that significant reductions in per capita demand from demand management measures will occur until after 2015 when a new water major source is on-stream and water supplies are no longer constrained. Wastewater treatment plant capacity is not expected to be significant until after 2015 similarly limiting the opportunities for recycling initiatives.

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4. Review of Current Operations

4.1 Water Supply Operations

4.1.1 Current Levels of Service

Table 4.1 summarizes the various service level indicators for the two concessions, as applicable to water supply, which includes service coverage, continuity of supply, pressure, and advances in non-revenue water (NRW) programs.

Table 4.1 - Service Level Indicators for the Concessionaires

SERVICE INDICATORS	PRE-PRIVATIZATION	END OF 2004		
		MWCI	MWSI	SYSTEM-WIDE
Population Served in Millions	7.3M	3.4M	4.9M	8.3M
Official Number of Water Service connections	779,380	425,802	602,821	1,028,623
Annual Average Water Production (MLD)	2,800	1,518	2,276	3,793
Non-Revenue Water (NRW)	61%	47.5%	69%	60%
NRW Volume	1,708	632	1,599	2,231
Water Availability	17	21	21	21
Water Coverage	67%	78%	70%	73%

Source: MWSS Regulatory Office

MWSS system-wide coverage for water supply has increased from 67% in mid 1997 to about 73% in 2004, with the East Concession reported at 78% coverage and the West Concession at 70% coverage as shown in **Figure 4.1.** The average domestic supply at present is estimated to be 118 lpcd for MWSI and 178 lpcd for MWCI.

MWSS system-wide NRW has not fared as well, with the NRW percentage decreasing only slightly from 61% in 1997 to just over 60% in 2004. This is mainly due to the increase in NRW in the West Zone from 66% in 1997 to 69% in 2004. The East Zone's NRW level went down from 58.5% to 47.5% in 2004 and is now reported to be 36%.

System-wide water availability, which was at 17 hours in 1997 prior to turnover to the Concessionaires, went up to 21 hours in 2003, equivalent to an increase of four hours. There are areas still with less than 24 hours supply and/or very low pressures as shown in **Figures 4.2 and 4.3** for the East Zone and **Figures 4.4 and 4.5** for the West Zone.

Based on concessionaire data submitted to the MWSS RO, water quality within the MWSS service area generally complies with the Philippine National Standards for Drinking Water. Occasionally, excursions in microbiological quality are recorded in areas subject to intermittent supply and cross contamination. Manganese above guideline levels has also been recorded more recently following first rains after summer periods.

Figure 4.1 MWSS Actual Service Coverage

Figure 4.2 Water Availability Map for the East Zone

Figure 4.3 Pressure Map for the East Zone

Figure 4.4 Water Availability Map for the West Zone

Figure 4.5 Pressure Map for the West Zone

A high level of fluoride (> 2 mg/L) in some groundwater supplies represents a serious water quality issue that warrants attention. The preferred course of action will be to displace these supplies with treated surface water as soon as possible.

4.1.2 Current Water Supply Projects

Angat Water Utilities and Aqueduct Improvement Project (AWUAIP)

The project aims to increase the allocation of MWSS from Angat by 750 MLD to be taken from the National Irrigation Administration share by providing an equivalent volume for irrigation water coming from alternative sources.

A component of AWUAIP, is Aqueduct no. 6 (AQ6) to be laid parallel to Aqueduct nos. 1 to 5 which carries the raw water coming from Ipo Dam down to La Mesa and Balara. Phase 1 of AQ6, a 3.3m-diameter steel pipeline, 5 km long, is now under construction. This was implemented in advance to pave the way for the temporary decommissioning of a parallel length of AQ5 where there are reported losses through leaks of about 100 to 150 MLD. Phase 2 includes the remaining section of AQ6, which has a total length of 11.5 km.

The feasibility study for Phase 2 of this project has tentatively identified three (3) potential water sources that can directly supply the irrigation water requirement of the Angat-Maasim River Irrigation System (AMRIS), which at present draws from Angat Reservoir. This will pave the way for the reduction of irrigation water being drawn from Angat and a corresponding increase in the MWSS allocation. The three sources are UPRIIS-Casecnan Reservoir System, Pampanga River and irrigation return flows at Cansinala, Apalit, Pampanga and the Bayabas River Dam and Reservoir.

This proposal will require the concurrence of NIA and the National Power Corporation (NPC), NIA for the reallocation of their water rights from Angat Reservoir and NPC since the reallocated water will now go through the Auxiliary Turbines rather than the Main Turbines. The head on the auxiliary turbines is 30 meters less than that on the main turbines and power generation will thus be adversely affected.

The feasibility study is now in its final stages and is expected to be submitted to MWSS shortly.

4.2 Water Supply System and Facilities

Water supply to the current MWSS service area is sourced from the Angat-Umiray-Ipo system and local groundwater. Total raw water supply capacity of the existing water source infrastructure is estimated at **4,090 MLD**, of which approximately 98% (4,000 MLD) of the daily supply comes from the Angat-Umiray-Ipo source.

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4.2.1 Raw Water Sources and Conveyance

Angat-Umiray-Ipo Sources

The main water supply source for MWSS is the Angat-Umiray-Ipo River System, as shown in **Figure 4.6**.

A schematic diagram for the existing bulk water system is shown in **Figure 4.7**.

The system originates in the Angat River basin with a transbasin tunnel, adding yield from the Umiray River basin. Inflow is impounded at the Angat Dam. Discharge from the dam flows down to Ipo Dam. From Ipo Dam, raw water is conveyed thru three tunnels to the Bicti interconnection structure, thence thru five raw water aqueducts to La Mesa. The conveyance from Ipo Dam to La Mesa involves some 20km of tunnel/conveyance pipes. At La Mesa, part of the raw water feeds directly to the La Mesa Treatment Plants and the rest goes to Balara or to the La Mesa Reservoir. The La Mesa Reservoir also receives inflow from Alat Dam and its own catchment.

The MWSS has an allocation of 22 m^3/s (1900 MLD) from the original Angat Multi-Purpose Project. On January 2, 1988, the National Water Resources Board (NWRB) granted an additional 15 m^3/s allocation to the MWSS with the following limitations:

a. The grant is for a maximum of 15 m^3/s.
b. It is to be taken out of the unutilized allocation for National Irrigation Administration (NIA).

After the completion of the Angat Water Supply Optimization Project (AWSOP) and the Umiray-Angat Transbasin Project (UATP), the average water production reached 4,000 MLD (46 m^3/s) which is matched by treatment capacity at the La Mesa and Balara WTPs.

It is estimated that out of this total 46 m^3/s, 9 m^3/s come from Umiray and 6.5 m^3/s comes from the intervening catchment area between Angat Dam and Ipo Dam. The remaining 30.5 m^3/s come mainly from Angat with some small contribution from the Alat-La Mesa catchment area.

Groundwater Sources

Sourcing of groundwater from deep wells to either fully meet local demands or augment supply capacity is widespread across Metro Manila, with significant competition existing for use of this resource.

In the concession areas, MWSI reportedly has 81 wells operating mainly in Parañaque, Las Piñas, Muntinlupa, Imus, Bacoor, Noveleta, and Cavite City with a total production of 57 MLD. The MWCI has some 50 wells operating in Cainta, Antipolo, Taytay, San Mateo, Rodriguez, Quezon City and Taguig, with a total production in the order of 35 MLD.

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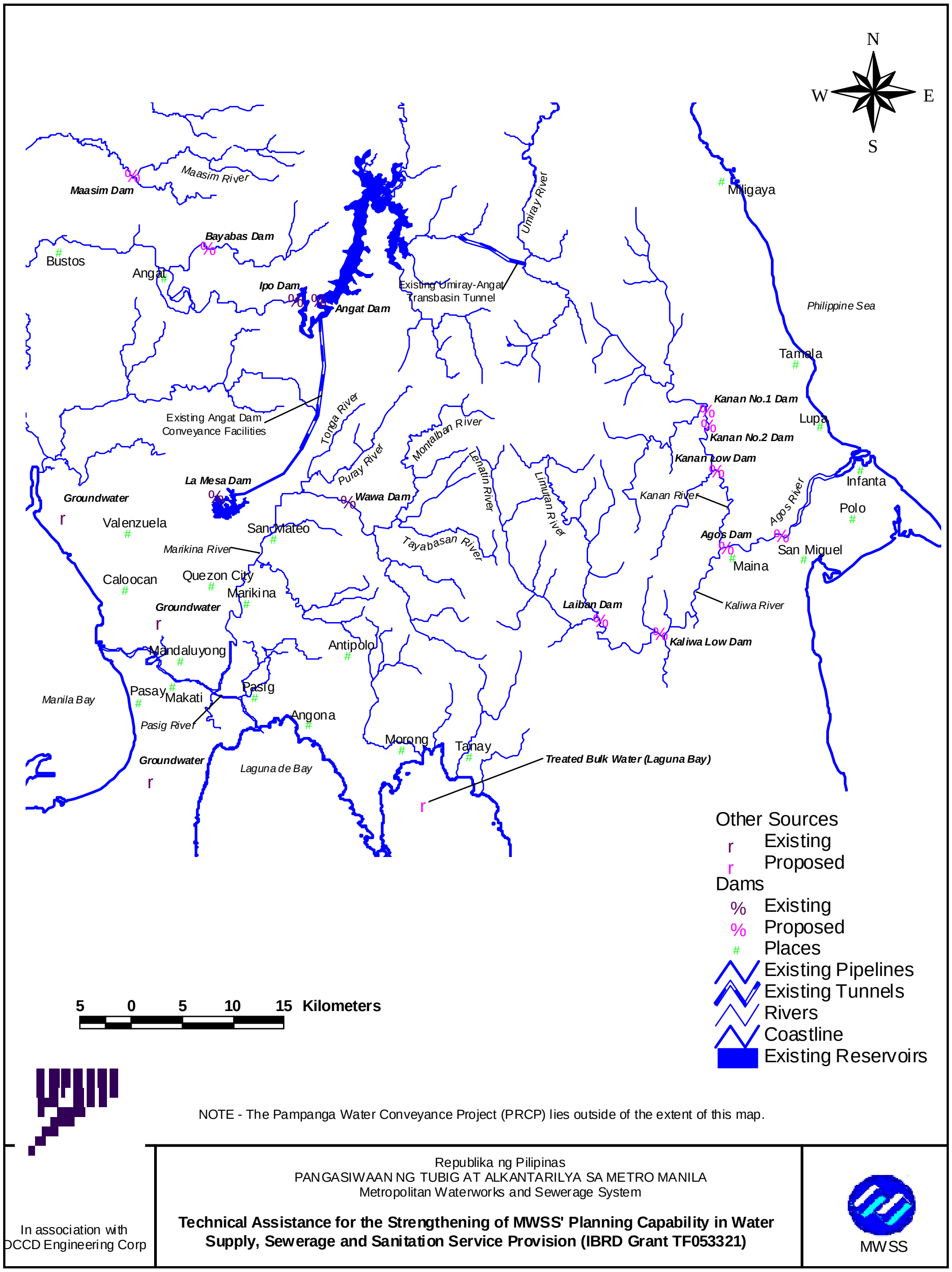

Figure 4.6 Angat-Umiray-Ipo River

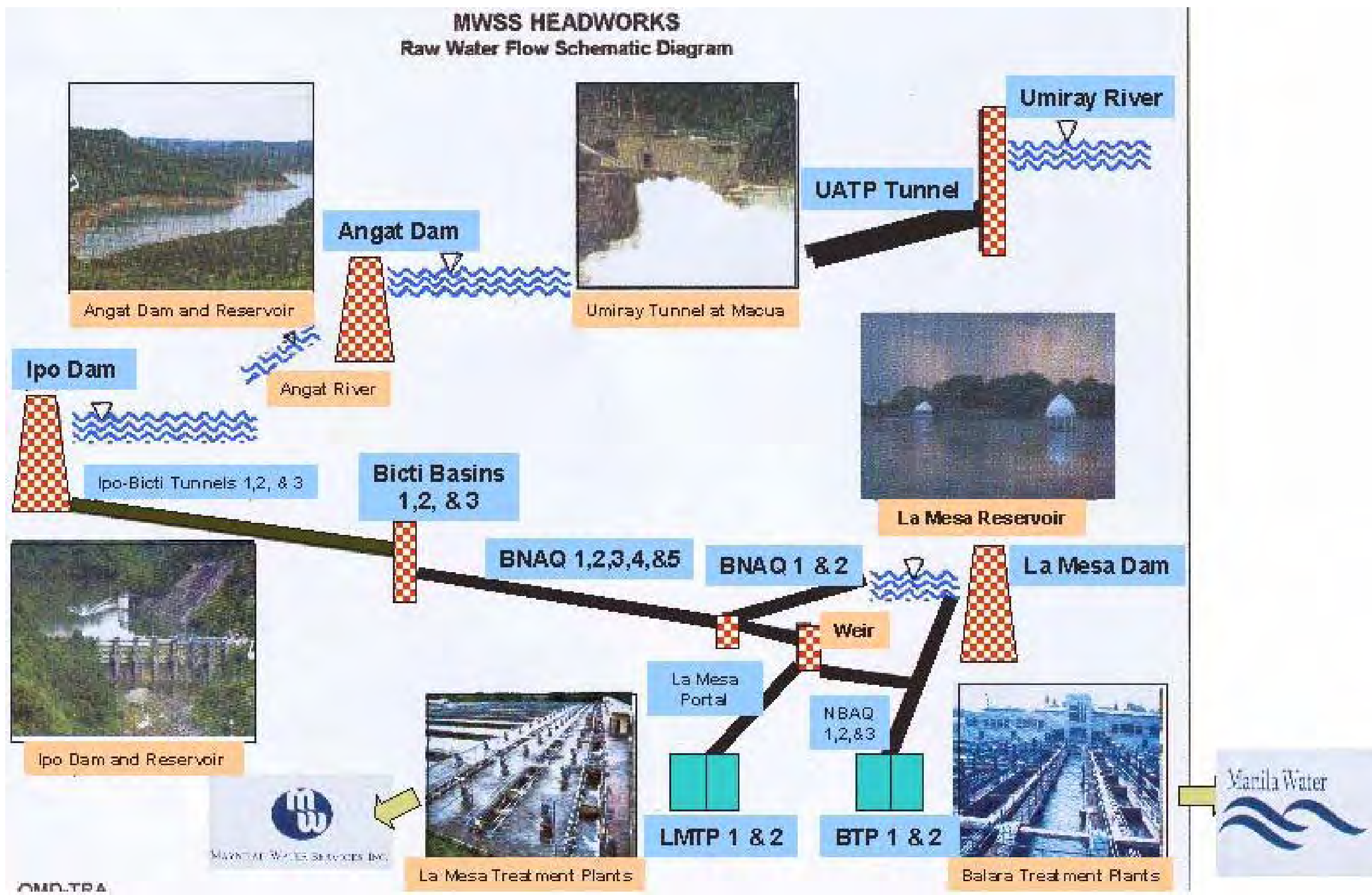

Figure 4.7 MWSS Headworks Raw Water Flow Schematic Diagram

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The total production capacity of 90 MLD from deep wells operated by the concessionaires represents about 70% of the installed capacity. The reduced level of production is due primarily to declines in aquifer levels and water quality resulting from over-abstraction of this resource. It is expected that these issues will continue to place increasing pressure on the use of groundwater as a resource for municipal water supply in the future.

Optimization of Present Water Sources

The Angat Water Utilities and Aqueduct Improvement Project is currently under construction and is projected to add 750 MLD as listed in the 2004 Road Map for water source development. This initial volume will be from the recovery of water losses in AQ-5 and additional allocation from Angat.

The additional allocation from Angat Dam is based on utilizing the full 37 m^3/s allocation that has been granted to the MWSS, i.e. 22 m^3/s original MWSS allocation plus 15 m^3/s additional allocation granted by the NWRB on January 2, 1988. As discussed above, it is estimated that currently only 30.5 m^3/s are being drawn from Angat Reservoir, which is 6.5 m^3/s (560 MLD) short of the total allocation. Moves to obtain the full 37 m^3/s allocation should therefore be pursued vigorously so that the full benefits from the Angat Water Utilities Improvement can be realized.

On the downstream end, the present capacity of the water treatment plants (4,000 MLD) is fully utilized and there is need for additional water treatment plant capacity of between 550 to 750 MLD as part of this optimization project.

4.2.2 Water Treatment Facilities

The West Concession (MWSI)

The West Concession has two water treatment Plants, the La Mesa Treatment Plant 1 (LMTP1) and La Mesa Treatment Plant 2 (LMTP2), both located next to the La Mesa Dam and Reservoir.

LMTP 1, which was commissioned in 1985, is a conventional rapid sand filtration plant with a design capacity of 1500 MLD plus an overload capability of 10% bringing the total to 1650 MLD. The total treatment process involves screening of the raw water, rapid mixing, flocculation, sedimentation, filtration, and post treatment with chlorine and fluoride. The plant has a very energy efficient design relying on gravity flow to backwash its filters and to convey water into the plant and into the distribution system.

La Mesa Treatment Plant 2, which was completed in 1994, has a design capacity of 900 MLD and overload capacity of 990 MLD. The treatment process involves screening, pre-chlorination, coagulation, flocculation, and settling with the aid of pulsator-clarifiers, filtration and post-chlorination.

The performance of both LMTP1 and LMTP2 is currently under review to optimize the output of these plants in readiness for additional raw water becoming available.

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The East Concession (MWCI)

The East Concession has two water treatment plants, Balara Water Treatment Plants 1 and 2, both located in Balara, Quezon City. Balara Water Treatment Plant 1 was commissioned in 1935 and has a design capacity of 470 MLD. This plant was rehabilitated in 1981 and 1996 and the treatment capacity was upgraded to 500 MLD.

Balara Water Treatment Plant 2 was commissioned in 1958 with a design capacity of 1000 MLD and overload capacity of 1100 MLD. Major rehabilitation work was done on the plant in 1981 and again in 1996. The plant now is reportedly capable of treating 1300 MLD. The treatment process in both plants is similar to La Mesa Plant 1. The treatment process involves screening of the raw water, rapid mixing, flocculation, sedimentation, filtration, and chlorination.

4.2.3 Water Distribution Facilities

The MWSS water distribution network had its beginning in 1882 under the old Manila Water District. It has since undergone a series of expansion and upgrading through:

- The Interim Projects in the 1960's;
- The Manila Water Supply Project 2 (MWSP2);
- The Metro Manila Water Distribution Project (MMWDP);
- Angat Water Optimization Project (AWSOP); and more recently,
- The Manila South Water Distribution Project (MSWDP).

Figure 4.8 shows the current distribution network for the East and West Concession areas.

The West Concession (MWSI)

a. Pipe Network

The West Zone distribution system was separated from the old MWSS system and it generally covers the influence area of La Mesa Treatment Plants 1 and 2. The pipe network has a total length of about 2500 km, with sizes ranging from 3200 mm diameter to 50 mm.

The primary distribution system (PDS), consisting of pipes 350 mm diameter and above is about 220 km. The secondary distribution system (SDS), consisting of pipe diameters 200 mm to 300 mm is approximately 290 km, while the tertiary distribution system (TDS) with pipes of up to 150 mm diameter, has a total length of around 2000 km.

Figure 4.8 Primary Water Supply Distribution Network

Treated water from the La Mesa treatment plants is conveyed through a 3200 mm diameter line to the 200-ML Bagbag treated water reservoir. From the Bagbag Reservoir, the water is directed south through a 3000 mm pipe up to the vicinity of A. Bonifacio Street (Balintawak Cloverleaf area), where the pipe size is reduced to 2800 mm. The size of the pipeline is further reduced to 2200 mm in Moriones, Tondo. The 2200-mm pipe continues up to the southern end of the line just upstream of the Pasay Reservoir and Pumping Station, which used to be interconnected with the Marikina Gravity line coming from the East zone. This interconnection was shut down after privatization.

Through the La Mesa Pumping Station, about 24 MLD is sent to Upper Caloocan and 117 MLD is pumped to the Valenzuela area.

The pipe materials used range from asbestos cement pipes (ACP), polyvinyl chloride (PVC), cast iron/ ductile iron pipes (CIP/DIP), and steel pipes. PVC accounts for about half of the tertiary distribution lines with a total length of about 1000 km. It is noted that there are still over 450 km of ACP mostly in the tertiary and secondary pipe network.

b. Reservoirs and Pump Stations

Table 4.2 shows the reservoirs and pumping stations in the West Zone and their capacities. There are eight large treated water reservoirs ranging in storage capacity from 18.9 ML (5 million gallons) to 200 ML. The largest, Bagbag reservoir is located just downstream of La Mesa Treatment Plants 1 and 2. The other seven reservoirs are distributed in the service area, five of which are in Manila, i.e. Algeciras (37.8 MLD), Ermita (18.9 MLD), Tondo (18.9 MLD) and Espiritu (18.9 MLD). The other three are in Pasay City (18.9 MLD), Caloocan City (18.9 MLD) and the D. Tuazon Reservoir (18.9 MLD) in Quezon City. All of the seven reservoirs are equipped with storage and booster pumping units. The total storage capacity is 351 ML, representing less than 10% of average day demand. Security of supply is therefore extremely limited under failure conditions.

The Bagbag reservoir was designed to enable the operation of the La Mesa Treatment Plants 1 and 2 at fairly constant rates, while the rest of the reservoirs distributed throughout the service area were designed to stabilize pressure, i.e. narrow the difference between maximum and minimum pressures in the network.

The 37.8-ML Algeciras reservoir is currently used only as a balancing reservoir and its storage and booster pumps are not in operation. The D. Tuazon, Tondo, and Caloocan reservoirs and pumping stations are also not in operation.

There are three smaller balancing reservoirs, the Binuksuk (30 ML), Sacred Heart (10 ML) and the Novaliches (7 ML), serving areas in the north and west of the La Mesa treatment plant. The Sacred Heart and Binuksuk Reservoirs are served by the La Mesa booster pumping station.

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Table 4.2 - Reservoirs and Pumping Stations in the West Zone

Pumping Stations	Reservoirs	Pumps & Motors	Pumping Capacity	Reservoir Capacity	Influence Area	Remarks
	Sacred Heart	none	none	10 ML	Upper Caloocan	Not being utilized due to unavailability of supply
	Binuksuk	none	none	30 ML	Valenzuela, Novaliches, and Upper Caloocan	Still not being utilized but has immediate plans of putting it in operation.
La Mesa	La Mesa	A = 4x375 HP B = 5x248 HP C = 4x563 HP	100 MLD 250 MLD 204 MLD	50 ML	Lagro, Sacred Heart, Quirino Hi-way Novaliches, Upper Caloocan, Valenzuela Fairview Payatas, Commonwealth	Not in full operation due to lack of supply from La Mesa Water Treatment Plant and gaps within the pipe network.
Novaliches	Novaliches	3x20 HP	9 MLD	7 ML	Previously Novaliches	Pump and reservoir not being operated. Influ-ence area taken over by Mesa B.
	Bagbag	none	none	200 ML	Novaliches, Quezon City	Serve as balancing reservoir
Caloocan	Caloocan	3x200 HP	66 MLD	19 ML	Caloocan	Pump and reservoir not being utilized
Algeciras	Algeciras	3x200 HP 5x225 HP	102 MLD 110 MLD	38 ML	Sampaloc, Manila	Pumps not operated. Reservoir used as balancing.
Tondo	Tondo	2x200 HP 3x225 HP	68 MLD 66 MLD	19 ML	Tondo, Manila	Pump and reservoir not in use.
Ermita	Ermita	2x150 HP 1x175 HP	44 MLD 34 MLD	19 ML	Ermita, Manila	Pump and reservoir being utilized.
Tuazon	Tuazon	3x200 HP 2x225 HP	102 MLD 44 MLD	19 ML	Sta. Mesa Heights, Q.C.	Pump and reservoir not in operation.
Espiritu	Espiritu	4x250 HP	100 MLD	19 ML	Malate, Manila	In operation. Serves Malate area.
Pasay	Pasay	4x300 HP 2x247 HP	190 MLD 34 MLD	19 ML	Pasay City	In operation. Serves Pasay, Paranaque, Las Pinas and northern towns of Cavite.
Villamor	line-booster	2x250 HP	68 MLD	none	Paranaque area	In operation. Completed last July 2005.

The East Concession (MWCI)

a. Pipe Network

The distribution network of the East Zone is generally the part of the MWSS network supplied by the Balara Water Treatment Plants 1 and 2. Total length of the pipes in the system is around 2600 km. About 83.5 km of these have diameters 750 mm and larger. It is estimated that 40% of the distribution system is served by gravity flow, while 60% requires pumping to maintain adequate pressure.

The Marikina Gravity Line, a 2200-mm steel pipe, flows by gravity from the Balara Treatment Plant Complex to Marikina, Pasig, Pateros, Makati. It feeds the Pasig, Fort Bonifacio and Makati Reservoirs and Pumping Stations.

The three Balara-San Juan Aqueducts feed the Balara and San Juan Reservoirs and Pumping Stations, as well as the Cubao Booster Pumping Station. AQ1 feeds the Balara Pumping Station, which discharges through the 1200-mm Katipunan line and the 1050-mm Tandang Sora line. AQ3 serves the San Juan Reservoirs and pumping stations, while AQ2 is currently not in use.

The 1200-mm Tanong line flows by gravity and serves parts of Cainta through the Masinag Booster pumping station.

The pipe materials range from reinforced concrete, steel, cast iron (CI), polyvinyl chloride (PVC) and asbestos cement (ACP). PVC and ACP are mostly found in the secondary and tertiary network.

b. Reservoirs and Pump Stations

The East Zone has five major reservoirs and pump stations as shown in Table 5.3, namely: San Juan with 152-ML storage capacity, Pasig (80 ML), Fort Bonifacio (28 ML), Balara (19 ML) and Makati (19 ML), providing a total storage of 298 ML. Compared with estimated 2005 demand levels, the 298 ML storage equates to approximately 20% of the average day demand and therefore offers limited security of supply under system failure conditions.

The Cubao pump station has no storage reservoir and draws directly from the Balara-San Juan Aqueduct. This pump station feeds the 900-mm diameter pipe going to Timog Avenue and South Triangle in Quezon City, and a 600-mm diameter pipe supplying the Araneta Center Complex up to Project 4. The current pumping station output is 88 MLD.

The Balara Reservoir and Pump Station has a storage capacity of 19 ML and current pumping output of 220 MLD, feeding the 1050-mm diameter Tandang Sora line and the 1200-mm diameter Katipunan Line.

The Fort Bonifacio Reservoir and Pumping Station located at Makati City has a storage capacity of 28 ML and total pumping capacity of 240 MLD. However, the current output is only 65 MLD.

Table 4.3 - Reservoirs and Pumping Stations in the East Zone

Pumping Stations	Reservoirs	Pump & Motors	Pumping Capacity	Reservoir Capacity	Influence Area	Remarks
Balara	Balara	6-800 HP 1-500 HP 1-250 HP	470 MLD	19 ML	Quezon City	In operation
San Juan	San Juan	5-800 HP 1-500 HP 1-300 HP	400 MLD	1-95 ML 1-57 ML	Quezon City San Juan Mandaluyong	Pumps and reservoir being utilized.
Cubao	*na	4-600 HP 1-200 HP	225 MLD	*na	Quezon City	In operation
Pasig	Pasig	4-700 HP 1-375 HP	250 MLD	80 ML	Mandaluyong	Pumps and reservoir being utilized.
Maybunga	*na	2-600 HP	160 MLD	*na	Pasig City Mandaluyong	In operation
Makati	Makati	4-300 HP (booster) 2-300 HP (storage)	250 MLD	19 ML	Makati City	Pumps and reservoir being utilized.
21st Street	*na	2-600 HP	150 MLD	*na	Makati City Taguig City	In operation
Fort Bonifacio	Fort Bonifacio	4-349 HP	240 MLD	28 ML	Makati City Taguig City	Pumps and reservoir being utilized.

*na – not applicable

The San Juan Reservoir and Pump Station has a storage capacity of 152 ML and a total pumping capacity of 400 MLD. The total current output is 234 MLD.

Pasig Reservoir and Pumping Station has a storage capacity of 80 ML and a pumping capacity of 250 MLD. The total current output is about 40 MLD, serving mainly the Ortigas Business District and the contiguous areas of San Juan and Mandaluyong.

The Makati Reservoir and Pumping Station has a storage capacity of 19 ML and a pumping capacity of 250 MLD. The total current output is about 120 MLD, serving mainly Makati City.

There are two other booster pumping units: the Maybunga with a total pumping capacity of 160 MLD serving Pasig City and Mandaluyong, and the 21st Street Pumping Station, with a pumping capacity of 150 MLD serving parts of Makati City and Taguig City.

5. Water Supply Master Plan

5.1 Approach

The MWSS was solely responsible for future water sources planning and development before privatization in 1997. After privatization, owing to the less than explicit provision on this issue in the concession agreement, it was unclear whether this responsibility was now delegated to the concessionaires.

If the responsibility for the development of future water sources now lies with the concessionaires as is the contention of MWSS, the less than 17 years remaining of the 25-year concession period serves to limit the choice of future water sources to those whose repayment periods are 17 years or less. This issue is discussed further in Chapter 7, Institutional Development.

Water Sources

This study proceeds on the assumption that the future water sources options are not limited to those needing only short term repayment periods, and that an agreement can be forged between MWSS and the two concessionaires for the implementation of the best long-term water source development option.

The cost of new water source development included in this study covers only the headworks, raw water conveyance, water treatment plants, hydro power generating unit, treated water trunk and primary lines to deliver treated water from the treatment plants to strategic off-take points of the East and West Concessions and does NOT include the cost of expansion and upgrading of the respective water distribution systems.

Non Revenue Water

This study projects a 30% NRW level at the end of the planning period for both Concessions.

The water distribution networks of both concessions are composed of pipes of different ages and materials. This consideration and the variable ground conditions and depth of cover on the pipes makes it extremely difficult to arrive at a base cost for NRW reduction applicable to all areas in the system.

For purposes of this study, the estimate of cost per million liters per day of NRW reduction in the East Zone were based on the actual cost as reported by MWCI, corrected for the succeeding years to reflect the fact that the cost of NRW reduction increases as NRW decreases. Additionally, operation and maintenance cost to maintain NRW at the desired level in the rehabilitated zones is also included.

For the West Zone the MWSI programmed Capex for the years 2005 and 2006 were adopted. From 2007 onwards, the required investments were estimated using costs about 10% higher than those used for the East Zone to account for the fact that the West Zone's pipe network is older and the more difficult working conditions because of the high water table and poor ground conditions in areas like Pasay, Manila, Caloocan, Navotas and

Malabon. As was done in the East Zone, operation and maintenance cost required to maintain NRW in the rehabilitated zones at the desired level is also included.

5.2 Future Service Area

5.2.1 West Zone

The areas in the West Zone most in need of additional water supply are Valenzuela, Caloocan City, Cavite City, Paranaque, Muntinlupa, Las Pinas, Bacoor, Imus, Rosario, Kawit and Noveleta. Some areas of Paranaque, Las Pinas and the five towns in Cavite and Cavite City, are currently supplied from deepwells, which are showing increasing levels of chlorides, an indication of saltwater intrusion into the aquifers. Several wells have been decommissioned because of this problem even prior to privatization in 1997. Upon the introduction of a new water source, a moratorium on the operation of the deep wells may prevent the further degradation of the ground water in these areas.

5.2.2 East Zone

The main population and demand growth area in the East Zone will be in Antipolo City, Cainta, Taytay, San Mateo, and Binangonan in the Province of Rizal. These areas currently rely mainly on ground water.

The water service coverage targets for the West and East concessions adopted in this Master Plan are shown in **Appendix A (Table A-1 and Figures A-1 to A-5)**.

5.2.3 Expansion of MWSS Service Area

There is a little known provision in Batas Pambansa Blg. 799, amending the MWSS Charter Republic Act no. 6234, as amended, which provides, and we quote; “ The System shall also own and/or have jurisdiction, supervision and control over all waterworks and sewerage systems in Lungsod Silangan, Muntinlupa, and subject to the approval of the President, other areas that may come within the development path of the expanding Metro Manila Area, which areas the Board of the Metropolitan Waterworks and Sewerage System may, from time to time, determine and declare as contiguous to its service area and requiring immediate attention by the system, under such terms and conditions as may be agreed upon by the parties concerned.”, unquote.

Figure 5.1 presents the potential expansion areas that may be serviced by MWSS. The source of water supply for the towns in the Provinces of Bulacan, Cavite and Laguna bordering on Metro Manila is ground water. Almost without exception, there is over extraction from this source and ground water levels are dropping. This opens up the potential expansion of the MWSS Service area to the other towns in Bulacan in the north, Cavite in the south, and some of the highly urbanized towns in Laguna after the Kanan River source comes on stream. For those towns already served by local water districts, service from MWSS or the Concessionaires can be in the form of bulk water supply.

Figure 5.1 MWSS Expansion Areas

5.3 Levels of Service

The concession agreement specifies a 24-hour water availability and 16-psi minimum pressure. The service coverage targets set forth in the Concession Agreement were revised in the 2003 rebasing for the East Zone, and soon after for the West zone. The revised water service coverage targets based on the rate rebasing submission of the two Concessionaires are shown in **Appendix B (Table B-1)**.

The required minimum pressure was also reduced from 16 psi to 7 psi for both the East and West concessions for the rebasing period 2002 to 2007, but will revert back to 16 psi after 2007.

The relevant standard applied under this Master Plan for water quality is the Philippine National Standards for Drinking Water.

It is highlighted that new proposed service reservoirs are typically designed and sized for only 6 hours (or less) of reserve storage for their respective command areas under this Master Plan, which is consistent with past studies. It is suggested that this criterion be reviewed in the future to improve the level of security of supply under failure conditions.

5.4 Potential Water Sources

5.4.1 Overview

For the purpose of this report, new water source options for Metro Manila have generally been divided into two categories – *interim* sources and *long-term* sources.

The interim sources are those being considered for immediate implementation to gain additional source production capacity as quickly as possible. It is assumed that two of these sources, namely the Laguna Lake BOT project and Wawa Dam, already have a high level of commitment and are not subject to review. Other interim source options being examined by the Concessionaires are presently less certain and as such have not been included in the Master Plan development program. These source options are however equally important in bridging the short-term supply gap and should be supported by the MWSS where cost effective.

The long-term source options, on the other hand, are those sources that are available for inclusion in a development program to address the longer-term water needs of Metro Manila through to 2025 and beyond. These options are centered on the Agos River basin and involve longer lead-time, large projects approaching a 10-year delivery timeframe.

A plan showing the location of potential water source options is included at **Figure 5.2**.

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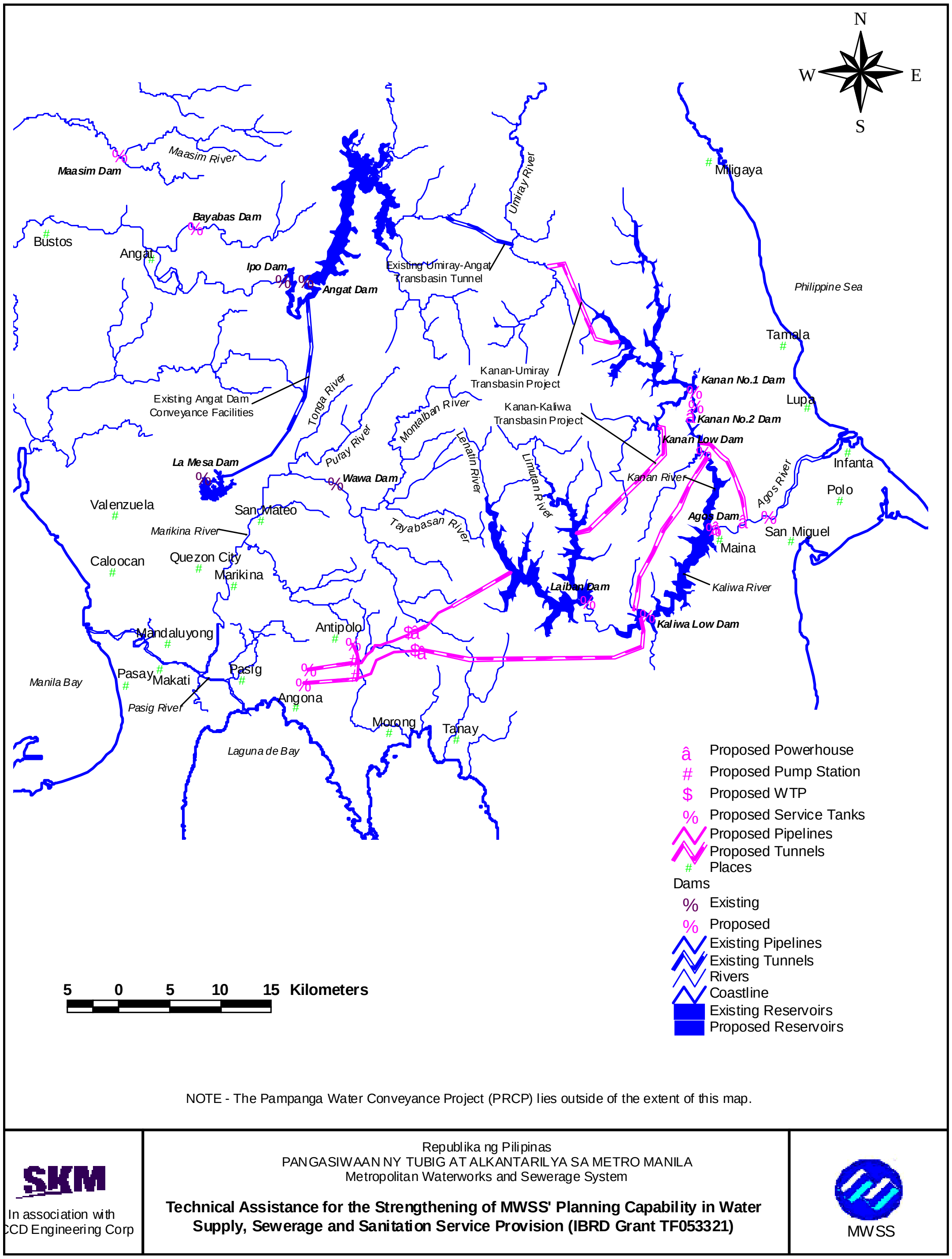

Figure 5.2 Potential Water Source Options

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5.4.2 Interim Sources

Wawa Dam

Consultants are currently engaged by the MWSS to conduct a feasibility study and preliminary design for a 50-MLD Wawa Dam Project with funding from Loan No. 2012 PH from the Asian Development Bank. Expected duration of the study is six months.

The Wawa Dam option involves re-development of an existing dam on the Wawa River, located in the upper reaches of the Marikina River basin in Rodriguez, Rizal. The project comprises a new raw water aqueduct from the dam to a 50-MLD WTP plus new conveyance works to a proposed 10-ML treated water service reservoir.

Potential risks to raw water quality have been identified within the watershed area of the existing dam, namely a piggery farm and sanitary landfill. These are **significant risks**. While these facilities in the past have been earmarked for relocation, residual levels of contamination from these sites will need to be mitigated and carefully monitored to safeguard raw water quality from this source.

According to a technical study on BOT options for treated bulk water supply, completed under funding by USAID in December 2003, further yield is available from this scheme if a larger dam is constructed in the watershed (up to ~ 18 m^3/s or 1,600 MLD).

Treated Bulk Water Supply – Laguna de Bay

This project has been prepared by MWSS for tendering through a Build-Operate-Transfer (BOT) scheme. Under the BOT project, raw water will be drawn from Laguna Lake, treated and supplied into the southern extents of the existing MWSS service area.

Several options exist for the proposed development of Laguna Lake, ranging in capacity from 300 to 1,200 MLD. The current tender has selected a target production of 300 MLD, which is to be supplied solely to MWSI. The original proposal for this project was for a capacity of 400 MLD, to be split as 300 MLD to MWSI and 100 MLD to MWCI. The option of a separate 100 MLD project to supply MWCI is still under consideration.

A schematic plan of the proposed project is shown in **Figure 5.3**.

The scheme includes raw water intakes, raw water pump station, raw and treated water conveyance pipelines and a WTP, all of which can be staged if further capacity from the scheme is required. Proposed abstraction is from the East Bay to minimize adverse water quality impacts resulting from Pasig River inflows to the lake.

A key issue associated with this development is the level of water treatment required. As extensive land development exists within areas draining to the lake, pollution of the resource is a potential risk that may necessitate implementation of further advanced treatment barriers. The likely water quality risks include salinity, nutrients, hydrocarbons and microbiological contamination.

Source: Radian Engineers and Co. The Study of Engineering Alternative for the 300 MLD Bulk Water Supply Project (Final Report)

Figure 5.3 400 MLD Treated Bulk Water Supply Project

Other Interim Sources

Both MWCI and MWSI are currently investing effort to explore opportunities to increase water source production levels in the interim period prior to the development of the next major water source for Manila.

MWCI have a range of water source options under review including:

- Laguna Lake infiltration wells (30 MLD)
- La Mesa watershed (10 MLD)
- Curayao wellfield (8 MLD)
- Nangka River (10 MLD)
- Rodriguez TP (100 MLD minimum)

The Rodriguez Water Treatment Plant, proposed for construction in the La Mesa area to service demands in municipality Rodriguez, represents the most significant opportunity to cut the short term deficit in source capacity. Selection of the plant capacity for this project will depend on the increased availability of raw water resulting from the AQ6 upgrade project and the split of this capacity between the concessionaires.

MWSI have commissioned a consultant to review opportunities to optimize production from the La Mesa water treatment plants. While the study is yet to be completed, early indications are that an additional 10-15% in capacity may be possible.

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5.4.3 Long-term Source Options

The source options identified in the 2003 Study on Water Resources for Metro Manila that warrant discussion in this report include:

- Laiban Dam
- Agos Dam
- Kaliwa Low Dam
- Kanan No.2 Dam

Other dam options considered in the 2003 study were either rejected or related primarily to power generation (rather than municipal water supply).

General details for each of the dam options are summarized in **Table 5.1.**

Table 5.1 - Water Source Option Summary

Name of Development Scheme	Reservoir Water Level (EL. m)		Exploitable Water	
	FSL	MOL	MLD	m^3/s
Laiban Dam	270	237	1,830	21.2
Kanan No.2 Dam	310	278 225	3,310 3,770	38.3 43.6
Agos Dam	159	133	5,210	60.2
Kaliwa Low Dam	-	-	550	6.4

Source – 2003 Study on Water Resources Development for Metro Manila (Nippon Koei and NJS)

Laiban Dam

The Laiban Dam Project involves a 113-m high concrete-face rockfill dam and spillway sited about 0.5km downstream of the confluence of the Lenatin and Limutan Rivers at Brgy. Laiban, Tanay, Rizal. The proposed dam will have an effective reservoir storage capacity of 470 MCM supplied by a watershed area of 276 sq. km.

From an upstream intake on the reservoir, raw water would be conveyed to the proposed Pantay WTP for treatment and supplied onwards to the proposed Taytay 120-ML Service Reservoir (TWL 104.5m EL) by gravity, and proposed Antipolo 100 ML Service Reservoir (TWL 270m EL) by pumping. An additional reservoir at Brgy. San Jose is proposed to supply new expansion areas from the municipality of Teresa to Jala-Jala and serve as the sump for the Antipolo pumping station.

A 22.6-MW baseload hydropower plant, designed for two turbine-generator units, also forms part of the overall scope of works under this project. This powerhouse could be expanded in capacity following further source development on the Kanan River.

It is highlighted that this is the only project listed in the 2004 Road Map of future sources that has generally passed the detailed engineering design stage. The feasibility study was completed in 1979 and detailed design followed immediately after.

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Construction of the diversion tunnel started in 1982 and was completed in 1984. The tendering and construction of the dam, which was planned to follow soon after it was deferred because of the change in political leadership and the very adverse economic climate at the time.

The MWSS engaged the services of Electrowatt Engineering Services and their associates to review and update the plans for Laiban Dam Project in 1996 and 1997. The original plans remained mainly unchanged after the update, except for the recommended relocation of the treated water reservoir from Cogeo to Taytay, and shifting of service area coverage as a result of the completion of AWSOP and the UATP projects.

The Laiban Dam Project (1,830 MLD) has historically been viewed as the first stage of the Kaliwa-Kanan Integrated Transbasin Scheme. The second stage will harness the runoff from the Kanan watershed through the construction of Kanan No.2 Dam and will add another 3,300 MLD for a total yield of 5,100 MLD.

The 5,100 MLD total yield of the combined scheme will be sufficient to meet the projected water demand of Metro Manila beyond 2025, potentially up to year 2032 depending on progress with NRW reduction.

Upon commissioning of the Laiban Dam Project (Kaliwa River), there will be an option to temporarily decommission or suspend operation of some existing groundwater deepwells, as well as booster pumping operations in the central and southern portions of the service area, to save on energy costs.

Agos Dam

The Agos Dam Project involves a 165-m high concrete-face rockfill dam and spillway sited just downstream of the junction of Kanan and Kaliwa Rivers, about 20 km from the Agos River mouth. The proposed dam will have an effective reservoir storage volume of 409 MCM supplied by a watershed area of 860 sq. km.

From an upstream intake on the reservoir (at the Kaliwa Low Dam site), raw water would be conveyed to the proposed Morong WTP for treatment and supplied onwards by gravity to a proposed Taytay 120 ML Service Reservoir (with a lower TWL of 72.0m EL compared with the Laiban option of 104.5m EL), and by pumping to the proposed Antipolo 100 ML Service Reservoir (FSL 270m EL).

An 85.6 MW peaking hydropower plant, sited at the toe of the Agos Dam, also forms part of the overall scope of works under this project along with an after-bay weir constructed about 8km downstream of the dam toe for regulation of peak operation discharge. Further power generation is possible at the outlet of the major raw water conveyance waterway (near Angono) to an estimated maximum capacity of 12.5 MW.

Various options have previously been titled as Agos River developments, such as Agos I and Agos II, which involve dams on the Kaliwa and Kanan Rivers. For the purpose of this study, the Agos option is reserved exclusively for a dam located downstream of the Kanan and Kaliwa River junction on the Agos River.

As for all options, the Agos Dam could be developed in combination with other source options as explored in Section 5.4.4. The most recent strategy proposed in the 2003 study by NJS, involves the development of a temporary low dam structure on the Kaliwa River to divert flows for Metro Manila supply while the Agos Dam Project is completed. Once the Agos Dam is completed, the reservoir will submerge the temporary dam.

Kanan No.2 Dam

The Kanan No.2 Dam Project involves a 170m high concrete-face rockfill dam and spillway sited on the Kanan River about 10km upstream of its junction with the Kaliwa River. The proposed dam will have an effective reservoir storage volume of 255 MCM (dependent on mode of operation) supplied by a watershed area of 289 sq. km.

From an upstream intake on the reservoir, raw water will be conveyed to the Kaliwa River Basin via proposed Transbasin Tunnel Project. Inflow to the Kaliwa River Basin would be either collected at the proposed Laiban Dam or diverted at the proposed Kaliwa Low Dam for supply to Metro Manila.

Various options exist for power generation from the Kanan No.2 Dam involving either local generation at the dam or remote generation at a location along the proposed conveyance waterways, towards Manila.

This project is viable as a “second stage” development only, as yield exported from the source via transbasin tunnel requires another dam to be in place on the Kaliwa River for integration into the Metro Manila supply scheme.

Kaliwa Low Dam

Two options exist for a Kaliwa Low Dam development – a *temporary* dam and a *permanent* dam. The temporary dam is proposed as an initial development prior to the construction of Agos Dam, which would lead to the submergence of the low dam. In this scenario, a concrete-face earthfill dam has been proposed. The permanent dam option would play a long-term role in stream diversion on the Kaliwa River and would involve a concrete gravity dam. The permanent dam option and Agos Dam are mutually exclusive.

The two Kaliwa Low Dam options are based on the same site, located ~ 4km downstream of Brgy Daraitan, Tanay, Rizal. The watershed area for the dam site is estimated to cover 366 sq. km.

From the dam site, raw water would be diverted/conveyed to the proposed Morong WTP for treatment and supplied onwards to a proposed Taytay 120-ML Service Reservoir (with a lower TWL of 72.0m EL compared with the Laiban option of 104.5m EL) and the proposed Antipolo 100-ML Service Reservoir (FSL 270m EL). Water treatment in this case would need to cater for greater extremes in raw water quality due to the lack of storage.

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Power generation under this source option would only be feasible in the event that Agos Dam is built as a subsequent development stage, as the available head from the Kaliwa Low Dam alone is not considered to be adequate for power generation purposes.

5.4.4 Combinations of Future Water Sources

The following source combinations have been considered for evaluation in this study to meet the long-term (2025) water demands of Metro Manila:

- Option 1 – Laiban Dam + Kanan No.2 Dam (see **Figure 5.4**)
- Option 2 – Kaliwa Low Dam + Agos Dam (see **Figure 5.5**)
- Option 3 – Agos Dam alone (see **Figure 5.6**)
- Option 4 – Laiban Dam + Agos Dam (see **Figure 5.7**)
- Option 5 – Kaliwa Low Dam + Kanan No.2 Dam (see **Figure 5.8**)

For each option, yield estimates from past studies have been reviewed and appear to be reliable. No detailed hydrological assessment has been conducted under this study.

A summary of the options is found at **Table 5.2**.

Importantly, while all options are capable of meeting the 2025 source capacity target as the primary concern identified for this study, the options **are not equivalent** in terms of the total yield, delivery pressure to the distribution network, current project status, level of flood protection offered, capacity for power generation, etc. Some of these differences are however accounted for in the comparative evaluation of options found at Section 5.4.6.

Table 5.2 - Water Source Combinations for Long-Term Water Supply

Option	Source Combination	Scheme Capacity (MLD)		
		Stage 1	Stage 2	Total
1	Laiban Dam + Kanan No.2 Dam	1,830	3,310	5,110
2	Kaliwa Low Dam + Agos Dam	(550)/0	3,000	3,000
3	Agos Dam (alone)	1,500	1,500	3,000
4	Laiban Dam + Agos Dam	1,830	1,500	3,330
5	Kaliwa Low Dam + Kanan No.2 Dam	(550)/290	3,310	3,600

Source – 2003 Study on Water Resources Development for Metro Manila (Nippon Koei and NJS)

Option 1 – Laiban Dam + Kanan No.2 Dam

This option commences with the construction of Laiban Dam and reservoir, and all associated downstream infrastructure for conveyance, treatment and storage.

The Kanan No.2 Dam follows as Stage 2 of development, including the Kanan-Kaliwa transbasin tunnel. The capacity of conveyance and treatment infrastructure constructed under Stage 1 must be augmented to accommodate the increased source capacity.

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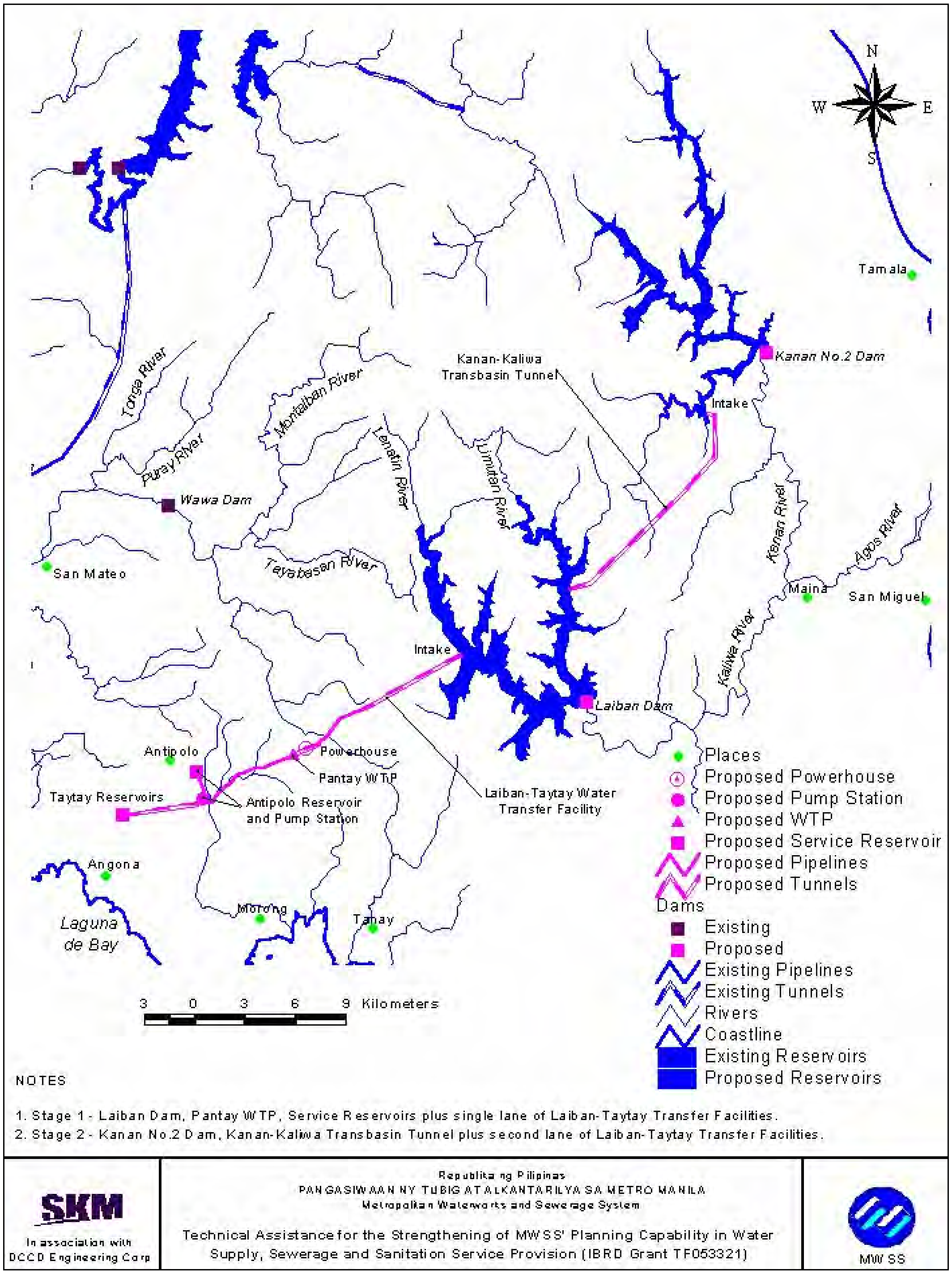

Figure 5.4 Option 1 - Laiban Dam + Kanan No. 2

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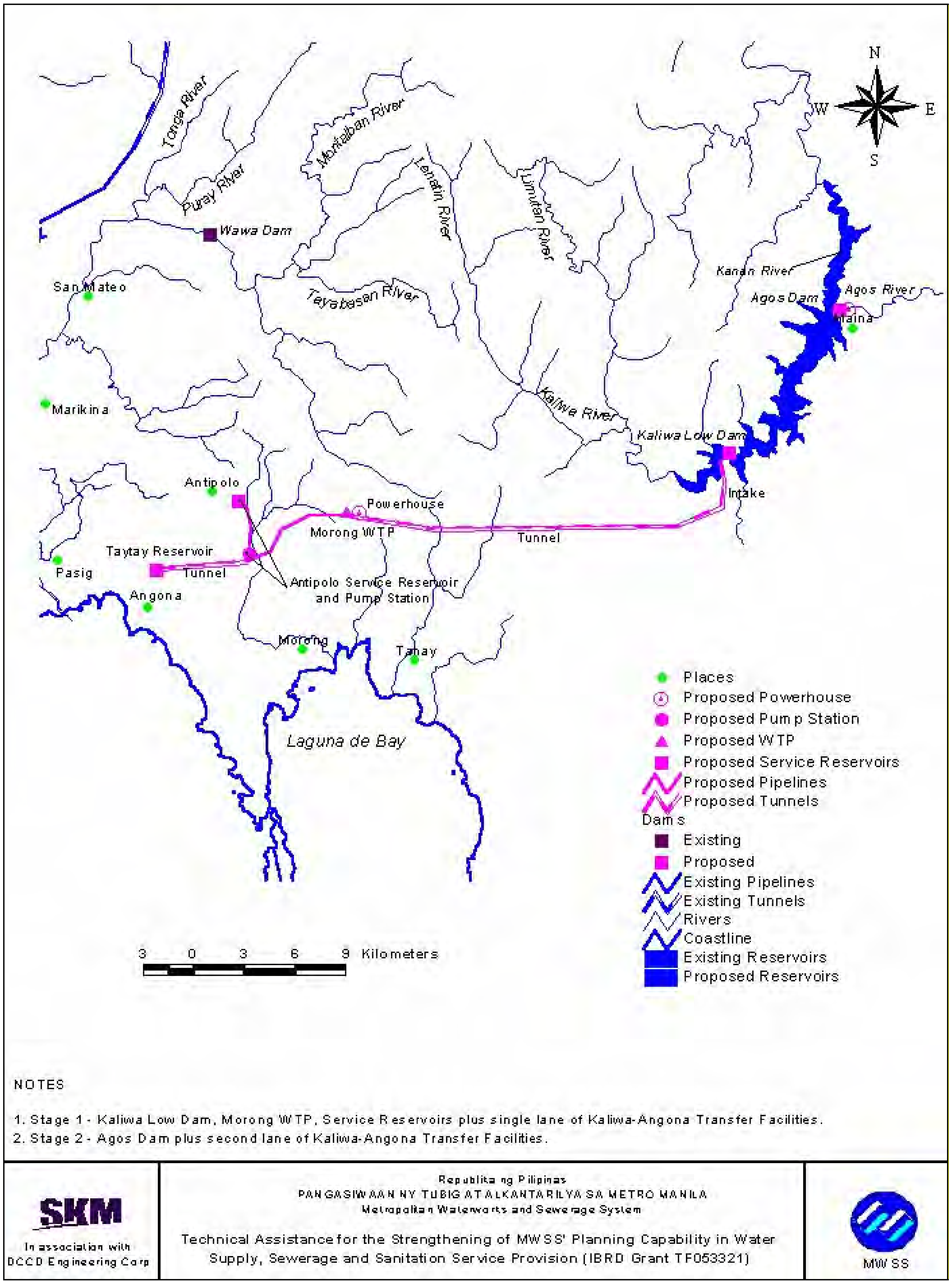

Figure 5.5 Option 2 – Kaliwa Low Dam + Kanan No. 2 Dam

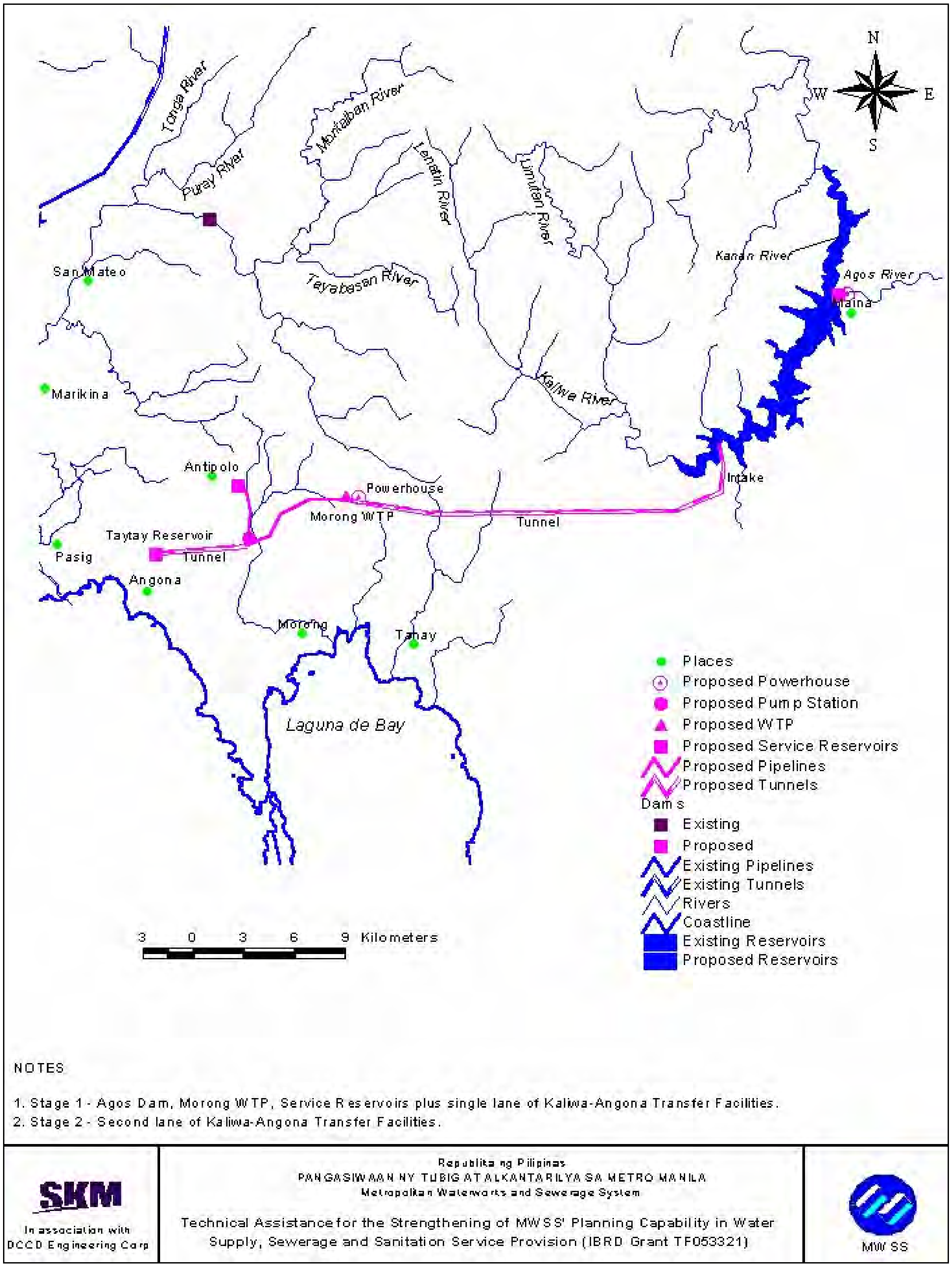

Figure 5.6 Option 3 – Agos Dam Alone

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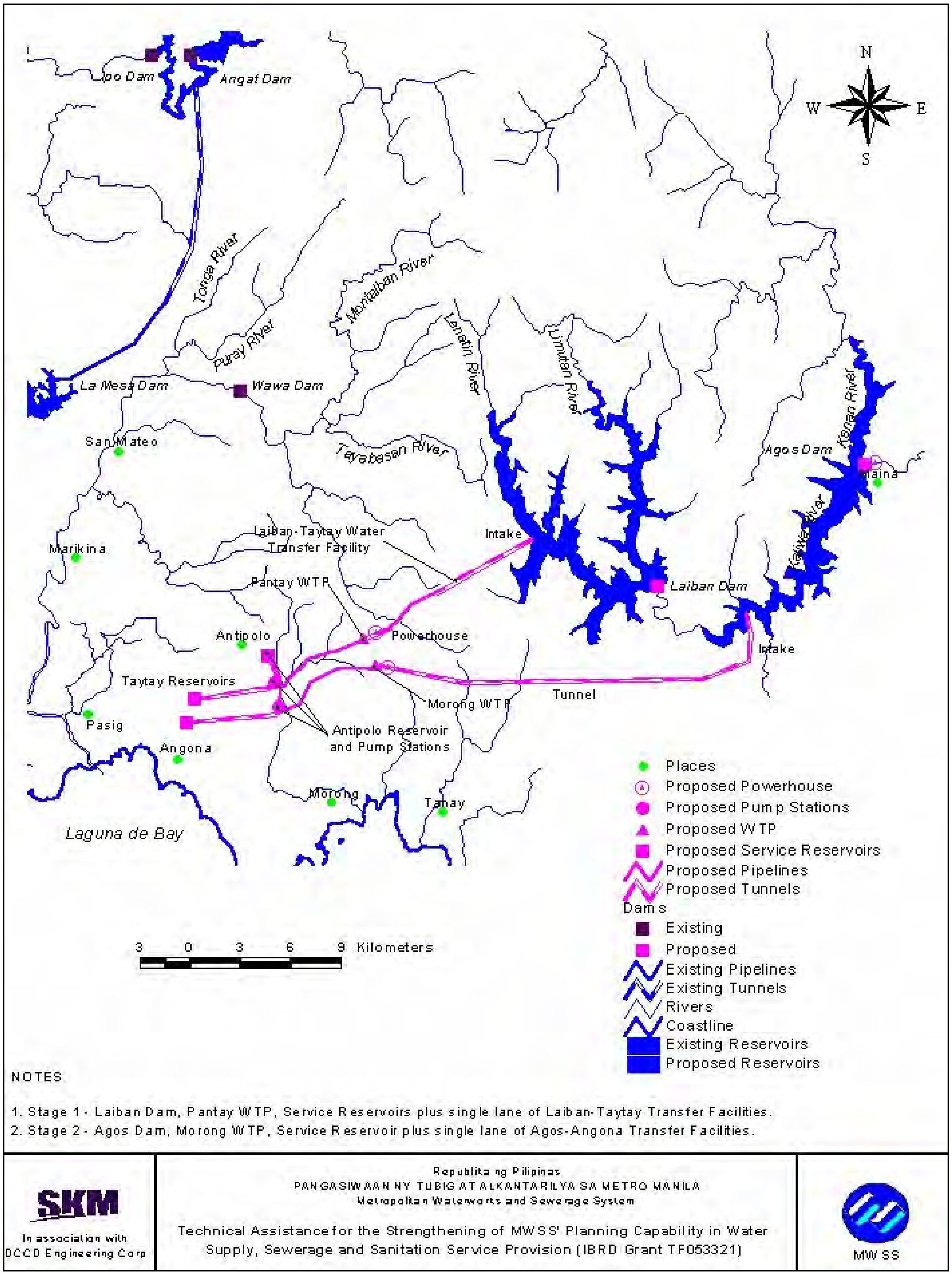

Figure 5.7 Option 4 – Laiban Dam + Agos Dam

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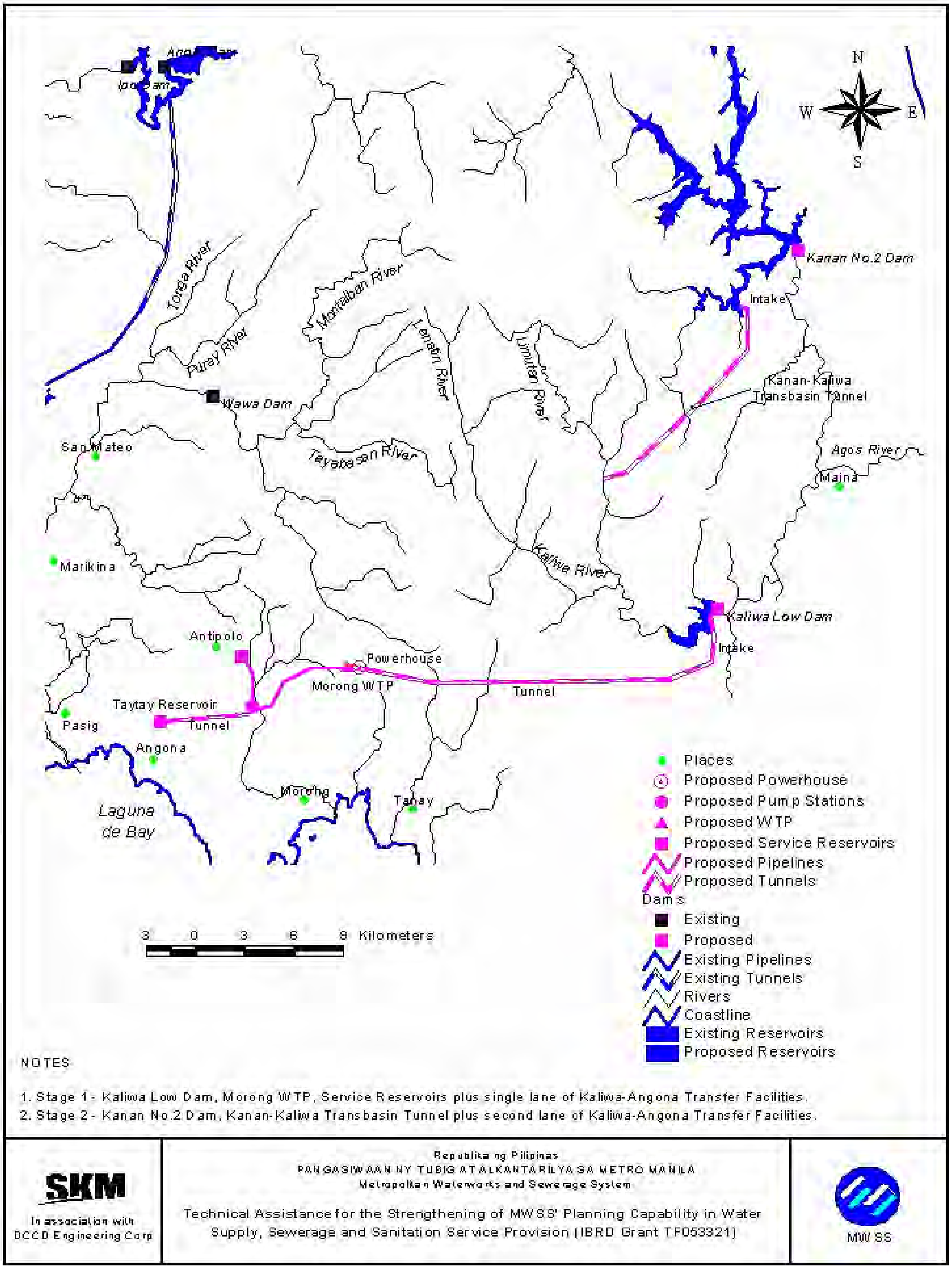

Figure 5.8 Option 5 - Kanan No. 2 Dam + Kaliwa Low Dam

Option 2 – Kaliwa Low Dam + Agos Dam

This option commences with the construction of a temporary Kaliwa Low Dam, and all associated downstream infrastructure for conveyance, treatment and storage. The project is intended only as an interim supply to boost source capacity within a shorter timeframe (7-years) than is achievable with the construction of a main dam and reservoir.

The Agos Dam is constructed and commissioned in rapid succession (within 3-years of completing Kaliwa Low Dam) to provide the target long-term source capacity required. The capacity of conveyance and treatment infrastructure constructed under Stage 1 must be augmented to accommodate the increased source capacity.

Option 3 – Agos Dam (alone)

This option commences with the construction of Agos Dam, with no further source development scheduled within the 2025 timeframe. While the dam will have capacity to supply 3,000 MLD from the outset, the capacity of associated downstream infrastructure for conveyance, treatment, and storage will be staged in two 1,500 MLD increments.

Option 4 – Laiban Dam + Agos Dam

This option commences with the construction of Laiban Dam and reservoir, and all associated downstream infrastructure for conveyance, treatment, and storage.

The Agos Dam follows as Stage 2 of development and includes a totally separate "train" of conveyance and treatment infrastructure to accommodate the Agos source capacity. The terminal service reservoir (at Taytay) for the Agos supply is approximately 30m lower than the Stage 1 service reservoir constructed with the Laiban Dam development.

Option 5 – Kaliwa Low Dam + Kanan No.2 Dam

This option commences with the construction of a permanent Kaliwa Low Dam for long-term stream flow diversion, and all associated downstream infrastructure for conveyance, treatment and storage.

The Kanan No.2 Dam follows as soon as possible as Stage 2 of development, including the Kanan-Kaliwa transbasin tunnel. The capacity of conveyance and treatment infrastructure constructed under Stage 1 must be augmented to accommodate the increased source capacity.

Beyond the 2025 Timeframe

Beyond the 2025 timeframe, the water source options examined are generally compatible with further source development in the Agos River Basin for either municipal water supply or power generation. Optimal use of the basin's capacity for municipal water supply purposes is not however achieved under all development combinations.

Information extracted from the 2003 Study on Water Resources Development on the compatibility of further source development beyond the 2025 timeframe is summarized at **Table 5.3**.

Table 5.3 - Future Water Source Development Compatibility

Option	Source Combination	Other Compatible Sources for Future Development
1	Laiban Dam + Kanan No.2 Dam	Agos Dam
2	Kaliwa Low Dam + Agos Dam	Laiban Dam or Kanan No.2 Dam
3	Agos Dam (alone)	Laiban Dam or Kanan No.2 Dam
4	Laiban Dam + Agos Dam	Kanan No.2 Dam
5	Kaliwa Low Dam + Kanan No.2 Dam	Laiban Dam

Source – 2003 Study on Water Resources Development for Metro Manila (Nippon Koei and NJS)

The potential for a Kanan-Umiray Transbasin Tunnel has also been explored as a long-range possibility for improving supply into Angat Reservoir via the Umiray River and Umiray-Angat Transbasin Project (completed in 2002). As the Kanan No.2 Dam will already have a transfer route via the Kaliwa drainage basin, this project is seen to offer limited benefit and has not been considered any further.

5.4.5 Other Future Water Sources

Based on the reports reviewed, a thorough attempt has been made to investigate all "conventional" water source options in the Metro Manila region. The only other source options that remain to be explored, aside from reducing water losses, are possibly reuse and desalination options.

Strategic Action Paper No.4 examines the feasibility of re-use options within the service area. Typically within the South-East Asian region, large-scale reuse has only been considered as a viable water supply option where access to abundant fresh water sources is limited thereby making it cost-effective (e.g. Singapore). This is not the case with Metro Manila. Potential may, however, exist for smaller-scale developments to be viable.

Prospective desalination options would include Laguna Lake, brackish groundwater wells and seawater abstracted from Manila Bay. Significant investigative effort is needed to test the feasibility of these options and address major technical, environmental, and other issues associated with these developments. As unit costs are expected to be in excess of PhP 30 per m^3 for these sources, no further consideration is given within this report.

5.4.6 NRW Reduction, Demand Management and Recycling/Re-Use Approaches

Reduction of non-revenue water, water conservation measures, and re-use/recycling of effluent are effective options as substitutes for new water source developments. With regard to non-revenue water, the timing of the proposed new water source developments has been based on reduction of NRW to 30% for both the East and West Zones by 2025. This will result in the availability of an additional 2400 MLD of water. Without this reduction, water source developments would need to be advanced to reduce the supply-demand gap. However, since the nature of the long-term water source developments is such that there is a long lead time before they can be implemented, the outcome of the failure to reduce NRW to the proposed levels is likely to be a continuation of constrained supply.

Opportunities for demand management and re-use/recycling are discussed in Section 3.9 and in more detail in *Strategic Action Paper No 4.* While currently these have a minimal impact on water demand, in the future, provided that effective programs are established, it may be possible to effect a reduction of up to about 5-10% of the projected water demand by 2025 and therefore defer the Stage 2 development of the new water source.

Realistically, it is unlikely that significant reductions in per capita demand from demand management measures will occur until after 2015 when a new water major source is on-stream and water supplies are no longer constrained. Moreover, wastewater treatment plant capacity is not expected to be significant until after 2015 similarly limiting the opportunities for recycling initiatives.

5.4.7 Evaluation of Water Source Options

Costs

Project costs from previous reports were reviewed for each of the development options and escalated to a cost base of 2005. The methodology applied for escalating costs was:

- *Local component*: 4.7% per annum from 2001 to 2005
- *Foreign component*: 2.2% per annum from 2001 to 2005

In addition, unit costs have been estimated for the source development options based on a similar methodology used in the 2003 Study on Water Resource Development (NJS). A key difference, however, in the analysis performed for this study is that unit costs reported include pumping cost to account for the 32.5 meters difference in elevation of the off-take points of the two basic schemes, (i.e., the Laiban Dam and the Agos Dam).

These unit costs were computed assuming there will be no interim sources in the immediate future. Higher unit costs are expected if interim sources were to be developed because of reduced utilization of the long-term sources.

Latest cost estimates for the evaluated options are included at **Table 5.4**.

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Table 5.4 - Cost Estimates for Water Source Combinations (at 2005)

Option	Source Combination	Capacity (MLD)	Estimated Project Cost (US $1000)	Ex-Plant Unit Cost (US $/m^3)
1	Laiban Dam + Kanan No.2 Dam	5,110	2,076,233	0.364
2	Kaliwa Low Dam + Agos Dam	3,000	1,740,872	0.393
3	Agos Dam (alone)	3,000	1,701,372	0.383
4	Laiban Dam + Agos Dam	3,330	1,913,387	0.372
5	Kaliwa Low Dam + Kanan No.2 Dam	3,600	1,676,882	0.396

Source –2003 Study on Water Resources Development for Metro Manila (Nippon Koei and NJS) escalated to 2005 prices

A more detailed presentation of the methodology and cost data adopted in deriving the unit cost of each option are shown in **Appendices C and D**.

Based on the costs reported at **Table 5.4**, it may be concluded that:

1. There is negligible difference between the options, in terms of unit cost of water (the differences are within the level of estimate accuracy).

2. The lower cost projects are typically associated with lower total yields, and as such would need to be accompanied by further source development (at additional cost) to provide the same level of production as other options into the longer term future.

It is therefore recommended that other factors, in conjunction with cost, be evaluated to determine the preferred water source development strategy.

Project Benefits

In addition to meeting water supply targets for Metro Manila, the source development options also provide hydropower generation capacity as an additional benefit.

A summary outline of the benefits afforded by each option follows at **Table 5.5**.

As proposed, none of the studied options offers irrigation or municipal water supply benefits to downstream settlements in the Agos River Basin. A previous study has determined that ample groundwater is available to satisfy the potential municipal water supply demands of the municipalities of Infanta and General Nakar. Irrigation supplies are taken directly from the Agos River mainstream.

Flood protection for the Infanta and General Nakar municipalities may be improved by the regulation of flood flows down the Agos River (and upstream tributaries) as a result of the proposed dams included under the source development options. This benefit has not however been quantified, as flood records and observations suggest that storm surge is also a major contributing factor to local flooding in these municipalities. Costs for new flood protection facilities in areas regularly impacted by floodwaters have been included in estimates for the Agos Dam development as an additional assistance to the community.

Table 5.5 - Project Benefits from Source Development Options

Option	Source Combination	Project Benefits	
		Yield (MLD)	Power Generation (MW)
1	Laiban Dam + Kanan No.2 Dam	5,110	54.1 (B)
2	Kaliwa Low Dam + Agos Dam	3,000	12.5 (B) 85.6 (P)
3	Agos Dam (alone)	3,000	12.5 (B) 85.6 (P)
4	Laiban Dam + Agos Dam	3,330	28.8 (B) 91.3 (P)
5	Kaliwa Low Dam + Kanan No.2 Dam	3,600	5.2 (B)

Source – 2003 Study on Water Resources Development for Metro Manila (Nippon Koei and NJS)
(B) – baseload hydropower plant
(P) – peaking hydropower plant

Project Timing

The estimated project timeline for each development option is summarized at **Table 5.6**, based primarily on the information sourced from the 2003 Study by NJS and updated to account for the projected water demand of this study (See **Appendix D, Figures D-1.1 to D-1.5** for details).

Timings listed will be highly dependent on the actual time required to resolve resettlement issues and secure environmental approvals. It is strongly recommended that these aspects be acted upon as soon as possible for the recommended development option.

Table 5.6 - Project Timing for Source Development Options

Option	Source Combination	Stage 1		Stage 2	
		Duration* (yrs)	Commission Date	Duration* (yrs)	Commission Date
1	Laiban Dam + Kanan No.2 Dam	9	2015	15	2021
2	Kaliwa Low Dam + Agos Dam**	11	2017	11	2017
3	Agos Dam (alone)	11	2017	13	2019
4	Laiban Dam + Agos Dam	9	2015	15	2021
5	Kaliwa Low Dam + Kanan No.2 Dam***	11	2017	11	2017

*Duration refers to the number of years elapsed from 2005.

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5.4.8 Issues and Constraints Affecting Options

The issues and constraints impacting the implementation of the source development options are typically universal, affecting all options to varying extents. These include:

- Project financing/acquisition;
- Acquisition of land and right-of-ways (ROW) for facilities;
- Securing environmental approvals;
- Resolving resettlement plans; and,
- Restriction of land development in watershed areas.

Project Financing and Acquisition
All options involve investment in a program of water source development projects valued in the order US$ 2 billion over a 20-year time frame. Overall, the only advantage to be gained from specific options will come from the ability to stage (phase) the proposed works and optimize the level of capital expenditure in each stage.

Options 2 and 5, involving the construction of the Kaliwa Low Dam as the first stage of development, appear to provide the most attractive investment profile of the options considered, however, will not be capable of matching water demand forecasts in the early years. It is therefore necessary to focus evaluation on the large dam options.

Land and ROW Acquisition
Land and ROW acquisition considerations generally tend to favor low dam options if the area of inundation is the only area of concern. It may be argued, however, that the key area of concern is actually the total watershed area, as both water quantity and quality are derived from this area. It is therefore concluded that the dam options with the largest catchment areas will result in the greatest effort and investment on land and ROW acquisition. All options tend to be similar under this criterion.

To date, the MWSS has already (partly) progressed purchase of land and re-settlement for the Laiban Dam source option. No other option has commenced through this process.

Securing Environmental Approvals
Every option will be required to pass through a common environmental approval process involving an Environmental Impact Assessment (EIA) and delivery of an Environmental Impact Statement (EIS) Report. An Environmental Management Plan (EMP) will also be prepared as an integral part of the EIS Report to ensure risks are managed and mitigated during project implementation.

Only the Laiban Dam option has commenced through this process and been awarded environmental approvals, although more than 10-years ago now.

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Resolving Resettlement Plans

Resettlement plans are yet to be fully defined for all the options, so it is difficult to assess the relative advantages of one option over another. The number of families affected under each development option needs to be more reliably estimated to draw conclusion on the influence of resettlement on the process of option selection.

As a large portion (reportedly 70%) of the families residing in the proposed Laiban Dam reservoir area have already been compensated and/or relocated, it is suggested that this option has some advantage over other developments. Problems with the remaining residents and claims for royalty payments from the local government unit must however be resolved in a timely manner to capitalize on this advantage.

Development Restrictions in Watershed Areas

It has been reported that the watershed for Kanan No.2 Dam is the least likely area to be developed in the future, due to the relief of the local terrain. This option is therefore preferred from a land development perspective, as it places less constraint on potential land-use. All other options are deemed to be equal based on available information.

5.4.9 Conclusion

The recommended option for implementation is **Option 1 – Laiban Dam + Kanan No.2 Dam**, based on the following rationale:

- It achieves the greatest level of long-term water resource utilization for municipal water supply purposes.
- It can be progressed as a priority with a higher level of confidence than other options, since the Laiban Dam project has already been developed through to detailed design status.
- It will provide the greatest benefit towards MWSS demand in the shortest period of time (low dam options offer only one-third of the source capacity).
- Previous investment on the diversion tunnel and resettlement payments for the Laiban Dam project will be utilized rather than wasted.
- It offers the least-cost approach to source development if the longer-term (beyond 2025 horizon) is taken into consideration, as other options still require investment on 1,500-2,000 MLD of source development to match the 5,110 MLD capacity delivered by Option 1.

As a significant lead-time is involved before the Laiban Dam can be brought on-line for Metro Manila supply, it is recommended that this strategy be endorsed forthwith and that progress be made to update designs and tender documentation as a matter of priority.

A graph of projected demand and supply is shown in **Figure 5.9** assuming Option 1 will be developed.

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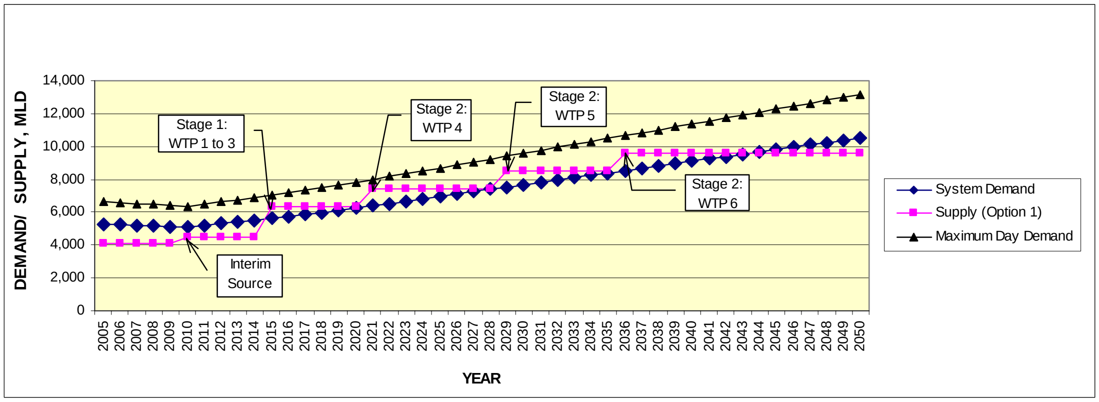

Figure 5.9 Projected Demand and Supply Curve

As discussed above, options for water conservation were examined, that may result in reduced per capita water demand and the deferral of new water source development. However, while reductions in per capita water demand may result in the deferral of the Stage 2 water source development (Kanan No.2 Dam), the development of Stage 1 (Laiban Dam) should proceed as scheduled since there is already a significant water supply shortfall.

5.4.10 Tariff Implication of Developing New Sources

Approach

The Concession Agreements between MWSS and the two Concessionaires provide for the bases in changes in tariff. Every five years, a rate rebasing exercise is done to allow the Concessionaires to recover historical cash flows, operating and investment expenditures efficiently and prudently incurred, and review future capital, operating and investment plans.

The key elements in the conduct of rate rebasing are:

1. Examination of the concessionaire's cash position;
2. Determination of appropriate discount rate (i.e. commencement ADR and future ADR);
3. Evaluation of past and future service obligation targets; and,
4. Evaluation of future capital and operating expenditures.

For this study, a limited financial evaluation is conducted. In relation to the rate rebasing exercise, this evaluation will focus only on future capital and operating expenditures, the last key element listed above.

Financial evaluation is conducted using the Financial Internal Rate of Return (FIRR). FIRR is defined as the rate of return at which investment costs will be recovered with the future benefits that will be generated by the investment, and therefore is compared to the

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financing costs (i.e. interest expense) for such investment in order to assess the financial viability of projects.

Financial costs of projects include capital costs plus operating expenses that will be necessary to operate new facilities that typically consist of direct operating expenses such as electricity, operating expenses, and repair and maintenance of facilities.

Financial benefits of projects will be the incremental revenue amount, which will be made possible in the future by those projects. Financial benefits will usually come from the increase in service capacity, which will be made possible by the projects.

FIRR is calculated for a period of 30 years (in recognition of the long asset lives of the projects) after the inception of projects using the cash flow based on constant price (i.e. inflation not considered). For this Master Plan study, it is calculated for the period for the full Laiban Dam/Kanan No.2 Dam development of 2007 to 2036.

Financial Costs

Financial costs of the Master Plan projects are determined or estimated as follows:

- All costs are at 2005 prices.
- Capital costs: per the engineering study, include development of the recommended water sources (Laiban and Kanan No.2), cost of distribution trunk and primary mains, and water treatment plants.
- Include engineering cost (7 percent), physical contingency (15 percent) and value-added tax (10 percent).
- Maintenance of facilities: assumed to be about 0.5 percent of initial capital cost of facilities.
- Water treatment cost: estimated at PhP 0.45 per m^3 at 2005 price level.
- Pumping station maintenance cost: 0.5 percent of initial capital cost of pumping station.
- Power cost for pumping: estimated at PhP 7.00 per kWH.

The capital investments of the recommended option in this Master Plan are summarized in **Table 5.7**.

Table 5.7 - Summary Cost of Investments (US$ 10^3)

Component/Stage	Land Acquisition /Resettlement ($x10^3$ US $)	Construction Cost ($x10^3$ US $)			Total Local Currency ($x10^3$ US $)	TOTAL Cost ($x10^3$ US $)
		Total	Foreign	Local		
Water Source Development						
1st Stage- Laiban Dam						
Laiban Dam	86,366.2	201,227.3	116,218.0	85,009.2	171,375.5	287,593.5
1st Waterway	15,075.4	455,535.1	309,840.0	145,695.1	160,770.5	470,610.4
WTP # 1 and # 2	13,985.2	192,551.0	151,103.5	41,447.5	55,432.7	206,536.2
WTP # 3	0.0	83,129.1	65,235.2	17,893.9	17,893.9	83,129.1
Sub-total...1st Stage	*115,426.8*	*932,442.4*	*642,396.7*	*290,045.7*	*405,472.5*	*1,047,869.2*
2nd Stage- Kanan Dam						
Kanan Dam	18,238.5	256,699.5	148,255.8	108,443.7	126,682.3	274,938.1
Kanan - Laiban Tunnel	489.9	170,625.8	116,054.1	54,571.7	55,061.7	171,115.7
Access Road	0.0	52,577.0	30,365.6	22,211.4	22,211.4	52,577.0
2nd Waterway	28,622.1	656,944.4	446,832.0	210,112.4	238,734.4	685,566.5
WTP #4	18,860.2	194,078.0	152,301.8	41,776.2	60,636.3	212,938.1
WTP # 5	0.0	150,531.1	118,128.6	32,402.5	32,402.5	150,531.1
WTP # 6	0.0	150,531.1	118,128.6	32,402.5	32,402.5	150,531.1
Sub-total...2nd Stage	*66,210.7*	*1,631,986.9*	*1,130,066.5*	*501,920.4*	*568,131.1*	*1,698,197.6*
Total Cost	181,637.5	2,564,429.4	1,772,463.2	791,966.1	973,603.6	2,746,066.9
Distriction Trunk and Primary Mains						
Phase 1 - Maynilad & Manila Water						
General		5,409.5	1,081.9	4,327.6	4,327.6	5,409.5
Pipe mains, supply		72,062.7	56,132.1	15,930.6	15,930.6	72,062.7
Pipe laying		27,744.1	5,548.8	22,195.3	22,195.3	27,744.1
Valves and appurtenances		9,980.7	1,996.1	7,984.5	7,984.5	9,980.7
Pipework ancillaries		13,473.9	2,694.8	10,779.1	10,779.1	13,473.9
Provisional item		11,976.8	2,395.4	9,581.5	9,581.5	11,976.8
Crossing Mangahan floodway, 2800mm		1,901.0	830.8	1,070.2	1,070.2	1,901.0
Crossing Pasig River, 2800mm		950.5	415.4	535.1	535.1	950.5
Indirect Costs, 35%		50,224.7	23,605.6	26,619.1	26,619.1	50,224.7
Sub-total...Phase 1		*193,724.0*	*94,700.9*	*99,023.1*	*99,023.1*	*193,724.0*
Phase 2 - Maynilad Water						
General		1,912.9	382.6	1,530.3	1,530.3	1,912.9
Pipe mains, supply		25,481.9	19,849.5	5,632.4	5,632.4	25,481.9
Pipe laying		9,810.5	1,962.1	7,848.4	7,848.4	9,810.5
Valves and appurtenances		3,529.2	705.8	2,823.4	2,823.4	3,529.2
Pipework ancillaries		4,764.5	952.9	3,811.6	3,811.6	4,764.5
Provisional item		4,235.1	847.0	3,388.1	3,388.1	4,235.1
Indirect Costs, 35%		17,406.9	8,181.3	9,225.7	9,225.7	17,406.9
Sub-total...Phase 2		*67,141.1*	*32,881.2*	*34,259.8*	*34,259.8*	*67,141.1*
Phase 3 - Maynilad Water						
General		6,902.1	1,380.4	5,521.6	5,521.6	6,902.1
Pipe mains, supply		10,508.0	8,178.2	2,329.9	2,329.9	10,508.0
Pipe laying		4,045.6	809.1	3,236.5	3,236.5	4,045.6
Valves and appurtenances		1,455.4	291.1	1,164.3	1,164.3	1,455.4
Pipework ancillaries		1,964.7	392.9	1,571.8	1,571.8	1,964.7
Provisional item		1,746.4	349.3	1,397.1	1,397.1	1,746.4
Indirect Costs, 35%		9,317.8	4,379.4	4,938.4	4,938.4	9,317.8
Sub-total...Phase 3		*35,940.0*	*15,780.3*	*20,159.6*	*20,159.6*	*35,940.0*
Total Cost		296,805.0	143,362.5	153,442.5	153,442.5	296,805.0
GRAND TOTAL COST	181,637.50	2,861,234.37	1,915,825.75	945,408.62	1,127,046.12	3,042,871.87

Financial Benefits

The financial benefits of the proposed projects will be realized as an increase in revenue resulting from increased water supply to target end users. The increase in supply capacity will be made possible by the two components of the proposed projects, namely:

- Increased water production due to the construction of the Laiban Dam, Kanan No.2 Dam, new water treatment plants and related facilities; and,
- Increased service coverage due to the laying of new distribution trunk and primary mains.

The first component will increase the production capacity at the water treatment plant level, the effect of which will be further enhanced by the expansion in the service coverage that will be made possible by the second component. These two components will complement each other and, as such, they are financially evaluated together.

Normally, the revenue water volume is the lesser of supply and demand. The demand has been established by the Study Team and included in the previous section of this report. This is fundamentally based on the projections of population and per capita consumption, and the designed service coverage. On the other hand, the supply capacity to end-users is based on production capacity and operation level. The production capacity of water treatment facilities for the master plan period is determined by the engineering design of water treatment plants and the timing of their construction.

The peso value of the financial benefits varies depending on the level of the tariff. Three scenarios in the implementation of revenue water rates are evaluated in this study. First, the current average water charge (2005) is used as the base scenario. Two levels of possible increases in water charge are then analyzed as to their affordability and viability. **Table 5.8** briefly describes the three scenarios:

Table 5.8 - Possible Water Charges

	Average Water Charge		Possible Increase in Water Charge
	PhP/m^3	US$/m^3	
Scenario 1	16.83	0.306	2005 Average Charge
Scenario 2	22.38	0.407	33%
Scenario 3	26.25	0.477	56%

Exchange Rate: US$1.00=PhP 55.00

In addition to the incremental increase in revenue water, there will be a by-product of electricity that will be generated at the new Laiban Dam and that will be sold to Meralco. It is assumed that the hydropower generation plant will have the capacity of 54.1 GWH. It is further assumed that electricity will be sold at PhP 4.41 per kWH.

The annual financial benefits (in million m^3 per year) of the proposed projects are summarized in **Table 5.9**:

Table 5.9 - Summary of Annual Financial Benefits

Year	Water Production				Electric Energy Production	
	Volume (MCM)	Income (US$)			Capacity (GWH)	Income (US$)
		Scenario 1	Scenario 2	Scenario 3		
2015	393	120,194	159,858	187,503	179	14,096
2016	435	133,107	177,033	207,647	179	14,096
2017	481	147,060	195,590	229,414	179	14,096
2018	526	161,013	214,147	251,180	179	14,096
2019	572	174,966	232,705	272,947	179	14,096
2020	617	188,919	251,262	294,714	179	14,096
2021	666	203,876	271,156	318,047	179	14,096
2022	718	219,839	292,385	342,948	418	32,910
2023	771	235,801	313,615	367,849	418	32,910
2024	823	251,763	334,845	392,750	418	32,910
2025	875	267,725	356,074	417,651	418	32,910
2026	927	283,687	377,304	442,552	418	32,910
2027	979	299,649	398,534	467,453	418	32,910
2028	1,031	315,612	419,763	492,354	418	32,910
2029	1,084	331,574	440,993	517,255	418	32,910
2030	1,136	347,536	462,223	542,156	418	32,910
2031	1,188	363,498	483,452	567,057	418	32,910
2032	1,240	379,460	504,682	591,958	418	32,910
2033	1,292	395,422	525,912	616,859	418	32,910
2034	1,344	411,385	547,142	641,760	418	32,910
2035	1,397	427,347	568,371	666,661	418	32,910
2036	1,449	443,309	589,601	691,562	418	32,910

Notes: Unit Cost of Water (US$/m^3)
Scenario 1 = US$0.306
Scenario 2 = US$0.407
Scenario 3 = US$0.474
Unit Cost of Energy = US$0.08/kWH

Financial Internal Rate of Return (FIRR) and Affordability Analysis

Based upon the net cash flows of the incremental revenue and costs, the financial internal rate of return and affordability results are shown in **Table 5.10**:

Table 5.10 - Summary Result of Financial Evaluation

Scenario	2005 Average Tariff		Possible Tariff Increase	% of Household Income	FIRR	NPV
	Php/m^3	US$/m^3				
1	16.83	0.306	-	3.2%	7.6%	(279,288)
2	22.38	0.407	33%	4.3%	10.4%	1,579
3	26.25	0.477	56%	5.0%	12.1%	197,334

The generally accepted guideline by international funding agencies for household expenditure on water supply, sewerage and sanitation services is no more than 5 percent of average household income.

The first scenario, which uses the current average water charge of PhP 16.83 per m^3 shows that while the total monthly water charge is only 3.2 percent of household income, the FIRR is below the current Weighted Average Cost of Capital (WACC) of 10.4 percent and NPV is negative.

The second scenario, wherein there would be a 33 percent increase in water charge to PhP 22.38 per m^3, is still acceptable since it is below 5 percent of household income. The FIRR likewise is level with WACC. However, if this scenario is subjected to sensitivity analyses of increase in cost or decrease in revenue, the resulting FIRR will already be below WACC.

The third scenario of 56 percent increase in water charge provides the maximum increase in water charge that will result in a monthly charge of about 5 percent of household income and a FIRR of 12.1 percent. Even if subjected to sensitivity tests of increase in cost or decrease in revenue, the FIRR will still be above WACC except in a worst case of simultaneous increase in cost and decrease in revenue by 10 percent.

Details of the evaluation of the three scenarios are presented in **Appendix E (Tables E-1.1 to E-1.3).**

5.5 Development Plan

Figure 5.10 indicates the preferred development plan for expansion of the MWSS service area headworks, including raw water conveyance, water treatment plant, treated water conveyance and storage. Major trunk and primary mains to the off-take points of the two concessions are also shown.

5.5.1 Water Sources (Headworks)

The preferred scheme, the Laiban Dam + Kanan No. 2, is a two-stage development. Stage 1 involves the construction of Laiban Dam on the Kaliwa River and the second stage is the Kanan No. 2 Dam with a transbasin tunnel conveying water from the Kanan watershed to the Kaliwa reservoir (Laiban Dam).

The principal headworks features of Stage 1, Laiban Dam, are as follows (originally designed in 1979-1983, reviewed and updated in 1997):

1. A 113 m high concrete-face rockfill dam (CFRD) with 650-m crest length, full supply level of 270 m EL and minimum operating level of 237 m EL.

2. Raw water intake works and headrace comprising of:

Figure 5.10 Preferred Development Plan

a. A three level intake structure (Intake No. 1) with discharge capacity of 27.5 m^3/s at each level for water from the Kaliwa River;

b. Tunnel No.1, a 3.2-m diameter, 7.5-km long concrete-lined tunnel followed by a 2.7-m diameter steel-lined tunnel section, 400 m long;

c. A 3.2-m diameter steel-lined reinforced concrete pipe (Pipeline No. 1), 4 km in length connecting Tunnels 1 and 2; and,

d. Tunnel No.2, a 2.7-m diameter, 1.8-km long steel-lined tunnel with surge shaft and adits connecting to the power plant.

3. A 30-MW Hydropower Plant located at Pantay normally discharging to the Pantay Water Treatment but will discharge part of the power plant tailwater into Pantay Creek when the treatment plants are not fully operational.

4. Treated waterway from Pantay Water Treatment Plant to Taytay Reservoir, consisting of:
   a. Pipeline No. 2, 3.2-m diameter and approximately 5 km in length; and,
   b. Tunnel No. 3, 3.6-m diameter concrete-lined, about 4.9 km long.

Both Pipeline No.2 and Tunnel No.3 will require a completely new geodetic route survey, geotechnical investigation, and hydraulic design. The overall capacity of the Stage 1 conveyance facilities is 2214 MLD.

The key headworks features of Stage 2, Kanan No.2 Dam, are as follows:

1. A 170 m high concrete-face rockfill dam (CFRD) with 700-m crest length, full supply level of 310 m EL and minimum operating level of 278 m EL.

2. Raw water intake works and a 3.7-m diameter tunnel, 14.5-km long concrete-lined tunnel discharging to the Kaliwa Reservoir (Laiban Dam).

3. Another three level intake structure (Intake No. 2) at Laiban Dam with discharge capacity of 46 m^3/s at each level to accommodate water from the Kanan River.

3. Duplication of outlet works from Laiban Dam including:

   a. A second lane Tunnel No.1, 4.0-m diameter, 7.5-km long concrete-lined tunnel followed by a 4.0-m diameter steel-lined tunnel section, 400 m long;

   b. A 4.21-m diameter steel-lined reinforced concrete pipe (Pipeline No. 1), 4 km in length connecting second lane Tunnels 1 and 2; and,

   c. A second lane Tunnel No.2, a 4.0-m diameter, 1.8-km long steel-lined tunnel with surge shaft and adits connecting to the power plant.

4. Upgrade of the Hydropower Plant located at Pantay to 54-MW capacity.

5. Augmentation of the treated waterway from Pantay Water Treatment Plant to Taytay Reservoir, consisting of:
   a. Second lane Pipeline No. 2, 4.21-m diameter and approximately 5 km in length; and,
   b. Second lane Tunnel No. 3, 4.73-m diameter concrete-lined, about 4.9 km long.

The overall capacity of the Stage 2 conveyance facilities is 4005 MLD.

5.5.2 Water Treatment Facilities

A water treatment plant, with Stage 1 capacity of 2400 MLD, will be developed in a single phase to meet the estimated water demand by 2015. The treatment plant will be located at a 32-ha. site near barrio Pantay, about 30 km east of Manila.

The base design treatment processes include screening, chemical coagulation, rapid mixing, flocculation, horizontal flow sedimentation, filtration, chlorination, fluoridation, and ph correction. The 1997 update introduced the following changes in the original design:

- Pumped backwashing of filters;
- Recycling of filter backwash water;
- Sludge thickening prior to disposal to sludge drying beds;
- Provision for hypochlorite and activated carbon dosing; and,
- Provision of influent and effluent water quality monitoring and recording equipment.

The expansion of the Pantay WTP to accommodate the integration of Kanan No.2 Dam requires further review and progress on land acquisition to ensure feasibility of this key project. Process selection is consistent with Stage 1 treatment works.

5.5.3 Water Distribution Facilities

Schematic diagrams of the proposed bulk water transmission per planning milestone are presented in **Appendix F (Figures F-1.1 to Figures F-1.10)**.

The Phase 1 distribution works shall consist of:

a. *Taytay Reservoir* - A 120-ML treated water reservoir, with a top water level of 104.5 m and a working depth of 6 meters;
b. *Antipolo Reservoir* - A 20-ML reservoir, with a top water level of 270 m and a working depth of 4.5 m;
c. *Antipolo Pumping Station* - discharge capacity of 100 MLD with about 155 m net head;
d. *San Jose Reservoir* – A 15-ML reservoir, with a top water level of 80.5 m to serve the lakeside towns of Morong and Cardona;
e. *Taytay Pressure Control Station* – A 3-ML break pressure tank on the 3200 mm trunk mains together with regulating valves on both the southern trunk main to the West Zone and the 2200-mm line to the East Zone;

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f. A 2800-mm diameter trunk main, 4 km long, from the Taytay treated water reservoir to Cainta, thence a 2500-m diameter trunk main, 3 km long to the point of interconnection, will serve the East Zone. A 1500 mm diameter, 2 km long line from Taytay to the proposed Antipolo Reservoir, and a 1200 mm diameter line from the San Jose Reservoir will serve Antipolo City and other towns in Rizal. **Appendix G** summarizes the distribution component catering to the East Concession.
g. A 2800-mm trunk main, 14.5 km long from Taytay treated water reservoir to South Superhighway, will carry the West Zone allocation. The lengths and sizes of the trunk and primary mains to Bacoor, Imus, Kawit, Rosario, Noveleta, and Cavite City are also shown in **Appendix G**. The distribution component will be done in three phases with a balancing reservoir located on high ground in Muntinlupa included in Phase 3.

5.5.4 Demand Management

The following demand management/water conservation proposals are recommended to be considered by MWSS for implementation during the master plan period.

Water Pricing Reforms: It is recommended that an optimal water pricing policy be adopted, which will reflect the scarcity value of water and take account of the cost of production and distribution and the opportunity cost of water. The opportunity cost of water and cost for its externalities can be recovered by (i) bulk water pricing through raw water charges levied on the Concessionaires and taxation of effluents to firms in the MWSS service area; (ii) peak load pricing during low flow periods; and (iii) tariff restructuring.

Water-Efficient Plumbing Fixtures and Appliances: It is recommended that households be encouraged through a public information campaign to use water saving technologies such as dual flush toilet, ultra low-flush toilets, low-flow showerheads and low-flow faucets which have payback periods of less than two years.

Public Education and Information: It is recommended that MWSS and the concessionaires conduct an intensive public information program on water conservation. The information, education, and communication (IEC) program should be designed to raise awareness and encourage participation of the younger population, industrial and commercial customers, public sector, householders, etc.

Water Audits; It is recommended that water audits be conducted by the concessionaires in commercial buildings and large industries to identify water efficiency and reuse options.

Legislation, Policies, and Regulation: It is recommended that a national policy should be formulated to support the implementation of the different demand management and water conservation strategies.

Rainwater Harvesting: It is recommended that rainwater harvesting be promoted at the household level, especially a simplified system which collects water and distributes it by gravity for non-potable household uses.

5.5.5 Recycling/ Reuse

- ***Short term.*** Reuse of water should be concentrated on irrigation and other municipal and city uses.
- ***Medium term.*** Recycled water may be marketed for application to the industrial or agricultural sector. Establishment of recycled water return systems for toilets and other non-potable uses can expand recycled water demand.
- ***Long term.*** To enhance the long term viability of the reuse of water, a recycled water management program must be established.

5.5.6 Staged Development Plan

The staged development of the MWSS system is described in 5-yearly increments through to the horizon of the Master Plan period (2025), with maps showing the assumed service area for each increment included at **Appendix H (Figures H-1.1 to H-1.5)**.

2005-2010
During this period, it is assumed that interim water source proposals at Wawa Dam and Laguna Lake (300 MLD BOT) will be completed. The Laguna Lake BOT development will service all or part of the municipalities Muntinlupa, Paranaque City, Las Pinas City and Bacoor as shown in **Figure 5.11**. A separate supply enclave is to be created for this source, which will extend into the existing Villamor Pumping Station zone, thereby reducing pumping requirements. As demand from these municipalities is shifted to the Laguna Lake supply, displaced supply from La Mesa WTP will be re-directed further south through to the areas of Cavite.

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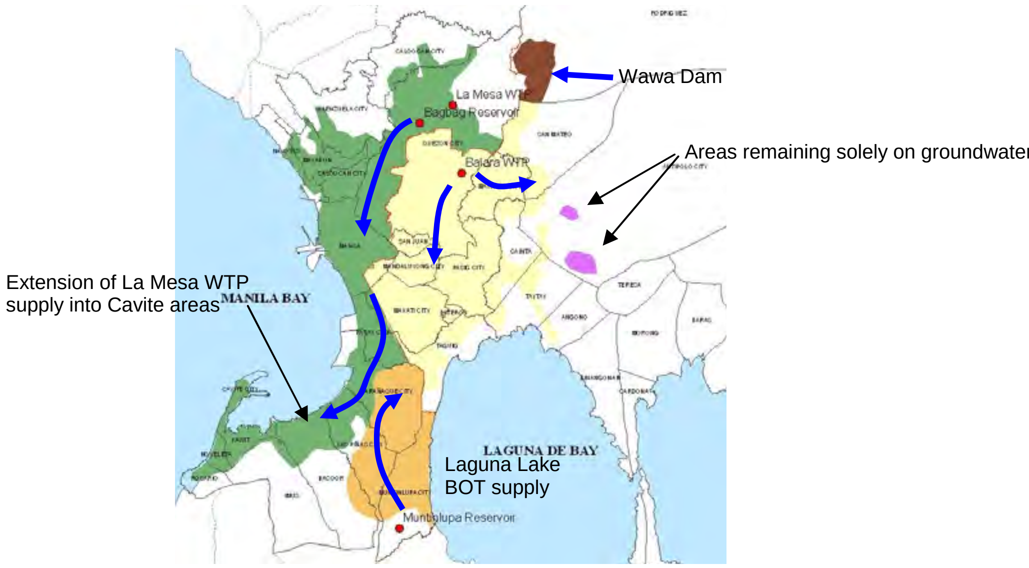

Figure 5.11 Staged Development Plan, 2005-2010

The Wawa Dam supply will service areas of municipality Rodriguez only, as demand in this municipality is expected to exceed the limited capacity (50 MLD) of the proposed development.

With reductions in NRW levels, it is expected that expansion of the primary distribution will also take place during this period to service additional consumers within the concession areas particularly to the east through the San Mateo and Antipolo City municipalities. Additional groundwater development in fringe areas outside of the current supply zone will also support service growth.

During this period, all existing deep well groundwater supplies operated by MWCI and MWSI are assumed to be continued to augment the main surface water supplies from the Angat-Umiray system and the new Wawa Dam and Laguna Lake BOT. These wells can be used to provide much needed peaking capacity during summer periods if operation year-round will lead to water quality issues.

2011-2015

The key development will be Laiban Dam, with associated bulk water conveyance and water treatment infrastructure. Significant investment in primary distribution mains will form part of the development plan to link new supply capacity to expansion areas and to improve levels of service in existing zones. Shown in **Figure 5.12** is the staged development plan for 2011-2015. The Laiban Dam supply via Taytay Reservoir will take control of supply along the south-west coastal corridor of the service area from Manila to Cavite City, freeing capacity at La Mesa WTP to improve supply to the north-western parts of the MWSS service area, namely the municipalities of Malabon, Navotas and Valenzuela City, as well as northwards to Caloocan City.

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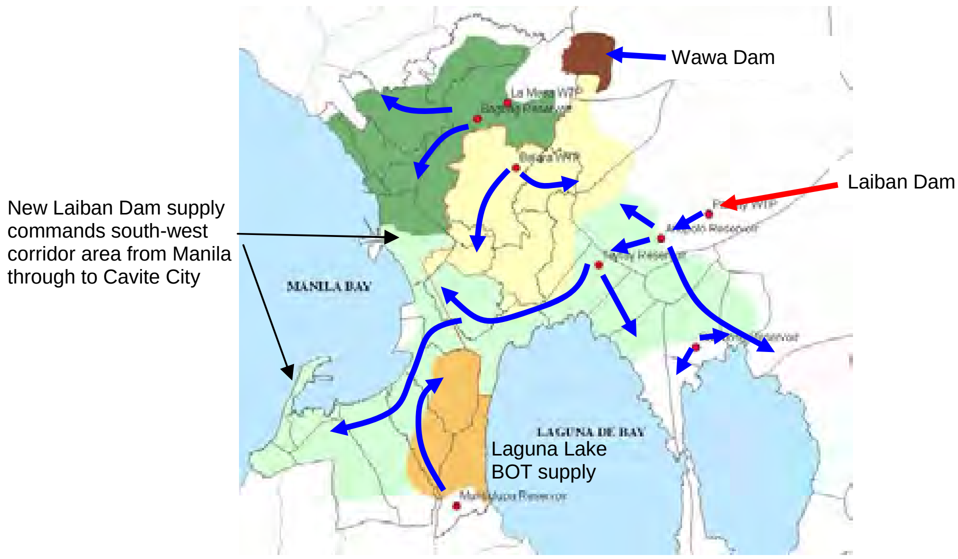

Figure 5.12 Staged Development Plan, 2011-2015

Supply from the Balara WTP will also be extended further eastwards into San Mateo, Antipolo City (lower elevation areas) and through to Rodriguez. The existing Balara supply zone will retract from Makati City and areas in Taguig, Taytay, Cainta and Angona, to create the necessary surplus capacity for re-direction to these new areas.

A new supply corridor via the proposed San Jose Reservoir (supplied from Laiban Dam) will be created through municipalities Teresa, Morong and Baras. The new Antipolo Reservoir will service only the higher elevation areas of Antipolo City (in order to minimize pumping costs).

Again, existing groundwater assets may continue to be operated to provide needed peaking capacity in localized areas.

2016-2020

The focus of development during this period is expansion of the primary distribution network to take advantage of gains made in water availability from NRW reduction activities. There are no new water sources proposed for this period, other than localized deep well groundwater augmentation, unless the concessionaires make progress with other interim source options as presented in **Figure 5.13**.

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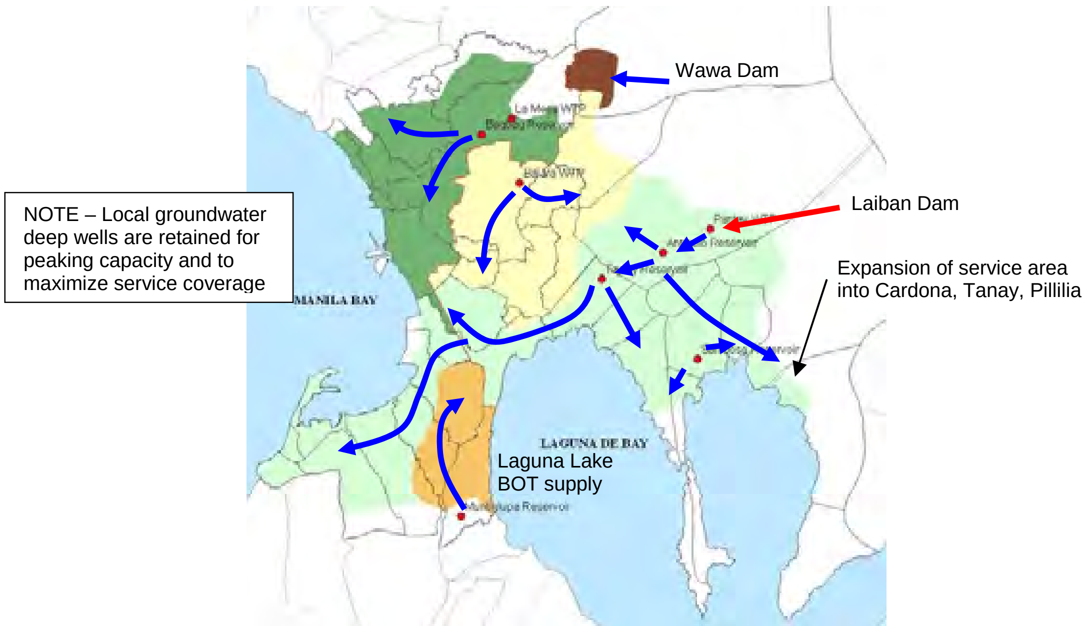

Figure 5.13 Staged Development Plan, 2016-2020

The extension of Laiban supply to municipalities Cardona, Tanay and Pililla is made possible if NRW Reduction Programs have been successful. Municipalities in Rizal along the eastern border of the service area such as San Mateo, Rodriguez and Antipolo City will also benefit from further service coverage.

It is noted that peaking capacity in the scheme will be limited during this period. Current projects examining capacity optimization on the Angat-Umiray system will be beneficial to address this issue. It is not considered appropriate to advance construction of the next major water source (Kanan River) as the solution to peaking capacity shortfalls, since this strategy is not considered affordable.

2021-2025

Figure 5.14 presents the staged development plan for 2021 to 2025. To meet growing demand levels and facilitate the further expansion of the service area, Kanan No.2 Dam is scheduled for completion in 2021. This will include all associated water conveyance and treatment infrastructure. Total capacity of the Kaliwa-Kanan System will be in excess of 3000 MLD, totally relieving the constraint on supply, which in turn will permit the de-commissioning of local groundwater assets.

With the integration of the new source, the full extent of the MWSI service area will experience water supply coverage. The service coverage of MWCI will continue to expand into the eastern municipalities of its allocated service area and extend southwards to Jala-Jala.

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By 2025, projections for this study assume that NRW Reduction Programs will have achieved a target level of 30%. Maintenance of this target will however require ongoing upgrades to the system as part of the post-rehabilitation program discussed in later sections of this report.

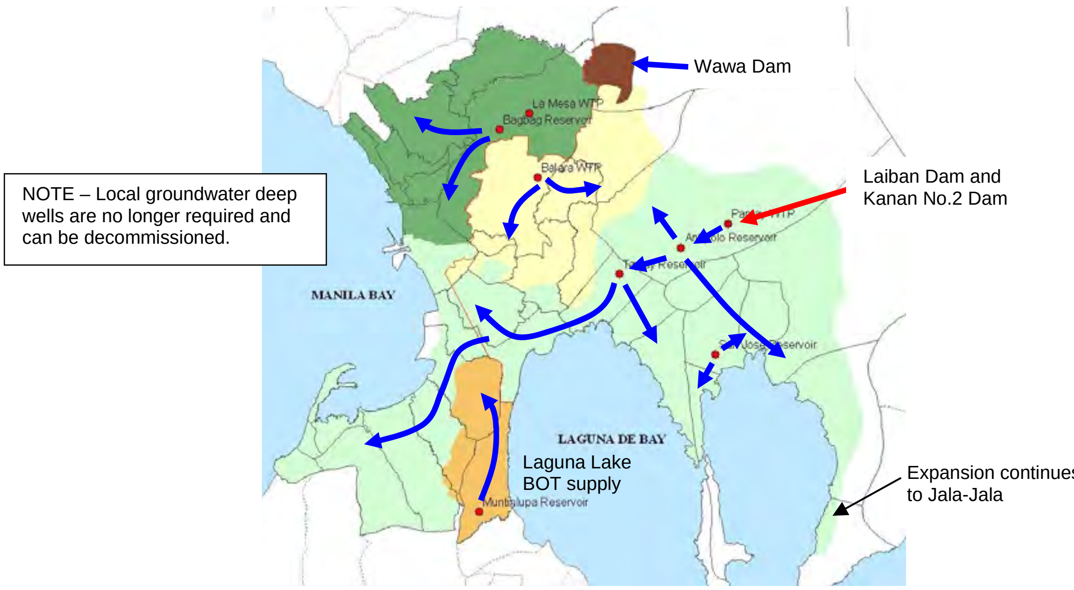

Figure 5.14 Staged Development Plan, 2021-2025

5.5.7 Capital Works Program

Master Plan Study

The summary of the implementation schedule and capital expenditures program is presented in **Table 5.11**. Allowing for a one-year tendering period, the earliest start for Stage 1 works is 2007 and Phase 1 of Stage 1 will be completed by 2014. The trunk and primary mains included in this program are only up to the off-take points of the two concessions and do not include additional primary and reinforcing water mains required in their respective distribution systems.

Stage 2 works are scheduled to be commissioned around 2021. Earlier development of these works is not recommended as affordability of the supply will become an issue.

The system rehabilitation and non revenue water (NRW) Capex program is mainly based on the current and planned programs of the Concessionaires. The estimates need to be refined as new data on the true condition of the distribution system is uncovered in the course of doing the NRW activities. (Refer to *Strategic Action Paper No. 3*).

Furthermore, the higher pressure of the supply from Laiban will require the replacement of additional old and substandard water mains beyond what is needed and currently planned given the prevailing low pressures. Failure to replace or repair these lines and tighten the distribution system will most likely result in an abrupt increase in NRW after the commissioning of the Laiban source.

East Concession

Manila Water's new water supply program as detailed in the 2003 rate rebasing submission for the charging year 2004 consists of concession fee projects, i.e., projects being implemented by MWSS and their own MWCI Capex Program. Listed under concession fee projects are the Laiban Dam Project, Angat Water Utilization and Aqueduct Improvement Project and the 50 MLD Wawa River Project. **Table 5.12** summarizes the East Concession's Capex Program. It is noted that the cost to convey water from the Laiban Dam Project (Pantay) treatment plant to the East Concession's distribution network is included in this program. This cost is also included in the cost summary of this study's Capex Program presented in **Table 5.11**.

West Concession

Maynilad is under court-mandated rehabilitation and their current Capex Program includes only NRW activities and some pipe replacement projects, covering the five-year period from 2004 to 2010. **Table 5.13** summarizes the West Concession's Capex Program.

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Table 5.11 - Implementation Schedule and Cost Summary

STAGE	ACTIVITY	IMPLEMENTATION PERIOD	COST @ 2005 PRICES US$'000	
1	Laiban Dam with Laiban-Taytay 1st Waterway			
	Land Acquisition and Resettlement	2007 - 2009		115,427
	Local Component in US$		115,427	
	Laiban Dam	2010 - 2014		201,227
	Local Component in US$		85,009	
	Foreign Component		116,218	
	1st Waterway	2010 - 2014		455,535
	Local Component in US$		145,695	
	Foreign Component		309,840	
	Pantay Water Treatment Plant #1 & 2	2010 - 2014		192,552
	Local Component in US$		41,448	
	Foreign Component		151,104	
	Pantay Water Treatment Plant #3	2014 - 2016		83,129
	Local Component in US$		17,894	
	Foreign Component		65,235	
	Sub-total			**1,047,870**
	Trunk and Primary Distribution Mains			
	Phase 1	2012 - 2014		193,724
	Local Component in US$		99,023	
	Foreign Component		94,701	
	Phase 2	2014 - 2015		67,141
	Local Component in US$		34,260	
	Foreign Component		32,881	
	Phase 3	2015 - 2016		35,940
	Local Component in US$		20,160	
	Foreign Component		15,780	
	Sub - total, trunk and primary mains			**296,805**
	Total Cost, Stage 1			**1,344,675**
	Local Component in US$		558,916	
	Foreign Component		785,759	
2	Kanan No. 2 with Laiban - Taytay 2nd Waterway			
	Land Acquisition and Resettlement	2013 - 2016		66,211
	Local Component in US$		66,211	
	Access Road via Laiban Damsite	2014 - 2015		52,577
	Local Component in US$		22,211	
	Foreign Component		30,366	
	Kanan Dam	2016 - 2020		256,700
	Local Component in US$		108,444	
	Foreign Component		148,256	
	Kanan No. 2 - Laiban Interbasin Tunnel	2016 - 2020		170,626
	Local Component in US$		54,572	
	Foreign Component		116,054	
	2nd Waterway	2016 - 2020		656,944
	Local Component in US$		210,112	
	Foreign Component		446,832	
	Water Treatment Plant # 4	2018 - 2020		194,078
	Local Component in US$		41,776	
	Foreign Component		152,302	
	Water Treatment Plant # 5	2026 - 2028		150,532
	Local Component in US$		32,403	
	Foreign Component		118,129	
	Water Treatment Plant # 6	2033 - 2035		150,532
	Local Component in US$		32,403	
	Foreign Component		118,129	
	Total Cost, Stage 2			**1,698,200**
	Local Component in US$		568,132	
	Foreign Component		1,130,068	
	Total Cost of Stage 1 and Stage 2			**3,042,875**
	Local Component in US$		1,127,048	
	Foreign Component		1,915,827	
	Pipe Replacement and NRW Reduction Progra	2006 - 2022		**1,306,400**
	Grand Total			**4,349,275**
	Local Component in US$		2,433,448	
	Foreign Component		1,915,827	

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Table 5.12 – MWCI Capex Program

PROJECT NAME	IMPLEMENTATION PERIOD	COST @ 2002 PRICES (PhP Millions)
Concession Fee Projects		
Water Supply Sources Projects		**49,042**
Laiban Multi-Purpose Dev. Project	2010 - 2014	45,292
Angat Utilization & Aqueduct Imp. Proj.	2005 - 2008	3,018
50 MLD Wawa Dam Project	2007 -2010	732
Total Cost, Concession Fee Projects		**49,042**
Capex Projects		
Water Supply Sources Projects		**160**
Rizal Wells Development Program	2005 - 2015	116
Taguig Wells Project	2003 - 2005	44
Water Distribution Network/Pipelines		
Expansion to East and Southeast Areas		**5,132**
Taguig/Pateros WSIP	2008 - 2010	199
Transmission Lines to Connect to Laiban	2012 - 2014	4,308
Other Expansion Projects	2012 - 2014	625
Other Pipeline Extn & Water Supply Imp Proj.		**1,538**
Manggahan Floodway WSIP	2008 - 2010	83
Maharlika-Quasay WSIP	2008 - 2010	50
Pipes from Montalban Plant to Distribution	2008 - 2010	1,001
Additional Reservoir for Balara WTP	2007 - 2008	404
Water Supply Facilities		**504**
Balara Water Treatment Plant Improvement	2005 - 2010	295
Raw Water Facilities Project	2005 - 2010	209
Total Cost, Capex Projects		**7,334**
Grand Total, Concession Fee + Capex Project		**56,376**

*Condensed from Rate Rebasing Submission,Charging Year-2003, MWCI

Table 5.13 – MWSI Capex Program

PROJECT NAME	IMPLEMENTATION PERIOD	COST @ 2005 PRICES (PhP Millions)
3R Projects		**8,048**
Northeast Business Area	2005 - 2010	1,332
Northwest Business Area	2005 - 2010	1,604
Central Business Area	2005 - 2010	1,528
South Business Area	2005 - 2010	2,852
Contingencies (10%)		732
3R Support Projects		**1,819**
Primary Network	2005 - 2010	803
Groundwater Development	2005 - 2008	86
Instrumentation	2005 - 2008	321
Business Process	2005 - 2008	268
Water Meters	2005 - 2008	176
Contingencies (10%)		165
Operational Support Projects		**917**
Facility Maintenance		
Ipo-Bicti / Nova Portal	2005 - 2008	45
La - Mesa Rehab	2005 - 2010	393
Facility Upgrade	2005 - 2010	253
Renewal Program	2005 - 2009	143
Contingencies (10%)		83
300 MLD Treated Bulk Water Supply Project		**2,212**
Primary Mains	2006 - 2010	1,417
Secondary Mains	2008 - 2010	594
Contingencies (10%)		201
Total Cost		**12,996**

*Condensed from Table 3.3.2, NRW Technical Plan, MWSI

5.6 Operation and Maintenance Plan

5.6.1 Water Source Operations

Dam operation and control can either be placed under MWSS or the Common Facilities Group. Intimately associated with dam operations is the management and protection of the watershed, which must be viewed from a very long-term perspective extending beyond the concession period. This consideration alone points to MWSS as the most logical entity principally responsible for both dam operations and watershed management. The Catchment Management Unit, Raw Water Planning and Supply Department proposed in Chapter 7- Institutional Development is recommended to take the lead role with additional resource and manpower support from the Common Facilities Group.

5.6.2 Water Treatment and Distribution Operations

5.6.2.1 Water Treatment and Distribution

The Stage 1- Pantay Water Treatment Plant will have a capacity of 2400 MLD corresponding to maximum day demand or 1.25 times the average day yield from the Kaliwa River Basin (Laiban Dam). Since the two concessionaires will share the production from the treatment plant, operation of the Water Treatment Plant in Pantay as well as the Treated Water Reservoir and the Pressure Control Station both located in Taytay may be placed under the Common Purpose Facilities group jointly manned by personnel from the two concessions.

Alternatively, if the WTP is constructed under a BOT development, a third party would be contracted to deliver bulk treated water to Taytay Reservoir. Under this scenario, the Concessionaires would separately operate and maintain the trunk and primary distribution mains coming out of the Taytay Reservoir to deliver water to strategic points of their concessions, including the 1500 mm pipe line and pumping station drawing directly from pipeline no.2 (upstream of the Taytay Reservoir).

The trunk and primary distribution lines in this report cover only those that will deliver to strategic points of interconnection to the distribution network of both the East and West Zones (see **Figure 4.8**). It is recommended that the Concessionaires make provisions to reinforce and re-evaluate their respective distribution systems to prepare for the new supply and higher pressures when the Laiban Dam source comes on stream. The higher-pressure heads of the new source (70 m top water level of Bagbag Reservoir as against 104.5 m top water level of the Taytay Reservoir) will provide opportunities to decommission a number of booster pumping operations in both the East and West zones, which prospectively may result in substantial savings in operating costs.

East Concession

The East Concession will be served by way of a 2500-mm trunk line from Taytay Treated Water Reservoir interconnected to the 2200-mm PG6 trunk main at Ortigas Ave.

Extension. This line will supply the northern part of Makati and Fort Bonifacio. The 1500-mm primary line tapped directly to Pipeline No.2 will discharge to the 20-ML Antipolo Reservoir, which has a top water level of 270 m, and will supply the Cogeo and Antipolo plateau areas. **Appendix G** shows the sizes and lengths of the trunk and primary lines delivering to the East Concession.

West Concession

The supply to the West Concession will be carried by a 2800-mm diameter trunk line coming out of the Taytay Reservoir and connected to a series of trunk and primary mains all the way to Cavite City. These trunk and primary mains are designed to supply the water demand in Makati, Taguig, Pasay, Las Pinas, Paranaque, Muntinlupa, Bacoor, Kawit, Imus, Rosario, Noveleta, Cavite City and potentially bulk supply to outlying Cavite and Laguna towns (see Section 5.2.3). The summary of the trunk and primary mains for the West Zone are shown in **Appendix G**. The demand in the southern portion of the West Zone will be supplied by the Laiban Dam source thereby releasing some of the production from the Angat-Ipo-La Mesa for the outlying towns in Bulacan. A bulk supply arrangement with those towns with functioning Water Districts is potentially viable.

5.6.2.2 System Rehabilitation and NRW Reduction

The need to reduce NRW and rehabilitate the pipe network gains added urgency when a new major source is to be introduced into the existing distribution system for the following reasons:

1. In a system with physical losses at 50%, one needs to produce 2 MLD for every 1 MLD actual demand. This entails huge additional treatment and delivery costs on top of the incremental development cost to provide the higher capacity required of the new sources.

2. The introduction of the Laiban supply will add about 50% more water into the distribution network and will result in higher pressures not only because of the improved demand and supply balance but also by the fact that the new supply will be entering the system at a hydraulic grade 34.5 m (about 50 psi) higher than the present Angat-Ipo-La Mesa supply.

   The MWSS experience in 1982 when additional supply from the Manila Water Supply Project II (MWSPII) came on stream highlights this problem. NRW at that time steadily increased from 48.9% to 66.4% four years later, an increase of more than 15%.

3. Particular attention should be focused on older portions of the distribution network that have been operating at very low pressures for a long period of time prior to the commissioning of the new water source. Leaks and latent weak points in the pipes in these areas are not apparent because of the low pressure. Subjecting this part of the pipe network to sudden and large incremental increases in pressure will result in several new breakages and increased discharges from old leaks.

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4. All old pipes that are way past the normal service life as well as those with doubtful ability to carry high pressures should be replaced, even if they are not leaking at the present low-pressure regime. Asbestos cement pipes (ACP) and old galvanized iron pipes (GI) are included in this category.

Recommended NRW reduction Strategy

The recommended NRW Program is divided into two phases. Phase 1, the District Metering or Zoning phase involves NRW measurement and reduction activities and Phase 2 covers the post rehabilitation measures to ensure that gains made in Phase 1 are maintained.

Phase 1 - The Zoning or District Metering Method

The two concessionaires, Maynilad and Manila Water, to some extent, have used this method in their non-revenue water reduction program. The procedure is briefly summarized as follows:

1. The distribution network is divided into zones such that inflows and outflows are easily measured and/or controlled.

2. Meters to measure inflows and outflows for a given zone are installed. The net inflow is then compared to billed consumption.

   The zones with very high inflows compared to billed consumption are given the highest priority for rehabilitation.

3. Total NRW in the zone consists of physical and non-physical losses. To ascertain which of these two types of losses are more prevalent in the zone, night flow measurements are then made, usually between midnight and around 5 am. High night flows indicate physical losses due to leaks and low night flows point to non-physical losses as the cause of the high NRW level.

4. Once it is determined that the problem in the zone is non-physical losses, the focus of the activities will be on metering and illegal connections.

   A street-by-street census/ survey to detect the un-metered connections and defective meters is given priority. The benefits from this exercise are immediately realized upon the installation of a new meter on previously un-metered connections or replacement of a defective meter.

5. In zones with high night flows, a new round of night flow measurements is made, with flow shut off to one pipeline at a time. A big drop in the night flow rate when a given pipe is valved-off indicates the presence of a leak on the pipe.

   A leak detection team is fielded to locate the leak and the leaking pipe is either repaired or replaced.

6. Steps 2, 3, and/or 5 are repeated until the desired level of NRW is achieved.

7. After work on a sufficient number of blocks is completed, the estimates of cost and time required to bring down NRW to a given level should be re-evaluated.

   This re-evaluated estimate will be the basis for a work program for the whole network. The duration of the NRW program will mainly depend on how many zones are worked on simultaneously.

In summary, this method of NRW reduction achieves the following:

1. All activities related to NRW reduction are addressed in a very organized way. If initial night flow measurements identify non-physical losses as the source of the high NRW, subsequent activities in the zone are focused on meter replacement and un-metered connections.

2. For areas with high physical losses, focus will be on leak repair and / or pipe replacement. This phase also offers the best opportunity to systematically identify pipes that need to be replaced.

3. Areas with very high losses are worked on first as they hold the highest potential returns on investment. It is generally conceded that to reduce NRW by five percent from say, 25% to 20%, is in general more costly than a five percent reduction from 70% to 65%.

Phase 2 - Post Rehabilitation Care

A system[7] similar to that which has been successfully employed in Japan for some time and more recently in the East Zone is recommended.

A Zone Manager or caretaker should be given charge of the rehabilitated zone or district metering area, taking responsibility for the overall performance of the zone with emphasis on revenues and customer care. The day-to-day activities of the zone manager should include the following;

1. Weekly reading of the district meter(s). An increase in NRW in the zone over the norm should trigger immediate corrective measures.

2. In close cooperation with meter readers, ensure accuracy of meters and timely replacement of malfunctioning meters.

3. Walk the entire zone at least weekly and take the time to interact with residents and inquire about quality of service, complaints, etc. Once friendly relations and trust are established with the community, those dutifully paying their water bills are inclined to expose illegal connections and other forms of cheating.

[7] Asian Water Supplies, Reaching the Urban Poor, by Arthur C. McIntosh

4. Keep track of meter-reading records and analyze changes in consumption patterns especially of big consumers.

   Report leaks and ensure timely repair to minimize losses to the system and disruption of service to the community.

6. Alert consumers to planned water service interruptions and maintenance activities.

7. Keep records of pressure variations through the day indicating maximum and minimum as well as interruptions in supply

8. Keep track of consumer complaints and make sure feedback on actions taken reaches the complainant

9. Offer technical assistance to customers on problems with household plumbing and leakage problems after the meter.

10. Monitor all the activities in the zone and keep a record updated daily. Submit a monthly report to the District Supervisor.

Between 6 to10 of the zone managers, the number depending on the number of connections in the zones will report to a District Supervisor who will have the following responsibilities;

1. Review of the reports and record of activities in the zones and provide inputs and guidance to the zone manager to improve performance.

2. Rate performance of zone managers monthly and encourage benchmarking and replication of strategies employed in high performing zones.

3. Ensure prompt action and support to the zone manager in the repair of leaks, replacement of meters, and other consumer complaints on water pressure and quality.

4. Walk the streets of the zones with zone managers once a month and take every opportunity to interact with the customers.

5. Assess and comment on monthly report of zone managers and submit consolidated report to Business Area Manager.

Projected NRW Targets

East Concession

To serve as basis in estimating the cost of NRW recovery and system demand, a revised projection of NRW reduction for the East Zone was made as shown in **Figure 5.15**. This was prepared based on the performance of MWCI in NRW reduction for the last two years

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and the fact that the cost of NRW reduction increases as NRW goes down. The revised NRW reduction curve adopts a more conservative rate for the period 2011 onwards than that of MWCI.

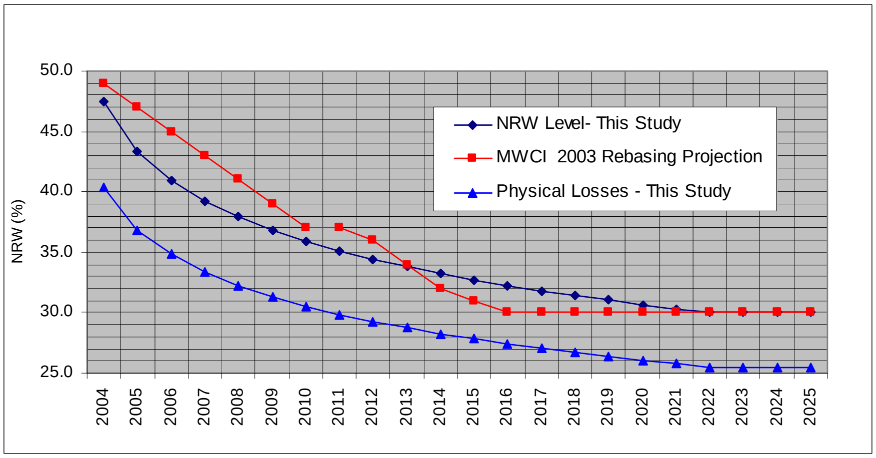

Figure 5.15 NRW Targets for the East Zone

West Concession

Figure 5.16 shows MWSI's NRW targets for the study period. A more conservative projection of NRW reduction was adopted in this study for the period up to 2011 because of the current financial restructuring of MWSI and the reorganization that may ensue upon the implementation of the financial rehabilitation program.

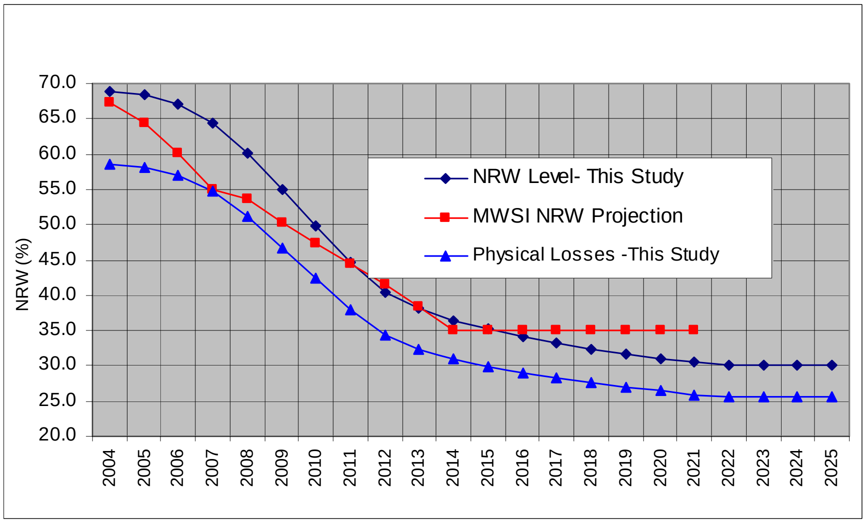

Figure 5.16 NRW Targets for the West Zone

MWSS System-Wide NRW Level Projection

Figure 5.17 the projected NRW levels for the whole service from year 2005 to 2025.

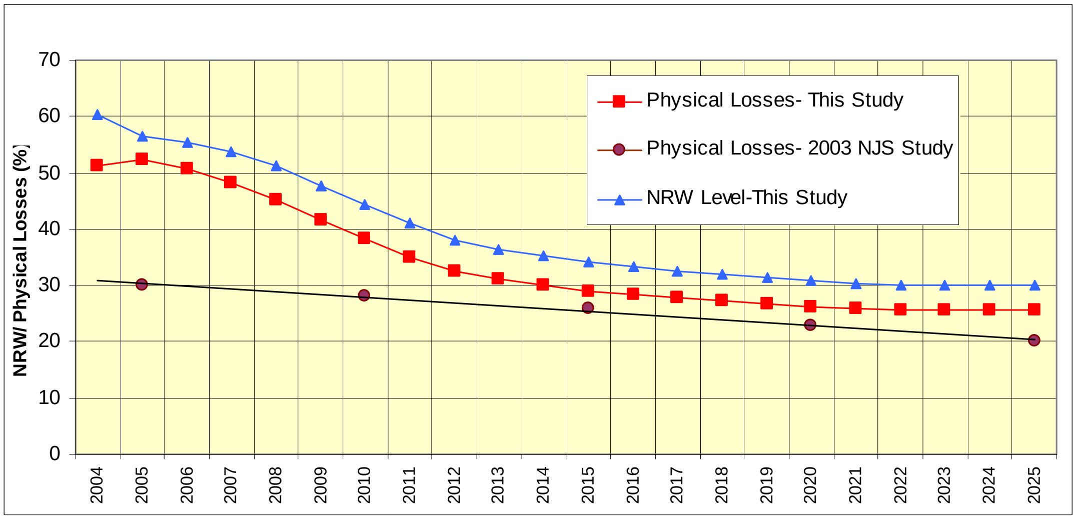

Figure 5.17 NRW Targets for the MWSS Service Area

Estimated Cost of NRW Recovery

Details of the cost estimates for NRW recovery are discussed in *Strategic Action Paper No. 3, NRW and Suggested System Improvements*. Of the total investment cost for NRW recovery per year, approximately 50% only is attributed to the NRW reduction, while the remaining 50% accounts for the cost of regular maintenance activities such as pipe, service connection, and meter replacement. Thus, the reduced cost that is directly attributable to NRW recovery will be PhP 21.98 and PhP 27.67 million per MLD for the East and West Zones, respectively.

Based on the estimated cost of NRW reduction programs being planned by the concessionaires and the expected revenue from the additional billed volume recovered, the payback periods have been estimated at 12 and 13 years for MWCI and MWSI, respectively. **Figures 5.18** and **5.19** show that the revenues from reselling recovered NRW will be more than adequate to sustain the program in the succeeding years after these payback periods are realized.

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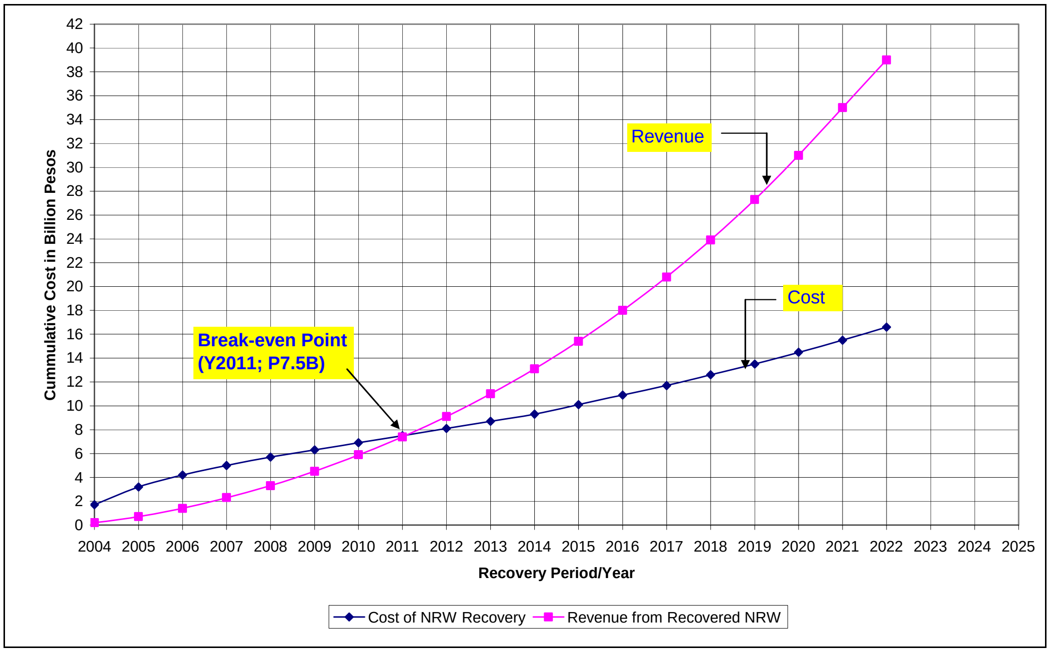

Figure 5.18 Estimated Cost and Revenue from Recovered NRW, East Zone

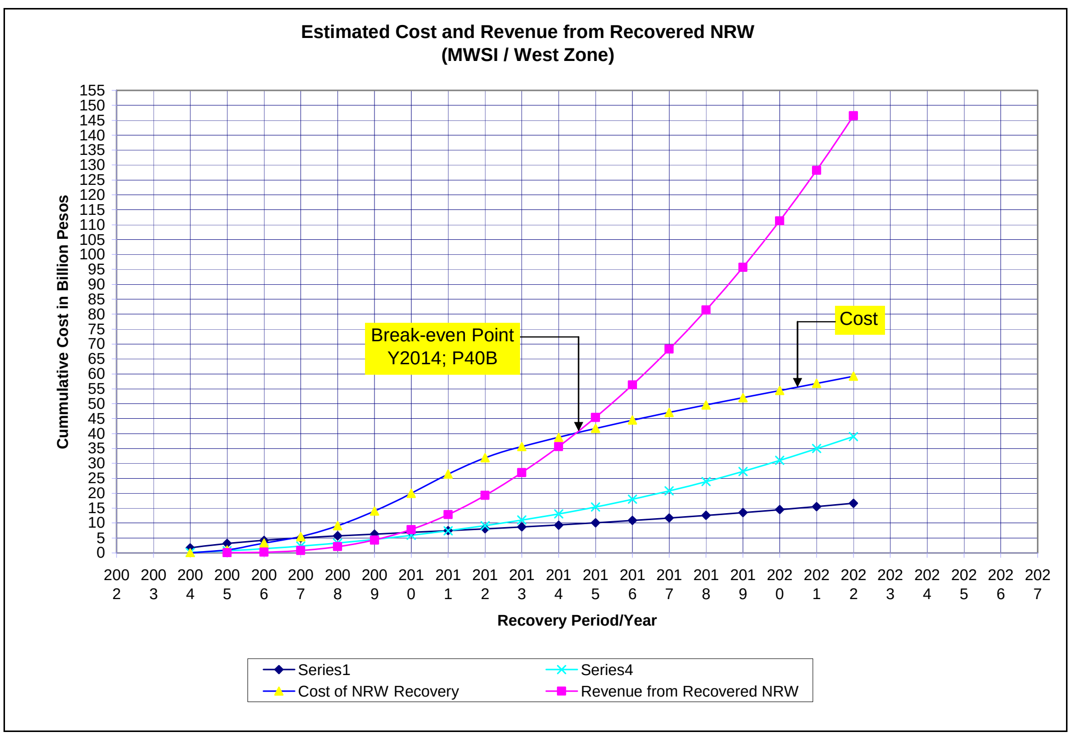

Figure 5.19 Estimated Cost and Revenue from Recovered NRW, West Zone

6. Master Plan Implementation

6.1 Project Implementation Schemes

Traditionally, major water supply development projects in the MWSS were funded by borrowings from international and local banking institutions and the debt servicing requirements taken out of MWSS revenues. Concessionary loans from international financing institutions were easily accessed because of the sovereign guarantee normally provided by the Philippine Government. The privatization of MWSS operations transferred the MWSS income base to the concessionaires and current Philippine Government policy does not encourage government corporations seeking sovereign guarantees for loans.

A number of design, finance and build BOT proposals have been received by MWSS and clearly this is an option that should be given serious consideration as an alternative to direct borrowing by MWSS.

Regardless of the finance structure used, the issue of the project having a servicing period of longer than the remaining term of the concessions or a transfer date (in the BOT case) after the end of the current concessions must be addressed and this is discussed in more detail in Chapter 7, Institutional Development.

6.1.1 Project Proponent Options

The long-term nature of major water supply projects, the limited term of the concession, and MWSS being the ultimate owners of the utility and its assets suggest that the lead role in the water source developments outlined in Section 5.5.7 should be assumed by MWSS. This will ensure that consumers of Metro Manila are not disadvantaged by short-term expedient decisions.

Two options could be considered:

Option 1: MWSS as Main Proponent

The MWSS is the borrower of record in the case of a loan with a take or pay agreement established with the two concessionaires to buy water. This will ensure debt servicing cash flows. If a BOT scheme is adopted, a similar take or pay agreement will be required with MWSS on selling to the concessionaires, water, which is bought from the BOT operators. In either case, a take or pay supply agreement between MWSS and the concessionaires must operate for a period at least matching the loan repayment or cost recovery period of the project, i.e. up to the time of transfer of the asset from the BOT operator to MWSS.

Consequently, the agreement period has to be considered in relation to the remaining concession period. It will have to be structured so that the agreement will transfer mandatorily, (i.e., as a term of the concession agreement) to any successor concessionaires).

Option 2: The Concessionaires Enter into a Joint Venture

The concessionaires may enter into a joint venture to develop and undertake the construction and supply project. MWSS participation will principally be in the resettlement of settlers affected by the project and the acquisition of rights-of-way for conveyance and treatment facilities. It may however be appropriate for MWSS to take a "golden share", i.e. an establishment of rights without equity subscription, in the joint venture. This would be in relation to managing the concession rollover process where there may be several options emerge, e.g.:

- The joint venture would continue as a BOT operator and supply water (under commercial terms) to the successor concessionaires;
- The joint venture capital (equity and debt) would be sold/transferred to the successor concessionaires;
- The joint venture is sold to MWSS, i.e. Option 2 is converted to Option 1.

The preferred option for progressing source development based on current considerations such as the financial status of MWSI is for MWSS to serve as the Main Proponent and broker contracts with the BOT proponent and the Concessionaires.

6.1.2 Project Financing Issues

The recommended water source development option involves investment in a program valued in excess of US$ 2 billion over a 20-year timeframe. This represents a significant challenge to the MWSS and the Government of the Philippines, especially in the context of the current Concession Agreement.

The basic provision of the concession agreements is that expenditures prudently incurred by the concessionaires in the provision of services can be recovered in general rates, i.e. there is guaranteed cost pass through. There are however some qualifications:

1. Concessionaires should not, without the prior approval of MWSS, incur debt that will mature after the expiration date of the Concession or allow security interest to accrue to any asset after the expiration date;

2. The Concessionaires can apply (alone or in association with MWSS) to concessionary lenders such as the World Bank and Asian Development Bank for funding which is available through subsidiary agencies such as IFC. It is, however, likely (and financially beneficial in reduced interest charges) that, for large, long term amounts it will be appropriate for the concessionary lenders to deal with the Government particularly as the concession approaches expiry;

3. A general strategy that is being used is for RP/MWSS to be the borrower of record (as is the case with loans incurred prior to the concession period) but with

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agreements separate to the concession agreements for concessionaires to service the debt;

4. Cost pass through requirements include the need for expenses to be prudently incurred. This may become an issue in respect to the supply increments that are established under a supply agreement. Thus, it will be necessary for the augmentation stages to be appropriate to demand growth and that low cost supply, e.g. from Angat is not displaced by significantly higher cost supply from a BOT/supply agreement.

6.1.3 Revision of BOT Laws

While several private sector organizations have expressed an interest in a BOT development for major water source development in Metro Manila, a common requirement of investors is that a sovereign (i.e., government backed) guarantee is established to secure the financial undertaking. This is not currently provided for in existing BOT law. An alternative is to seek non-recourse (project) financing where the debt is only secured by the BOT assets themselves. This is employed internationally in many projects but inevitably result in higher costs of debt, which are then passed through in operating fees.

Applying a sovereign guarantee will require amendment to the BOT Law as well as careful consideration of the balance of risks to be shared by proponents. However, it is understood that many legislators do not support sovereign guarantees on what is private debt. It is noteworthy that current law provides for up to 50% of the project cost to be incurred as the allowable government share in a BOT contract. This can be in the form of direct government appropriations or concessionary loans. In either case, the government capital participation reduces debt servicing costs overall.

A suggestion has been put forward that the law could be revised to increase the government share to a maximum of say 80% of the project cost. This would attract more bidders and minimize water tariff due to a significant reduction in financing cost. It is observed however that at this level of government participation, the value of BOT as a financing method is minimal, unless there is say a significant consideration in regard to specific technologies and operational skill transfer, in which case there are alternative non-financial strategies possible. Ultimately, the issue has to be considered and negotiated with potential finance sources (both ODA and non ODA) and take account of the cash flow stream (i.e., a take or pay agreement with MWSS) which will service the debt and which is effectively government guaranteed.

6.2 Project Implementation Issues

6.2.1 Land and ROW Acquisition

As recommended in past reports, a strong preference exists for the MWSS to take a lead role in the acquisition of land and ROWs for proposed water supply assets, to limit the extent of private sector involvement in this sensitive area. As the timeframe involved in acquiring land can be protracted, the MWSS has an advantage in being able to immediately progress this activity, prior to engaging a BOT proponent to save time.

6.2.2 Securing Environmental Approvals

For any development option commencing the environmental approval process now, a crucial element of the process will be community consultation, as a range of significant issues have been identified in the preliminary environmental screening of proposals including:

- Impounding of surface water conflicting with other beneficial land uses and its influence on downstream users;
- Encroachment into precious ecology zones – sites are located within a national park and involve access roads that extend through hilly virgin forests;
- Downstream environmental impacts particularly at the river mouth and swampy area at the Agos River estuary;
- Need for watershed management for source protection, especially in view of human activities in the area;
- Impairment of cultural areas/monuments and possible ancestral domains of the Indigenous People;
- Irreversible loss of agricultural resources and scenic spots in areas such as Brgy Daraitan, Tanay following submergence;
- Resettlement of families living in the reservoir areas;
- Construction impacts such as erosion, noise, quarrying activities; and,
- Operational issues including disposal of sludge wastes from WTPs, chlorine hazards, etc.

An Environmental Compliance Certificate (ECC) will be required as the final approving document for the proposed projects, given that these developments will occur within a national park. While the Laiban Dam development was awarded environmental approvals more than 10 years ago, it is likely that an EIA update will be required. The requirement should be determined at an early stage based on the negotiation with the DENR.

6.2.3 Resolving Resettlement Plans

The Laiban Dam and Kanan No. 2 Dam had its resettlement program already in progress since the early 1980's up to around 1996. This activity was authorized under Memorandum Circular no.725 issued by the Office of the President on May 19, 1981, creating an Inter-Agency Committee for the relocation of families affected by the Laiban Dam Project. In 1986, Presidential Proclamation No. 2480 was issued reserving a relocation site of 4,424 hectares in San Isidro Valley in Antipolo, Rizal.

In December 1, 1993, a Memorandum of Agreement was forged between the Metropolitan Waterworks and Sewerage System, the Department of Agrarian Reform (DAR) and the

Department of Environment and Natural Resources (DENR) detailing the rules, procedures and the role of each of the agencies in the relocation process.
Activities on this relocation program tapered down by around 1996 as a result of the impending privatization of the MWSS. In May 2000, the MWSS commissioned the UP Social Action and Research for Development Foundation Inc. (UPSARDF), an affiliate of the College of Social Work and Community Development of the University of the Philippines to conduct an inventory of needs, problems and proposed solutions of families affected by the proposed Laiban Dam Project. The results of the survey are in the final report submitted to MWSS in October 2000.

Among the significant findings of the report are the following, we quote:

1. "The respondents are very much aware of the inevitability of moving away from the Laiban Dam project site. They are ready to accept relocation with the proviso that they are fairly compensated and relocation is prepared with the amenities of an organized community."

2. "Many of the respondents gave a favorable opinion in the construction of Laiban dam. They have a good grasp of the benefits that the dam will provide toward development and they expressed their readiness to cooperate with the government."

3. "The government, through the MWSS, should be ready to utilize this positive outlook from the affected people."

4. "The survey results as well as the interactive process (community assemblies, information meetings, etc) have shown the overall positive attitudes of all concerned towards the Laiban dam project."

While the report showed that majority of the respondents agreed to the choice of relocation site (San Ysiro), the area appeared not to be attractive to prospective relocatees for a combination of reasons. It was recommended that MWSS ensure availability of funds to effect improvements to the site to make San Ysiro an attractive place for the Laiban families. This will include the provision of facilities for roads, transportation, electricity, water supply, health, education and livelihood opportunities. The outcomes of the 2000 study of UPSARDF will need to be reviewed and a Land Acquisition, Resettlement, and Rehabilitation Report have to be prepared, leading eventually to the preparation of the Resettlement Action Plan.

6.2.4 MWSS Resources for Project Implementation

Significant MWSS resources will be required to manage and support the implementation of a major water source development program. Some of the activities involved include:

- Project management responsibilities;
- Assistance in acquiring land and rights-of-way for project structures;
- Assistance in acquiring abstraction rights for raw water;

- Leadership and coordination of resettlement programs for families living in proposed reservoir areas;
- Jointly addressing ongoing catchment management issues;
- Addressing the institutional issues associated with the concession framework; and
- Addressing the long-term financial issues, which will include debt-servicing costs, commitments to both supply and purchase water; cost pass through and ultimate tariff impacts.

Based on an assessment of current resources, additional personnel with considerable project management experience in major water supply developments will be needed.

Recent MWSS experience with resettlement for the proposed Laiban Dam development, confirms that the effort required to plan and implement resettlement of families occupying watershed areas is substantial and involves resolution of complex issues. Formation of a dedicated taskforce led by MWSS and involving relevant government agencies, NGOs and community representation under a people participatory approach is recommended to promote a successful outcome on resettlement issues in a reasonable period of time.

It is understood that ADB assistance is being offered to resolve resettlement issues, which will have the opportunity to establish the required framework and approach.

6.3 Outcome of Consultation on Laiban Dam Development

The most recent consultation with the Municipal Mayor of Tanay and other Municipal officials was September 22, 2005. There are several new developments in the area since the last survey and community consultations commissioned by MWSS in year 2000 and 2001(see section 6.2.3). The more significant new developments communicated to the SKM-DCCD team who went to Tanay are the following;

1. There has been a continuous influx of settlers into the watershed area, including a number who were already paid by MWSS and who have returned to the site. The Municipal officials estimate that the number of settlers may have increased to over 5,000 families. The relocation sites already acquired and/or identified by MWSS may no longer be sufficient and the Mayor recommends an additional relocation site in the Palayang Bayan area, which is preferred by some of the settlers because of its proximity to Tanay.

2. Some settlers are selling the titles or occupancy rights to their farms and the Municipal officials say that the Lucio Tan group has reportedly acquired about 700 hectares in Barangays Mamuyao and Sto. Nino. There may be other land speculators who have similarly acquired land in the area.

   The watershed area was set aside as permanent forest reserve under Presidential Proclamation no. 573, dated June 26, 1969, and as such is considered withdrawn from sale or settlement.

3. The Department of Agrarian Reform (DAR) is reportedly working on declaring the watershed as ancestral domain of the indigenous inhabitants of the area, the Dumagats.

4. As a result of the presentation made by proponents of the various Agos Basin development schemes, some residents have expressed preference for the Kaliwa Low Dam + Agos Dam Option.

5. The Municipal Mayor also warned against agitators instigating protest actions against the project like the rally held near the Tanay Municipal Hall recently.

6. The DENR has initiated the Kaliwa River Watershed Management and Development Project supported with funds from World Bank and DANIDA. The project components include reforestation, agroforestation, livelihood programs such as farming, fish farming, cattle and goat raising. Timber species were planted above the 270-meter maximum reservoir level of Laiban Dam and is not in conflict with future development. However, the project has attracted new settlers into the watershed area.

   The Municipal Mayor, however, stressed that he realizes the importance of the project and that it is in the national interest. He will support the project and offers the following suggestions:

   a. The MWSS should get the support of the National Government for the successful implementation of the project further suggesting that it be declared a Presidential Flagship Project.

   b. The MWSS should initiate immediate implementation, as any delay will result in the further influx of new settlers and land speculators into the watershed area, rendering future relocation activities more costly and difficult.

Details of the consultation process are included in **Appendix I**.

6.4 Current Regulations Relating to Water Supply

There are a number of Presidential Decrees, Executive Orders and Bills that have been issued in the Philippines for the management and regulation of production and use of water. The current structure on water governance calls for economic, administrative and political authority over water resources and services. Institutions at the national, regional or local levels and private agencies are given their own mandate and jurisdiction in water management. Therefore, water resource management is largely an inter-sectoral issue that calls for proper coordination and setting up of appropriate institutional and regulatory mechanisms.

Strategic Action Paper No.1, *Volume 3* discusses the various agencies involved in water management, their mandates, and the regulatory provisions under the various laws. Some of the key provisions considered in the context of the water supply sector in Metro Manila include:

- Presidential Decree No. 1067 – “The Water Code of the Philippines”
- Presidential Decree No. 705 – Revised Forestry Code
- Republic Act 7586 – National Integrated Protected Areas System Act
- Presidential Decree No. 1151 – Philippine Environment Policy
- Presidential Decree No. 1152 – Philippine Environment Code
- Presidential Decree No. 984 – Pollution Control Law (1976)
- Presidential Decree No. 1586 – Establishing an Environmental Impact System (1978); and
- Republic Act 9275 – Philippine Clean Water Act

Further description of these provisions is found at **Appendix J**.

Several impacts of the Clean Water Act on water supply programs were identified, which require further consideration in the context of the long term development of water services for the MWSS service area. These include:

- *Water Quality Management Areas*

Management of the identified watershed will be a critical component of the WQMA. The Agos River Basin, for instance, may be designated as one WQMA. The activities and programs of the proposed Inter-agency Coordination Committee of the Agos River Project and the Agos River Basin Committee may be integrated in the establishment of the Agos River Water Quality Management Board.

- *Holistic Program for Water Supply and Wastewater Management*

With the CWA, it is envisioned that the provision of wastewater treatment services would be given higher level of significance as compared to water supply and distribution. The designation of WQMAs in compliance with the CWA may altogether change the policy structure in Metro Manila. In this context, developing a new major water source will result in additional quantities of water being delivered into areas that are currently suffering water shortages, such as in the southern portions of Metro Manila (Paranaque and Las Pinas) as well as in Cavite. This is likely to have a detrimental environmental impact without a concurrent program to improve wastewater disposal in these areas. This has been addressed in the sewerage and sanitation master plan where some sewerage development is proposed for those areas where water supply will be improved after 2015 as a result of the Laiban Dam development.

- *Promotion of Water Conservatio*n

The wastewater charge system takes into consideration the quality of the water supply in the computation of the discharge fees. Establishments need to monitor the quality of raw water (from an intake or source) as well as the quality of the effluent (after treatment) in determining the wastewater discharge rates.

The introduction of the wastewater discharge system and the load-based fee structure in the CWA will provide incentives for the consumer to conserve water and minimize generation of wastes. The idea is to promote the adoption of waste minimization practices.

- *Water Tariff Structure and the Discharge Fee Computation*

In general, the water tariff structure should reflect the true economic cost of water such as the cost of treatment and distribution, opportunity cost of water, and other cost of externalities such as the wastewater discharge fees now imposed by DENR through the CWA.

The discharge fee would result to costs to be paid by the Concessionaires operating the sewerage systems and treatment plants, thus, possibly affecting the water tariff structure.

- *Impacts of the Abstracted Water Quality on Fee Calculation*

The load-based fee formula suggests that consideration will be made on the quality of the abstracted or intake water and the quality of the treated effluent. Although guidelines are still necessary for the implementation of the discharge fee system by DENR, the following scenarios that may affect water tariff should be considered and clarified with the DENR.

- *Water Supply Disconnection*

Rule 27.6 of the CWA-IRR stipulates that the DENR Secretary may issue an order to the to private water supplier such as MWCI or MWSI to disconnect the water service of a service customer in the event that the said customer violates any provisions of the CWA. This particular rule may need further legal analysis by MWSS particularly for cases where the establishment is using the MWCI/MWSI water service but is not tapped into the MWSI/MWCI sewerage system.

6.5 Permitting Requirements

Permits are required for projects related to water supply, grouped according to the implementation stage, i.e., pre-operating and operational stage of the project are indicated in *Strategic Action Paper No 1, Volume 3 – Review of Relevant Regulations Relating to Water Supply.*

7. Institutional Development

7.1 General

The institutional component of this partial update of the water supply master plan has focused primarily on the role of MWSS and the Regulatory Office in the context of the concession framework. The manner in which each of the concessionaires implements their responsibilities is not discussed in detail since this is subject to the contractual arrangements under the Concession Agreement. What is addressed are issues that would either clarify some constraints that have become apparent following implementation of the concession arrangements as well as areas that would enable the MWSS Corporate Office and the Regulatory Office better manage the Concession Agreements.

This section of the master plan should be read in conjunction with the following reports prepared as part of this study:

- Strategic Action Paper No.1 – Institutional, Environmental and Physical Targets for the Water Supply Sector, Volume 2
- Working paper No.1 – Role of MWSS
- Working Paper No.2 – Asset management Issues
- Working Paper No.3 – Key Performance Indicators and Business Efficiency Measures

7.2 Key Agencies and Institutions Involved in Water Supply in the Philippines

Water supply in Metro Manila involves a number of key stakeholders including the following agencies and institutions:

- Department of Environment and Natural Resources (DENR)
- Department of Public Works and Highways (DPWH)
- National Water Resources Board (NWRB)
- Department of Health, and
- Local Government Units (including Metro Manila Development Authority)

A description of these agencies and institutions and their respective roles is found at **Appendix K** to provide further context to discussion on institutional matters.

7.3 Institutional Framework for Service Provision

In 1997, as part of the Government's policy on private sector involvement in public utility service delivery, water and wastewater services to the MWSS service area were privatized by awarding concession contracts.

The key features of the concessions established in the service area are:

SKM

1. The city has been split into two service areas (East and West).

2. The bids were accepted and evaluated in terms of the proposed reduction in tariff, which would be accepted by the successful concession bidder.

3. The contracts were negotiated and the concessions awarded after employee numbers had been substantially reduced.

4. There was extensive planning prior to bids being called, including a major marketing/public relations program to sell the concept.

5. The successful bidders were required to assume the existing debt of MWSS and to service it during the period of the concession. The debt however was disproportionately (approximately 90%) held in one concession area (the West Zone).

The concession agreements have resulted in four entities being directly involved in water and sewerage service provision in the city:

Two concessionaires, **Maynilad Water Services, Inc. (MWSI)** which operates in the west of the city and **Manila Water Company, Inc. (MWCI)** which operates in the east.

The Regulatory Office is established as the representative of the customers and is created under provisions of the concession agreements. It is established to be responsible for monitoring the concession agreements generally and to monitor specifically the performance of the concessionaires including sponsoring technical and financial audits. The Regulatory Office also has the role of facilitating and implementing changes to rates and charges.

The MWSS Corporate Office has responsibility for the retained functions, i.e. those not passed to the concessionaires, facilitating the performance by the concessionaires of their obligations, managing the Umiray-Angat Transbasin Project (UATP)***,*** managing the loans which are in the name of MWSS but serviced under the agreements by the concessionaires and managing and where appropriate disposing of the “retained assets” i.e. those assets not conceded for the duration of the agreement. Notably the Corporate Office takes responsibility in some respect for supply of raw water, i.e. water before treatment, and generally acts on behalf of the concessionaires for Raw Water Access management.

By default, it is the representative of the asset owners, i.e. the Government and people of the Philippines. Conceptually, the relationship between the four entities is shown in **Figure 7.1**.

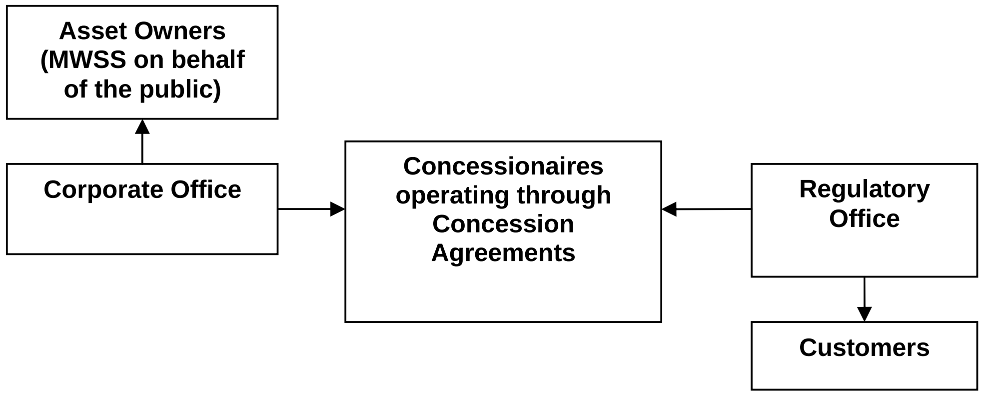

Figure 7.1 Conceptual Relationship

The two MWSS entities and the concessionaires formally relate through the concession agreements and through an annual review (see **Figure 7.2**). There is however substantial day-to-day liaison with the Corporate Office and the Regulatory Office.

The concession agreements are explicitly between MWSS and the relevant concessionaire. The agreements are for a limited period (25 years) and all rights, assets (except for cash), duties and entitlements revert from the concessionaires to MWSS on expiry of the concession period.

Since commencement of the concessions there have been several significant events which have impacted on the concept, in particular the devaluation of the Philippine Peso in late 1997, which coincided with El Nino-based severe drought. The MWSI concession claimed substantial hardship as a result of the devaluation and other causes and submitted a case for adjustment of rates as well as other issues.

Further detail on the role, responsibilities and performance of the MWSS and the two Concessionaires is attached at **Appendix L**.

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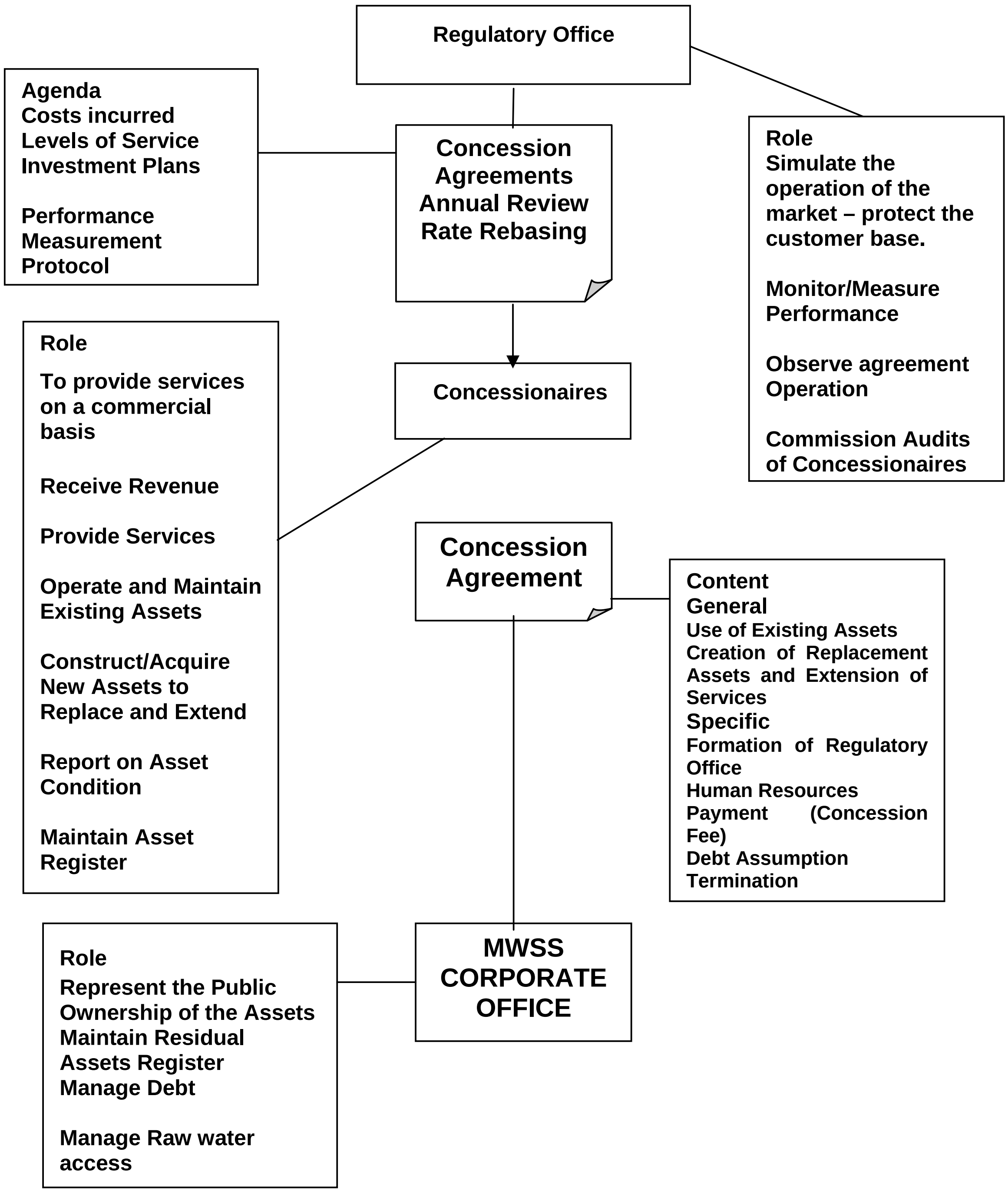

Figure 7.2 Institutional Framework

7.4 Institutional Issues for MWSS Organization

7.4.1 General

Establishment of the concessions in August 1997 was the largest ever private sector participation project in the water and sanitation sector in the world and was carried out within the constraints of urgency and limitations in regard to the legislative capability available. In addition, the concessions involved multinational participation and substantial debt.

In late 1997, there were very significant shifts in the foreign exchange value in many Asian currencies including the Philippine Peso. The result of both the preparation constraints on the project from within and the financial issues from without resulted in several issues emerging. Furthermore, there was a major raw water shortage from late 1997 to the end of 1998.

The financial and other issues include:

1. The provisions for raw water access;
2. Long term planning for the sector;
3. The financial impacts of currency devaluation;
4. Asset Management;
5. Planning for the end of the concession;
6. Regulation; and,
7. Raw Water Protection and Coordination;

These issues are discussed in detail in *Strategic Action Paper No 1*. They are noted and discussed below. Some can be addressed through the strengthening of several departments within the MWSS Corporate Office, which is discussed in *Working Paper No.1 – Role of MWSS* and summarized below in Section 8.7.

7.4.2 Raw Water Access Control

General

The concession framework generally provides for the concessionaires to have total sector responsibility from the treatment of raw water to the delivery to customers and ultimately to the disposal of wastewater, i.e. sewerage and other sanitation.

The agreements deal with provision of raw water supply through cross-reference to agreements between MWSS and the National Water Resources Board (NWRB). These agreements confirm raw water access (i.e. abstraction rights) for the concessionaires on the basis of assignment of MWSS rights. Significantly, the agreements are not specific with regard to the ongoing responsibilities for developing new water sources or expanding existing ones.

The concession agreements are specified to run for 25 years from August 1, 1997. However, the nature of long term planning for water, sewerage, and sanitation is that investments are made for a very long term and invariably develop sunk assets, i.e. assets with no real residual value if they are decommissioned. In addition, because of the long-term nature of the assets, it is generally regarded as appropriate on intergenerational equity grounds that the funding (generally loans) is also long.

Since 1997, there have been several instances of water shortages and it is accepted that there is an express need to augment raw water supply for Metro Manila, and the Master Plan project is a manifestation of the need.

Privatization of Angat Dam Power Generating Facilities
This issue is discussed in detail in *Strategic Action Paper No.6 – Turnover of Angat Dam and Reservoir.*

As discussed earlier in this study, raw water supply for the MWSS service area comes from Angat Dam, which was built in 1967 by the Government of the Philippines as a multi-purpose impoundment to serve:

- Electricity Generation - controlled by National Power Corporation (NPC) through the inclusion of Hydro Electric Generators in the dam structure;
- Irrigation via regulation of the flow of the Angat River downstream of the dam and under the control of the National Irrigation Administration; and,
- Water supply for Metro Manila under the control of MWSS.

Significantly, ownership of the dam is historically vested by the government in the National Power Corporation, which has also taken responsibility for operation and maintenance of the impoundment. There has, however, been a sound history of cooperation between NPC, MWSS, and the National Irrigation Administration (NIA) in management of the complex. In particular, there is an agreed protocol to ensure that priority is given to metropolitan water supply.

The Government of the Philippines has legislated to sell the National Power Corporation including its assets and that process has commenced with the comprehensive transfer of the NPC assets into the Power Sector Assets and Liabilities Management Corporation (PSALM), which is managing the sale process.

MWSS has made significant capital cost contributions including power-generating facilities since construction of the dam in 1962. In addition, the recently constructed Umiray-Angat Transbasin Project that supplements the water supply to Angat Dam was funded completely by MWSS. On a long-term basis, MWSS has been the majority capital contributor to the Dam asset.

Transfer of control of the complex to a private sector owner has strong ramifications for MWSS and for the city of Manila both in a strategic context and in a managerial one. Representations have been made by the MWSS Board and management to exclude all parts of the complex from the sale process.

PSALM have responded to the Board by stating that the Angat Hydro Electric Plant (HEP) could not be exempted from the privatization although it was not intended that the impoundment structure, i.e. the dam should be included in the sale. Furthermore, there should be no objection to the maintenance and management of the Dam and Reservoir being turned over to MWSS.

Current Status of Privatization of Angat Dam Power Generating Facilities
The bidding for the assets is scheduled to take place in October 2005 and legislation (Electric Power Industry Reform Act) and subsidiary implementing rules and regulations have however been promulgated. The drafting of the implementing rules gives some concern in that it states that:

NPC and PSALM or NIA, as the case may be shall continue to be responsible for the dam structure and all other appurtenant structures necessary for the safe and reliable operation of the hydropower plants. The NPC and PSALM or NIA, as the case may be, shall enter into an operations and maintenance agreement with the private operator of the power plant to cover the dam structure and all other appurtenant facilities. (Rule 23 (6) (d).

This provision is reasonable for dams and facilities, which have a predominant purpose of irrigation (i.e., water flow regulation) or electricity generation.

The provisions are inappropriate when the predominant purpose is urban water supply particularly with respect to Angat as effectively the exclusive water source for the national capital. The design of the Angat complex is that water for potable use (after treatment) is discharged to the Ipo River through the five auxiliary turbines. The consequence is that water supply for Manila is ultimately dependent on the effective operation of the turbines.

Should two of the turbines be shut down, then supply to the Ipo Dam is insufficient and water drawn from Ipo Dam for treatment and ultimate supply for the city cannot be replenished. At current demand levels, it is estimated that severe supply problems would arise if the turbines were shut down for approximately 10 days or more. This shutdown could occur for a number of reasons but could conceivably result from the private operator's inability or unwillingness to effect repairs in a timely manner or from the private operator being in dispute with the government. This strategic risk should be considered by the government and the implementing rules be amended to ensure that MWSS has a clear mandate to operate and manage the dam complex including the authority to invoke the demand curve rules that currently apply.

Furthermore, there is concern with respect to catchment management. Irrigation and hydro-electric power generation are not impacted by land management in the catchment/watershed. However, potable water production can be severely impacted by both agricultural and secondary industry production practices in the catchment or by residential development. In most developed countries, catchments are controlled by specific catchment authorities that have the power and responsibility to regulate land management in accordance with the application of water flows.

7.4.3 Long Term Strategic Planning

As a basic premise, headworks development for municipal water supply is typically viewed as a long-term investment, with assets created to support a 50 to 100-year strategy and recovered over a 30-year (or greater) period. The alternative where asset costs are more quickly passed through user charges raises significant issues with regard to intergenerational equity. Water source development, for example, requires long-term consideration in order to establish the optimal strategic approach.

At present, by default, long-range planning is being undertaken by MWCI and MWSI. This has two constraints:

1. The planning horizons are nominally set at the end of the concession contract (Year 2022). This may be extended by a consideration by each company of the likelihood of the concession being retained. This is, of course, appropriate to the business interests of each concessionaire and they would be significantly remissed to take a different approach.

2. The planning of each of the concessionaires is appropriately directed at their individual business interests and not at the long-term interests of the overall customer base.

A further consideration is available capital funding (apart from strategies like BOT).

In regard to debt and capital funding, the concession agreements are specific in providing for the servicing of "existing loans" by the concessionaires through the concession fees. There is no explicit provision for new debt to be sourced by MWSS and serviced through the concession agreements. This is particularly limiting in respect to multi-lateral lenders, which have significant limitations on loans made to non-government entities.

As a consequence, new borrowings are either:
- Undertaken by the concessionaires on commercial terms with lenders taking account of the provisions of the concession agreement in setting the terms. Lenders have included bilateral lenders such as DANIDA, International Finance Corporation (the private sector focused operation of the World Bank) and commercial banks; or,
- Concessionary (soft) loans sourced by MWSS from providers such as the World Bank with arrangements being established outside of the concession agreements for the concessionaires to service the debt.

Headworks development, which is directed at potable water production essentially requires that MWSS take the lead on strategic planning in this area.

7.4.4 Financial Issues

The insolvency of MWSI and the consequent transfer of equity to MWSS presents a major issue to be managed within the current institutional framework.

It is now understood that MWSS's ownership will not be maintained long-term although it may be up to 2 years before it is divested. The divestiture process (i.e. sale of equity) is being developed by the government and will be subject to assistance from consultants. Consequently, there is no available detail of the process to be followed.

There have been expressions of interest to bid for the company by others including a consortium lead by MWCI. The alternative bids would require agreement by MWSS (as the Concession Agreement principal) since the equity structure of Maynilad is restricted by the terms of the Concession Agreement.

The following issues emerge from this situation:

- The potential swap of debt for equity by MWSS creates a significant issue with regard to the appropriateness of the Regulatory Office remaining within the MWSS corporate framework.

- The insolvency draws attention to the need to positively manage debt and that debt sourced from outside of the multilateral/concessionary lenders will be more difficult to source and expensive. Multilateral/ concessionary debt, on the other hand, is available to private operators in a restricted way (via IFC). However, debt sourcing is further restricted by the terms of the concession agreement with regard to borrowing by concessionaires and the diminishing period of the concession.

- The nature of the divestiture of the MWSS ownership has not been decided, i.e. it can possibly be:

  (a) Sale of the MWSS share holding;

  (b) Sale of the MWSI company; and,

  (c) Sale of the concession rights which would require a formal call for new bids and awarding of a new concession.

There are issues specific to each of these alternatives that will need to be resolved prior to a decision being taken on the most appropriate mode of divestiture.

7.4.5 Asset Management Issues

For a more detailed assessment of asset management issues, reference is made to *Working Paper No. 2 – Asset Management Issues.*

Asset Management
Water and sewerage/sanitation assets are notable in that:

- The useful asset life can range from five to ten years in the case of pumps and motors, up to decades in the case of civil structures such as pumping stations and ultimately to centuries in the case of sewer mains.

- Long-lived assets such as sewer mains and water mains are often buried below land and road surfaces with consequent difficulty with regard to assessment of their condition.

- Accounting for asset usage (i.e. depreciation) is complicated by changes in technology, e.g. local water reservoirs established to maintain a pressure head in urban areas are now replaced with variable speed pressure pumps which accomplish the same purpose without alienating valuable city land. As a consequence, asset depreciation is often based not on the historical cost of the asset but on the replacement cost of the asset potential. This is referred to as the Modern Equivalent Engineering Reference Asset (MEERA). Under this principle the reservoir may be valued in the accounts of an entity on the basis of the cost of a replacement pump.

Sector performance is thus driven in the long term by the quality of its asset management. Effective private sector participation as well as public management of infrastructure relies on the asset owners having reliable and comprehensive asset data with asset management systems and sound expertise.

Creation of an asset register is therefore essential in that it provides a database of asset condition against which the assets returned at the end of the concession can be reconciled and intermediate repairs, maintenance, replacements, augmentations and disposals can be reconciled.

Currently, the assets are being documented in a fragmented manner via:

- Creation of an apparently very robust asset register in the East concession;
- Limited creation of a register of some assets in the West concession; and,
- Documentation of the “residual” assets (generally real property) within the Corporate office.

This fragmentation is exacerbated by the concessionaires regarding the asset registers as corporately valuable. This attitude is commercially appropriate but forebodes badly for the documentation at the end of the concession period, which will be essential for decision-making by the asset owners (MWSS), the concessionaires, other bidders for the concessions and other stakeholders including the RP government.

Asset Information in the Concession Framework
Concessions are based on the owner of an asset conceding the use of the asset by another party in return for consideration paid by the Concessionaire.

In any concession, particularly a long term one, information pertinent to the assets becomes the core of the relationship between the asset owner and the concessionaire. This is principally because the concessionaire has a clear economic incentive to extract a maximum value from the asset (which may be by depleting it) whereas the asset owner will have an opposite incentive of ensuring that the asset value (its service potential) is maintained or any depletion (depreciation) is minimized.

Furthermore, as the concession period approaches expiration and consequent renewal/ rebidding, the possession of asset information, with regard to both nature and condition of the assets, achieves greater value since the information is the basis on which the costs of providing services in the new concession period will be assessed. It is therefore important that the asset owner retains and extends this information during the concession period so that it can be passed to potential bidders for the next period. The alternative is for the information to only be held by the existing concessionaire, who thus has a critical competitive advantage when the concession is rebid.

If the concession is not rebid, the criticality of the asset information can increase as the nature and condition of the assets, which are passed back to the owner, will be the basis of the terms under which the termination occurs.

Repair or Replace Decisions
Decisions on repair or replacement of assets in the water and sanitation sector are a major component of asset management. Failure of assets will generally have a strong impact on customers and the environment. The impact will be financial, regulatory and on corporate “image”. These failure impacts must be assessed against the cost and other impacts of asset replacement such as traffic disruption in the case of pipelines.

At the current time, decision-making is the sole right and responsibility of the concessionaires with the Regulatory Office taking a role through the review process associated with Rate Rebasing. This results in the decisions being generally taken in consideration of the business considerations of the concessionaires (modified by the customer focused regulatory concerns). There is no direct input on behalf of the long-term asset owners.

In the early stages of the concession period, the absence of the long term asset owners in the decision making is of generally minor consequence. It is noted that there is concern by the concessionaires that extending the decision process to include the owners will cause significant delay and ultimately economic loss.

In the middle and later stages of the concession, however, there arises scope for decisions to be made based on the remaining period of the concession rather than on the very long term associated with asset lives. This is problematic but there is reluctance to overly “bureaucratize” decision processes.

A possible solution would be for the Regulatory Office, in the middle term of the concession (2008-2012), to continue in its review role but to take advice from the Asset Management group of the Corporate Office in relation to decisions taken.

In the fourth and fifth terms (2013-2022), the Corporate Office as representatives of the Asset Owners should participate in any decision-making, which involves assets where lives will directly extend beyond the concession period.

Asset Condition Monitoring
It was noted above that there is a requirement in the Concession Agreements for regular Asset Condition Reports to be submitted to the Regulatory Office.

This reporting is desirable on the basis that the role of the Regulatory Office is essential to monitor the performance of the Concessionaires with respect to the service commitments under the agreements and to assess the capability of the Concessionaires to maintain their performance in the future.

The consequence is that Asset Condition is a necessary consideration with respect to assessing future capability and service levels. However, it must be noted that the objectives of the Regulatory Office are quite different to those of the Corporate Office in its nominal role as the manifestation or representation of the asset owners. Generally, the assessment horizon for the Regulatory Office will be:

- Short to medium term, e.g. to the next Rate Rebasing date;
- At a high level, e.g. at primary water main; and,
- Based on possibility of the asset set failing and causing an inability to meet service commitments.

The planning and assessment horizon for the Corporate Office will be:

- Longer term and focused on the end of the Concession Period and beyond;
- At a detailed level and generally at the lowest replaceable construction unit, e.g. a pipe length between manholes; and,
- Directed at retaining/maximizing economic value in the assets.

There is, therefore, a need to provide more detailed asset condition data to the Corporate Office and for the Office to be strengthened to permit it to manage the data.

7.4.6 Concession Planning

The Need for Concession Planning
Concessions are a common form of long term Private Sector Participation around the world. They apply in the water sector in Europe, many parts of Asia, South America and elsewhere.

Concessions are based on an assignment of assets, rights, and responsibilities.

A major feature is for the asset set to be clearly defined in quantum and condition by both the asset owner who has to ensure that the asset is not being inappropriately depleted by the concessionaire and the concessionaire who has to ensure that the asset is not being excessively enhanced at the concessionaire's expense or detriment. The critical time for assessment of asset quantum and condition is at the start of the management period and at the end of the period.

Concession Planning at MWSS
There is an emerging requirement for active concession planning by MWSS. The need is moderate currently as the concession period is now approaching the tenth year but will become critical by 2010.

The key objective will be to ensure that decisions are made by the concessionaires, which are in accordance with the best interests of the asset owners and the customers, e.g. that capital replacement decisions are in accordance with least-cost long term plans, and that MWSS as asset owners are placed in the strongest negotiating position possible when (and if) new concession bids are called in 2021.

Regardless of the options chosen, possession of the asset register (including condition information) will be critical and commercially extremely valuable for the owners (MWSS), the current concessionaires, and potential new entrants.

7.4.7 Regulation

Independence of the Regulatory Office
The establishment of clear and effective regulatory systems is critical to the autonomy of water service providers. They are established to constrain service providers' operations so as to avoid exploitation of the environment and customers in the corporation's or agency's pursuit of its commercial objectives. Frequently, the frameworks also have a provision to provide protection to other stakeholders such as community groups, which are not necessarily customers.

The concession agreements do not *per se* demand a totally independent Regulatory Office in that there is an acceptance of reliance on MWSS being the ultimate controller of the Regulatory Office albeit with defined independence requirements with regard to location and staffing (it is notable, however, that the Regulatory Office is located in the same building complex as both concessionaires and MWSS). It is reported that this association of the Regulatory Office with MWSS was necessary due to the urgency with which the overall privatization process took place and the possible cost burden (which is borne by the concessionaires) of total independence. This is acceptable currently although it is noted that the 2003 ADB TA project made a recommendation to relocate the Regulatory Office physically away from MWSS and to provide greater emphasis on independence.

The impending possibility that MWSS will take a significant and perhaps majority shareholding in MWSI changes the situation. Having a Regulator, which is a functioning arm of the owner of one of the concessionaires will create tensions, which must be avoided.

The Role of the Regulatory Office

The current role of the Regulatory Office as provided in the Concession Agreement is based on self measurement and reporting by the operator to the regulator with consulting assistance being provided as necessary. The mandate of the office is nominally to implement the provision of the Concession Agreement. While the role will evolve over time, it is generally consistent with single sector economic and performance regulation as it is practiced internationally. An issue that could be considered is whether the Regulatory Office should have a more specific audit role, such as a review of performance of the operator against an operating license that occurs in some other situations. It is not considered that such an extension of the role of the Regulatory Office is currently required for the following reasons:

- If an operational audit was to be instituted it would most likely be associated with the rate rebasing process where there already appears to be reasonable vigilance applied by the Regulatory Office.
- The Regulatory Office is a single sector continuous regulator. Audits may be more appropriate where the Regulator is a multi-sector periodic regulator, which occurs in some cases in other locations.
- The current staffing of the Regulatory Office is staffed adequately for a monitoring role, but not necessarily for an audit role.

However, there is currently no institutional barrier to the Regulatory Office in conducting periodic audits as necessary, and this has occurred on occasions in the past usually by employing consultants.

7.4.8 Raw Water Protection and Coordination

The protection of water resources identified for Metro Manila water supply is of primary importance for sustainable development and use of these sources. It is therefore essential that an effective management structure and process be established to control access and catchment activities within watershed areas and administer the operation of sources for the benefit of all users. At the same time, it is essential that stakeholder rights are not overly compromised.

At present, there are several key stakeholders involved in the protection of water resources for Metro Manila. In addition to MWSS, these are:

- National Water Resources Board (NWRB)
- Department of Environment & Natural Resources (DENR)
- National Irrigation Administration (NIA)
- National Power Corporation (NPC)
- Local Government Units (LGU)
- Local residents

Based on discussions with MWSS and other stakeholders, it has been resolved that MWSS has the most interest in the integrity of the catchment and is likely to hold, long term the necessary competence to manage the catchments.

7.5 Institutional Development Plan

7.5.1 General

Analysis of the institutional issues related to the delivery of water supply services in Metro Manila outlined in Section 7.4 leads to a series of recommendations that have resulted in the formulation of an Institutional Development Plan as discussed further below.

7.5.2 Raw Water Access Control

The intent of the concession agreements is for a “joint venture company” to be established by the concessionaires to manage operations and maintenance of raw water facilities both upstream and downstream of Angat and for subsequent development of raw water supply. However, no company has been formed and there is only an agreement with regard to cost sharing under the Common Purpose Facilities Agreement with regard to operations and maintenance.

Raw water access control is therefore by default the responsibility of MWSS and this may be appropriate given the long-term nature of raw water source facilities as discussed in Section 7.4.2. It is proposed that raw water access control be undertaken by MWSS by an additional department/function group, the ***Raw Water Planning and Access Management Department*** under the Office of the Deputy Administrator for Operations within the MWSS Corporate Office as discussed in Section 7.5.10.

Recommendations on Privatization of Angat Dam Power Generating Facilities
Advice has been received from PSALM that NPC will continue to exist after privatization and will continue to manage the Angat complex including (where appropriate) the catchment. Funding will be provided via the Universal Charge that is incorporated into the electricity tariff structure. That is, the current arrangements will be maintained.

Prima Facie the advice is reassuring, however, it is understood that NPC as an organization will diminish significantly after the sale of its assets. As a consequence, it is possible that it will be insufficiently resourced physically to meet its Angat obligations (despite the funding being generated via the Universal Charge).

A further concern is that MWSS is not listed as a successor manager and NPC may be succeeded by NIA, which will then contract operations to a private entity in accordance with the implementing rules. The following actions are recommended:

1. That the government addresses this concern by clearly appointing MWSS as the successor to NPC as manager of Angat and that MWSS should make continued

submissions to government on the matter. Alternatively, MWSS can negotiate with PSALM/NPC to transfer operation and management of Angat to MWSS prior to the sale.

2. That MWSS make representations to the DoE, PSALM/NPC so that it can actively participate in watershed management through membership of a committee responsible for the formulation and implementation of the watershed rehabilitation management program or through an appropriate Memorandum of Agreement.

3. That MWSS make representations with the PSALM/HEPP Sales Committee of the inclusion in the bidding documents of an approved Water Protocol that safeguards the water supply for Metro Manila in the interest of national security.

7.5.3 Long Term Strategic Planning

The current framework for long term planning which relies primarily on the plans developed by the concessionaires has significant risks in terms of loss of synergy and of deriving solutions that are sub-optimal as discussed in Section 7.4.3.

Water source development, which is directed at potable water production, essentially requires that MWSS take the lead on strategic planning in this area.

To adequately perform long-term strategic planning and project management for water related services in Metro Manila area, the MWSS would need to reinforce its present staff. While it is cost efficient to outsource most of the project planning, detailed engineering, and construction management services, engagements of this nature are relatively short term.

It is proposed that long-term strategic planning be undertaken by an additional department/function group, the ***Master Plan and Lender Liaison Division***, under the Engineering and Project Management Department within the MWSS Corporate Office as discussed in Section 7.5.10. This new group will specifically address the future beyond the horizon of the concession agreements and liaise with donors and lenders (both concessionary and commercial) with regards to financial needs to undertake long-term developments.

7.5.4 Financial Issues

The issues raised in Section 7.4.4 relate to the implications to the concession arrangements that have been demonstrated from the insolvency of MWSI.

Firstly, to the extent that ineffective debt management was a factor in the MWSI difficulties, the need to more effectively manage debt suggests that MWSS has to take a primary role as a borrower of record in transactions with concessionary lenders and effectively operate as a merchant bank.

Secondly, the potential swap of debt for equity by MWSS, even if only on a temporary basis, reinforces the need that the Regulatory Office be made fully independent under its own legislation, as recommended below in Section 7.5.7.

Thirdly, the choice of divestiture strategy from MWSS will be very critical and overall is expected to be the basis of the terms of reference for a separate consultancy. It is recommended that the issues related to the mode of divestiture outlined in Section 7.4.4 be addressed by a two-stage consultancy and advice process as follows:

Phase 1 - Analysis of the Debt and Capital Restructuring Agreement (DCRA)

> This would review the DCRA and clearly define in non contractual terms the timeline that applies as an outcome of the agreement, i.e. when specific requirements and conditions arise. From this timeline, the windows of opportunity for the sale and change options can be identified and terms of reference scoped and developed for further assistance in Phase 2;

Phase 2 – Supporting the Change Process

> The first task in this phase would be a Strength Weakness Opportunity and Threat (SWOT) analysis of the identified options for change leading to a recommendation and program for the change/sale.
>
> The second task would be monitoring and assistance to MWSS in managing the change process particularly in the context of the outcomes of the Master Plan development.

7.5.5 Asset Management

The following recommendations are made to address the issues related to the need for the MWSS Corporate Office to more effectively manage and monitor the assets being used by the concessionaires.

Retention of Existing Information
It is understood that drawings exist of most of the water system and all of the sewerage system in 1:2000 scale on a work-as executed basis. Some of these drawings are retained in the MWSS vault, while others have been borrowed by one or other of the concessionaires. The drawings generally indicate materials used, e.g. pipe material and date of installation. They are thus vital to the asset management process.

The drawings that have been borrowed by concessionaires should be immediately returned and physical security of these drawings should be assigned to a senior manager in the MWSS Corporate Office who should take responsibility for conversion to digital format and storing them in a secure manner and making them available to appropriate stakeholders.

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Establishment of Concession-Based Asset Registers
This master planning project includes in the methodology the intent to create a Geographic Information System, which can contain spatial data on both the water and sewerage systems maintained by the concessionaires. The system will be established using the ArcView Mapping Package.

ArcView has the capability of establishing quantitative (attribute) data alongside the spatial data set and the establishment of the data is discussed in *Strategic Action Paper No.5 – The Use of GIS and Modeling.*

It is recommended that the data collection for each system asset node and segment should include specific asset data including:

1. Installation Date
2. Historical Cost (actual or estimate)
3. MEERA Cost
4. Condition
5. Remaining Life
6. Residual Value

This data collection should be based on copies of the drawings noted above and on concessionaire data, which should be reconciled against records of capital expenditure, which has been included in Rate Rebasing submissions.

The data collection project should be undertaken by the concessionaires and should be controlled by the Corporate Office who should employ a rigorous audit process. Alternately, the data collection should be undertaken by a joint group or by contractors but in all cases with a rigorous audit/ quality assurance process. The cost of the project will be substantial and outside the ambit of the Master Plan project to estimate. Multilateral donor assistance will probably be appropriate particularly given that such a project and the resulting asset register will be a valuable case study in applying asset management principles and technology in a developing country.

The development of the asset-based registers would be in conjunction with the establishment of a GIS function within the Corporate Office.

Strengthening the Corporate Office for Asset Management
It is recommended that the Corporate Office establish an **Asset Management Group** within the Corporate Planning Department under the Office of the Senior Deputy Administrator. The Group will be responsible for:

- Coordinating the establishment of a comprehensive asset register, which is compatible with the asset registers developed by the concessionaires;
- Participating in the Asset Condition Report process in association with the Regulatory Office;
- Establishing a long-term process to prepare for the expiry of the current concession period.

- Supporting the activities and responsibilities of the Concession Planning group that has been recommended for establishment with Corporate Planning.

Initially, the GIS function would be housed within the asset management group in Corporate Planning. However, should the GIS function expand to become an enterprise-based GIS, a separate GIS Center may be established as a new division within the Corporate Planning department.

This staffing would be supplemented by consulting assistance supplied under the asset register development and otherwise.

7.5.6 Concession Planning

In order to ensure adequate information is in place for decision-making with regard to the future after the end of the current concession period, it is recommended that the MWSS Corporate Office include a **Concession Planning Group** within the Corporate Planning Department under the Office of the Senior Deputy Administrator. This group would have the following broad responsibilities:

1. Monitoring and where appropriate participating in the asset maintenance/ repair/replacement/disposal process particularly as the end period is approached when there is increasing incentives for gaming by the concessionaires;

2. Appropriate and comprehensive accounting of the asset set that is made available by the concessionaire for return;

3. Establishing the options that are available to provide services after the period end that may include, for example, a rollover of the existing concession(s), a call for submissions for the next concession period or a reversion to some other institutional form of supply; and,

4. Managing the process of commissioning the consequent framework for the new period.

7.5.7 Regulation

It is recommended that legislation be developed (based on the current concession agreement provisions) which will totally separate the Regulatory Office both geographically and conceptually from the other participants in the framework.

7.5.8 Raw Water Protection and Coordination

It is proposed that MWSS seek formal delegation of raw water protection (catchment management) duties from the NWRB for Angat Dam, as part of the current review into source management being driven by the privatization of NPC hydropower business activities, and all other future dams to be constructed for water supply or multi-purpose use. MWSS is considered the most appropriate agency to accept delegated authority to enforce the provisions of the Water Code of the Philippines in the area of water source protection and management.

For MWSS to effectively discharge its duties in relation to water source protection and management assuming this responsibility is delegated by NWRB, staffing levels and funding of new activities must be resolved. It is recommended that these requirements be established as a matter of priority.

7.5.9 MWSS Resources for Project Implementation

It is apparent that MWSS will need to take a greater role in the planning, lender liaison, and management of the implementation of major water source development programs. Significant MWSS resources will be required to manage and support the implementation activities. Some of the activities involved include:

- Project management responsibilities;
- Assistance in acquiring land and rights-of-way for project structures; and,
- Leadership and coordination of resettlement programs for families living in proposed reservoir areas.

Based on an assessment of current resources, it is recommended that additional personnel with considerable project management experience in major water supply developments be appointed or contracted by MWSS to augment current resource levels. The preferred structure and type of resources recommended is discussed further in the following section.

Recent MWSS experience with resettlement for the proposed Laiban Dam development, confirms that the effort required to plan and implement resettlement of families occupying watershed areas is substantial and involves resolution of complex issues. Formation of a dedicated taskforce led by MWSS and involving relevant government agencies, NGOs, and community representation under a people participatory approach is recommended to promote a successful outcome on resettlement issues in a reasonable period of time.

7.5.10 MWSS Corporate Office Strengthening

Many of the above recommendations require strengthening of some departments within the MWSS Corporate Office to enable them to better manage the concession contracts, but most importantly to ensure effective long-term strategic planning. The proposed strengthening is discussed in detail in *Working Paper No.1 – The Role of MWSS* and is summarized in this section.

To address the recommendations made above, the following changes are proposed in the structure of the MWSS Corporate Office as indicated in **Figure 7.3**:

(a) That Corporate Planning be restructured as a Line Department with clear responsibility for the:
- Creation of an Asset Management System;
- Concession Planning;
- Government Relations;

(b) That a new Department for Raw Water Planning and Access Management be created under the Office of the Deputy Administrator for Operations; and,

(c) That a new Division for Master Planning and Lender Liaison be created under the Engineering and Project Management Department.

Functions and anticipated competencies for each department are indicated in **Table 7.1.**

Water Demand Management
One of the most critical issues in the implementation of water efficiency and demand management programs is lack of appropriate institutional arrangement.

MWSS is a member of the Water Conservation and Demand Management Committee, a Committee responsible for:
- Preparing a nationwide Water Conservation Plan;
- Undertaking a nationwide information drive;
- Encouraging active private sector participation;
- Providing research, monitoring, and feedback; and,
- Mobilizing needed funds.

However, not a single task is clearly delegated to any of the divisions of MWSS. It is suggested that the responsible department under the current organization be identified and the needed staffing and funding be addressed. This department shall coordinate with other members and actively participate in the activities of the Committee.

The Concessionaires are also recognized as key players in undertaking water efficiency programs, particularly in the reduction of NRW levels, optimal water pricing, pressure management, conduct of water audits, public information and dissemination, and recycling and reuse of water.

However, a problem may arise regarding this role of the Concessionaires because of the conflict of interest between maximizing water sales and achieving demand reduction targets. Private water companies will tend to relate the reduction of demand with negative impacts on revenue. In addition to this, no contractual requirements exist, which specify water efficiency targets within the current Concession framework.

The MWSS Regulatory Office may set performance targets on water-use efficiency to which the Concessionaires must comply, associated with a system of incentives and disincentives. This will encourage the Concessionaires to enforce water efficiency programs where practical, prior to future approvals of proposed water source development. The different water demand management strategies are discussed in detail in *Strategic Action Paper No. 4*.

7.5.11 Cost of Implementing Institutional Development Plan

The cost of implementing the Institutional Development Plan results primarily from:

- The cost of additional personnel required to strengthen the MWSS Corporate Office;
- The cost of establishing a GIS function in the MWSS Corporate Office;
- The costs involved in the operation and maintenance of Angat Dam and Reservoir (including catchment management and security) should these functions be transferred to MWSS following privatization of the Angat hydro-electric generating facilities;
- The costs involved in asset data collection to develop an asset management system within MWSS, either in-house of through a consultancy contract;
- The costs of additional resources on an as needed basis for management of implementation of major water source programs; and,
- The cost of a consultancy to assist in the development of the strategy related to the rehabilitation of the West Zone concession.

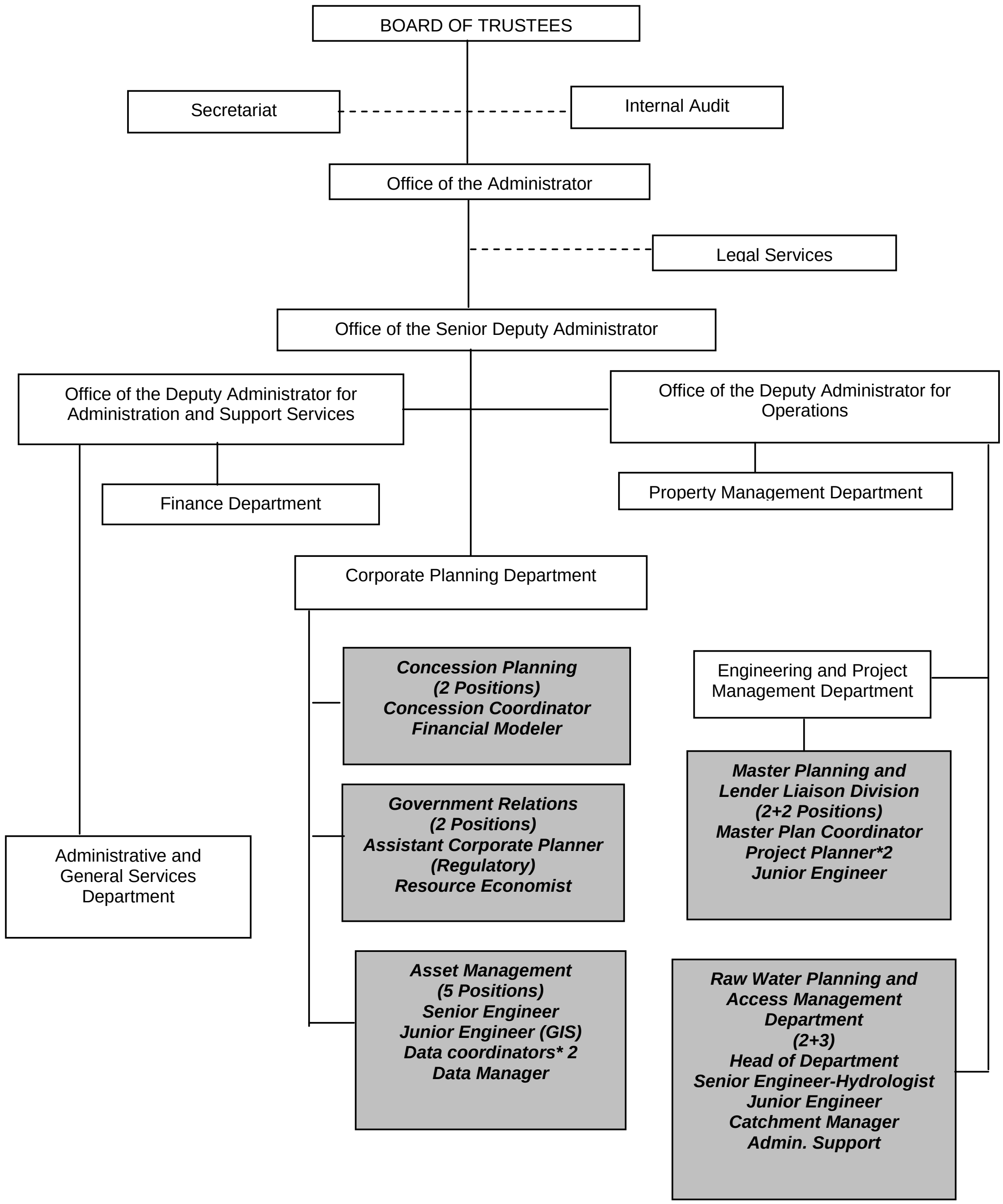

Figure 7.3 Proposed Functional Structure

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Table 7.1 - New Departments and Additional Function for MWSS Corporate Office

Department/Division	Function	Competencies	Staffing
Technical Planning and Monitoring (Master Planning and Lender Liaison Division)	Master Planning and Lender Liaison for long term water supply services to Metro Manila. This is a new function and will specifically address the future beyond the horizon of the concession agreements and liaise with donors and lenders in regard to financial needs to undertake master plans and long-term programs.	Civil Engineering Mechanical Engineering Engineering Investigation and Analysis	Specifically identified positions arising out of the development of master plans are: Master Plan Coordinator Project Planner (2) Junior Engineer
Raw Water Planning (and Supply) (Raw Water Planning and Access Management Department)	This is a new department that will report to the Office of the Deputy Administrator for Operations and will address (i) Long Term Water Demand Planning and Management (ii) Raw Water Supply Planning (iii) Raw Water Access Negotiation and Management (iv) Catchment Management	Hydrology Urban Economics and Planning Negotiation Skills Community Consultation and Relations Environmental Management	Head of Department Senior Engineer/Hydrologist Junior Engineer Catchment Manager Admin. Support
Corporate Planning and Asset Management	This is a revision of the existing Corporate planning function. Conceptually the department's role is to draw together the government agencies and regulators, current and future concessionaires and MWSS as strategic components of water and sanitation service provision. In general the functions that the department will carry out are: (i) Developing Water, Sewer, Sanitation Sector Strategy in association with central agencies (ii) Negotiating with Government Regulators (iii) Business Planning (iv) Concession Planning particularly in regard to termination/rollover preparation (v) Asset management of the total asset base on behalf of the public owners in cooperation with the Regulator	Policy analysis Economic analysis Resource Economics Strategic Planning Negotiation skills Financial modeling and analysis Data analysis and Management relative to the asset base	**Corporate Policy and Planning** Head of Department **Concession Planning** Concession Coordinator Financial Modeler **Government Relations** Assistant Corporate Planner (Regulatory) Resource Economist **Asset Management** Senior Engineer Junior Engineer (GIS) Data Coordinator (2) Data Manager
Finance	This department retains its current functions and will have a greater focus on capital management. Its general functions are: (i) Corporate Accounting as a government owned corporation; (ii) Financial Planning in particular sourcing of debt for long term asset development and on lending where appropriate to concessionaires; and, (iii) Loan Administration in cooperation with Regulatory Commission.	Financial Accounting Financial Analysis Financial Management	
Personnel	This department groups together the currently separate functions of: • Personnel • Secretariat • Legal Services A particular need is for personnel planning which moves away from the redundancy management which was needed following the implementation of the concessions to forward planning	Professional Skills	

The costs of the additional personnel required to strengthen the MWSS Corporate Office as outlined in Section 7.5.10 and for establishing a GIS facility in the Corporate Office have been estimated and are indicated below. Costs for the other elements of the Institutional Plan have not been estimated as they depend largely on the strategy adopted and are outside the scope of this study to estimate.

Impact of Additional Personnel in the Corporate Office Budget

The proposed new department, Raw Water Planning and Access Management Department under the Office of the Deputy Administrator for Operations, and the transformation of the Corporate Planning Department from the staff function to line function will result into additional annual budget for personnel cost of about PhP 12.27 million, shown in **Table 7.2.** This amount represents about 9.6% of the 2005 personnel cost budget of the Corporate Office (PhP 127.23 million) or 6.4% of the total MWSS personnel cost budget of PhP 191.82 million (Corporate Office and Regulatory Office).

Currently, there are 38 contractual positions in the CO, which is almost the same number as the vacant positions (37). As the vacant positions are filled up, the contractual positions would consequently diminish. The budget for personnel cost is being prepared based on the approved positions. Therefore, the PhP 12.27 million would have to be added to the total budget to determine its effect in the financial situation of the Corporate Office.

A comparison of the 2005 Budget and the "Increased Budget" brought about by the proposed additional personnel in the Corporate Office shows that the budget can still absorb the additional cost.

Table 7.2 - Comparison of the Corporate Office 2005 Budget and "Increased Budget" brought about by the Proposed Additional Personnel (In Million Pesos)

Description	2005 Budget	Increased Budget
SOURCES OF FUNDS		
Concession Fees – Corporate Operating Budget	154.11	154.11
Collection of Accounts Receivable	38.57	38.57
Miscellaneous Income	142.95	142.95
Total	**335.63**	**335.63**
APPLICATION OF FUNDS		
Personnel Cost	127.23	139.50
Maintenance and Other Operating Expenditures	150.80	150.80
Equipment Outlay	7.50	7.50
Total	**285.53**	**297.80**
SURPLUS	**50.10**	**37.83**

The additional cost of PhP12.27 Million was based on the additional personnel as shown in the proposed Revised Functional Structure. The positions recommended were compared to the positions defined in the Qualification Standards (QS) issued by the Civil Service Commission, Revised 1997 to determine the Salary Grade of the position.

Establishment of GIS function within MWSS Corporate Office

Establishment of a GIS function within the MWSS Corporate Office would be carried out in two phases. In the initial phase, the GIS function would be incorporated within the Asset Management Group of the Corporate Planning Department. During this phase, the GIS software and equipment would be procured and its function would be largely limited to the development of corporate databases related to asset management.

The second phase of GIS development will create a new unit within the Corporate Planning Department to manage GIS on an enterprise basis, but this will not occur until the asset management system has been substantially established and some degree of GIS expertise has been developed.

The estimated expenditure on GIS development is indicated in **Table 7.3**.

Table 7.3 – Estimated Expenditure to establish GIS in MWSS Corporate Office

	PHASE 1 (PhP)			PHASE 2 (PhP)
ACTIVITIES	**Year 1**	**Year 2**	**Year 3**	
Network Installation				
Hardware Upgrade	104,500	82,500		2,348,000
Software Upgrade		990,000		6,712,000
Digital Database Development				
Development of Application Systems		1,000,000	2,000,000	3,500,000
Development of Technical Skills	6,000	48,000	192,000	280,000
Other Expenditures				
Hardware Maintenance	10,450	18,700	18,700	330,000
Software Maintenance		148,500	148,500	1,773,000
Supplies and Materials	60,000	110,000	121,000	280,000
Grand Total	180,950	2,397,700	2,480,200	15,223,000

7.5.12 Summary of Recommendations

A summary of the recommendations for institutional development is presented in **Table 7.4.**

Table 7.4 - Institutional Development Recommendation Summary

Action	Urgency	Priority
Organizational		
Establish Raw Water Planning and Access Management Department under the Office of the Deputy Administrator for Operations within the MWSS Corporate Office	Immediate	High
Establish Master Plan and Lender Liaison Division under the Engineering and Project Management Department within the MWSS Corporate Office.	Immediate	High
Corporate Planning be restructured as a Line Department with clear responsibility for • Creation of an Asset Management System • Concession Planning • Government Relations	Within 6 months	Very High
Establish an Asset Management Group within the Corporate Planning Department under the Office of the Senior Deputy Administrator. Commence centralized development of a comprehensive Asset Register for system assets.	Within 6 months	Very High
Establish a Concession Planning Group within the Corporate Planning Department under the Office of the Senior Deputy Administrator.	Within the next two years	Extreme
Establish a GIS Facility within the Asset management Group of the Corporate Planning Department. GIS to be primarily used as an asset management tool.	Within 6 months	Very High
Establish an Enterprise wide GIS within the Corporate Planning Department to provide support all functions within the MWSS Corporate Office.	After 3 years	Moderate
Privatization of Angat Dam Power Generating Facilities		
MWSS to seek appointment as the successor to NPC as manager of Angat.	Immediate	High
MWSS make representations to the DoE, PSALM/NPC so that it can actively participate in watershed management through membership of a committee responsible for the formulation and implementation of the watershed rehabilitation management program	Within next 6 months	High
MWSS make representations with the PSALM/HEPP Sales Committee of the inclusion in the bidding documents of an approved Water Protocol that safeguards the water supply for Metro Manila in the interest of national security	Immediate	High
Management		
The 1:2000 drawings that have been borrowed by concessionaires should be immediately returned and physical security of these drawings should be assigned to a senior manager in the MWSS Corporate Office who should take responsibility for copying them in a secure manner and making them available to appropriate stakeholders.	Immediate	Extreme

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8. References and Further Reading

The issues discussed, comments and recommendations contained in Section 4 are partially condensed from the following reports:

1. Strategic Action Paper No. 1 (Volume 1): Land Use, Demography, and Water Demands
2. Strategic Action Paper No. 1 (Volume 2): Institutional Review
3. Strategic Action Paper No. 1 (Volume 3): Review of Relevant Regulations Relating to Water Supply
4. Strategic Action Paper No. 2: Future Water Sources
5. Strategic Action Paper No. 3: NRW & Suggested System Improvements
6. Strategic Action Paper No. 4: Water Demand Management and Reuse Options
7. Strategic Action Paper No. 5: The Use of GIS and Modeling
8. Strategic Action Paper No. 6: Turnover of Angat Dam and Reservoir
9. Working Paper No.1: The Role of MWSS
10. Working Paper No.2: Asset Management Issues
11. Working Paper No.3: Key Performance Indicators and Business Efficiency Measures

The studies/ reports used as reference for this master plan are as follows:

1. Black & Veatch. Masterplan for Sewerage System for Metro Manila, 1969.
2. Clemente, Roberto S., et al. Philippine Institute for Development Studies, “Groundwater Supply in Metro Manila: Distribution, Environmental, and Economic Assessment”, February 2001.
3. Comprehensive Land Use Plans of all cities and municipalities of NCR including:
   - Pasay City
   - Quezon City
   - Mandaluyong City
   - Las Pinas City
   - Makati City
   - Malabon City
   - Marikina City
   - Muntinlupa City

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- Paranaque City
- Pasig City
- Taguig City
- Manila City
- Valenzuela City
- Caloocan City
- San Juan
- Navotas
- Pateros

4. Comprehensive Land Use Plans of Cavite Service Areas including:

   - Cavite City
   - Bacoor
   - Imus
   - Rosario

5. Comprehensive Land Use Plans of Rizal province except the municipality of Baras.

6. DENR Administrative Order No. 34 – Revised Water Usage and Classification Criteria of 1990.

7. DENR Administrative Order No. 35 – Revised Effluent Regulations of 1990.

8. Dumol, Mark. The Manila Water Concession: An Insider's Look at the World's Largest Water Privatisation, World Bank, 2000.

9. Electrowatt Engineering and Renardet S. A. Feasibility Study Report for Manila Water Supply Project III, 1979.

10. Electrowatt Engineering and Renardet S. A. Summary Engineering Report for the Detailed Engineering Design of Manila Water Supply Project III, 1984.

11. Electrowatt Engineering and Renardet S. A. Manila Water Supply III Project Review, 1997.

12. Executive Order 123 series of 2002

13. Executive Order 927, Laguna Lake Development Authority

14. Implementing Rules and Regulations of Republic Act 9275 (February 21, 2005 version)

15. Laguna Lake Development Authority (LLDA) Masterplan

16. Manila Water Company Inc. Prospectus for Initial Public Offering of Shares in Manila Water Company Inc., 2005.

17. Metro Manila Development Authority. Metro Manila Physical Framework Plan, 1997 to 2016.

18. MWSS Concession Agreement

19. National Housing Authority (NHA), Fast Facts on Philippine Housing and Population.

20. National Plumbing Code of the Philippines

21. National Statistical Coordination Board (NSCB) Provincial Poverty Estimates, 1997 and 2000

22. Nippon Jogesuido Sekkei Co. Ltd., CEST, Inc., Mott Macdonald Co. Ltd. East Concession Area Master Plan Update, 2005.

23. Nippon Jogesuido Sekkei Co. Ltd. and Tomatsu & Co. Study of the Water Supply and Sewerage Master Plan of Metro Manila in the Republic of the Philippines, 1996.

24. Nippon Koei, Co. Ltd., and Nippon Jogesuido Sekkei Co. Ltd. Master Plan Study of the Water Resources Management in the Republic of the Philippines, 1998.

25. Nippon Koei, Co. Ltd., and Nippon Jogesuido Sekkei Co. Ltd. Study on Water Resources Development for Metro Manila in the Republic of the Philippines, 2003.

26. NSO Census of Philippine Population and Housing, 1980 to 2000.

27. NSO Family Income and Expenditure Survey, 1997 to 2003.

28. Presidential Decree 856, The Code on Sanitation of the Philippines

29. Presidential Decree No. 957, Housing and Land Use Regulatory Board Regulations and Standards

30. Presidential Decree 1067, Water Code of the Philippines – Reconstituting the National Water Resources Board

31. Presidential Decree 1096, National Building Code of the Philippines

32. Presidential Decree No. 1151, Philippine Environment Policy

33. Presidential Decree No. 1152, Philippine Environment Code

34. Presidential Decree 1586, Establishing an Environmental Impact Statement System

35. Provincial Physical Framework Plan of Rizal Province

36. Radian Engineers & Co. Conceptual Study for the 1200 MLD Laguna Lake Bulk Water Supply Project, 2001.

37. Radian Engineers & Co.: The Study of Engineering Alternative for the 300 MLD Bulk Water Supply Project (Final Report), September 2003.

38. Republic Act No. 7160, Local Government Code of the Philippines of 1991

39. The UP Social Action & Research for Social Development Foundation, Inc. (UPSARDFI), College of Social Work and Community Development. An Inventory of Needs, Problems and Proposed Solutions of Families Affected by the Proposed Laiban Dam Project, Final Report, 2000.

Appendix A – Water Demand Projection

Table A-1 - Service Coverage Targets

CITY/ MUNICIPALITY		Actual Coverage	SERVICE COVERAGE TARGETS				
			2005	2010	2015	2020	2025
I.	**WEST ZONE**						
A.	**National Capital Region**						
	Makati (part)	100%	100%	100%	100%	100%	100%
	Manila (part)	100%	100%	100%	100%	100%	100%
	Quezon City (part)	100%	100%	100%	100%	100%	100%
	Caloocan	97%	100%	100%	100%	100%	100%
	Las Piñas	38%	60%	92%	95%	97%	99%
	Malabon	99%	100%	100%	100%	100%	100%
	Muntinlupa	22%	47%	87%	90%	94%	98%
	Navotas	79%	96%	100%	100%	100%	100%
	Parañaque	100%	100%	100%	100%	100%	100%
	Pasay	100%	100%	100%	100%	100%	100%
	Valenzuela	87%	97%	100%	100%	100%	100%
B.	**Cavite**						
	Bacoor	41%	62%	91%	93%	95%	97%
	Cavite City	100%	100%	100%	100%	100%	100%
	Imus	11%	35%	62%	65%	71%	77%
	Kawit	93%	86%	100%	100%	100%	100%
	Noveleta	36%	45%	100%	100%	100%	100%
	Rosario	31%	48%	90%	90%	90%	90%
II.	**EAST ZONE**						
A.	**National Capital Region**						
	Makati (part)	100%	100%	100%	100%	100%	100%
	Manila (part)	100%	100%	100%	100%	100%	100%
	Quezon City (part)	100%	100%	100%	100%	100%	100%
	Mandaluyong	100%	100%	100%	100%	100%	100%
	Marikina	100%	100%	100%	100%	100%	100%
	Pasig	100%	100%	100%	100%	100%	100%
	Pateros	100%	100%	100%	100%	100%	100%
	San Juan	100%	100%	100%	100%	100%	100%
	Taguig	54%	54%	70%	92%	100%	100%
B.	**Rizal**						
	Angono	10%	20%	32%	55%	92%	100%
	Antipolo	19%	27%	51%	73%	93%	100%
	Baras	0%	0%	0%	24%	52%	80%
	Binangonan	0%	0%	0%	28%	77%	100%
	Cainta	51%	60%	72%	74%	78%	82%
	Cardona	0%	0%	0%	24%	52%	80%
	Jala-jala	0%	0%	0%	24%	52%	80%
	Morong	0%	0%	0%	24%	52%	80%
	Pililla	0%	0%	0%	24%	52%	80%
	Rodriguez	24%	37%	86%	95%	97%	99%
	San Mateo	43%	56%	90%	99%	100%	100%
	Tanay	0%	0%	0%	32%	69%	100%
	Taytay	53%	53%	60%	66%	94%	100%
	Teresa	0%	0%	0%	24%	55%	86%

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Table A-2 - Projected Population Served

	CITY/ MUNICIPALITY	PROJECTED POPULATION SERVED				
		2005	2010	2015	2020	2025
I.	**WEST ZONE**					
A.	**National Capital Region**					
	Makati (part)	68,832	60,001	51,698	43,943	36,831
	Manila (part)	1,392,475	1,362,213	1,319,161	1,261,987	1,191,956
	Quezon City (part)	1,566,679	1,699,517	1,817,217	1,911,860	1,978,540
	Caloocan	1,305,994	1,428,308	1,546,404	1,654,073	1,746,872
	Las Piñas	335,689	600,673	716,572	835,072	960,457
	Malabon	330,538	317,956	302,785	284,860	264,608
	Muntinlupa	195,096	389,732	430,730	474,829	515,889
	Navotas	235,703	258,011	268,413	275,867	279,944
	Parañaque	498,242	544,239	588,518	628,723	663,185
	Pasay	355,122	350,412	342,295	330,334	314,760
	Valenzuela	512,489	567,069	602,531	632,489	655,543
	Subtotal…NCR	***6,796,860***	***7,578,133***	***7,986,325***	***8,334,037***	***8,608,585***
B.	**Cavite**					
	Bacoor	218,707	359,696	401,394	435,262	458,456
	Cavite City	103,976	105,650	104,612	100,701	94,199
	Imus	79,351	158,306	182,143	212,274	238,686
	Kawit	62,565	81,901	89,850	95,828	99,318
	Noveleta	17,130	44,032	49,631	54,385	57,911
	Rosario	45,572	106,938	130,419	154,631	178,159
	Subtotal…Cavite	***527,301***	***856,523***	***958,049***	***1,053,081***	***1,126,728***
	Total…West Zone	***7,324,161***	***8,434,656***	***8,944,373***	***9,387,118***	***9,735,314***
II.	**EAST ZONE**					
A.	**National Capital Region**					
	Makati (part)	392,647	384,206	371,593	354,551	333,577
	Manila (part)	180,313	180,642	179,145	175,508	169,760
	Quezon City (part)	722,137	676,968	625,537	568,728	508,624
	Mandaluyong	296,293	310,882	322,918	331,374	335,752
	Marikina	412,731	429,446	442,354	450,155	452,302
	Pasig	576,228	648,316	722,104	794,589	863,297
	Pateros	57,438	56,673	55,357	53,419	50,897
	San Juan	119,133	118,932	117,541	114,765	110,638
	Taguig	298,048	449,943	681,764	844,040	949,194
	Subtotal…NCR	***3,054,969***	***3,256,009***	***3,518,312***	***3,687,129***	***3,774,042***
B.	**Rizal**					
	Angono	20,099	42,679	96,413	209,508	292,250
	Antipolo	172,747	437,194	830,368	1,387,411	1,932,861
	Baras	-	-	11,477	30,369	56,370
	Binangonan	-	-	101,919	341,634	534,256
	Cainta	185,192	278,902	356,276	461,333	588,576
	Cardona	-	-	14,060	34,100	58,012
	Jala-jala	-	-	10,106	26,078	47,202
	Morong	-	-	16,814	42,068	73,829
	Pililla	-	-	19,829	51,316	93,157
	Rodriguez	55,162	163,666	228,555	291,592	367,350
	San Mateo	102,969	221,268	322,296	426,083	550,900
	Tanay	-	-	43,781	111,176	187,452
	Taytay	141,535	212,895	308,158	570,824	780,232
	Teresa	-	-	13,623	37,849	70,881
	Subtotal…Rizal	***677,705***	***1,356,604***	***2,373,674***	***4,021,342***	***5,633,330***
	Total…East Zone	***3,732,674***	***4,612,612***	***5,891,986***	***7,708,471***	***9,407,372***
	GRAND TOTAL	***11,056,835***	***13,047,268***	***14,836,359***	***17,095,589***	***19,142,686***

Table A-3 - Annual Family Income Distribution in MWSS Service Areas, Year 2000

City/ Municipality	Family Income Group*							
	Low Income	%	Middle Income	%	High Income	%	Total	%
I. COMMON AREAS								
Makati	20,979	20%	56,479	55%	25,227	25%	102,685	100%
Manila	111,718	34%	185,318	56%	32,603	10%	329,639	100%
Quezon City	128,009	28%	248,100	55%	74,033	16%	450,142	100%
II. WEST ZONE								
A. National Capital Region								
Caloocan	115,512	46%	119,348	48%	15,991	6%	250,851	100%
Las Piñas	19,554	18%	69,693	63%	21,479	19%	110,726	100%
Malabon	46,556	56%	33,760	41%	2,748	3%	83,064	100%
Muntinlupa	43,984	41%	51,351	48%	11,126	10%	106,461	100%
Navotas	32,506	60%	20,753	39%	611	1%	53,870	100%
Parañaque	32,746	34%	46,013	48%	16,988	18%	95,747	100%
Pasay	28,282	32%	53,911	61%	6,891	8%	89,084	100%
Valenzuela	49,962	45%	56,442	50%	5,528	5%	111,932	100%
B. Cavite	107,254	54%	82,662	42%	7,349	4%	197,265	100%
III. EAST ZONE								
A. National Capital Region								
Mandaluyong	16,495	26%	40,579	64%	6,060	10%	63,134	100%
Marikina	34,551	41%	43,053	51%	6,907	8%	84,511	100%
Pasig	33,444	28%	69,311	59%	15,233	13%	117,988	100%
Pateros & Taguig	36,312	32%	70,985	62%	7,493	7%	114,790	100%
San Juan	5,501	23%	13,842	58%	4,711	20%	24,054	100%
B. Rizal	96,356	54%	74,910	42%	6,758	4%	178,024	100%

Source: National Statistics Office, 2000 Family Income and Expenditures Survey
Annual Income Levels: Low Income – less than PhP 150,000
Middle Income – equal to or greater than PhP 150,000 but less than PhP 500,000
High Income – over PhP 500,000

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Table A-4 - Domestic Water Demand Projections for Year 2005 & 2010

	City/ Municipality	Population Distribution by Income Level			Weighted Ave. per Capita Demand (lpcd)*	Projected Population Served		Domestic Demand (MLD)	
		Low	Middle	High		2005	2010	2005	2010
I.	**WEST ZONE**								
A.	**National Capital Region**								
	Makati (part)	20	55	25	167	68,832	60,001	11.46	9.99
	Manila (part)	34	56	10	161	1,392,475	1,362,213	223.91	219.04
	Quezon City (part)	28	55	16	163	1,566,679	1,699,517	255.29	276.94
	Caloocan	46	48	6	157	1,305,994	1,428,308	204.78	223.96
	Las Piñas	18	63	19	167	335,689	600,673	55.89	100.01
	Malabon	56	41	3	154	330,538	317,956	50.74	48.81
	Muntinlupa	41	48	10	159	195,096	389,732	30.94	61.80
	Navotas	60	39	1	152	235,703	258,011	35.85	39.24
	Parañaque	34	48	18	162	498,242	544,239	80.52	87.95
	Pasay	32	61	8	161	355,122	350,412	57.21	56.45
	Valenzuela	45	50	5	157	512,489	567,069	80.46	89.03
B.	**Cavite**								
	Bacoor	54	42	4	154	218,707	359,696	33.72	55.47
	Cavite City	54	42	4	154	103,976	105,650	16.03	16.29
	Imus	54	42	4	154	79,351	158,306	12.24	24.41
	Kawit	54	42	4	154	62,565	81,901	9.65	12.63
	Noveleta**	54	42	4	145	17,130	44,032	2.48	6.38
	Rosario**	54	42	4	145	45,572	106,938	6.61	15.51
	Subtotal... West Zone					***7,324,161***	***8,434,656***	***1,168***	***1,344***
II.	**EAST ZONE**								
A.	**National Capital Region**								
	Makati (part)	20	55	25	167	392,647	384,206	65.38	63.97
	Manila (part)	34	56	10	161	180,313	180,642	28.99	29.05
	Quezon City (part)	28	55	16	163	722,137	676,968	117.67	110.31
	Mandaluyong	26	64	10	163	296,293	310,882	48.35	50.74
	Marikina	41	51	8	159	412,731	429,446	65.42	68.07
	Pasig	28	59	13	163	576,228	648,316	93.87	105.61
	Pateros	32	62	7	161	57,438	56,673	9.25	9.13
	San Juan	23	58	20	165	119,133	118,932	19.67	19.63
	Taguig	32	62	7	161	298,048	449,943	48.02	72.50
B.	**Rizal**								
	Angono**	54	42	4	145	20,099	42,679	2.91	6.19
	Antipolo	54	42	4	154	172,747	437,194	26.64	67.42
	Baras**	54	42	4	145	-	-	-	-
	Binangonan**	54	42	4	145	-	-	-	-
	Cainta	54	42	4	154	185,192	278,902	28.56	43.01
	Cardona**	54	42	4	145	-	-	-	-
	Jala-jala**	54	42	4	145	-	-	-	-
	Morong**	54	42	4	145	-	-	-	-
	Pililla**	54	42	4	145	-	-	-	-
	Rodriguez**	54	42	4	145	55,162	163,666	8.00	23.73
	San Mateo	54	42	4	154	102,969	221,268	15.88	34.12
	Tanay**	54	42	4	145	-	-	-	-
	Taytay**	54	42	4	145	141,535	212,895	20.52	30.87
	Teresa**	54	42	4	145	-	-	-	-
	Subtotal... East Zone					***3,732,674***	***4,612,612***	***599***	***734***
	Total					***11,056,835***	***13,047,268***	***1,767***	***2,078***

Average Per Capita Demand (lpcd): 160

* Based on the following assumed per capita dema ** For selected towns in Rizal and Cavite

High income (lpcd):	180	High income (lpcd):	160
Middle income (lpcd):	170	Middle income (lpcd):	150
Low income (lpcd):	140	Low income (lpcd):	140

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Table A-5 - Domestic Water Demand Projections for Year 2015 to 2025

	City/ Municipality	Population Distribution by Income Level			Weighted Ave. Per Capita Demand (lpcd)*	Projected Population Served			Domestic Water Demand (MLD)		
		Low	Middle	High		2015	2020	2025	2015	2020	2025
I.	**WEST ZONE**										
A.	**National Capital Region**										
	Makati (part)	20	55	25	197	51,698	43,943	36,831	10.18	8.66	7.26
	Manila (part)	34	56	10	188	1,319,161	1,261,987	1,191,956	248.53	237.76	224.56
	Quezon City (part)	28	55	16	192	1,817,217	1,911,860	1,978,540	348.40	366.54	379.33
	Caloocan	46	48	6	183	1,546,404	1,654,073	1,746,872	282.68	302.36	319.33
	Las Piñas	18	63	19	197	716,572	835,072	960,457	140.88	164.18	188.83
	Malabon	56	41	3	178	302,785	284,860	264,608	53.96	50.76	47.15
	Muntinlupa	41	48	10	185	430,730	474,829	515,889	79.89	88.07	95.68
	Navotas	60	39	1	176	268,413	275,867	279,944	47.29	48.61	49.33
	Parañaque	34	48	18	190	588,518	628,723	663,185	111.82	119.46	126.01
	Pasay	32	61	8	189	342,295	330,334	314,760	64.58	62.32	59.38
	Valenzuela	45	50	5	183	602,531	632,489	655,543	110.26	115.75	119.96
B.	**Cavite**										
	Bacoor	54	42	4	179	401,394	435,262	458,456	71.93	78.00	82.16
	Cavite City	54	42	4	179	104,612	100,701	94,199	18.75	18.05	16.88
	Imus	54	42	4	179	182,143	212,274	238,686	32.64	38.04	42.77
	Kawit	54	42	4	179	89,850	95,828	99,318	16.10	17.17	17.80
	Noveleta**	54	42	4	150	49,631	54,385	57,911	7.44	8.16	8.69
	Rosario**	54	42	4	150	130,419	154,631	178,159	19.56	23.19	26.72
	Subtotal... West Zone					***8,944,373***	***9,387,118***	***9,735,314***	***1,665***	***1,747***	***1,812***
II.	**EAST ZONE**										
A.	**National Capital Region**										
	Makati (part)	20	55	25	197	371,593	354,551	333,577	73.20	69.85	65.71
	Manila (part)	34	56	10	188	179,145	175,508	169,760	33.75	33.07	31.98
	Quezon City (part)	28	55	16	192	625,537	568,728	508,624	119.93	109.04	97.51
	Mandaluyong	26	64	10	192	322,918	331,374	335,752	61.87	63.49	64.33
	Marikina	41	51	8	185	442,354	450,155	452,302	81.92	83.37	83.77
	Pasig	28	59	13	191	722,104	794,589	863,297	138.21	152.08	165.24
	Pateros	32	62	7	189	55,357	53,419	50,897	10.44	10.08	9.60
	San Juan	23	58	20	195	117,541	114,765	110,638	22.89	22.35	21.55
	Taguig	32	62	7	189	681,764	844,040	949,194	128.58	159.19	179.02
B.	**Rizal**										
	Angono**	54	42	4	150	96,413	209,508	292,250	14.46	31.43	43.84
	Antipolo	54	42	4	179	830,368	1,387,411	1,932,861	148.80	248.62	346.37
	Baras**	54	42	4	150	11,477	30,369	56,370	1.72	4.56	8.46
	Binangonan**	54	42	4	150	101,919	341,634	534,256	15.29	51.25	80.14
	Cainta	54	42	4	179	356,276	461,333	588,576	63.84	82.67	105.47
	Cardona**	54	42	4	150	14,060	34,100	58,012	2.11	5.11	8.70
	Jala-jala**	54	42	4	150	10,106	26,078	47,202	1.52	3.91	7.08
	Morong**	54	42	4	150	16,814	42,068	73,829	2.52	6.31	11.07
	Pililla**	54	42	4	150	19,829	51,316	93,157	2.97	7.70	13.97
	Rodriguez**	54	42	4	150	228,555	291,592	367,350	34.28	43.74	55.10
	San Mateo	54	42	4	179	322,296	426,083	550,900	57.76	76.35	98.72
	Tanay**	54	42	4	150	43,781	111,176	187,452	6.57	16.68	28.12
	Taytay**	54	42	4	150	308,158	570,824	780,232	46.22	85.62	117.03
	Teresa**	54	42	4	150	13,623	37,849	70,881	2.04	5.68	10.63
	Subtotal... East Zone					***5,891,986***	***7,708,471***	***9,407,372***	***1,071***	***1,372***	***1,653***
	Total					***14,836,359***	***17,095,589***	***19,142,686***	***2,736***	***3,119***	***3,465***

Average Per Capita Demand (lpcd): **180**

* Based on the following assumed per capita demand:		** For selected towns in Rizal and Cavite	
High income (lpcd):	220	High income (lpcd):	180
Middle income (lpcd):	200	Middle income (lpcd):	160
Low income (lpcd):	160	Low income (lpcd):	140

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Table A-6.1 - Historical Domestic per Capita-Billed Volume in the West Concession by City/ Municipality (2000 to 2004)

CITY/ MUNICIPALITY	Domestic Per Capita Billed Volume (lpcd)*				
	2000	2001	2002	2003	2004
WEST ZONE					
National Capital Region					
Manila	120	126	122	119	114
Caloocan City	128	122	111	107	102
Pasay	151	154	146	138	134
Quezon City	146	146	134	126	122
Las Piñas	110	119	116	111	102
Makati	185	178	169	166	163
Malabon	135	125	117	111	111
Navotas	133	117	105	94	99
Parañaque	146	181	175	160	155
Valenzuela	112	133	123	127	131
Muntinlupa	96	93	110	80	87
Cavite Province					
Bacoor	127	136	136	132	128
Cavite City	115	112	111	105	104
Imus	89	99	97	90	88
Kawit	76	98	98	95	92
Noveleta	79	89	90	83	85
Rosario	139	140	137	129	127
Average	**131**	**135**	**127**	**122**	**118**

Number of persons per connection = 7.26

Table A-6.2 - Historical Domestic per Capita-Billed Volume in the East Concession by Branch (2000 to 2004)

BRANCH	Domestic Per Capita-Billed Volume* (lpcd)				
	2000	2001	2002	2003	2004
Balara	243	214	219	211	212
Cubao	207	201	198	196	187
San Juan	178	200	198	193	176
Makati	188	191	181	180	174
Rizal/ Pateros	145	184	190	190	199
Marikina	166	157	159	151	148
Pasig	161	154	158	145	153
AVERAGE	**184**	**187**	**187**	**181**	**178**

Number of persons per connection = 8.11

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Table A-7.1 - Historical Commercial and Industrial Per Capita-Billed Volume for the East Concession (2000 to 2004)

BRANCH	Commercial Per Capita-Billed Volume* (lpcd)					Industrial Per Capita-Billed Volume* (lpcd)				
	2000	2001	2002	2003	2004	2000	2001	2002	2003	2004
Balara	103	91	93	89	82	14	12	12	6	6
Cubao	117	114	112	106	110	21	20	20	17	14
San Juan	85	95	94	88	101	37	41	41	35	31
Makati	125	127	120	123	112	15	15	14	9	9
Rizal/ Pateros	33	42	44	43	43	8	11	11	12	11
Marikina	23	22	22	20	18	9	8	8	8	8
Pasig	32	31	32	27	21	15	14	15	12	10
AVERAGE	**78**	**78**	**77**	**73**	**70**	**17**	**18**	**18**	**14**	**13**

*Number of persons per connection: 8.11

Table A-7.2 - Historical Commercial and Industrial Per Capita- Billed Volume for the West Concession (2000 to 2004)

CITY/ MUNICIPALITY	Commercial Per Capita-Billed Volume* (lpcd)					Industrial Per Capita-Billed Volume* (lpcd)				
	2000	2001	2002	2003	2004	2000	2001	2002	2003	2004
National Capital Region										
Manila	95	98	95	94	92	10	13	13	12	12
Caloocan City	28	26	20	18	17	16	13	13	13	13
Pasay	88	87	84	83	80	11	11	10	9	8
Quezon City	28	27	24	21	20	11	11	10	8	7
Las Piñas	11	12	11	9	9	1	1	1	1	1
Makati	89	83	75	74	70	19	18	17	18	16
Malabon	26	24	21	20	21	41	42	35	30	27
Navotas	23	25	19	16	17	56	55	51	46	42
Parañaque	42	49	45	41	36	14	17	17	13	9
Valenzuela	20	23	19	18	18	14	15	12	12	11
Muntinlupa	3	2	3	3	3	0	0	0	0	1
Cavite Province										
Bacoor	11	16	15	13	17	1	1	1	0	0
Cavite City	13	13	11	10	10	2	1	1	1	2
Imus	6	7	7	6	5	0	0	0	0	1
Kawit	10	9	9	9	8	5	1	1	1	1
Noveleta	2	2	1	1	1	0	0	0	0	0
Rosario	12	12	11	10	9	2	1	1	1	1
Average	**53**	**52**	**47**	**44**	**42**	**14**	**15**	**13**	**12**	**11**

*Number of persons per connection= 7.26

Table A-8.1 - Projected Water Demand by City/ Municipality for Year 2005

	CITY/ MUNICIPALITY	Population	Service Coverage Targets	Population Served	Per Capita Consumption (lpcd)	Projected Water Demand (MLD)						
						Domestic	Commercial	Industrial	Total	Physical Losses	System Demand	Maximum Demand (125%)
I.	**WEST ZONE (MWSI)**									*58%*		
A.	**National Capital Region**											
	Makati (part)	68,832	100%	68,832	167	11.5	8.9	1.4	21.8	30.4	52.1	65.2
	Manila (part)	1,392,475	100%	1,392,475	161	223.9	207.1	18.2	449.3	625.8	1,075.1	1,343.9
	Quezon City (part)	1,566,679	100%	1,566,679	163	255.3	48.3	13.5	317.0	441.6	758.7	948.3
	Caloocan	1,305,994	100%	1,305,994	157	204.8	20.3	8.9	233.9	325.8	559.8	699.7
	Las Piñas	559,481	60%	335,689	167	55.9	1.5	0.1	57.5	80.2	137.7	172.1
	Malabon	330,538	100%	330,538	154	50.7	8.9	9.7	69.3	96.6	165.9	207.4
	Muntinlupa	415,098	47%	195,096	159	30.9	0.1	0.0	31.1	43.3	74.3	92.9
	Navotas	245,524	96%	235,703	152	35.9	4.2	7.4	47.5	66.2	113.6	142.1
	Parañaque	498,242	100%	498,242	162	80.5	15.8	3.6	100.0	139.3	239.2	299.0
	Pasay	355,122	100%	355,122	161	57.2	34.9	2.9	95.0	132.3	227.2	284.0
	Valenzuela	528,340	97%	512,489	157	80.5	9.0	4.1	93.6	130.4	224.0	279.9
								-				
B.	**Cavite**							-				
	Bacoor	352,753	62%	218,707	154	33.7	1.4	0.0	35.1	48.9	84.0	105.0
	Cavite City	103,976	100%	103,976	154	16.0	1.4	0.1	17.5	24.4	42.0	52.5
	Imus	226,717	35%	79,351	154	12.2	0.1	0.0	12.3	17.2	29.5	36.9
	Kawit	72,750	86%	62,565	154	9.6	0.7	0.1	10.4	14.5	24.9	31.1
	Noveleta	38,068	45%	17,130	145	2.5	0.0	-	2.5	3.5	6.0	7.5
	Rosario	94,941	48%	45,572	145	6.6	0.3	0.0	6.9	9.7	16.6	20.7
	Subtotal…West Zone	***8,155,530***	***90%***	***7,324,161***		***1,168***	***363***	***70***	***1,601***	***2,230***	***3,831***	***4,788***
II.	**EAST ZONE (MWCI)**									*37%*		
A.	**National Capital Region**											
	Makati (part)	392,647	100%	392,647	167	65.4	29.9	5.6	100.8	58.9	159.7	199.6
	Manila (part)	180,313	100%	180,313	161	29.0	13.2	2.5	44.7	26.1	70.8	88.5
	Quezon City (part)	722,137	100%	722,137	163	117.7	53.8	10.0	181.4	106.0	287.4	359.2
	Mandaluyong	296,293	100%	296,293	163	48.4	22.1	4.1	74.6	43.5	118.1	147.6
	Marikina	412,731	100%	412,731	159	65.4	29.9	5.6	100.9	58.9	159.8	199.7
	Pasig	576,228	100%	576,228	163	93.9	42.9	8.0	144.7	84.5	229.2	286.6
	Pateros	57,438	100%	57,438	161	9.3	4.2	0.8	14.3	8.3	22.6	28.3
	San Juan	119,133	100%	119,133	165	19.7	9.0	1.7	30.3	17.7	48.0	60.0
	Taguig	551,941	54%	298,048	161	48.0	21.9	4.1	74.0	43.2	117.3	146.6
B.	**Rizal**											
	Angono	100,496	20%	20,099	145	2.9	1.3	0.2	4.5	2.6	7.1	8.9
	Antipolo	639,804	27%	172,747	154	26.6	12.2	2.3	41.1	24.0	65.1	81.3
	Baras	31,018	0%	-	145	-	-	-	-	-	-	-
	Binangonan	237,025	0%	-	145	-	-	-	-	-	-	-
	Cainta	308,654	60%	185,192	154	28.6	13.0	2.4	44.0	25.7	69.7	87.2
	Cardona	45,233	0%	-	145	-	-	-	-	-	-	-
	Jala-jala	28,724	0%	-	145	-	-	-	-	-	-	-
	Morong	50,832	0%	-	145	-	-	-	-	-	-	-
	Pililla	56,027	0%	-	145	-	-	-	-	-	-	-
	Rodriguez	149,087	37%	55,162	145	8.0	3.7	0.7	12.3	7.2	19.5	24.4
	San Mateo	183,874	56%	102,969	154	15.9	7.3	1.3	24.5	14.3	38.8	48.5
	Tanay	95,441	0%	-	145	-	-	-	-	-	-	-
	Taytay	267,047	53%	141,535	145	20.5	9.4	1.7	31.6	18.5	50.1	62.6
	Teresa	37,362	0%	-	145	-	-	-	-	-	-	-
	Subtotal…East Zone	***5,539,486***	***67%***	***3,732,674***		***599***	***274***	***51***	***924***	***539***	***1,463***	***1,829***
	TOTAL	***13,695,016***	***81%***	***11,056,835***		***1,767***	***636.5***	***121***	***2,525***	***2,769***	***5,294***	***6,617***

SINCLAIR KNIGHT MERZ in association with DCCD Engineering Corporation

Table A-8.2 - Projected Water Demand by City/ Municipality for Year 2010

	CITY/ MUNICIPALITY	Population	Service Coverage Targets	Population Served	Per Capita Consumption (lpcd)	Projected Water Demand (MLD)						
						Domestic	Commercial	Industrial	Total	Physical Losses	System Demand	Maximum Demand (125%)
I.	**WEST ZONE (MWSI)**									***42%***		
A.	**National Capital Region**											
	Makati (part)	60,001	100%	60,001	167	10.0	12.1	1.9	24.1	17.6	41.7	52.1
	Manila (part)	1,362,213	100%	1,362,213	161	219.0	281.6	25.1	525.7	385.6	911.3	1,139.2
	Quezon City (part)	1,699,517	100%	1,699,517	163	276.9	65.6	18.5	361.1	264.8	625.9	782.4
	Caloocan	1,428,308	100%	1,428,308	157	224.0	27.6	12.2	263.7	193.4	457.1	571.4
	Las Piñas	652,906	92%	600,673	167	100.0	2.1	0.2	102.3	75.0	177.3	221.6
	Malabon	317,956	100%	317,956	154	48.8	12.1	13.4	74.3	54.5	128.7	160.9
	Muntinlupa	447,968	87%	389,732	159	61.8	0.2	0.0	62.0	45.5	107.4	134.3
	Navotas	258,011	100%	258,011	152	39.2	5.7	10.2	55.2	40.5	95.6	119.6
	Parañaque	544,239	100%	544,239	162	87.9	21.5	5.0	114.5	83.9	198.4	248.0
	Pasay	350,412	100%	350,412	161	56.4	47.4	4.0	107.8	79.1	186.9	233.6
	Valenzuela	567,069	100%	567,069	157	89.0	12.2	5.7	106.9	78.4	185.4	231.7
								-				
B.	**Cavite**							-				
	Bacoor	395,270	91%	359,696	154	55.5	1.8	0.1	57.4	42.1	99.4	124.3
	Cavite City	105,650	100%	105,650	154	16.3	1.9	0.2	18.3	13.4	31.8	39.7
	Imus	255,332	62%	158,306	154	24.4	0.1	0.0	24.6	18.0	42.6	53.2
	Kawit	81,901	100%	81,901	154	12.6	0.9	0.1	13.7	10.0	23.7	29.6
	Noveleta	44,032	100%	44,032	145	6.4	0.0	-	6.4	4.7	11.1	13.9
	Rosario	118,820	90%	106,938	145	15.5	0.4	0.0	15.9	11.7	27.6	34.5
	Subtotal…West Zone	***8,689,607***	***97%***	***8,434,656***		***1,344***	***493***	***97***	***1,934***	***1,418***	***3,352***	***4,190***
II.	**EAST ZONE (MWCI)**									***31%***		
A.	**National Capital Region**											
	Makati (part)	384,206	100%	384,206	167	64.0	34.5	6.6	105.0	46.2	151.2	189.0
	Manila (part)	180,642	100%	180,642	161	29.0	15.7	3.0	47.7	21.0	68.7	85.8
	Quezon City (part)	676,968	100%	676,968	163	110.3	59.5	11.3	181.1	79.6	260.7	325.9
	Mandaluyong	310,882	100%	310,882	163	50.7	27.4	5.2	83.3	36.6	119.9	149.9
	Marikina	429,446	100%	429,446	159	68.1	36.7	7.0	111.8	49.1	160.9	201.1
	Pasig	648,316	100%	648,316	163	105.6	57.0	10.8	173.4	76.2	249.6	312.0
	Pateros	56,673	100%	56,673	161	9.1	4.9	0.9	15.0	6.6	21.6	27.0
	San Juan	118,932	100%	118,932	165	19.6	10.6	2.0	32.2	14.2	46.4	58.0
	Taguig	642,775	70%	449,943	161	72.5	39.1	7.4	119.0	52.3	171.4	214.2
B.	**Rizal**											
	Angono	133,373	32%	42,679	145	6.2	3.3	0.6	10.2	4.5	14.6	18.3
	Antipolo	857,242	51%	437,194	154	67.4	36.4	6.9	110.7	48.7	159.3	199.2
	Baras	38,701	0%	-	145	-	-	-	-	-	-	-
	Binangonan	295,155	0%	-	145	-	-	-	-	-	-	-
	Cainta	387,364	72%	278,902	154	43.0	23.2	4.4	70.6	31.0	101.7	127.1
	Cardona	51,727	0%	-	145	-	-	-	-	-	-	-
	Jala-jala	34,948	0%	-	145	-	-	-	-	-	-	-
	Morong	59,966	0%	-	145	-	-	-	-	-	-	-
	Pililla	68,367	0%	-	145	-	-	-	-	-	-	-
	Rodriguez	190,309	86%	163,666	145	23.7	12.8	2.4	39.0	17.1	56.1	70.1
	San Mateo	245,853	90%	221,268	154	34.1	18.4	3.5	56.0	24.6	80.6	100.8
	Tanay	114,826	0%	-	145	-	-	-	-	-	-	-
	Taytay	354,825	60%	212,895	145	30.9	16.7	3.2	50.7	22.3	73.0	91.2
	Teresa	46,275	0%	-	145	-	-	-	-	-	-	-
	Subtotal…East Zone	***6,327,773***	***73%***	***4,612,612***		***734***	***396***	***75***	***1,206***	***530***	***1,736***	***2,170***
	TOTAL	***15,017,380***	***87%***	***13,047,268***		***2,078***	***889.4***	***172***	***3,139***	***1,948***	***5,088***	***6,360***

Table A-8.3 - Projected Water Demand by City/ Municipality for Year 2015

	CITY/ MUNICIPALITY	Population	Service Coverage Targets	Population Served	Per Capita Consumption (lpcd)	Projected Water Demand (MLD)						
						Domestic	Commercial	Industrial	Total	Physical Losses	System Demand	Maximum Demand (125%)
I.	**WEST ZONE (MWSI)**									*30%*		
A.	**National Capital Region**											
	Makati (part)	51,698	100%	51,698	197	10.2	13.9	2.2	26.3	11.2	37.5	46.9
	Manila (part)	1,319,161	100%	1,319,161	188	248.5	322.7	28.8	600.0	255.6	855.6	1,069.5
	Quezon City (part)	1,817,217	100%	1,817,217	192	348.4	75.2	21.3	444.9	189.5	634.3	792.9
	Caloocan	1,546,404	100%	1,546,404	183	282.7	31.6	14.0	328.3	139.8	468.1	585.1
	Las Piñas	754,286	95%	716,572	197	140.9	2.4	0.2	143.5	61.1	204.5	255.7
	Malabon	302,785	100%	302,785	178	54.0	13.8	15.4	83.1	35.4	118.5	148.2
	Muntinlupa	478,589	90%	430,730	185	79.9	0.2	0.0	80.1	34.1	114.2	142.8
	Navotas	268,413	100%	268,413	176	47.3	6.6	11.7	65.6	27.9	93.5	116.9
	Parañaque	588,518	100%	588,518	190	111.8	24.7	5.7	142.2	60.6	202.8	253.5
	Pasay	342,295	100%	342,295	189	64.6	54.3	4.6	123.4	52.6	176.0	220.0
	Valenzuela	602,531	100%	602,531	183	110.3	14.0	6.5	130.8	55.7	186.5	233.1
								-				
B.	**Cavite**							-				
	Bacoor	431,607	93%	401,394	179	71.9	2.1	0.1	74.1	31.6	105.7	132.1
	Cavite City	104,612	100%	104,612	179	18.7	2.1	0.2	21.1	9.0	30.1	37.6
	Imus	280,220	65%	182,143	179	32.6	0.2	0.0	32.8	14.0	46.8	58.5
	Kawit	89,850	100%	89,850	179	16.1	1.0	0.2	17.3	7.4	24.6	30.8
	Noveleta	49,631	100%	49,631	150	7.4	0.0	-	7.5	3.2	10.7	13.3
	Rosario	144,910	90%	130,419	150	19.6	0.5	0.0	20.1	8.5	28.6	35.8
	Subtotal…West Zone	***9,172,727***	***98%***	***8,944,373***		***1,665***	***565***	***111***	***2,341***	***997***	***3,338***	***4,173***
II.	**EAST ZONE (MWCI)**									*28%*		
A.	**National Capital Region**											
	Makati (part)	371,593	100%	371,593	197	73.2	33.0	6.3	112.6	43.4	155.9	194.9
	Manila (part)	179,145	100%	179,145	188	33.8	15.2	2.9	51.9	20.0	71.9	89.9
	Quezon City (part)	625,537	100%	625,537	192	119.9	54.1	10.4	184.4	71.1	255.5	319.3
	Mandaluyong	322,918	100%	322,918	192	61.9	27.9	5.4	95.1	36.7	131.8	164.7
	Marikina	442,354	100%	442,354	185	81.9	36.9	7.1	126.0	48.5	174.5	218.1
	Pasig	722,104	100%	722,104	191	138.2	62.3	12.0	212.5	81.9	294.4	368.0
	Pateros	55,357	100%	55,357	189	10.4	4.7	0.9	16.1	6.2	22.2	27.8
	San Juan	117,541	100%	117,541	195	22.9	10.3	2.0	35.2	13.6	48.8	61.0
	Taguig	741,048	92%	681,764	189	128.6	58.0	11.1	197.7	76.2	273.9	342.4
B.	**Rizal**											
	Angono	175,297	55%	96,413	150	14.5	6.5	1.3	22.2	8.6	30.8	38.5
	Antipolo	1,137,491	73%	830,368	179	148.8	67.1	12.9	228.8	88.2	317.0	396.2
	Baras	47,820	24%	11,477	150	1.7	0.8	0.1	2.6	1.0	3.7	4.6
	Binangonan	363,995	28%	101,919	150	15.3	6.9	1.3	23.5	9.1	32.6	40.7
	Cainta	481,453	74%	356,276	179	63.8	28.8	5.5	98.2	37.8	136.0	170.0
	Cardona	58,582	24%	14,060	150	2.1	1.0	0.2	3.2	1.2	4.5	5.6
	Jala-jala	42,110	24%	10,106	150	1.5	0.7	0.1	2.3	0.9	3.2	4.0
	Morong	70,059	24%	16,814	150	2.5	1.1	0.2	3.9	1.5	5.4	6.7
	Pililla	82,620	24%	19,829	150	3.0	1.3	0.3	4.6	1.8	6.3	7.9
	Rodriguez	240,584	95%	228,555	150	34.3	15.5	3.0	52.7	20.3	73.0	91.3
	San Mateo	325,552	99%	322,296	179	57.8	26.0	5.0	88.8	34.2	123.0	153.8
	Tanay	136,816	32%	43,781	150	6.6	3.0	0.6	10.1	3.9	14.0	17.5
	Taytay	466,906	66%	308,158	150	46.2	20.8	4.0	71.1	27.4	98.5	123.1
	Teresa	56,761	24%	13,623	150	2.0	0.9	0.2	3.1	1.2	4.4	5.4
	Subtotal…East Zone	***7,263,642***	***81%***	***5,891,986***		***1,071***	***483***	***93***	***1,647***	***635***	***2,281***	***2,852***
	TOTAL	***16,436,369***	***90%***	***14,836,359***		***2,736***	***1,048***	***204***	***3,988***	***1,632***	***5,619***	***7,024***

Table A-8.4 - Projected Water Demand by City/ Municipality for Year 2020

	CITY/ MUNICIPALITY	Population	Service Coverage Targets	Population Served	Per Capita Consumption (lpcd)	Projected Water Demand (MLD)						
						Domestic	Commercial	Industrial	Total	Physical Losses	System Demand	Maximum Demand (125%)
I.	**WEST ZONE (MWSI)**									***26%***		
A.	**National Capital Region**											
	Makati (part)	43,943	100%	43,943	197	8.7	16.0	2.6	27.2	9.8	37.0	46.3
	Manila (part)	1,261,987	100%	1,261,987	188	237.8	372.0	33.1	642.8	230.6	873.4	1,091.8
	Quezon City (part)	1,911,860	100%	1,911,860	192	366.5	86.7	24.5	477.7	171.3	649.0	811.3
	Caloocan	1,654,073	100%	1,654,073	183	302.4	36.4	16.1	354.9	127.3	482.2	602.7
	Las Piñas	860,899	97%	835,072	197	164.2	2.7	0.2	167.1	60.0	227.1	283.9
	Malabon	284,860	100%	284,860	178	50.8	15.9	17.7	84.4	30.3	114.6	143.3
	Muntinlupa	505,137	94%	474,829	185	88.1	0.2	0.0	88.3	31.7	120.0	150.0
	Navotas	275,867	100%	275,867	176	48.6	7.6	13.5	69.7	25.0	94.6	118.3
	Parañaque	628,723	100%	628,723	190	119.5	28.4	6.6	154.5	55.4	209.9	262.3
	Pasay	330,334	100%	330,334	189	62.3	62.6	5.2	130.2	46.7	176.9	221.1
	Valenzuela	632,489	100%	632,489	183	115.7	16.1	7.5	139.4	50.0	189.4	236.8
B.	**Cavite**											
	Bacoor	458,171	95%	435,262	179	78.0	2.4	0.1	80.5	28.9	109.4	136.7
	Cavite City	100,701	100%	100,701	179	18.0	2.5	0.2	20.8	7.4	28.2	35.2
	Imus	298,977	71%	212,274	179	38.0	0.2	0.0	38.2	13.7	52.0	64.9
	Kawit	95,828	100%	95,828	179	17.2	1.2	0.2	18.5	6.6	25.2	31.5
	Noveleta	54,385	100%	54,385	150	8.2	0.0	-	8.2	2.9	11.1	13.9
	Rosario	171,812	90%	154,631	150	23.2	0.5	0.1	23.8	8.5	32.3	40.4
	Subtotal…West Zone	***9,570,046***	***98%***	***9,387,118***		***1,747***	***652***	***128***	***2,526***	***906***	***3,432***	***4,290***
II.	**EAST ZONE (MWCI)**									***26%***		
A.	**National Capital Region**											
	Makati (part)	354,551	100%	354,551	197	69.8	30.1	5.8	105.8	37.3	143.1	178.9
	Manila (part)	175,508	100%	175,508	188	33.1	14.3	2.8	50.1	17.7	67.8	84.7
	Quezon City (part)	568,728	100%	568,728	192	109.0	47.0	9.1	165.2	58.2	223.4	279.3
	Mandaluyong	331,374	100%	331,374	192	63.5	27.4	5.3	96.2	33.9	130.1	162.6
	Marikina	450,155	100%	450,155	185	83.4	36.0	7.0	126.3	44.5	170.8	213.5
	Pasig	794,589	100%	794,589	191	152.1	65.6	12.7	230.4	81.2	311.6	389.5
	Pateros	53,419	100%	53,419	189	10.1	4.3	0.8	15.3	5.4	20.6	25.8
	San Juan	114,765	100%	114,765	195	22.4	9.6	1.9	33.9	11.9	45.8	57.3
	Taguig	844,040	100%	844,040	189	159.2	68.7	13.3	241.2	85.0	326.2	407.7
B.	**Rizal**											
	Angono	227,726	92%	209,508	150	31.4	13.6	2.6	47.6	16.8	64.4	80.5
	Antipolo	1,491,840	93%	1,387,411	179	248.6	107.3	20.8	376.7	132.8	509.5	636.8
	Baras	58,403	52%	30,369	150	4.6	2.0	0.4	6.9	2.4	9.3	11.7
	Binangonan	443,681	77%	341,634	150	51.2	22.1	4.3	77.6	27.4	105.0	131.3
	Cainta	591,452	78%	461,333	179	82.7	35.7	6.9	125.3	44.1	169.4	211.8
	Cardona	65,576	52%	34,100	150	5.1	2.2	0.4	7.7	2.7	10.5	13.1
	Jala-jala	50,151	52%	26,078	150	3.9	1.7	0.3	5.9	2.1	8.0	10.0
	Morong	80,900	52%	42,068	150	6.3	2.7	0.5	9.6	3.4	12.9	16.2
	Pililla	98,685	52%	51,316	150	7.7	3.3	0.6	11.7	4.1	15.8	19.7
	Rodriguez	300,610	97%	291,592	150	43.7	18.9	3.7	66.3	23.4	89.6	112.0
	San Mateo	426,083	100%	426,083	179	76.4	32.9	6.4	115.7	40.8	156.5	195.6
	Tanay	161,125	69%	111,176	150	16.7	7.2	1.4	25.3	8.9	34.2	42.7
	Taytay	607,260	94%	570,824	150	85.6	36.9	7.2	129.7	45.7	175.5	219.3
	Teresa	68,816	55%	37,849	150	5.7	2.4	0.5	8.6	3.0	11.6	14.5
	Subtotal…East Zone	***8,359,437***	***92%***	***7,708,471***		***1,372***	***592***	***115***	***2,079***	***733***	***2,812***	***3,515***
	TOTAL	***17,929,483***	***95%***	***17,095,589***		***3,119***	***1,244***	***242***	***4,605***	***1,639***	***6,244***	***7,805***

Table A-8.5 - Projected Water Demand by City/ Municipality for Year 2025

	CITY/ MUNICIPALITY	Population	Service Coverage Targets	Population Served	Per Capita Consumption (lpcd)	Projected Water Demand (MLD)						
						Domestic	Commercial	Industrial	Total	Physical Losses	System Demand	Maximum Demand (125%)
I.	**WEST ZONE (MWSI)**									***26%***		
A.	**National Capital Region**											
	Makati (part)	36,831	100%	36,831	197	7.3	18.0	2.9	28.1	9.6	37.7	47.2
	Manila (part)	1,191,956	100%	1,191,956	188	224.6	417.4	37.1	679.1	232.4	911.6	1,139.4
	Quezon City (part)	1,978,540	100%	1,978,540	192	379.3	97.3	27.4	504.0	172.5	676.6	845.7
	Caloocan	1,746,872	100%	1,746,872	183	319.3	40.9	18.1	378.2	129.5	507.7	634.6
	Las Piñas	970,158	99%	960,457	197	188.8	3.1	0.3	192.2	65.8	257.9	322.4
	Malabon	264,608	100%	264,608	178	47.2	17.9	19.8	84.9	29.0	113.9	142.4
	Muntinlupa	526,418	98%	515,889	185	95.7	0.3	0.0	95.9	32.8	128.8	161.0
	Navotas	279,944	100%	279,944	176	49.3	8.5	15.1	72.9	25.0	97.9	122.4
	Parañaque	663,185	100%	663,185	190	126.0	31.9	7.4	165.3	56.6	221.9	277.3
	Pasay	314,760	100%	314,760	189	59.4	70.3	5.9	135.5	46.4	181.9	227.4
	Valenzuela	655,543	100%	655,543	183	120.0	18.1	8.4	146.5	50.1	196.7	245.8
B.	**Cavite**											
	Bacoor	472,635	97%	458,456	179	82.2	2.7	0.1	85.0	29.1	114.0	142.6
	Cavite City	94,199	100%	94,199	179	16.9	2.8	0.3	19.9	6.8	26.7	33.4
	Imus	309,981	77%	238,686	179	42.8	0.2	0.0	43.0	14.7	57.7	72.1
	Kawit	99,318	100%	99,318	179	17.8	1.3	0.2	19.3	6.6	25.9	32.4
	Noveleta	57,911	100%	57,911	150	8.7	0.0	-	8.7	3.0	11.7	14.6
	Rosario	197,955	90%	178,159	150	26.7	0.6	0.1	27.4	9.4	36.7	45.9
	Subtotal…West Zone	***9,860,814***	***99%***	***9,735,314***		***1,812***	***731***	***143***	***2,686***	***919***	***3,605***	***4,507***
II.	**EAST ZONE (MWCI)**									***26%***		
A.	**National Capital Region**											
	Makati (part)	333,577	100%	333,577	197	65.7	28.1	5.5	99.3	34.0	133.3	166.6
	Manila (part)	169,760	100%	169,760	188	32.0	13.7	2.7	48.3	16.5	64.9	81.1
	Quezon City (part)	508,624	100%	508,624	192	97.5	41.7	8.1	147.3	50.4	197.8	247.2
	Mandaluyong	335,752	100%	335,752	192	64.3	27.5	5.4	97.2	33.3	130.5	163.1
	Marikina	452,302	100%	452,302	185	83.8	35.8	7.0	126.6	43.3	169.9	212.3
	Pasig	863,297	100%	863,297	191	165.2	70.6	13.8	249.6	85.5	335.1	418.9
	Pateros	50,897	100%	50,897	189	9.6	4.1	0.8	14.5	5.0	19.5	24.3
	San Juan	110,638	100%	110,638	195	21.5	9.2	1.8	32.6	11.1	43.7	54.6
	Taguig	949,194	100%	949,194	189	179.0	76.5	15.0	270.5	92.6	363.1	453.8
B.	**Rizal**											
	Angono	292,250	100%	292,250	150	43.8	18.7	3.7	66.2	22.7	88.9	111.1
	Antipolo	1,932,861	100%	1,932,861	179	346.4	148.0	28.9	523.3	179.1	702.4	878.1
	Baras	70,463	80%	56,370	150	8.5	3.6	0.7	12.8	4.4	17.1	21.4
	Binangonan	534,256	100%	534,256	150	80.1	34.2	6.7	121.1	41.4	162.5	203.2
	Cainta	717,776	82%	588,576	179	105.5	45.1	8.8	159.4	54.5	213.9	267.4
	Cardona	72,515	80%	58,012	150	8.7	3.7	0.7	13.1	4.5	17.6	22.1
	Jala-jala	59,003	80%	47,202	150	7.1	3.0	0.6	10.7	3.7	14.4	17.9
	Morong	92,286	80%	73,829	150	11.1	4.7	0.9	16.7	5.7	22.5	28.1
	Pililla	116,446	80%	93,157	150	14.0	6.0	1.2	21.1	7.2	28.3	35.4
	Rodriguez	371,061	99%	367,350	150	55.1	23.5	4.6	83.3	28.5	111.7	139.7
	San Mateo	550,900	100%	550,900	179	98.7	42.2	8.3	149.2	51.1	200.2	250.3
	Tanay	187,452	100%	187,452	150	28.1	12.0	2.3	42.5	14.5	57.0	71.3
	Taytay	780,232	100%	780,232	150	117.0	50.0	9.8	176.8	60.5	237.3	296.7
	Teresa	82,420	86%	70,881	150	10.6	4.5	0.9	16.1	5.5	21.6	27.0
	Subtotal…East Zone	***9,633,964***	***98%***	***9,407,372***		***1,653***	***707***	***138***	***2,498***	***855***	***3,353***	***4,191***
	TOTAL	***19,494,777***	***98%***	***19,142,686***		***3,465***	***1,438***	***281***	***5,184***	***1,774***	***6,958***	***8,698***

Appendix B – Revised Service Coverage Targets from Rate Rebasing Submission

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Table B-1.1 - MWSI Revised Service Coverage Targets (Based on the Proposed Deferment as per May 30, 2002 Submission)

CITY/ MUNICIPALITY	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
NCR																				
Manila (Part)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Quezon City	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Caloocan	89	90	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Malabon	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Navotas	87	91	92	96	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Valenzuela	88	90	93	97	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Las Pinas	37	39	38	60	81	86	91	92	92	93	93	94	94	95	95	96	96	97	97	98
Makati (Part)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Muntinlupa	29	28	28	47	66	76	86	87	87	88	88	89	89	90	90	91	92	93	94	95
Paranaque	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Pasay City	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
CAVITE																				
Bacoor	32	33	33	62	90	90	90	91	91	92	92	92	93	93	93	93	94	94	95	95
Cavite City	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Imus	10	9	9	35	61	61	81	62	62	63	63	64	64	65	65	66	68	69	71	72
Kawit	83	82	82	86	90	95	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Noveleta	36	34	33	45	56	78	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Rosario	30	30	29	48	66	78	90	90	90	90	90	90	90	90	90	90	90	90	90	90
TOTAL (with deferment)	84.6	85.2	86.9	91.2	95.5	96.3	97.1	97.2	97.3	97.4	97.5	97.5	97.6	97.6	97.7	97.8	98.0	98.1	98.3	98.4
CA Targets	89.3	91.3	93.2	95.2	97.1	97.2	97.2	97.3	97.3	97.4	97.5	97.5	97.6	97.6	97.7	97.8	98.0	98.1	98.3	98.4

Table B-1.2 - MWCI Revised Service Coverage Targets (%)

CITY/MUNICIPALITY	2006	2011	2016	2021
Mandaluyong	100	100	100	100
Makati (part)	100	100	100	100
Marikina	98	100	100	100
Quezon (part)	99	100	100	100
Pasig	97	100	100	100
Pateros	100	100	100	100
San Juan	100	100	100	100
Taguig	40	60	100	100
Angono	30	33	60	100
Antipolo	35	55	77	97
Baras	0	0	30	58
Binangonan	0	0	35	87
Cainta	70	72	75	79
Cardona	0	0	30	58
Jala-jala	0	0	30	58
Morong	0	0	30	58
Pililla	0	0	30	58
Rodriguez (part)	50	95	95	98
San Mateo	70	95	100	100
Tanay	0	0	40	76
Taytay	40	50	70	100
Teresa	0	0	80	61
Manila (part)	100	100	100	100

Appendix C – Methodology in the Derivation of Comparative Unit Cost of Water

1. Evaluation Horizon and Base Year

The planning horizon used was 40 years from 2007 to 2046. The base year for assessing the present worth of cost and revenue streams was set at 2005.

2. Components of Project Cost

The components of estimated project costs used in this study are the headworks (dam and reservoir), waterways and treatment plants, as well as land acquisition and resettlement. These estimated costs were lifted from Appendix E-2 of the 2003 Study on Water Resources Development for Metro Manila in the Republic of the Philippines (Volume III) by Nippon Koei Co., Ltd and NJS Consultants.

In the absence of a clear description of the costs obtained from the said reference, they were assumed to be basic costs, i.e., without engineering cost, physical contingency, and value-added tax. They were escalated to 2005 price levels using the inflation rates indicated in Item 3c below and the escalated costs are presented in Comparative Base Costs of the Five Options for Future Water Source Development (page 65 of this study).

For the capital cost of pumping stations, the following formula was adopted:

$$C = 6.09 * Q^{0.598}$$

Where, Q = peak discharge in cubic meters per minute
C = cost of pumping station in million pesos

The peak discharge was obtained by applying a maximum factor of 125% and peak factor of 121% to the treatment plant capacity. The local and foreign components were assumed 30% and 70% of the cost of pumping station, respectively.

3. Financial Conditions

It is assumed in this comparative study that the project would be implemented with funds from concessional loans and that land acquisition as well as resettlement cost would be funded from direct government appropriations.

(a) Base Cost

The base costs presented represent the cost in 2005 price levels. These were escalated from the 2001 cost estimate as mentioned above. These base costs do not consider engineering cost, physical contingency and value-added tax.

(b) Project Cost and Disbursement Schedule

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The project costs, which include 7.0 % engineering cost, 15% physical contingency and 10% value-added tax, were tabulated in the Unit Cost Computation for each option and were assumed to be disbursed in accordance with the corresponding implementation schedule.

(c) Price Contingency

The price escalation rates adopted were as follows:

- *Local component*:

2001	2002	2003	2004	2005	2006
7.3%	3.6%	3.3%	5.8%	6.0%	7.0%

- *Foreign component*:

2001	2002	2003	2004	2005	2006
2.8%	1.6%	2.3%	2.7%	2.5%	2.5%

(d) Value Added Tax

An amount equivalent to 10% of all costs, except for land acquisition and resettlement, was added as the value-added tax (VAT).

(e) Electricity Selling Price

The selling price adopted for the electricity to be generated by the power plants was PhP 4.41 per kWH (US$0.0788) at 2005 prices. The net present value of income from power generation was obtained by applying 12% per annum discounting rate to the yearly income disbursements. The assumed exchange rate for 2005 is PhP 56 per US$1.00.

4. Salvage Value and Net Capital Cost

A salvage value was applied at the 40th year of each option assuming an average economic life of 50 years. The present worth of this salvage value was obtained by applying a discounting rate of 12% per annum. The net capital cost was then derived by deducting the discounted salvage value from the discounted capital cost.

5. Operation and Maintenance Costs

- Water Treatment Cost: PhP 0.45 per cu m (US$ 0.008) of water produced at 2005 prices.

- Maintenance Cost: 0.5% of the initial cost of water treatment and power plant facilities

- Pumping Cost:

  The power consumption due to pumping was computed based on the following formula:

  $$P = 1.2 * (9.81\ Q\ H)/\ E$$

  Where, P = power consumption in kilowatts
  Q = water discharge in cubic meter per second
  H = difference in elevation of the off-take points of Laiban Dam and Agos Dam equal to 32.5 meters
  E = efficiency equal to 70%

  The power cost for pumping used was PhP 7.00 per kW-hr. This was obtained by averaging the cost per kW-hr consumption of large pumping stations of MWSI.

- Pumping Station Maintenance Cost: 0.5% of the initial capital cost of pumping station

6. Cost Stream and Water Production Stream

The disbursement schedule for each option was prepared based on a double implementation schedule of the respective options, considering the loan negotiation period and the extent of detailed engineering works required. The options involving Laiban Dam which has detailed engineering works were expected to be completed two years ahead of the options involving Agos Dam which has no feasibility study yet. The water production stream for each option was likewise computed based on the scheduled commissioning year of the respective treatment plants.

The present worth of the yearly capital disbursements was computed using 12% per annum discounting rate. The O&M cost and the volume of production was also discounted in the same manner.

7. Net Project Cost

The present worth of the Net Cost of each option was computed by deducting the discounted income from power generation from the discounted capital and O&M costs. The sale of electric energy and the Net Cost of each option are also shown in Tables D-2.1 to D-2.5 in Appendix D.

8. Derivation of the Unit Cost of Water

The unit cost of water (in US$ per cubic meter) was derived by dividing the Net Project Cost by the discounted volume of water production.

Appendix D – Detailed Breakdown of Project Costs

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Table D-1 - Comparative Base Costs of the Five Options for Future Water Source

Options / Stage /Component	Average Capacity (MLD)	Land Acquisition /Resettlement ($x10^3$ US $)	Construction Cost ($x10^3$ US $) Total	Construction Cost ($x10^3$ US $) Foreign	Construction Cost ($x10^3$ US $) Local	Total Local Currency ($x10^3$ US $)	TOTAL Cost ($x10^3$ US $)
Option 1 - Laiban Dam + Kanan No. 2 Dam							
1st Stage- Laiban Dam							
Laiban Dam		86,366.2	148,666.3	85,861.6	62,804.7	149,170.9	235,032.6
1st Waterway		15,075.4	336,548.4	228,909.2	107,639.2	122,714.6	351,623.8
WTP # 1	610	13,985.2	80,840.7	63,439.4	17,401.3	31,386.5	94,825.9
WTP # 2	610	0.0	61,415.6	48,195.6	13,220.0	13,220.0	61,415.6
WTP # 3	610	0.0	61,415.6	48,195.6	13,220.0	13,220.0	61,415.6
Sub-total…1st Stage	***1,830***	***115,426.8***	***688,886.6***	***474,601.4***	***214,285.2***	***329,712.0***	***804,313.4***
2nd Stage- Kanan Dam							
Kanan Dam		18,238.5	228,492.9	131,965.2	96,527.7	114,766.3	246,731.4
Kanan - Laiban Tunnel		489.9	126,058.0	85,740.5	40,317.5	40,807.4	126,547.9
2nd Waterway		28,622.1	485,349.2	330,118.6	155,230.6	183,852.7	513,971.3
WTP #4		18,860.2	143,384.4	112,520.2	30,864.2	49,724.3	162,244.6
WTP # 5	1,090	0.0	111,212.1	87,273.2	23,938.9	23,938.9	111,212.1
WTP # 6	1,090	0.0	111,212.1	87,273.2	23,938.9	23,938.9	111,212.1
Sub-total...2nd Stage	***3,280***	***66,210.7***	***1,205,708.6***	***834,890.9***	***370,817.8***	***437,028.5***	***1,271,919.3***
Total Cost - Option 1	**5,110**	**181,637.5**	**1,894,595.2**	**1,309,492.3**	**585,103.0**	**766,740.5**	**2,076,232.7**
Option 2 - Kaliwa Low Dam + Agos Dam							
1st Stage- Kaliwa Low Dam	550						
Kaliwa Low Dam (incl in 1st Waterway)	750	0.0	0.0	0.0		0.0	0.0
1st Waterway		22,347.4	392,603.8	267,036.2	125,567.6	147,915.0	414,951.2
WTP # 1		13,114.0	101,204.4	79,419.8	21,784.7	34,898.7	114,318.4
Pumping Station			6,278.5	4,395.0	1,883.6	1,883.6	6,278.5
Sub-total...1st Stage	***750***	***35,461.4***	***500,086.7***	***350,850.9***	***149,235.8***	***184,697.2***	***535,548.1***
2nd Stage- Agos Dam							
2nd stage (1st Phase)							
Agos Dam		21,682.9	364,552.3	210,545.8	154,006.6	175,689.5	386,235.2
Power House		0.0	119,946.3	94,127.3	25,819.1	25,819.1	119,946.3
WTP # 2	750	0.0	75,524.8	59,267.7	16,257.1	16,257.1	75,524.8
Pumping Station			6,278.5	4,395.0	1,883.6	1,883.6	6,278.5
Sub-total...2nd Stage (1st Phase)	***750***	***21,682.9***	***566,301.9***	***368,335.7***	***197,966.3***	***219,649.1***	***587,984.8***
2nd stage (2nd Phase)							
2nd Water way		15,415.0	387,762.2	263,743.0	124,019.1	139,434.1	403,177.1
WTP # 3	750	12,594.0	113,486.2	89,057.7	24,428.5	37,022.5	126,080.2
WTP # 4	750	0.0	75,524.8	59,267.7	16,257.1	16,257.1	75,524.8
Pumping Stations			12,557.0	8,789.9	3,767.1	3,767.1	12,557.0
Sub-total...2nd Stage (2nd Phase)	***1,500***	***28,009.0***	***589,330.2***	***420,858.4***	***168,471.8***	***196,480.8***	***617,339.1***
Total Cost - Option 2	**3,000**	**85,153.3**	**1,655,718.8**	**1,140,044.9**	**515,673.9**	**600,827.2**	**1,740,872.1**
Option 3 - Agos Dam Alone							
1st Stage - Agos Dam w/ 1st Waterway							
Agos Dam		21,682.9	364,552.3	210,545.8	154,006.6	175,689.5	386,235.2
Power House		0.0	119,946.3	94,127.3	25,819.1	25,819.1	119,946.3
1st Waterway		11,082.3	364,369.1	247,832.0	116,537.2	127,619.5	375,451.5
WTP#1	750	13,114.0	101,204.4	79,419.8	21,784.7	34,898.7	114,318.4
WTP#2	750	0.0	75,524.8	59,267.7	16,257.1	16,257.1	75,524.8
Pumping Stations			12,557.0	8,789.9	3,767.1	3,767.1	12,557.0
Sub-total...1st Stage	***1,500***	***45,879.2***	***1,038,154.0***	***699,982.4***	***338,171.6***	***384,050.8***	***1,084,033.2***
2nd Stage- Kaliwa-Angono 2nd Waterway							
2nd Waterway		15,415.0	387,762.2	263,743.0	124,019.1	139,434.1	403,177.1
WTP#3	750	12,594.0	113,486.2	89,057.7	24,428.5	37,022.5	126,080.2
WTP#4	750	0.0	75,524.8	59,267.7	16,257.1	16,257.1	75,524.8
Pumping Stations			12,557.0	8,789.9	3,767.1	3,767.1	12,557.0
Sub-total…2nd Stage	***1,500***	***28,009.0***	***589,330.2***	***420,858.4***	***168,471.8***	***196,480.8***	***617,339.1***
Total Cost - Option 3	**3,000**	**39,091.3**	**953,699.3**	**1,120,840.7**	**506,643.5**	**580,531.6**	**1,701,372.4**
Option 4 - Laiban Dam + Agos Dam							
1st Stage - Laiban Dam							
Laiban Dam		86,366.2	148,666.3	85,861.6	62,804.7	149,170.9	235,032.6
1st Waterway		15,075.4	332,401.9	226,088.8	106,313.1	121,388.4	347,477.3
WTP#1	610	13,985.2	83,330.5	65,393.2	17,937.3	31,922.5	97,315.7
WTP#2	610	0.0	63,905.4	50,149.5	13,755.9	13,755.9	63,905.4
WTP#3	610	0.0	63,905.4	50,149.5	13,755.9	13,755.9	63,905.4
Sub-total...1st Stage	***1,830***	***115,426.8***	***692,209.6***	***477,642.7***	***214,566.9***	***329,993.7***	***807,636.4***
2nd Stage - Agos Dam							
Agos Dam		21,682.9	364,552.3	210,545.8	154,006.6	175,689.5	386,235.2
Powerhouse		0.0	125,998.4	98,876.6	27,121.8	27,121.8	125,998.4
1st Waterway, (Kaliwa-Angono)		11,082.3	380,034.7	258,487.2	121,547.5	132,629.9	391,117.0
WTP#3	750	13,114.0	101,204.4	79,419.8	21,784.7	34,898.7	114,318.4
WTP#4	750	0.0	75,524.8	59,267.7	16,257.1	16,257.1	75,524.8
Pumping Stations			12,557.0	8,789.9	3,767.1	3,767.1	12,557.0
Sub-total...2nd Stage	***1,500***	***45,879.2***	***1,059,871.7***	***715,386.9***	***344,484.8***	***390,364.0***	***1,105,750.9***
Total Cost - Option 4	**3,330**	**161,306.0**	**1,752,081.2**	**1,193,029.6**	**559,051.6**	**720,357.6**	**1,913,387.2**
Option 5 - Kaliwa Low Dam + Kanan No.2 Dam							
1st Stage - Kaliwa Low Dam							
1st Waterway including Kaliwa Low Dam		22,347.4	392,603.8	267,036.2	125,567.6	147,915.0	414,951.2
WTP#1	750	13,114.0	101,204.4	79,419.8	21,784.7	34,898.7	114,318.4
Pumping Station			6,278.5	4,395.0	1,883.6	1,883.6	6,278.5
Sub-total...1st Stage	***750***	***35,461.4***	***500,086.7***	***350,850.9***	***149,235.8***	***184,697.2***	***535,548.1***
2nd Stage - Kanan No. 2 Dam							
2nd Stage (1st Phase)	750						
Kanan No. 2 Dam		18,238.5	228,492.9	131,965.2	96,527.7	114,766.3	246,731.4
Kanan - Laiban Tunnel		489.9	126,058.0	85,740.5	40,317.5	40,807.4	126,547.9
WTP#2		0.0	75,524.8	59,267.7	16,257.1	16,257.1	75,524.8
Pumping Station			6,278.5	4,395.0	1,883.6	1,883.6	6,278.5
Sub-total...2nd Stage (1st Phase)	***750***	***18,728.5***	***436,354.2***	***281,368.3***	***154,985.9***	***173,714.3***	***455,082.6***
2nd Stage (2ndPhase)							
2nd Waterway	1,050	15,415.0	387,762.2	263,743.0	124,019.1	139,434.1	403,177.1
WTP#3		17,291.9	144,193.9	113,155.5	31,038.4	48,330.3	161,485.7
WTP#4	1,050	0.0	106,232.4	83,365.4	22,867.0	22,867.0	106,232.4
Pumping Stations			15,355.8	10,749.0	4,606.7	4,606.7	15,355.8
Sub-total...2nd Stage (2nd Phase)	***2,100***	***32,706.8***	***653,544.3***	***471,013.0***	***182,531.3***	***215,238.1***	***686,251.1***
Total Cost - Option 5	**3,600**	**86,896.7**	**1,589,985.1**	**1,103,232.2**	**486,753.0**	**573,649.7**	**1,676,881.8**

Figure D-1.1 Proposed Implementation Schedule of Option 1 - Laiban Dam + Kanan No.2

Stage	Name of Option / Activity	Average Capacity (MLD)	Year																																								
			06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
1	**Laiban Dam w/ Laiban-Taytay 1st Waterway**	**1,830**																																									
	Financing for Government Share on BOT Project		■	■	■																																					
	Mobilization of Resettlement Team within MWSS		■	■	■																																					
	Dialogue with people to be affected by the project			■	■																																					
	Land Acquisition and Compensation by MWSS			■	■	■																																				
	Resettlement Site Infrastructure			■	■	■	Monitoring																																			
	Resettlement of People				■	■																																				
	Finalization of BOT Tender Documents		■																																							
	Tender/Evaluation/Negotiation			■	■																																					
	Design review by BOT Contractors					■																																				
	Construction Works(All works by BOT)																																									
	Laiban Dam						■	■	■	■	■																															
	1st Waterway						■	■	■	■	■	WTP#1to 3																														
	WTP #1 to 3	1,830					■	■	■	■	■																															
2	**Kanan No.2 with Laiban-Taytay 2nd Waterway**	**3,280**																																									
	Feasibility Study				■	■																																				
	Financing for Detailed Design					■	■																																			
	Detailed Design and Tender Documents						■	■																																		
	Financing for ODA Portion (Dam)						■	■																																		
	Land Acquisition and Compensation by MWSS									■	■																															
	Resettlement of Affected People											■	■																													
	Tender/Evaluation/Negotiation								■	■																																
	Main Construction Works																																									
	Access Roads(via Laiban Damsite) (ODA)										■	■																														
	Kanan Dam												■	■	■	■	■																									
	Kanan Laiban Interbasin Tunnel												■	■	■	■	■																									
	2nd Waterway (ODA)												■	■	■	■	■	WTP#4																								
	WTP #4 (BOT)	1,090													■	■	■									WTP#5																
	WTP #5 (BOT)	1,090																					■	■	■								WTP#6											
	WTP #6 (BOT)	1,090																												■	■	■												
Total		5,110																																									

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Figure D-1.2 Proposed Implementation Schedule of Option 2 - Kaliwa Low Dam + Agos Dam

Stage	Name of Option / Activity	Average Capacity (MLD)
1	**Kaliwa Low Dam w/ Kaliwa Angono 1st Waterway**	**550**
	Financing for Basic Design and Tender Documents	
	Tendering of Basic Design and Bid Documents Preparation	
	Basic Design and BOT Bid Documents Preparation	
	Financing for Government Share on BOT Project - Phase 1	
	Tender and Award Whole Project as Single BOT Contract	
	Detailed Design - Phase 1	
	Land Acquisition and Compensation by MWSS	
	Resettlement Site Infrastructure	
	Resettlement of Affected People	
	Construction Kaliwa of Low Dam + 1st Waterway	750
	WTP #1	
2a	**Agos Dam + WTP #2**	**3,000**
	Financing for gov't share and PSP on BOT- Phase 2	
	Detailed Design (Phase 2a)	
	Land Acquisition and Compensation by MWSS	
	Resettlement Site Infrastructure	
	Resettlement of Affected People	
	Main Construction Works	
	Agos Dam (ODA)	
	Power House	
	WTP #2	750
2b	**Kaliwa-Angono 2nd Waterway + WTP #3 & #4**	
	Detailed Design (Phase 2b)	
	Financing for gov't share and PSP on BOT- Phase 2b	
	Land Acquisition and Compensation	
	Resettlement of Affected People	
	Main Construction Works	
	2nd Waterway	
	WTP #3	750
	WTP #4	750
Total		**3,000**

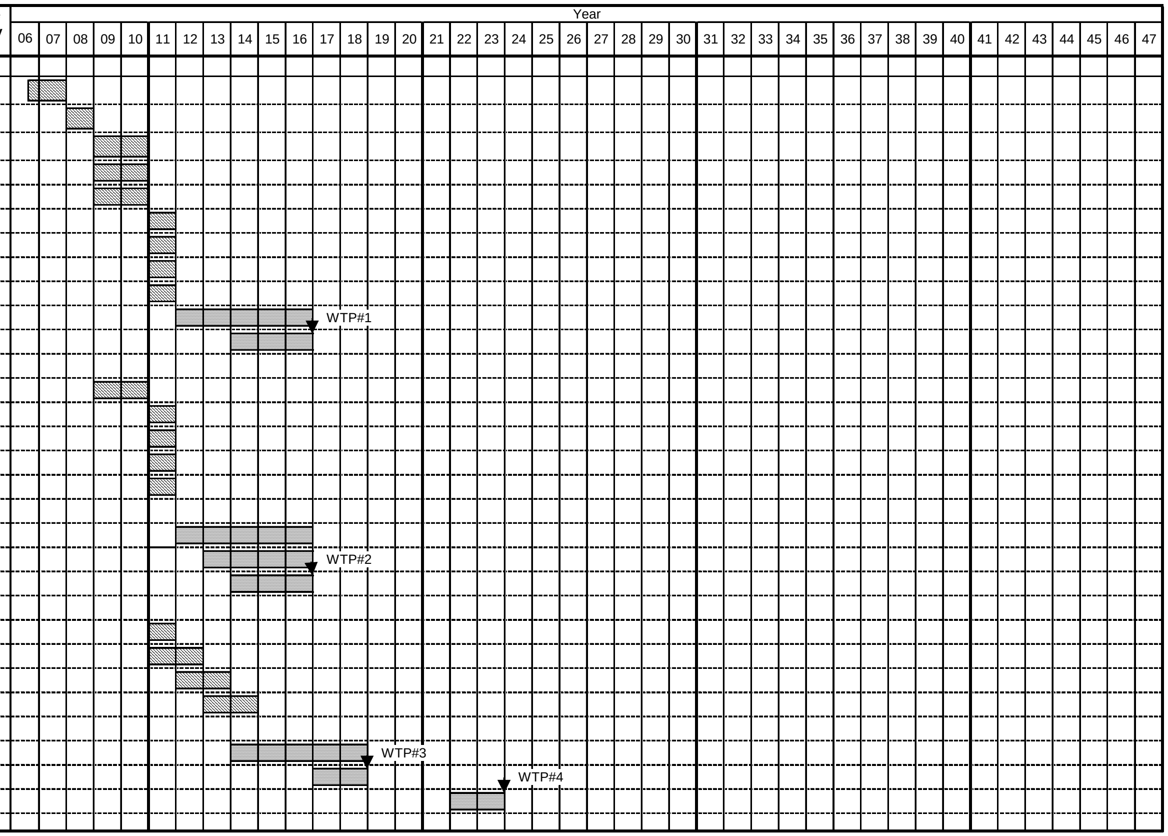

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Figure D-1.3 Proposed Implementation Schedule of Option 3 - Agos Dam Alone

Stage	Name of Option / Activity	Average Capacity (MLD)	Year																																								
			06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
1	**Agos Dam w/ Kaliwa Angono 1st Waterway**	**550**																																								
	Financing for Basic Design and Tender Documents																																									
	Tendering of Basic Design and Bid Documents Preparation																																									
	Basic Design and BOT Bid Documents Preparation																																									
	Financing for Government Share on BOT Project - Stages 1 & 2																																									
	Tender and Award Whole Project as Single BOT Contract																																									
	Detailed Design - Stage 1																																									
	Land Acquisition and Compensation by MWSS																																									
	Resettlement Site Infrastructure																																									
	Resettlement of Affected People																																									
	Agos Dam (ODA)																																									
	1st Waterway																																									
	Power House													WTP#1 &2																														
	WTP #1 & 2	1,500																																								
2	**Kaliwa-Angono 2nd Waterway + WTP #3 & #4**																																									
	Detailed Design (Stage 2)																																									
	Land Acquisition and Compensation																																									
	Resettlement of Affected People																																									
	2nd Waterway															WTP#3																												
	WTP #3	750																				WTP#4																							
	WTP #4	750																																								
Total		**3,000**																																								

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Figure D-1.4 Proposed Implementation Schedule of Option 4 - Laiban Dam + Agos Dam

Stage	Name of Option / Activity	Average Capacity (MLD)
1	**Laiban Dam w/ Laiban-Taytay 1st Waterway**	**1,830**
	Financing for Government Share on BOT Project	
	Mobilization of Resettlement Team within MWSS	
	Dialogue with people to be affected by the project	
	Land Acquisition and Compensation by MWSS	
	Resettlement Site Infrastructure	
	Resettlement of People	
	Finalization of BOT Tender Documents	
	Tender/Evaluation/Negotiation	
	Design review by BOT Contractors	
	Construction Works(All works by BOT)	
	Laiban Dam	
	1st Waterway	
	WTP #1&2	1220
	WTP #3	610
2	**Agos Dam with 1st Waterway (Kaliwa-Angono)**	**1,500**
	Financing & Tendering for Detailed Design	
	Detailed Design and Tender Documents	
	Finacing for ODA Portion (Dam)	
	Land Acquisition and Compensation by MWSS	
	Resettlement of Affected People	
	Tender/Evaluation/Negotiation	
	Main Construction Works	
	Agos Dam	
	1st Waterway (Kaliwa-Angono)	
	Powerhouse	
	WTP # 3	750
	WTP # 4	750
Total		**3,330**

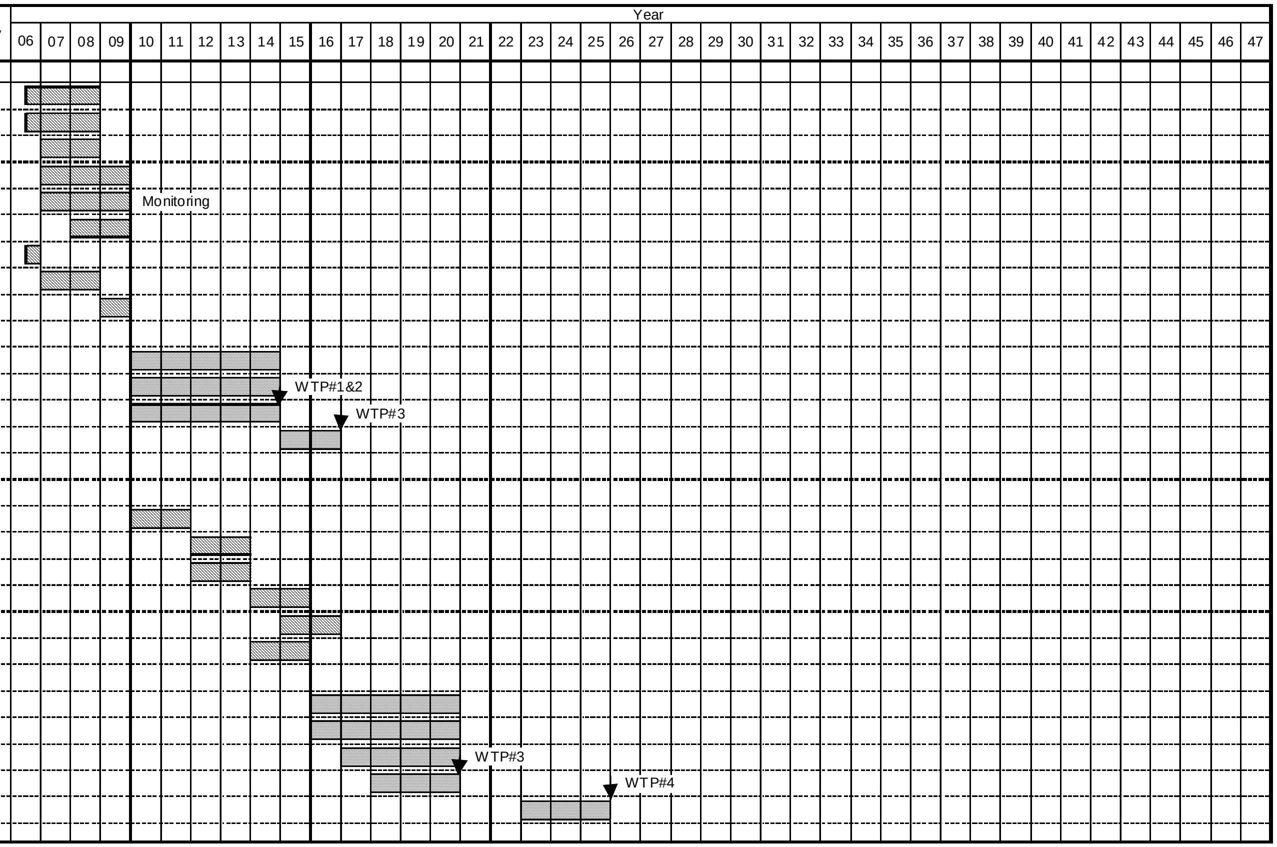

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Figure D-1.5 Proposed Implementation Schedule of Option 5 - Kaliwa Low Dam + Kanan No. 2 Dam

Stage	Name of Option / Activity	Average Capacity (MLD)
1	**Kaliwa Low Dam w/ Kaliwa Angono 1st Waterway**	**550**
	Financing for Basic Design and Tender Documents	
	Tendering of Basic Design and Bid Documents Preparation	
	Basic Design and BOT Bid Documents Preparation	
	Financing for Government Share on BOT Project - Phase 1	
	Tender and Award Whole Project as Single BOT Contract	
	Detailed Design - Phase 1	
	Land Acquisition and Compensation by MWSS	
	Resettlement Site Infrastructure	
	Resettlement of Affected People	
	Construction of Kaliwa Low Dam + 1st Waterway	
	WTP #1	750
2a	**Kanan No. 2 Dam with Kanan-Laiban Tunnel**	
	Feasibility Study	
	Financing for Detailed Design	
	Detailed Design and Tender Documents (Phase 2a)	
	Finacing for ODA Portion (Dam)	
	Land Acquisition and Compensation by MWSS	
	Resettlement of Affected People	
	Tender/Evaluation/Negotiation	
	Main Construction Works	
	Kanan Dam	
	Kanan Laiban Interbasin Tunnel	
	WTP #2	750
2b	**Kaliwa-Angono 2nd Waterway + WTP #3 & #4**	
	Detailed Design (Phase 2b)	
	Financing for gov't share and PSP on BOT- Phase 2b	
	Land Acquisition and Compensation	
	Resettlement of Affected People	
	Main Construction Works	
	2nd Waterway	
	WTP #3	1,050
	WTP #4	1,050
Total		**3,600**

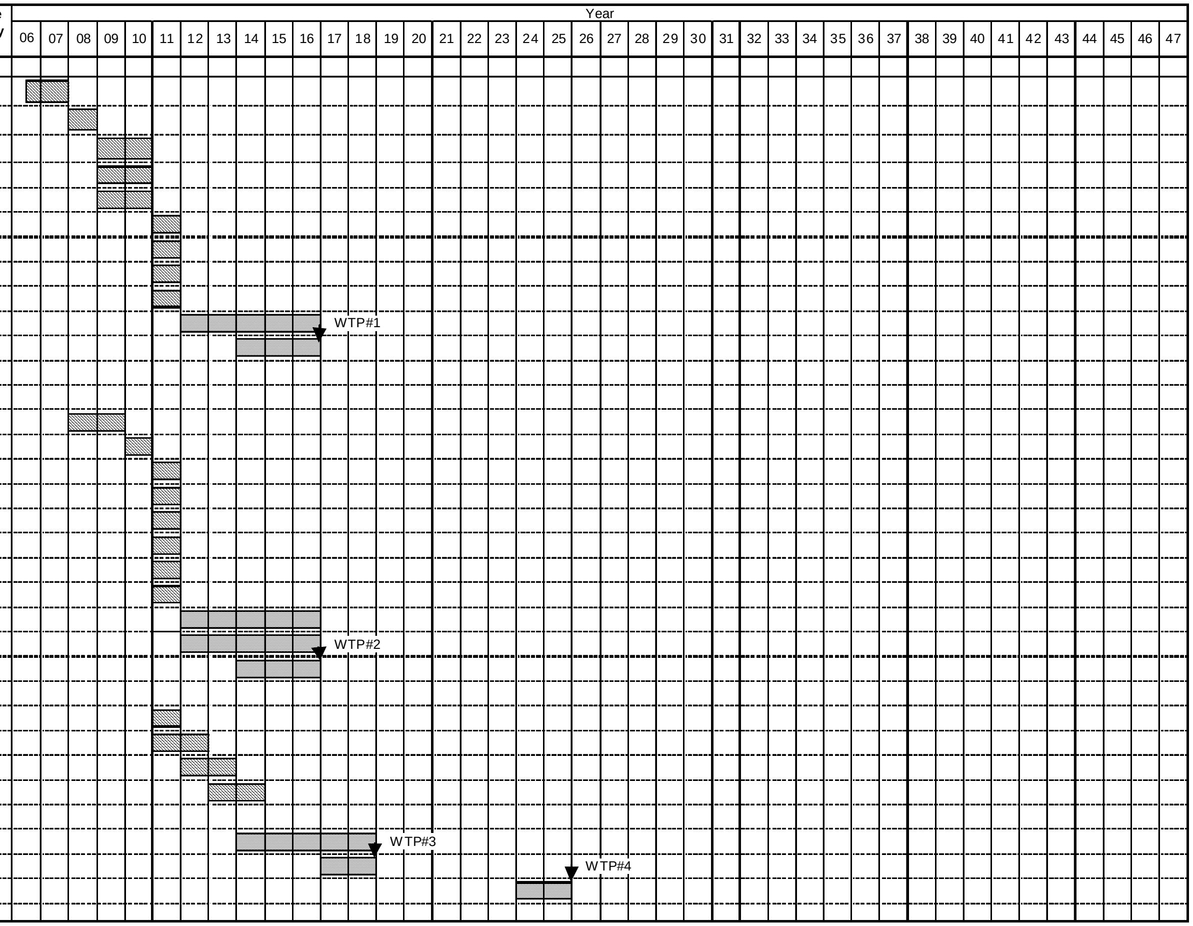

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Table D-2.1 - Unit Cost Computation for Option 1 – Laiban Dam + Kanan No. 2 Dam

Table D-2.2 - Unit Cost Computation for Option 2 – Kaliwa Low Dam + Agos Dam

Table D-2.3 - Unit Cost Computation for Option 3 – Agos Dam Alone

Table D-2.4 - Unit Cost Computation for Option 4 – Laiban Dam + Agos Dam

Table D-2.5 - Unit Cost Computation for Option 5 – Kaliwa Low Dam + Kanan No.2 Dam

Appendix E – Financial Evaluation

Table E-1.1 - Financial Evaluation (Scenario 1)

(in US$'000, 2005 prices)

Year	Capital Costs			Operating Cost (Php M)	Income			Net Income	Sensitivity Analysis		
	Source Devt.	Distribution Mains	Total		Electric Energy	Water Production	Total		Cost +10%	Revenue -10%	Cost +10% Rev -10%
2007	38,476	-	38,476	-	-	-	-	(38,476)	(42,323)	(38,476)	(42,323)
2008	38,476	-	38,476	-	-	-	-	(38,476)	(42,323)	(38,476)	(42,323)
2009	38,476	-	38,476	-	-	-	-	(38,476)	(42,323)	(38,476)	(42,323)
2010	186,488	-	186,488	-	-	-	-	(186,488)	(205,137)	(186,488)	(205,137)
2011	186,488	-	186,488	-	-	-	-	(186,488)	(205,137)	(186,488)	(205,137)
2012	186,488	48,431	234,919	-	-	-	-	(234,919)	(258,411)	(234,919)	(258,411)
2013	203,041	48,431	251,472	-	-	-	-	(251,472)	(276,619)	(251,472)	(276,619)
2014	229,330	70,811	300,141	-	-	-	-	(300,141)	(330,155)	(300,141)	(330,155)
2015	42,841	82,791	125,633	5	14,096	120,194	134,290	8,653	(3,911)	(4,776)	(17,340)
2016	233,407	34,360	267,767	5	14,096	133,107	147,204	(120,568)	(147,345)	(135,289)	(162,066)
2017	216,854	11,980	228,834	5	14,096	147,060	161,156	(67,683)	(90,567)	(83,798)	(106,682)
2018	281,547	-	281,547	6	14,096	161,013	175,109	(106,443)	(134,598)	(123,954)	(152,109)
2019	281,547	-	281,547	6	14,096	174,966	189,062	(92,490)	(120,646)	(111,397)	(139,552)
2020	281,547	-	281,547	6	14,096	188,919	203,015	(78,538)	(106,693)	(98,839)	(126,995)
2021	-	-	-	8	14,096	203,876	217,973	217,965	217,964	196,168	196,167
2022	-	-	-	8	32,910	219,839	252,748	252,740	252,739	227,465	227,464
2023	-	-	-	9	32,910	235,801	268,710	268,702	268,701	241,831	241,830
2024	-	-	-	9	32,910	251,763	284,673	284,664	284,663	256,196	256,195
2025	-	-	-	9	32,910	267,725	300,635	300,625	300,624	270,562	270,561
2026	50,177	-	50,177	10	32,910	283,687	316,597	266,410	261,391	234,750	229,732
2027	50,177	-	50,177	10	32,910	299,649	332,559	282,372	277,353	249,116	244,097
2028	50,177	-	50,177	11	32,910	315,612	348,521	298,334	293,315	263,481	258,463
2029	-	-	-	12	32,910	331,574	364,483	364,472	364,470	328,023	328,022
2030	-	-	-	12	32,910	347,536	380,446	380,433	380,432	342,389	342,388
2031	-	-	-	13	32,910	363,498	396,408	396,395	396,394	356,754	356,753
2032	-	-	-	13	32,910	379,460	412,370	412,357	412,356	371,120	371,119
2033	50,177	-	50,177	13	32,910	395,422	428,332	378,142	373,122	335,308	330,289
2034	50,177	-	50,177	14	32,910	411,385	444,294	394,103	389,084	349,674	344,655
2035	50,177	-	50,177	14	32,910	427,347	460,256	410,065	405,046	364,039	359,020
2036	-	-	-	16	32,910	459,271	492,181	492,165	492,163	442,947	442,945
FIRR								**7.58%**	**6.59%**	**6.49%**	**5.54%**
NPV	-			-				**(279,288)**	**(400,945)**	**(373,016)**	**(494,673)**

Table E-1.2 - Financial Evaluation (Scenario 2)

(in US$'000, 2005 prices)

Year	Capital Costs			Operating Cost (Php M)	Income			Net Income	Sensitivity Analysis		
	Source Devt.	Distribution Mains	Total		Electric Energy	Water Production	Total		Cost +10%	Revenue -10%	Cost +10% Rev -10%
2007	38,476	-	38,476	-	-	-	-	(38,476)	(42,323)	(38,476)	(42,323)
2008	38,476	-	38,476	-	-	-	-	(38,476)	(42,323)	(38,476)	(42,323)
2009	38,476	-	38,476	-	-	-	-	(38,476)	(42,323)	(38,476)	(42,323)
2010	186,488	-	186,488	-	-	-	-	(186,488)	(205,137)	(186,488)	(205,137)
2011	186,488	-	186,488	-	-	-	-	(186,488)	(205,137)	(186,488)	(205,137)
2012	186,488	48,431	234,919	-	-	-	-	(234,919)	(258,411)	(234,919)	(258,411)
2013	203,041	48,431	251,472	-	-	-	-	(251,472)	(276,619)	(251,472)	(276,619)
2014	229,330	70,811	300,141	-	-	-	-	(300,141)	(330,155)	(300,141)	(330,155)
2015	42,841	82,791	125,633	5	14,096	159,858	173,954	48,317	35,754	30,922	18,358
2016	233,407	34,360	267,767	5	14,096	177,033	191,129	(76,643)	(103,420)	(95,756)	(122,533)
2017	216,854	11,980	228,834	5	14,096	195,590	209,686	(19,153)	(42,037)	(40,121)	(63,005)
2018	281,547	-	281,547	6	14,096	214,147	228,244	(53,309)	(81,464)	(76,133)	(104,288)
2019	281,547	-	281,547	6	14,096	232,705	246,801	(34,752)	(62,907)	(59,432)	(87,587)
2020	281,547	-	281,547	6	14,096	251,262	265,358	(16,195)	(44,350)	(42,730)	(70,886)
2021	-	-	-	8	14,096	271,156	285,252	285,244	285,243	256,719	256,718
2022	-	-	-	8	32,910	292,385	325,295	325,287	325,286	292,757	292,757
2023	-	-	-	9	32,910	313,615	346,525	346,516	346,515	311,864	311,863
2024	-	-	-	9	32,910	334,845	367,754	367,745	367,744	330,970	330,969
2025	-	-	-	9	32,910	356,074	388,984	388,975	388,974	350,076	350,075
2026	50,177	-	50,177	10	32,910	377,304	410,214	360,027	355,008	319,005	313,987
2027	50,177	-	50,177	10	32,910	398,534	431,443	381,256	376,237	338,112	333,093
2028	50,177	-	50,177	11	32,910	419,763	452,673	402,485	397,467	357,218	352,199
2029	-	-	-	12	32,910	440,993	473,903	473,891	473,890	426,501	426,499
2030	-	-	-	12	32,910	462,223	495,132	495,120	495,119	445,607	445,606
2031	-	-	-	13	32,910	483,452	516,362	516,349	516,348	464,713	464,712
2032	-	-	-	13	32,910	504,682	537,592	537,579	537,577	483,820	483,818
2033	50,177	-	50,177	13	32,910	525,912	558,821	508,631	503,612	452,749	447,730
2034	50,177	-	50,177	14	32,910	547,142	580,051	529,860	524,841	471,855	466,836
2035	50,177	-	50,177	14	32,910	568,371	601,281	551,089	546,070	490,961	485,942
2036	-	-	-	16	32,910	610,831	643,740	643,724	643,723	579,350	579,349
FIRR								**10.41%**	**9.36%**	**9.25%**	**8.22%**
NPV	-			-				**1,579**	**(120,078)**	**(120,236)**	**(241,893)**

Table E-1.3 - Financial Evaluation (Scenario 3)

(in US$'000, 2005 prices)

Year	Capital Costs			Operating Cost (Php M)	Income			Net Income	Sensitivity Analysis		
	Source Devt.	Distribution Mains	Total		Electric Energy	Water Production	Total		Cost +10%	Revenue -10%	Cost +10% Rev -10%
2007	38,476	-	38,476	-	-	-	-	(38,476)	(42,323)	(38,476)	(42,323)
2008	38,476	-	38,476	-	-	-	-	(38,476)	(42,323)	(38,476)	(42,323)
2009	38,476	-	38,476	-	-	-	-	(38,476)	(42,323)	(38,476)	(42,323)
2010	186,488	-	186,488	-	-	-	-	(186,488)	(205,137)	(186,488)	(205,137)
2011	186,488	-	186,488	-	-	-	-	(186,488)	(205,137)	(186,488)	(205,137)
2012	186,488	48,431	234,919	-	-	-	-	(234,919)	(258,411)	(234,919)	(258,411)
2013	203,041	48,431	251,472	-	-	-	-	(251,472)	(276,619)	(251,472)	(276,619)
2014	229,330	70,811	300,141	-	-	-	-	(300,141)	(330,155)	(300,141)	(330,155)
2015	42,841	82,791	125,633	5	14,096	187,503	201,599	75,962	63,398	55,802	43,238
2016	233,407	34,360	267,767	5	14,096	207,647	221,744	(46,028)	(72,805)	(68,203)	(94,980)
2017	216,854	11,980	228,834	5	14,096	229,414	243,510	14,671	(8,213)	(9,680)	(32,564)
2018	281,547	-	281,547	6	14,096	251,180	265,277	(16,275)	(44,431)	(42,803)	(70,958)
2019	281,547	-	281,547	6	14,096	272,947	287,043	5,491	(22,665)	(23,214)	(51,369)
2020	281,547	-	281,547	6	14,096	294,714	308,810	27,257	(898)	(3,624)	(31,779)
2021	-	-	-	8	14,096	318,047	332,143	332,136	332,135	298,921	298,921
2022	-	-	-	8	32,910	342,948	375,858	375,850	375,849	338,264	338,263
2023	-	-	-	9	32,910	367,849	400,759	400,750	400,749	360,674	360,674
2024	-	-	-	9	32,910	392,750	425,660	425,651	425,650	383,085	383,084
2025	-	-	-	9	32,910	417,651	450,561	450,551	450,550	405,495	405,494
2026	50,177	-	50,177	10	32,910	442,552	475,462	425,275	420,256	377,729	372,710
2027	50,177	-	50,177	10	32,910	467,453	500,363	450,175	445,157	400,139	395,120
2028	50,177	-	50,177	11	32,910	492,354	525,264	475,076	470,057	422,550	417,531
2029	-	-	-	12	32,910	517,255	550,165	550,153	550,152	495,136	495,135
2030	-	-	-	12	32,910	542,156	575,066	575,053	575,052	517,547	517,546
2031	-	-	-	13	32,910	567,057	599,967	599,954	599,953	539,957	539,956
2032	-	-	-	13	32,910	591,958	624,868	624,855	624,853	562,368	562,366
2033	50,177	-	50,177	13	32,910	616,859	649,769	599,578	594,559	534,601	529,582
2034	50,177	-	50,177	14	32,910	641,760	674,670	624,479	619,460	557,012	551,993
2035	50,177	-	50,177	14	32,910	666,661	699,571	649,379	644,360	579,422	574,403
2036	-	-	-	16	32,910	716,463	749,373	749,357	749,355	674,419	674,418
FIRR								**12.13%**	**11.02%**	**10.91%**	**9.84%**
NPV	-			-				**197,334**	**75,678**	**55,944**	**(65,713)**

Appendix F – Schematic Diagram of Bulk Water Transmission

Figure F-1.1 Schematic Diagram of Bulk Water Supply, 2005

Figure F-1.2 Schematic Diagram of Bulk Water Supply, 2010

Figure F-1.3 Schematic Diagram of Bulk Water Supply, 2015

Figure F-1.4 Schematic Diagram of Bulk Water Supply, 2020

Figure F-1.5 Schematic Diagram of Bulk Water Supply, 2025

Appendix G – Lengths and Sizes of Trunk and Primary Distribution Mains

Location	Size (mm)	Length (meters)
PHASE-1		
Manila Water (MWCI)		
1. Along Ortigas Avenue Ext'n	2,800	4,000
(Taytay Res - Cainta)		
2. Along Ortigas Avenue Ext'n	2,500	3,000
(Cainta - Interconnection)		
3.Along C. Lawis	1,500	2,000
(Antipolo Res.-Circumf. Road)		
4. Along Circumf. Road,	1,050	1,400
(C.Lawis-Sumulong Highway)		
5. Along Circumf. Road	1,050	1,050
6. Along Circumf. Road	900	450
7. Along Circumf. Road		
(ML Quezon Ext'n-P. Oliveros)	600	1,350
8. Along ML Quezon Ext'n	750	2,000
9. From Circumf. Road to	600	1,300
San Antonio Village		
10. Along P. Oliveros Road	600	2,500
(Sumulong Highway-Melendres		
Homes)		
11. Along Sumulong Highway	900	3,520
(Circumf. Road-Marcos Hi-way)		
12. Along Marcos Highway	750	1,550
13. Along Marcos Highway	600	2,050
Maynilad Water (MWSI)		
1. Along C-5, C-6 Route	2,800	14,500
(Taytay Res - South		
Superhighway)		
2. AlongMoonwalk Access	2,800	2,820
Road(South Super-Armstrong)		
3. Along Armstrong/Multi-	2,800	3,500
national Avenue		
4. Along Dr. A. Santos Ave.	2,200	2,800
(Multinational-Coastal Road)		
5. Along Manila-Cavite Coastal	2,000	3,700
Road		
6. Along Real and Evangelista	1,800	4,520
Streets (Coastal Road-Tirona		
Highway)		
7. Along Medicion/Gen. F.	1,050	4,160
Yengko and Nuevo Avenue		
8. Along Kawit National Road	1,200	4,840
(from Gen. F. Yengko to Gen.		
P. Alvarez)		
9. Along National Road	900	6,120
(Noveleta-Cavite City)		
10. Along National Road	900	5,400
(Noveleta-Rosario)		
11. Along Lopez Jaena Road	750	1,100

Location	Size (mm)	Length (meters)
PHASE 2		
1. Along Canaynay/	2,800	1,960
J. Tionquiao, Las Pinas		
2. Along CAA Road,	2,500	2,350
Las Pinas		
3. CAA Road-South Super	2,200	10,520
Highway		
4. Along South Superhighway,	2,200	4,130
Muntinlupa		
5. Along Acacia Avenue	900	2,000
(Univ. Ave.-Alavang Zapote Rd)		
6. Along South Superhighway	900	1,650
(Alabang Zapote Rd-Magsay		
Road)		
PHASE 3		
1. South Superhighway-	2,200	3,890
Muntinlupa Reservoir		
2. Along Dona Soledad,	1,500	8,480
Paranaque (Armstrong-South		
Superhighway		

Appendix H – Zoning of Distribution Network, 2005-2025

Figure H-1.1 Zoning of Distribution Network, 2005

Figure H-1.2 Zoning of Distribution Network, 2010

Figure H-1.3 Zoning of Distribution Network, 2015

Figure H-1.4 Zoning of Distribution Network, 2020

Figure H-1.5 Zoning of Distribution Network, 2025

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Appendix I – Initial Environmental Assessment of the Proposed Laiban Dam Project

Background Information

In 1996, MWSS commissioned the conduct of a study to review and update the design of Manila Water Supply Project III (MWSP III) for its implementation through a Build-Operate-Transfer (BOT) scheme. The MWSP III will utilize the Laiban Dam on the Kaliwa River to supply water for Metro Manila.

The project commenced in 1984 with the construction of a twin 9-meter diameter temporary diversion tunnels with stoplog gates at the Laiban dam site. The construction of the dam was to follow suit but was deferred because of the change in political leadership and the unfavorable economic situation in the country during that time.

The relocation program for Kaliwa Reservoir was also reviewed in 1984. The report identified the affected families at the Laiban Dam in Tanay, Rizal. The project will inundate seven (7) barangays composed of 1,637 settler-families classified as Christians (1,307), remontados or Christianized Dumagats (300) and pure Dumagats (30). These families are not squatters but long-time residents granted land allocations by the Department of Agrarian Reform (DAR).

Meanwhile, the 7,000-hectare relocation site in San Ysiro was partly acquired, proclaimed and surveyed. Some 78% of the affected population was compensated. There was already an influx of informal dwellers to the relocation site and disputes have erupted among the prior land occupants. The presence of some 500 informal settlers has prevented MWSS to implement work plans on land distribution as spelled out in the Memorandum of Agreement (MOA) between MWSS, DAR and the Department of Environment and Natural Resources (DENR). Also stopped were the construction of access road, lot monumenting and survey on actual areas developed by the occupants and squatters.

The Kilusang Magbubukid ng Pilipinas and Agrarian Reform Beneficiaries Association (ARBA) have established as substantial foothold in San Ysiro. Both claim that San Ysiro is covered by the CARP, therefore, must be awarded to them.

It was further reported that at seven (7) barangays affected by the Laiban project, the resettlement program is no longer acceptable to the settler-families. A barangay resolution concurred by the mayor of Tanay was passed in 1997 firming up their stand against resettlement, thus, no actual resettlement has occurred. Cited was the MWSS' failure to keep its promises of relocation as early as 1984.

Components of the Proposed Laiban Dam Project

The Kaliwa River Basin Project was initially seen as the second stage of the MWSP III. The project will involve the construction of a 113 meter high concrete-face rockfill dam and spillway situated approximately 0.5 km downstream of the confluence of Lenatin and Limutan Rivers at Barangay Laiban, Tanay, Rizal.

The proposed dam will have an effective reservoir storage capacity of 470 MCM. The dam will trap fresh water from the surrounding watershed covering an area of approximately 28,000 hectares.

From an upstream intake on the reservoir, raw water would be conveyed to the proposed treatment plant in Pantay using a conventional system with a direct filtration provision (bypassing clarifier) when turbidity is low. Thereafter, treated water will be supplied by gravity to the proposed Taytay 120-ML service reservoir and by pumping to the proposed Antipolo 100-ML service reservoir.

Methodology

With the identification of the Laiban Dam as the most feasible option for water supply for Metro Manila, a meeting with the Local Government Unit (LGU) was undertaken on September 22, 2005 to determine issues of stakeholders about the revival of the proposed project. The meeting was attended by the following:

1. Mayor Tomas Tanjuatco - Municipal Mayor
2. Mr. Efren Danao - President, Association of Barangay Captains (ABC)
3. Mr. Adorable Sunga - Municipal Planning and Development Coordinator
4. Mr. Carlito Dadivas - Market Security
5. Ms. Merlinda Manila - Chief, Forest Management Division, DENR-CALABARZON
6. Engr. Delfin Sespene - MWSS
7. Engr. Cherry Rivera - SKM, Environmental Specialist
8. Engr. Narciso Tolentino – SKM, Water Supply Support Specialist

Site assessment was conducted last September 26, 2005 to determine the current environmental situation at the project site and to validate the information revealed by Mayor Tanjuatco about the new developments in the area.

Description of Existing Condition

The municipality of Tanay is situated at the foothills of the Sierra Madre Mountain with bearings 14^{o} 30' latitude and 121^{o} 17' longitude. The municipality is bounded on the north by the towns of Antipolo, Baras, Teresa and Montalban; on the east by Quezon Province; on the south by Pililla and the Province of Laguna; and on the west by Laguna de Bay.

The municipality is located 54 kilometers away, southeast of Manila. Tanay is the major agricultural and commercial center of eastern Rizal. It has a total land area of 33,466 hectares consisting of nineteen (19) barangays.

With the construction of the dam, the low-lying vicinity that includes seven (7) barangay communities covering a total land area of 12,035 hectares will be inundated, representing 35.96% of Tanay's land area. The seven (7) mountain barangays that will be affected by the proposed project are presented in **Table I-1.1**.

Table I-1.1 – Seven Affected Barangays

Barangays to be Inundated	Area (has)	% of Municipal Area
Cayabu	679	2.03
Laiban	1,593	4.76
Mamuyao	2,229	6.66
San Andres	1,777	5.31
Santa Ines	2,290	6.84
Santo Niño	2,202	6.58
Tinucan	1,265	3.78
Total	12,035	35.96

Topography at the mountain barangays ranges from 0 to 45 degrees slope. The major soil type in the lowland areas is silty loam to clay loam soil. The watershed is underlain almost entirely by Quartenary (Pliocene-Pleistocene) clastic, pyroclastic and volcanic rocks, except for the extreme northern portion of the region, which is occupied chiefly by Tertiary rocks and a few erosional remnants of Cretaceous rocks.

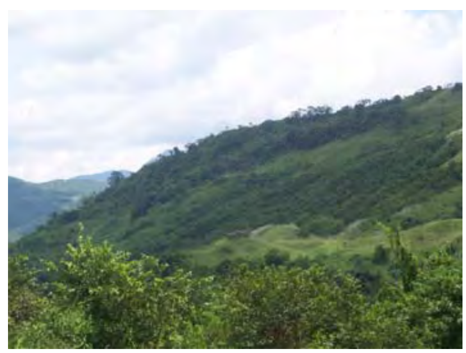

Figure I-1.1 View of Vegetation in the Seven Barangays

The valley of Linatin River, which forms the western side of the catchment, is characterized by sparse vegetation consisting of bushes and scattered trees as shown in **Figure I-1.1**. The biodiversity of the area is under severe pressure due to the people's activities. Limutan watershed has moderate to intensive forest cover and is virtually inaccessible. Small scale logging, grazing, and kaingin are seen as the causes of the reduction of forest cover in various parts of the catchment basin.

A gravel-paved access road is now available from the Marcos Highway going to the seven barangays (See **Figure I-1.3**). This gravel-paved road was constructed as part of the

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Kaliwa River Watershed Management and Development Project of the DENR which was implemented in 1997 and was completed last June 2005.

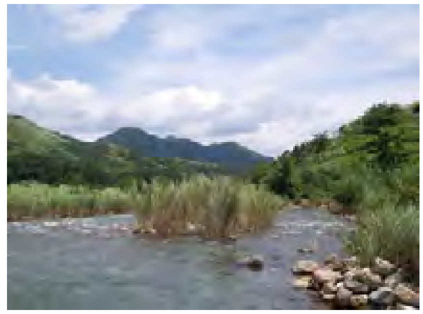

Figure I-1.2 View of the Linatin River

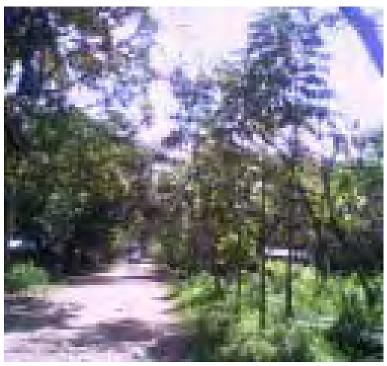

Figure I-1.3 Existing Gravel Road from Marcos Highway to Barangay Sta.Ines

Settlers within the watershed are now engaged in farming, goat and cattle raising. Pollution load on the river consists of discharges from households and agricultural runoff.

Population has increased and new houses are existing and being built within the watershed. New projects in the watershed have developed renewed interest in the area. There are more settlers now which are estimated at about 5,000 households than during the inventory in year 2000 wherein there were only about 2,400 families.

Anticipated Impacts and Mitigating Measures

The impacts of the project can be divided into two principal categories, i.e., (1) direct impacts, which result from the physical presence, design, construction, and operation of the facilities, and (2) indirect impacts which stems from the economic activities surrounding the construction and the induced economic effects resulting from the proposed Laiban Dam project. These impacts occur in two main phases – during construction and during operation.

During the construction phase of the project, the potential impacts would include the following:

1. Worker accidents
2. Sanitation disease hazards
3. Insect vector hazards
4. Hazardous materials handling
5. Dust
6. Odors
7. Fumes
8. Explosions/fires
9. Noise and vibration
10. Quarrying/blasting
11. Water pollution

During operation, the project would present irreversible changes in the environment such as:

1. Changes in downstream hydrology and water quality
2. Loss of habitat and disturbance of breeding sites
3. Loss of forest resources and arable lands
4. Displacement of families and IPs
5. Loss of economic activities

Impacts on the Physical Environment

- *Air quality*

Locally, significant impacts of dust emission are expected during the expected 7-8 year construction period caused by the movement of construction vehicles, operation of construction equipment, batching plant, earthworks, and other related activities. However, these impacts will cease following the completion of construction and the vegetative stabilization of slopes and bare ground.

- *Water quality*

Sediments from the construction activities may be disposed as runoff to the river which could increase sedimentation and affect water quality. Concrete batching plant operations at the dam may produce liquid wastes from mixers, washing of trucks and other equipment, and solid wastes in the form of concrete residues. Liquid wastes, diesel oil, lubricating oils, grease, paints, and other chemicals could have an impact on local water supplies and the river.

Another adverse impact of the construction of the project would be the discharge of sewage from the domestic workforce. Appropriate sewage treatment systems should be installed to avoid the discharge of untreated sewage into the river.

During operation, there would be changes in downstream water quality due to temperature changes, removal of nutrients, and flooding of forests. Each of these effects may have an impact on the life that depends on the water. These effects are generally related to how long the water has remained in the reservoir. Particularly, severe effects can occur when a reservoir is first formed, and submerged vegetation and soil decomposes. As it does so, it will deplete oxygen in the reservoir water.

Almost all dams also reduce normal flooding, effectively isolating the river from its floodplain, and eliminating the ecological benefits provided by this flooding.

The impacts of these changes are magnified by changes in the flow pattern of rivers downstream that is caused by normal operation of dams. These changes, whether in total streamflow, in seasonal timing, or in short-term, even hourly fluctuations in flows, generate a range of impacts on rivers. This is because the life of rivers is usually tightly linked to the existing flow patterns of rivers. Any disruption of those flows, therefore, is likely to have substantial impacts.

- *Spoil disposal*

Excavated rock will be generated. While some of these excavated soils can be used as backfill material, the absence of suitable locations for spoil dumps could contribute to sedimentation of the river during high precipitation periods.

Impacts on the Biological Environment

The major direct impacts on natural vegetation cover will occur at the dam site, in the flooded zone of the reservoir, and along the access roads. Crops planted by settlers such as rice, vegetables, fruits, and other high-value crops would be affected and are considered to be potentially significant locally.

During construction, mammals and birds are likely to suffer from disturbance due to construction activities, increased hunting, and trapping pressure from the work force and the destruction of forest habitat.

During operation, there would be potential changes in downstream morphology of riverbed and banks due to altered sediment load. Much of the impact of dams on downstream habitats is through changes in the sediment load of the river. All rivers carry some sediment as they erode their watershed. When the river is held behind a dam in the reservoir for a period of time, most of the sediment will be trapped in the reservoir, and settle to the bottom, so that water released by the dam will be much clearer, with less sediment than it had once had. Eventually, all the easily erodible material on the riverbed below the dam will be eroded away, leaving a rocky streambed, and a poorer habitat for aquatic fauna. Erosion may also increase along the coast. The mouth of the river will also tend to become narrower and deeper, which will also reduce the diversity of animal and plant life that it can support.

There will be potential reduction of biodiversity due to blocking of movement of organisms. Perhaps, the most significant environmental consequence of dams is that they tend to fragment river ecosystems, isolating species populations living up and downstream of the dam, and cutting off migrations and other movements.

Impacts on the Socio-Economic and Cultural Environments

Project construction is expected to have a significant adverse impact on local communities because of the following:

1. Existence of Indigenous Peoples (IPs)
2. Displacement of an estimated 5,000 – 6,000 families
3. Disturbance/displacement of economic activities
4. Loss of infrastructure facilities established by LGUs and other government projects (schools, old churches, covered courts, roads, etc.)

On the other hand, the construction of the project would generate labor requirements which could be tapped from locally qualified settlers. There will be extensive local employment opportunities over the entire construction stage.

The different physical, biological, and socio-economic impacts of the Laiban Dam Project are presented in **Table I-1.2**.

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Table I-1.2 - Impacts of Laiban Dam Project

Issue	Potential impacts	Construction/ Operation	Direct /Indirect	Significance High/Medium/Low	Mitigating measures
Air quality	Increase in airborne dusts during dry season	C	D	L	Install dust collectors (filters), water sprays and emission control equipment
Land	Spoil disposal; changes in drainage systems, vegetation cover, runoff, slopes	C	D	M	Reduce to extent possible, spoil dumps; salvage soils for use in reclamation; institute slope protection measures; revegetate all disturbed slopes
	Loss of productive forest lands; loss of cultivated land	C	D	H	Compensation of settlers for productive land
	Loss of scenic spots – Sta. Ines Falls and Sangab Cave	C	D	M	
Hydrology and Water quality	Disposal of oil, grease, concrete residues from batching plant and other activities into the river	C	D	L	Institute waste management system to avoid discharge to the river
	Generation of sewage from domestic workforce	C	D	L	Provide sewage treatment system at the jobsite
	Changes in downstream morphology and hydrological regime; downstream	C/O	D	L	Provide hazard warning for

Issue	Potential impacts	Construction/ Operation	Direct /Indirect	Significance High/Medium/Low	Mitigating measures
	dewatering; reservoir sedimentation				downstream areas when flushing reservoir
Biological	Loss of habitat, disturbance of breeding sites	C/O	D	M	Rare and endangered species not yet known; further surveys required Develop a watershed management plan to protect forests
	Loss of forest resources	C	D/I	M	Control deforestation; develop forestry conservation and development program for watershed
Socio-economic and cultural	Loss of arable land	C	D	M	Resettlement of settlers with provision for livelihood programs
	Displacement of families and IPs	C/O	D	M	Resettlement and rehabilitation program; programs for non-indigenous labor
	Interruption of normal farming activities	C	D	M	Provide livelihood training including skill training for

Issue	Potential impacts	Construction/ Operation	Direct /Indirect	Significance High/Medium/Low	Mitigating measures
					employment on construction
	Increase job opportunities	C/O	D	M	Training of local people to fill appropriate positions
	Sustainable and constant supply of water	O	D	H	Ensure adequate supply of water for Metro Manila and adjacent provinces
Sanitation/Disease Hazards	Unsanitary conditions would create health hazard to workers	C	D	L	Ensure sanitation onsite
	Presence of insect vectors	C	D	L	Workers protection

Socio-Economic Issues Raised by Stakeholders

Mayor Tanjuatco disclosed that the situation in the seven barangays is different now as compared to the period in the 1980s – 1990s when people have accepted the fact that they would be resettled to give way to the project.

The following issues were cited by the stakeholders:

1. *There are several government projects that were implemented in the area that contributed to its ongoing development* (See **Figure I-1.4** and **Table I-1.3**).

   Some of the recent projects within the seven barangays are the Kaliwa River Watershed Management and Development Project of the DENR, schools, covered courts, and agricultural plantations. Proposed projects are also planned such as the Bilibid Prison camp in Barangay San Andres and mining of manganese, iron and gold in Barangays Sta. Ines, Tinukan, and Mamuyao.

   By far, the Kaliwa River Watershed Management and Development Project is the major project that was implemented in the watershed. The project was supported by the DENR with funds from the World Bank and DANIDA to formulate a watershed management strategy and long-term program of investments for the sustainable management of the Kaliwa River watershed. It has the following components:

   - Reforestation of the watershed
   - Agroreforestation and establishment of agroforestry plantations
   - Development of livelihood programs such as farming, fish farming, cattle and goat raising
   - Strengthening/organization of communities
   - Capacity building of stakeholders
   - Establishment of demo farms
   - Construction of infrastructure facilities such as farm-to-market roads, drainage canals, and other community amenities.

   Under the reforestation program, the People's Organizations (POs) were granted by the DENR 25-year rights through the Community-Based Forest Management Agreement (CBFMA). Timber species were planted in the watershed above the 270 m elevation while crops were planted in the low-lying areas. The planting of trees coincides with the proposed flooding of the area up to elevation 270.

   An Inter-Agency Committee composed of DENR, DAR, Department of Agriculture (DA), National Economic Development Authority (NEDA), Bureau of Soils and Water Management (BSWM), Laguna Lake Development Authority (LLDA), People's Organizations, and the LGUs was created through the project. MWSS was inadvertently excluded in the said Inter-Agency Committee but was consulted for a time.

New house | 2-storey house | Vegetable farm using greenhouse

2-storey school | Basketball court | Drainage canal

Figure I-1.4 New Infrastructures in the Seven Barangays

People initially resented the DENR project because of the perception that DENR is just acting in connivance with the MWSS to pursue the Laiban Dam project. However, with the introduction of community projects, soon after, the project got the people's acceptance and cooperation.

Table I-1.3 – Newly Implemented Projects in the Seven Barangays

Newly Implemented Projects	Principal Agency	Status
Kaliwa River Watershed Management & Development Project	DENR	Completed in June 2005
San Andres Elementary School	LGU	Operational
Sto. Nino Elementary School	LGU	Operational
Sto. Nino High School	LGU	Operational
Tinukan Covered Court	LGU	Operational
Sto. Nino Covered Court	LGU	Operational

2. *The DAR is currently working on declaring the watershed as ancestral domain of the Dumagats.*

3. *Increase in population in the area*

4. *Acquisition and Titling of Land*

The stakeholders cited that some of the settlers which were surveyed returned to the site because of the lack of news/update from MWSS about the implementation of the project. Some of these settlers were already paid by MWSS. Families that were surveyed 20 years ago now have grown-up children with their own families as well. In addition, there are new settlers in the area.

An area of about 700 hectares has been acquired by Lucio Tan in Barangays Mamuyao and Sto.Nino. Settlers are now selling titles and rights to their land.

5. *Sangguniang Bayan (SB) resolution issued against the project*

   The SB passed a resolution against the project. The opposition is based on the delay in the implementation of the project which has caused uncertainties on the part of the stakeholders.

6. *Inadequate relocation area*

   The Mayor said that with the increase in population, the identified relocation site in San Ysiro, Antipolo may be inadequate. He added that settlers prefer the relocation site in Palayang Bayan because it is within Tanay. However, even with the addition of the relocation site, the Mayor foresees an insufficiency of area.

7. *Preference to the Laiban Low Dam + Agos Dam Option*

   The proposed Laiban Low Dam in Barangay Daraitan and Agos Dam option is preferred by the stakeholders because this would prevent the flooding of the seven barangays.

8. *Positive support of the Mayor to the Project*

   Mayor Tanjuatco stressed that he realizes the importance of the project. He approves of the project because it is for national interest. However, he noted that the stakeholders should be justly compensated. The Mayor does not want the lump sum payment scheme but rather a program that would look at the long-term production assessment and livelihood program for the stakeholders to achieve sustainable development.

9. *Warning on Instigators*

   Mayor Tanjuatco cautions against instigators because of a recent rally held in front of the municipality against the Laiban Dam project.

10. *MWSS should act ASAP*

Mayor Tanjuatco said that if MWSS is really serious with the Laiban project, then immediate action should be done. He added that it will be very hard to persuade the people later, when they can see good livelihood opportunities in the area. He added that MWSS should seek support from the President to make the Laiban Dam project one of her flagship projects and gain wider support by all sectors of society.

Further delays in implementing the project would result to stronger resistance, influx of more people in the watershed and continued implementation of development projects for the community.

11. Royalty for the Municipality from the Project

MWSS could look at the possibility of granting royalty to the municipality as host of the project.

Remarks and Recommendations
The project site is ideal as a water supply source but would have irreversible and adverse impacts to the environment. From the foregoing, it may be concluded that:

During the construction phase of the project, the potential impacts would include:

- Worker accidents
- Sanitation disease hazards
- insect vector hazards
- Hazardous materials handling
- Dust
- Odors
- Fumes
- Explosions/fires
- Noise and vibration
- Quarrying/blasting
- Water pollution

During operation, the project would present irreversible changes in the environment such as:

- Changes in downstream hydrology and water quality
- Loss of habitat and disturbance of breeding sites
- Loss of forest resources and arable lands
- Displacement of families and IPs
- Loss of economic activities

The environmental impacts associated with the construction phase of the project will be of limited duration except for the resettlement of the settlers.

The proposed project will be required to undertake an Environmental Impact Assessment (EIA) and to submit an Environmental Impact Statement (EIS) Report to the DENR as part of the requirements in securing the Environmental Compliance Certificate (ECC) based on Presidential Decree 1586. An Environmental Management Plan (EMP) will also be prepared as an integral part of the EIS Report to ensure risks are managed and mitigated during project implementation.

Although the project already carries a provisional ECC based on an EIS conducted in 1986, an environmental updating is necessary since the validity of the environmental baseline information for the project already lapsed. The environmental impact assessment should include but not limited to the following:

1. Geology and geohazard assessment
2. Hydrology and water quality of the river and its impact on land uses and downstream users
3. Survey of flora and fauna that will be affected
4. Updating of the survey of settlers and IPs
5. Cultural areas/monuments and possible ancestral domains of the Indigenous People
6. Loss of agricultural resources and scenic spots in areas
7. Resettlement of families
8. Management of waste materials and spoils
9. Development of a watershed management plan

The proposed relocation site shall also be covered by the EIS system and must be submitted for screening to the DENR. Likewise, an Engineering Geological and Geohazard Assessment Report (EGGAR) may be required by the Bureau of Mines and Geosciences (BMG) of the DENR for the Laiban Dam project.

The environmental management plan of the project should include a watershed management program that would ensure sustainable management of the ecosystem. The Inter-agency formed under the WB-DENR project should be sustained but should include MWSS.

The proposed project should gain support of the President as one of the flagship projects. The long wait of stakeholders since 1980s indicates a lack of decisiveness by the government to pursue the project.

A positive development is the support of the Mayor of Tanay to the proposed Laiban Dam project. However, the Mayor wants assurance that livelihood and just compensation is accorded to the stakeholders.

A resettlement and compensation program that is acceptable to the stakeholders should be developed. The program should include the identification of additional resettlement areas, development of livelihood programs for displaced families, and fair compensation program.

Current and planned development projects for the watershed should be aligned with the plan to develop Laiban Dam, otherwise, resources would be wasted and the project would have difficulty in gaining support of stakeholders.

Government has to act fast to control further development of the area and to immediately protect the watershed against human encroachment. The project could also look at the creation or revival of an Inter-Agency Committee which could be composed of the agencies comprising the committee created under the DENR project as well as from the Protected Area Management Board (PAMB). In this way, programs of all agencies would be in support of the development of Laiban Dam. The creation of the coordinative body would avoid conflicts, waste of resources, and perception of disorder among government agencies.

Appendix J – Current Regulations Relating to Water Supply

1. Presidential Decree No. 1067 - "The Water Code of the Philippines"

PD 1067 or "The Water Code of the Philippines" was issued in 1976 by then President Ferdinand E. Marcos. This code mandated the National Water Resources Council, the precursor of the National Water Resources Board (NWRB) jurisdiction over the utilization, exploitation, development, conservation and protection of water resources in the Philippines.

The Code specified regulations on appropriation, utilization, control and conservation of various water resources owned by the State.

Appropriation of Waters
Appropriation of water is the acquisition of rights over the use of waters or the taking or diverting of waters from a natural source in the manner and for any purpose allowed by law. Water may be appropriated for the following purposes: (a) domestic, (b) municipal (c) irrigation, (d) power generation, (e) fisheries, (f) livestock raising, (g) industrial and, (h) recreational. Some provisions on the Code regarding appropriation of waters include the following:

- The state, for reasons of public policy, may declare waters not previously appropriated, in whole or in part, exempt from appropriation for any or all purposes and, thereupon, such waters may not be appropriated for those purposes.
- Waters appropriated for a particular purpose may be applied for another purpose only upon prior approval of the NWRB and on condition that the new use does not unduly prejudice the rights of other permit holders, or require an increase in the volume of water.
- No person, including government instrumentalities or government-owned or controlled corporations, shall appropriate water without a water right, which shall be evidenced by a document known as a water permit.
- Only citizens of the Philippines, of legal age, as well as juridical persons, who are duly qualified by law to exploit and develop water resources, may apply for water permits.
- All water permits granted shall be subject to conditions of beneficial use, adequate standards of design and construction, and such other terms and conditions as may be imposed by the NWRB.
- Between two or more appropriations of water from the same sources of supply, priority in time of appropriation shall give the better right, except that in times of emergency the use of water for domestic and municipal purposes shall have a better right over all other uses.

Utilization of Waters
As stated in the Code, preference in the development of water resources shall consider security of the State, multiple use, beneficial effects, adverse effects, and cost of development. NWRB is tasked to promulgate rules and regulations and declare the existence of control areas for the coordinated development, protection, and utilization of subterranean or groundwater and surface waters.

Control area is an area of land where subterranean or ground water and surface water are so interrelated that withdrawal and use in one similarly affects the other. The boundary of a control area may be altered from time to time, as circumstances warrant.

Some important provisions on water utilization include:

- Works for the storage, diversion, distribution and utilization of water resources shall contain adequate provision for the prevention and control of diseases that may be induced or spread by such works when required by the Board.

- When the reuse of wastewater is feasible, it shall be limited as much as possible, to such uses other than direct human consumption. No person or agency shall distribute such water for public consumption until it is demonstrated that such consumption will not adversely affect the health and safety of the public.

- Authority for the construction of dams, bridges and other structures across of which may interfere with the flow of navigable or floatable waterways shall first be secured from the appropriate agencies.

- No person shall raise or lower the water level of a river stream, lake, lagoon or marsh nor drain the same without a permit.

- The banks or rivers and streams and the shores of the seas and lakes throughout their entire length and within a zone of three (3) meters in urban areas, twenty (20) meters in agricultural areas and forty (40) meters in forest areas, along their margins, are subject to the easement of public use in the interest of recreation, navigation, flotage, fishing and salvage.

Control of Waters
Some important provisions on water control include:

- The impounding of water in ponds or reservoirs may be prohibited by the NWRB upon consultation with the Department of Health if it is dangerous to public health, or it may order that such pond or reservoirs be drained if such is necessary for the protection of public health.

- Waters of a stream may be stored in a reservoir by a permit holder in such amount as will not prejudice the right of any other permit holders downstream. Whoever operates the reservoir shall, when required, release water for minimum stream flow.

- No person shall drill a well without prior permission from the NWRB. (Article 64)
- Water from one river basin may be transferred to another river basin only with the approval of the NWRB.

Conservation and Protection Water and Watershed and Related Land Resources
The tasks for protection and preservation of watershed and any area of land adjacent to any surface water or overlying any ground water were delegated to the DENR. The agency may declare such area as protected area. Other important provisions on water conservation include:

- In the consideration of a proposed water resource project, due regard shall be given to ecological changes resulting from the construction of the project in order to balance the needs of development and the protection of the environment.
- The conservation of fish and wild life shall receive proper consideration and shall be coordinated with other features of water resources development programs to ensure that fish and wildlife values receive equal attention with other project purposes.
- No person shall, without prior permission from the Environmental Management Bureau (EMB) build any works that may produce dangerous or noxious substances or perform any act which may result in the introduction of sewage, industrial waste, or any pollutant into any source of water supply.
- The establishment of cemeteries and waste disposal areas that may affect the source of a water supply or a reservoir for domestic or municipal use shall be subject to the rules and regulations promulgated by the Department of Health.
- Tailings from mining operations and sediments from placer mining shall not be dumped into rivers and waterways without prior permission from the NWRB upon recommendation by EMB.
- The application of agriculture fertilizers and pesticides may be prohibited or regulated by the EMB in areas where such application may cause pollution of a source of water supply.

2. Presidential Decree 705 – Revised Forestry Code

PD 705, which was promulgated in 1975, is one of the significant policy issuances in watershed management. The law governs the management, utilization and conservation of the country's forestlands including watersheds and reservations. It also provided for the formal definitions of a watershed and watershed reservation.

Under the law, critical watershed is viewed in relation to downstream infrastructure facilities. Although this definition is deemed inadequate and needs further consideration, PD 705 has served as the guideline in determining criticality of watersheds in relation to their classification/prioritization.

PD 705 accorded protected status to critical watersheds by prohibiting commercial logging and grazing operations therein. It also authorizes the President to proclaim portions of the public domain as watershed reservations in order to secure their protection and preservation.

3. Republic Act 7586 – National Integrated Protected Areas System Act

The Act covers all areas that prior to the effectivity on June 1, 1992, have been declared or designated through law, presidential decree, presidential proclamation or executive order, national park, game refuge, bird and wildlife sanctuary, strict nature reserve, watershed, mangrove reserve, fish sanctuary, natural or historical landmark, protected and managed landscape or sea escape as well as identified virgin forests. The law will also apply subsequently to all declared protected areas. It calls for the creation of NIPAS which will involve compilation of technical descriptions and maps, initial screening for suitability of the area, and baseline studies. DENR will recommend to the President and Congress areas, which will be declared as NIPAS.

Proposed water sources and their watershed may be included in the designated NIPAS. Any development on the site must be integrated in the protected area management plan and the general management planning strategy. The plan must promote the adoption and implementation of innovative management zones, buffer zones for multiple use and protection, habitat protection and biodiversity management.

4. Presidential Decree No. 1151 - Philippine Environment Policy

PD 1151 or the Philippine Environment Policy defines the general state policy on the pursuit of a better quality of life without degrading the environment. One of the most important provisions of PD 1151 was the requirement for all agencies and corporations to prepare an Environmental Impact Statement (EIS) for every project or undertaking, which significantly affects the quality of the environment.

PD 1151 also created the NEPC and recognized the strength on environmental protection and requirements of environmental impact assessment and environmental monitoring activities. The above functions were later transferred to the DENR as per Executive Order 192.

5. Presidential Decree No. 1152 - Philippine Environment Code

PD 1152 or the Philippine Environment Code establishes specific environmental policies and quality standards for a comprehensive program on environmental management. The law specifies the classification of water bodies according to best use. In cases where the quality of the water has deteriorated to a degree where its state will adversely affect its best usage, the government agencies directed under the law are required to take measures as may be necessary to upgrade the quality of the water to meet the standards.

6. Presidential Decree No. 984 - Pollution Control Law (1976)

PD 984 or The Pollution Control Law sets up the administrative and regulatory mechanisms for pollution control and establishes air and water quality standards that define maximum allowable limits of emissions and effluents from domestic, commercial and industrial activities.

PD 984 created the National Pollution Control Commission (NPCC) and gave them the powers with respect to control of air, water, and land pollution from point sources. The function of NPCC was subsequently passed on to the DENR by virtue of the department reorganization as per Executive Order 192.

In 1967, the first set of water quality criteria and effluent standards were promulgated by the NAWAPCO. The 1978 rules and regulations of PD 984 included provisions on air, water, land, noise, and odor pollution, including the ambient water quality criteria. The Effluent Standards was developed in 1982.

After the DENR reorganization in 1987, a review/revision of the standards was again undertaken, hence, developing what we now have as the Revised Water Quality Criteria of 1990 (DENR Administrative Order No. 34) and the revised Effluent Standards (DENR Administrative Order No. 35). DENR AO 34 classifies water bodies in accordance with its use and degree of protection required with Class AA and SA requiring the most stringent water quality. The prescribed allowable concentration of effluent from a building, facility, or wastewater treatment plant is outlined in DENR AO 35 (Revised Effluent Standards).

7. Presidential Decree No. 1586 – Establishing an Environmental Impact System (1978)

PD 1586 or the Environmental Impact Statement System established a landmark policy that required projects with potential adverse effects on the environment to obtain an Environmental Compliance Certificate (ECC) as a prerequisite for implementation.

Under the EIS System, a project proponent is tasked to undertake an environmental impact assessment (EIA) study and to prepare an Environmental Impact Statement (EIS) or an Initial Environmental Examination (IEE), depending on the scope of the project. The EIS/IEE is a written report containing an assessment of the most likely impacts of the project on the environment and on the people in the areas to be affected by the project. The EIS/IEE is submitted to the DENR for review and forms the basis for the approval or denial of the project's ECC application.

P.D. 1586 was further strengthened through DENR Administrative Order No. 37, series of 1996 and DENR Administrative Order No. 30, series of 2004. These refinements have clarified procedures for screening and scoping of projects, and expanded the application of the EIS system to programs (co-located or similar projects). However, while procedural compliance to the EIS system has been strengthened, there remain issues in speeding up the review of EIS documents themselves and the attendant issuance of ECCs.

The DENR has defined requirements for the issuance of the ECC for water supply development projects, including those involving water supply, as follows:

- **Environmental Impact Statement (EIS) / Initial Environmental Examination (IEE)**

Water resource development projects such as major reservoirs and dams require the preparation of EIS for the procurement of ECC. Small water impounding projects and water treatment plants are required under DENR Administrative Order No. 30 to submit the IEE Checklist report which is a simplified form designed by DENR to assist proponents in complying with the EIS system.

- **Social Acceptability**

The review of the EIS/IEE by the DENR is guided by three general criteria: (1) environmental considerations that are integrated into the overall project planning, (2) technically sound and effective environmental mitigation measures, and (3) social acceptability of the project. For projects required to submit the EIS, a public consultation process is required with the stakeholders to inform the public about the proposed project and to enhance community participation. All projects should submit proofs of social acceptability as a pre-requisite to the ECC.

It is the task of the proponent to initiate the public consultations to ensure that environmentally relevant concerns of the stakeholders are taken into consideration in the EIA study and in the formulation of the environmental management plan. All consultation meetings should be documented, validated by the DENR-EMB, and shall constitute part of the records of the EIA process.

- **Multi-Partite Monitoring Team and Environmental Monitoring Fund**

One of the standard conditions of the ECC is the formulation of a Multi-Partite Monitoring Team (MMT) immediately after the issuance of an ECC for environmentally critical projects like water resource development projects. The MMT shall be composed of representatives of the DENR-EMB, other relevant government agencies, the project proponent, and the local government unit. Likewise, the MMT shall put up an Environmental Monitoring Fund (EMF) for the operationalization of the MMT.

The MMT shall have the following functions:

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- ➢ Monitor project compliance with the Environmental Management Plan and the conditions set in the Environmental Compliance Certificate;
- ➢ Gather relevant information to determine cause of damage and public complaints/concerns about the project;
- ➢ Prepare, integrate, and disseminate monitoring status reports and submit recommendations to the DENR; and
- ➢ Undertake community information and education campaign program.

- **Environmental Guarantee Fund**

Environmentally critical projects that are determined by the DENR to pose significant risk or those projects that require rehabilitation or restoration are required to establish an Environmental Guarantee Fund (EGF).

The process also involves the formation of an EGF Committee to manage the fund. The committee shall be composed of representatives from the EMB Central Office, EMB Regional Office, affected communities, concerned LGUs, and relevant government agencies identified by the EMB.

- **Validity of ECC**

Based on Section 5.4.3 of DENR Administrative Order No. 30, series of 2004, the <u>ECC of a project not implemented within five years from the date of its issuance will be considered expired</u>. In case the project proponent intends to pursue the project, the proponent will then be required by DENR to apply for a new ECC. The reckoning date of the project implementation will be the date of the groundbreaking based on the work plan submitted to the DENR-EMB.

8. Republic Act 9275 – Philippine Clean Water Act

RA 9275, otherwise known as the Philippine Clean Water Act (CWA) was enacted into law last March 22, 2004. The act provides a comprehensive national water quality program to protect, preserve, and revive the quality of the country's fresh, brackish, and marine waters. The act primarily addresses the abatement and control of pollution from land-based sources and covers all water bodies (natural and man-made), bodies of fresh, brackish, and saline waters, and includes but not limited to aquifers, groundwater, springs, creeks, streams, rivers, ponds, lagoons, water reservoirs, lakes, bays, estuarine, coastal, and marine waters.

Scope and Lead Agencies for the Implementation of CWA
The CWA integrates the management and control of wastewater and water quality policies that were previously issued through various laws and are currently being implemented among various agencies. The CWA enables the creation and delegation of new regulatory, planning and infrastructure development functions to agencies and subsidiary multi-sectoral bodies and on streamlining inter-agency coordination.

The DENR is the lead agency tasked to implement and enforce the CWA and is accorded majority of the functions and responsibilities. However, the CWA recognizes areas for integration of the management and control of water pollution through strategies for complementary rulemaking by other agencies as mentioned in different laws.

Water Quality Management Areas (WQMA)
The CWA directs the DENR and the National Water Resources Board (NWRB) to designate WQMAs based on general ecological/hydrological, meteorological or geographic criteria rather than in accordance with existing political boundaries.

A Governing Board will administer the WQMA with the DENR acting as chair. The governing board will be composed of representatives of LGUs, relevant national government agencies, non-government organizations (NGOs), water utility sector, and business sector. The Governing Board is primarily tasked to oversee implementation of the WQMA action plans and review and revise the plans, as necessary. In addition, each management area can create a multi-sectoral group to conduct surveillance and monitoring.

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Appendix K – Key Agencies and Institutions Involved in Water Supply in the Philippines

1. Department of Environment and Natural Resources (DENR)

The DENR is the primary government agency responsible for the management, conservation, and development of forest lands and watersheds. It is also involved in the promulgation of rules and regulations for the control of water, air, and land pollution in the Philippines. The DENR was created through Executive Order 192.

The DENR has five (5) staff bureaus, namely: (1) Environmental Management Bureau (EMB), (2) Forest Management Bureau (FMB), (3) Land Management Bureau (LMB), (4) Ecosystems Research and Development Bureau (ERDB), and (5) Parks and Wildlife Bureau (PAWB). Through the EMB, the DENR formulates policies and guidelines for the enforcement of environmental protection and pollution control regulations. The classification of water bodies and the task of water quality monitoring are being undertaken by the EMB.

The FMB provides support to the DENR on forest development and conservation and in the implementation of the National Forestation Program.

2. Department of Public Works and Highways (DPWH)

The DPWH is the government agency that is in-charge with the design, construction, and maintenance of infrastructure facilities, particularly national highways, flood control, and water resources development systems, and other public works in accordance with national development programs. DPWH's responsibility extends to other infrastructure services such as highways, ports, flood control, water supply, school buildings, and urban community infrastructure.

The Metropolitan Waterworks and Sewerage System (MWSS) is an attached agency of the DPWH.

The Implementing Rules and Regulations (IRR) of NEDA Board Resolution No. 4, series of 1994 direct the DPWH to set the technical standards for engineering surveys, design, and construction of Level I water systems.

3. National Water Resources Board (NWRB)

The NWRB has the overall responsibility for coordination of water resources development and management. The agency, formerly known as the National Water Resources Council, was created in 1976 and is mandated to administer and enforce the Philippine Water Code. The NWRB is principally tasked with the coordination, regulation, and supervision of the ownership, appropriation, utilization, exploitation, development, conservation, and protection of the country's water resources.

The NWRB was previously composed of the secretaries of DPWH (chairman), DENR, DA, DOH, DTI, and NEDA as well as the heads of MWSS, NIA and LWUA. The new board is now composed of the secretaries of DENR (chairman), NEDA (vice chairman), DOF, DOJ, DOH, the head of the UP National Hydraulic Research Centre and the executive director of the NWRB Secretariat.

The NWRB regulates water use, resolves issues and conflicts in water resources management and development such as inconsistencies in fees and charges.

4. Department of Health

The Department of Health (DOH) is the principal government organization responsible for planning, implementation, and coordination of the policies and programs for public health protection and sanitation. DOH is mandated to ensure access to basic health services to all Filipinos through the provision of quality health care services. Its mission is to guarantee equitable, sustainable, and quality health for all Filipinos, especially the poor and to lead the quest for excellence in health.

The DOH through its Bureau of Research Laboratories (BRL) monitors drinking water quality with the Philippine National Standards for Drinking Water (PNSDW) as the index for determining the potability of water for drinking.

5. Local Government Units

Through the Local Government Code of 1991, the Philippines have implemented a decentralized form of government. As such, there are two main levels of government: central or national government and local government units. The policy described in the Local Government Code is to devolve authority to LGUs who will operate autonomously under the regulatory supervision of the National Government.

LGUs are responsible for the provision of basic services, such as water supply systems, sewerage, and sanitation, either directly or through contracts with the private sector. They are also empowered to collect taxes and fees necessary for providing these services.

The Local Government Code also mandates the LGUs to implement community-based forestry projects and manage communal forest with an area not exceeding five thousand (5,000) hectares and enforce forestry laws.

Appendix L – Role, Responsibilities, and Performance of MWSS and the Concessionaires

A. Role of MWSS

1. Overall Responsibility

MWSS is constituted under Republic Act No. 6234 (1971). It is not a registered company under Philippine Law, but in common with many water and sanitation agencies, it internationally operates as a government-owned, autonomous statutory corporation. Essentially, the defining duty for the company is to provide water and sewerage services to its defined service area, which is dominated by Metro Manila.

Within the concession-based delivery framework, the direct service delivery is delegated to the concessionaires, together with the right to operate the asset set. The assignment of the right to use the assets does not include transfer of title and ownership of assets existing at the commencement of the concession is retained in title by MWSS.

As noted above, under the concession agreement, MWSS operates primarily through two agencies, the Regulatory Office and the Corporate Office.

2. Regulatory Office

Constitution/Enabling Legislation
The Regulatory Office is constituted in concept under *Article 11* and in detail under *Exhibit A* of the Concession agreements. The features of *Exhibit A* are:

- The Office is composed of 5 appointed members who are demonstrably independent of MWSS and the Concessionaires. The members act as a governance board for the Office operations.
- The Office shall be physically separate from the MWSS and the Concessionaires.
- The staff of the Office shall be employees of MWSS for payroll and associated purpose but should otherwise be independent of MWSS and the concessionaires.
- The mandate of the Office is nominally to implement the provisions of the Concession agreements. In actuality, the role of the Office will evolve in detail over time but is generally consistent with single sector economic and performance regulation as it is practiced internationally.
- There is intent to extensively use consultants to augment the economic, financial and technical competence of the employees.

Business Plan
The Mission of the Office is declared in its Information Kit as:

(i) To ensure that the quality and level of service provided by the Concessionaires meet global standards and (ii) To balance the interests of the stakeholders.

The Office is established as an organization comprising four areas:

- Technical (Performance) Regulation;
- Financial/Economic (including financial modeling & analysis);
- Customer Service Performance; and,
- Administration and Legal.

There are approximately 70 employees.

Performance
The Regulatory Office is regarded by the stakeholders as well performing and generally all requirements of the concession agreements have been met.

The Office was supported in 2003 by an ADB-financed Technical Assistance Project, which addressed the practices, methodologies and procedures followed by the Office. The project methodology was generally focused on capacity building by workshops.

3. Corporate Office

Constitution/Enabling Legislation
The Corporate Office of MWSS is not explicitly defined by legislation or by the Concession Agreement. It arises in general out of *Article 8* of the Concession Agreement, which specifies the "Retained Functions" of MWSS. These are essentially:

- Facilitating the operations of the Concessionaires (by reinforcing the role of the concessionaires as an agent of MWSS as a principal);
- Loan Administration;
- Managing the "retained" assets, i.e. those not assigned to the concessionaires;
- General accounting and administration (particularly with regard to the financial arrangements with the concessionaires, e.g. in payment of the Concession Fee); and,
- Managing and operating the raw water conveyance of the Umiray-Angat Trans basin Project (UATP).

The functional organization of the Corporate Office is shown in **Figure L-1.1**. A more detailed description of the MWSS organizational structure is provided in *Working Paper No.1: The Role of MWSS.*

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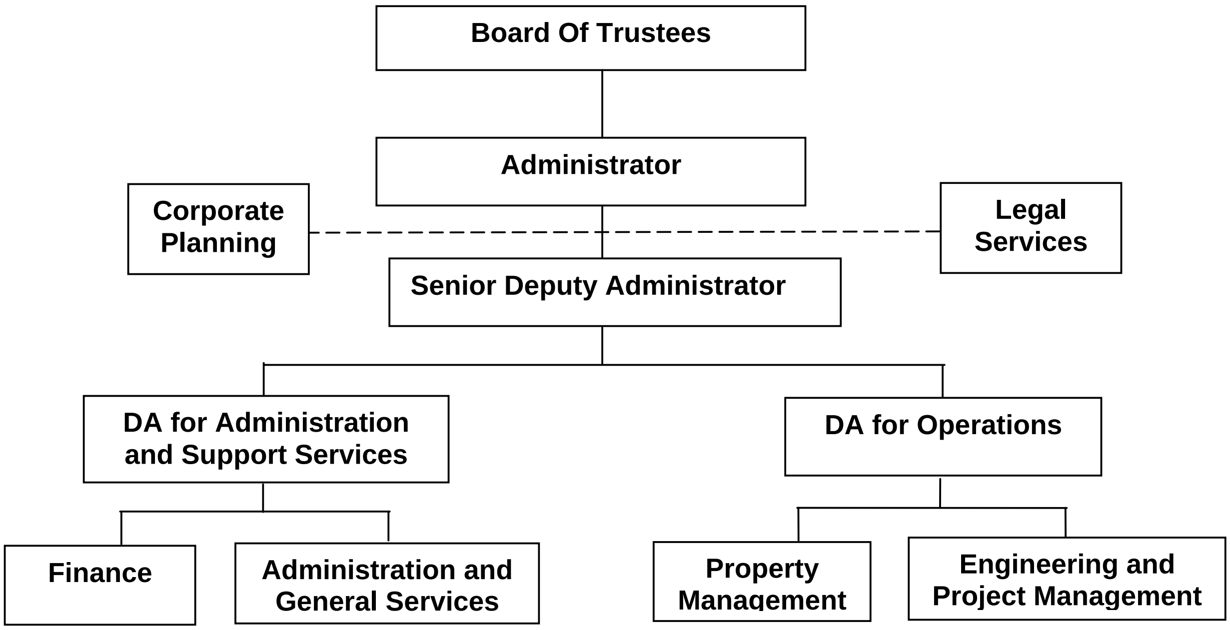

(Source: MWSS Website www.mwss.gov.ph updated)

Figure L-1.1 Organization of MWSS Corporate Office

The responsibilities of these groups are not explicitly stated in any of the concession documentation but are seen as:

Finance

To administer the debt portfolio of MWSS generally;

To administer the payments by the Concessionaires of the Concession Fee.

Administrative and General Services

To administer personnel affairs and perform general services functions.

Property Management

To oversee the retained assets, principally the real property (land and buildings) such as the complex in Quezon City, which houses the administration of the Corporate Office, the Regulatory Office, the Concessionaire Administrations and other entities.

Engineering and Project

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Management	To oversee and manage major projects such as UATP for which the Concessionaires are not responsible; To oversee the provision of raw water to the concessionaires; To oversee master planning projects such as the Manila Sewerage Project and the project that this paper is being prepared under.

Notably, the last two functions of the Engineering and Project Management group occur by default in that they are essential to the provision of services and span both concessions and there is no responsibility otherwise specified in the concession agreement.

B. The Concessionaires

1. General Responsibilities

The duties and responsibilities of the Concessionaires are detailed in *Article 5* of the Concession Agreement. Essentially they are to:

- Provide safe (potable) water supply to the connections in the concession area;
- Make new connections to the system in accordance with priorities prescribed in the concession agreement;
- Provide sewerage service to properties connected to sewer mains in the concession area;
- Provide septage collection service to unconnected property;
- Make new connections on request from property owners in accordance with priorities prescribed in the concession agreement; and,
- Overall, meet specified performance standards.

The Concessions are structured on the achievement of gradual performance targets set for a range of parameters of water and sewerage service coverage and quality.

2. Manila Water Company

Corporate Structure
Manila Water Company Inc. (MWCI) is owned by a consortium, which includes Ayala Corporation (a large Manila based Conglomerate) as majority shareholder and United Utilities, which is a subsidiary of North West Water Company of U.K.

The company launched an Initial Public Offering (IPO) in February 2005, which closed on March 9, 2005 and was heavily oversubscribed. The shares listed on the Philippines Stock Exchange (PSE) on March 18, 2005.

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The company shares are currently quoted at PhP 6.40 (7 October 2005) on the PSE indicating a current market capitalization of approximately US$ 235 Million. Based on the 31 December Balance Sheet Net Assets of US$ 123 Million there is an implied value of the Concession business of approximately US$ 112 Million.

Organizational Structure and Management

The company has a fairly standard organizational structure consisting of an operations functional group matched by a Project Delivery (Asset Development) group together with support groups in Business Management, Planning and Regulation, Finance and Human Resources Management reporting to the company President.

To a large extent the company's top and middle management have backgrounds outside of MWSS and often come from other Ayala entities.

Several functions are outsourced including leak repairs, civil construction and bill delivery/ cash collection. Pumps are vendor maintained.

Asset management is well-developed with an asset register developed for 90+% of above groundwater assets and a system of reporting, whereby the condition of below ground assets is reported whenever breaks are prepared.

Operational Performance

MWCI has the east concession, which includes many of the economic growth areas of Manila such as Makati, Cainta and Antipolo. Operational performance is generally regarded as meeting license requirements satisfactorily. There is some concern with regard to lack of progress in sewerage coverage; however, this is generally due to tariff issues on the part of customers.

MWCI have installed a comprehensive suite of SAP software, which is an internationally well-regarded business system targeted at operational performance. It will be interfaced with the ArcInfo and ArcView packages and the Asset Register.

Operational performance data for MWCI for the years 2002 to 2004 is shown in **Table L-1.1.**

Table L-1.1 - Operational Data for Manila Water Company Inc.

Indicator	2002	2003	2004
Population Served	3.40 M	3.21 M	3.45M
No. of Water Connections	369,699	396,778	425,802
Water Production (MLD)	1,663	1,578	1,518
Water Service Coverage	82.1%	75.0%	78%
Sewer Service Coverage	2.9%	7.4%	6.9%
No. of Sewer Connections	10,520	29,334	29,406
Septic Tanks Desludged	5,724	11,130	17,674
Water Availability (hrs/day)	21	21	21
No. of Staff	1,516	1,515	1,516
Reported Leaks	38,255	-	221*
Leaks Repaired	37,464	30,221	221*
Non Revenue water	52.4%	52.1%	47.5%

Urban Poor Connections	22,160	33,833	43,771

Source: MWSS Regulatory Office
Note: Population served was computed based on 9.2 persons per connection until 2002 and 8.1 persons per connection from 2003 onwards.
*Refers only to main pipes

Capital Expenditure and Expansion Commitments

Actual and planned capital expenditure is detailed in **Table L-1.2** below.

Table L-1.2 - Capital Expenditure Actual and Planned

Period	Direct (PhP Bn)	Concession Fee Based (PhP Bn)	Total (PhP Bn)
Actual to Dec. 31, 2004	6.4	2.5	8.9
Water System	34.8	105.5	140.3
Wastewater System	7.1		7.1
Management and Overhead System	2.9		2.9
Total Planned (2005-2022	**44.8**	**105.5**	**150.3**

Source: IPO Document MWCI
Notes:
Direct expenditure is recoverable over the concession period.
Concession fee-based expenditure is funded through MWSS loans.

3. Maynilad Water Services

Corporate Structure

As of July 2005, the ownership of Maynilad water Services (MWSI) is subject to restructure due to previous insolvency. The restructure is an outcome of a submission, which was made in late 2003 by MWSI to the Quezon City Regional Trial Court to seek protection from the company's creditors. MWSS is a major creditor due to the failure by MWSI to pay its concession fees since 2002.

The court has now approved a 'Rehabilitation Plan' submitted by the company and approved by its creditors. The plan details reconstruction of the company in ownership terms as well as operational plans to trade out of insolvency.

The Rehabilitation results in 84% of the equity in the company being held by MWSS as a result of debt for equity and creates a significant propriety issue with regard to the appropriateness of the Regulatory Office remaining within the MWSS corporate framework. The remaining equity will be held by the Suez group, which is an existing minority shareholder.

It is the intent of MWSS that its majority ownership of MWSI will be interim, i.e. for a maximum of approximately two years with the ownership returning to the private sector by sale of its holding or by a comprehensive sale of the company. The issues that arise out of the potential sale are discussed in Section 7.4.4.

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Organizational Structure and Management
MWSI has a similar flat structure to MWCI. Its management generally has been drawn more from previous MWSS employees rather than new employees.

Operational Duties and Responsibilities
MWSI has the Western concession, which is reportedly dominated by older infrastructure, particularly in water distribution mains with consequent high levels of main breaks.

The relevant operational data for MWSI is shown below in **Table L-1.3**.

Table L-1.3 - Operational data for Maynilad Water Services Inc.

Indicator	2002	2003	2004
Population Served	5.27 M	4.75 M	4.88 M
No. of Water Connections	573,194	585,953	602,821
Water Production (MLD)	2,362	2,313	2,276
Water Service Coverage	77.7%	68.9%	69.9%
Sewer Service Coverage	10.0%	9.6%	9.1%
No. of Sewer Connections	57,555	56,305	55,080
Septic Tanks Desludged	9,843	16,017	7,645
Water Availability (hrs/day)	21	21	21
No. of Staff	2,427	2,381	2,369
Reported Leaks	98,611	50,778	71,502
Leaks Repaired	92,189	43,328	69,514
Non Revenue water	68.7%	69.5%	69.0%
Urban Poor Connections	63,370	74,266	83,220

Source: MWSS Regulatory Office
Note: Population served was computed based on 9.2 persons per connection in 2002 and 8.1 persons per connection from 2003 onwards.

Capital Expenditure and Expansion Commitments
The MWSI capital program is subject in the main to the Rehabilitation Plan. An indication of the likely capital expenditures is given in a concept paper, prepared by MWSI, which is intended to lead to World Bank funding for major infrastructure as shown below in **Table L-1.4**.

Table L-1.4 - MWSI Planned Capital Expenditure 2004-2010

Program Component	Indicated Expenditure (2004-2010) (PhP Million)
3R (Recover Reallocate Resell) Program	7,626
3R Support Program	1,799
Operations Support	2,213
Medium Term	2,124
Total	**13,762**

Source: Concept Paper for the World Bank Package MWSI

It is notable that the Operations Support and Medium Term programs (directed at business expansion) are dominated by water supply expenditure and sanitation (septage management) and have no significant expenditures on sewerage works. Sewerage development is nominally planned for post 2010.

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PANGASIWAAN NG TUBIG AT ALKANTARILYA SA METRO MANILA
Metropolitan Waterworks and Sewerage System

TA for the Strengthening of MWSS's Planning Capability in Water Supply, Sewerage and Sanitation Service Provision
IBRD Grant No. TF053321

WATER SUPPLY, SEWERAGE, AND SANITATION MASTER PLAN FOR METRO MANILA

VOLUME 3
SEWERAGE AND SANITATION MASTER PLAN – Situation Analysis

FINAL REPORT

November 2005

SINCLAIR KNIGHT MERZ (PHILIPPINES), INC.

in association with

DCCD ENGINEERING CORPORATION

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Acronyms and Abbreviations

AALA	-	Agreement Amending Loan Agreement
ADB	-	Asian Development Bank
ADWF	-	Average Dry Weather Flow
AIC	-	Average Incremental Cost
AWSOP	-	Angat Water Supply Optimisation Project
BOD	-	Biological Oxygenation Demand
BOT	-	Build Operate Transfer
BRL	-	Bureau of Research Laboratories
BSWM	-	Bureau of Soils and Water Management
CA	-	Concession Agreement
CAD	-	Computer-Aided Design
CARP	-	Comprehensive Agrarian Reform Program
CAS	-	Conventional Activated Sludge
CCC	-	Capital Contribution Charge
CERA	-	Currency Exchange Rate Adjustment
CFR	-	Code of Federal Regulations
CHD	-	Center for Health Development
CLUP	-	Comprehensive Land Use Plan
COD	-	Chemical Oxygen Demand
CO	-	Corporate Office
CPLR	-	Cumulative Pollutant Loading Rate
CST	-	Communal Septic Tank
CVM	-	Contingent Valuation Method
CWA	-	Clean Water Act
CWA-IRR	-	Clean Water Act-Implementing Rules and Regulations
DA	-	Department of Agriculture
DAF	-	Dissolved Air Flotation
DAO	-	Departmental Administrative Order
DANR	-	Department of Agriculture and Natural Resources
DAR	-	Department of Agrarian Reform
DBP	-	Development Bank of the Philippines
DBM	-	Department of Budget and Management
DCCD	-	Design Consultation Construction Management Engineering Corporation
DENR	-	Department of Environment and Natural Resources
DEWATS	-	Decentralized Dirty Water Systems
DI	-	Ductile Iron
DOE	-	Department of Energy
DOF	-	Department of Finance
DOH	-	Department of Health
DOJ	-	Department of Justice
DPWH	-	Department of Public Works and Highways
DTI	-	Department of Trade and Industry
ECC	-	Environmental Compliance Certificate
EIRR	-	Economic Internal Rate of Return
EIS	-	Environmental Impact Statement
EO	-	Executive Order

EMB	-	Environmental Management Bureau
EMC	-	Environmental Management Committee
EMP	-	Environmental Management Plan
ERDB	-	EcoSystems Research and Development Bureau
ESC	-	Environmental Sanitation Clearance
EUFS	-	Environmental User Fee System
FCDA	-	Foreign Currency Differential Adjustment
FGD	-	Focus Group Discussion
FIES	-	Family Income and Expenditure Survey
FIRR	-	Financial Internal Rate of Return
FMB	-	Forest Management Bureau
FPA	-	Fertilizer and Pesticides Authority
FRP	-	Fiberglass Reinforced Pipe
FTI	-	Food Terminal Inc.
GDP	-	Gross Domestic Product
GIS	-	Geographic Information System
GLS	-	Gas, Liquid, or Solid
GP	-	Grinder Pump
GPS	-	Global Positioning System
GRDP	-	Gross Regional Domestic Product
HLURB	-	Housing and Land Use Regulatory Board
HUDCC	-	Housing and Urban Development Coordinating Council
ICC	-	Investment Coordinating Committee
IEPC	-	Industrial Efficiency and Pollution Control
IPO	-	Initial Public Offering
IRR	-	Implementing Rules and Regulations
ISP	-	Information System Plan
IWL	-	International Water Limited
JICA	-	Japan International Cooperation Agency
JMM	-	James M. Montgomery
LAREC	-	Luzon Agricultural Research Center
LBP	-	Land Bank of the Philippines
LGU	-	Local Government Unit
LLDA	-	Laguna Lake Development Authority
LMB	-	Land Management Bureau
LMTP	-	La Mesa Treatment Plant
LOI	-	Letter of Instruction
LWUA	-	Local Water Utilities Administration
MCA	-	Multi-criteria Analysis
MCSP	-	MSSP Community Sanitation Project
MCSS	-	Manila Central Sewerage System
MDU	-	Mobile Dewatering Units
MEERA	-	Modern Equivalent Engineering Reference Asset
METROSS	-	Metro Manila Sewerage and Sanitation
MM	-	Metro Manila
MMEIRS	-	Metro Manila Earthquake Impact Reduction Study
MMDA	-	Metro Manila Development Authority
MMT	-	Multi-partitie Monitoring Team
MOA	-	Memorandum of Agreement
MOSS	-	MWSS Operational Strengthening Study

MRB	-	Medium Rise Buildings
MSITS	-	Medium Scale Inland Treatment System
MSSP	-	Manila Second Sewerage Project
MSWDP	-	Manila South Water Distribution Project
MTDP	-	Medium Term Development Plan
MTSP	-	Manila Third Sewerage Project
MWCI	-	Manila Water Company Inc.
MWSI	-	Maynilad Water Services Inc.
MWSP	-	Manila Water Supply Project
MWSS	-	Metropolitan Waterworks and Sewerage System
NAIA	-	Ninoy Aquino International Airport
NCR	-	National Capital Region
NEDA	-	National Economic Development Authority
NEPC	-	National Environmental Protection Council
NGO	-	Non-Government Organisation
NHA	-	National Housing Authority
NHMFC	-	National Home Mortgage Finance Corporation
NIA	-	National Irrigation Administration
NJS	-	Nippon Jogesuido Sekkei Co.
NPC	-	National Power Corporation
NPPC	-	National Pollution Control Commission
NPV	-	Net Present Value
NRW	-	Non Revenue Water
NSO	-	National Statistics Office
NTP	-	Notice to Proceed
NWRB	-	National Water Resources Board
OD	-	Oxidation Ditch
O&M	-	Operation and Maintenance
PAWB	-	Parks and Wildlife Bureau
PAWS	-	Public Assessment of Water Services
PC	-	Pollutant Concentration
PCG	-	Philippine Coast Guard
PD	-	Presidential Decree
PHILVOLCS	-	Philippine Institute of Volcanology and Seismology
PNOC	-	Philippine National Oil Company
PNSDW	-	Philippine National Standards for Drinking Water
PROGRESS	-	Program to Eliminate Sewage from the Streets
PRRC	-	Pasig River Rehabilitation Commission
PRRP	-	Pasig River Rehabilitation Program
PSE	-	Philippine Stock Exchange
PCG	-	Philippine Coast Guard
PSP	-	Private Sector Participation
PVC	-	Polyvinyl Chloride
PV	-	Present Value
QS	-	Qualification Standards
RA	-	Republic Act
RAS	-	Return Activated Sludge
RBC	-	Rotating Biological Contactor
RCP	-	Reinforced Concrete Pipe
RO	-	Regulatory Office

ROW	-	Right of Way
RP	-	Republic of the Philippines
RR	-	Rate Rebasing
SAP	-	Strategic Action Paper
SBR	-	Sequencing Batch Reactor
SKM	-	Sinclair Knight Merz
SpTP	-	Septage Treatment Plant
SME	-	Small and Medium Enterprises
SMP	-	Sewerage Master Plan
SRA	-	Sugar Regulatory Administration
SRT	-	Sludge Retention Time
SSMP	-	Sanitation and Sewerage Master Plan
STAMP	-	Septic Tank Management Program
STED	-	Septic Tank Effluent Disposal
STEP	-	Septic Tank Effluent Pump
STGS	-	Septic Tank Gravity System
STP	-	Sewerage Treatment Plant
TA	-	Technical Assistance
TDS	-	Total Dissolve Solids
TF	-	Trickling Filter
TKN	-	Total Khedhal Nitrogen
TOR	-	Terms of Reference
TS	-	Total Solids
TSS	-	Total Suspended Solids
TW	-	Treatment Works
UASBR	-	Upflow Anaerobic Sludge Blanket Reactor
UATP	-	Umiray-Angat Transbasin Project
UP	-	University of the Philippines
UP NEC	-	University of the Philippines National Engineering Center
USEPA	-	United States Environmental Protection Agency
VAT	-	Value-Added Tax
WACC	-	Weighted Average Cost of Capital
WAS	-	Waste Activated Sludge
WB	-	World Bank
WEF	-	Water Environment Federation
WHO	-	World Health Organization
WTP	-	Willingness-to-Pay/Water Treatment Plant
WWTP	-	Wastewater Treatment Plant

Units

°C	-	degree Celsius
g	-	gram
gpcd	-	grams per capita per day
ha	-	hectare
kg	-	kilogram
kL	-	kilo liter
km	-	kilometer
kPa	-	kilo Pascal
kW	-	kilo Watt

lpcd	-	liter per capita per day
l/cap/yr	-	liter per capita per year
m	-	meter
m^2	-	square meter
m^3/d	-	cubic meter per day
mg/l	-	milligrams per liter
ML	-	Mega Liters
MLD	-	Mega Liters per Day or Million Liters per Day
mm	-	millimeter
PhP	-	Philippine peso
P/m^3	-	Peso per cubic meter
sq. km.	-	square kilometer
US$	-	United States Dollar

Abstract

The Metropolitan Waterworks and Sewerage System service area consists of 16 cities and 21 municipalities with a 2000 population of 12.4 million that is projected to increase to 19.5 million by 2025. Domestic sewage is reported to account for 60 to 65% of the pollution loading on the Pasig River as Metro Manila is only about 12% sewered. Those in Metro Manila not connected to sewerage are served by over 2 million ill-maintained septic tanks, with almost no pump out services, which overflow into the storm drains. Up to 30% of these septic tanks are estimated to be inaccessible for pumpout.

Storm drains ultimately terminate in local esteros, to rivers (Pasig River being the major one) and eventually to either Manila Bay or to the potential future water source Laguna de Bay. These three main receiving waters in Metro Manila exhibit varying degrees of environmental degradation in spite of being a source of food, livelihood, employment, and recreation to an estimated 23 million Filipinos within its 17,000 km^2 watershed (World Bank). A World Bank report in 2003 indicated that water pollution costs the Philippine economy P67b ($US1.22b) per year, inclusive of health costs, fishery damage and loss of tourism.

MWSS received a Technical Assistance (TA) grant from the World Bank to affect a partial update of the Water Supply Master Plan and the preparation of a comprehensive Master Plan for Sewerage and Sanitation for the MWSS service area, covering the planning time horizon of 2005 to 2025.

There were three sewerage and sanitation master plans prepared prior to MWSS being privatized in 1997 to two private concessionaires: Manila Water Company, Inc. for the East Zone of the MWSS service area and Maynilad Water Services Inc. for the West Zone. All the master plans were either not implemented or only partially due to proposing conventional, large-bore, gravity sewerage systems that were too expensive to implement. This was been compounded by the fact that in the last few years dirty water (sewage) management has had a low priority as evidenced by the fact that only three percent (3%) of the budget allocated for water projects in the Philippines is channelled to sanitation and sewerage. A willingness-to-pay survey conducted as part of this study, however, indicated that around 75% of the 2,000 participants, spread across the service area, were willing to pay 20 to 40% on top of their water bills for improved sewerage and sanitation.

The most suited options for Metro Manila for sewerage, sanitation and treatment were identified by evaluating the options for each with a multi-criteria analysis (MCA). Amongst the constraints considered in the MCA, affordability was heavily weighted. The MCA identified:

- *Sanitation*- the Aqua Privy was the most suitable sanitation for lower income, informal settlements with no public toilets and the two chamber septic tank was preferred over other septic tank designs,
- *Sewerage*- combined drainage scored the highest due to its lower capital cost but was followed closely by the small-bore sewerage options such as Septic Tank Effluent Disposal or STED and condominial, and
- *Treatment*- a system that contains a combination anaerobic-aerobic biological treatment scored the highest due to its lower operating costs. A purely aerobic biological treatment was second ranked for use with dilute sewage.

The MCA, consultation with MWSS and the two concessionaires, and a review of the available documentation helped identify the overall strategy for the Sewerage and Sanitation Master Plans:

- Keep Septic Tanks (over 2m already); Pump Out Tanks Regularly, Catch Overflow for Treatment;
- Use Combined Drainage & Small-bore Sewerage for decentralised systems; and
- Move Sewage from East to West (away from Laguna Lake Water Source) in Continually More Centralised Plants.

The Sanitation Master Plan recognized that the keeping of septic tanks and the use of STED would have to involve an active sanitation program, which includes active septic tank pumpouts and subsequent treatment of septage to DENR Class C standards. Three septage treatment plants were being bid as of November 2005. To cover the whole of the planning period of 2005 to 2005, additional trucks will have to be purchased as will additional treatment capacity constructed. The Sanitation Master Plan proposed a schedule for these activities at a cost of Php7.02 b ($US128 m) in 2005 currencies. O & M costs would rise from P196m ($US3.6m) per annum in the first five years to P484m ($US8.8m) by 2025.

Dirty water (sewage) flows were taken as 80% of water consumption plus infiltration for the study. The MWSS service area was split up into 31 separate drainage catchments and each was analysed for the best system to suit its particular circumstances. Areas that had good drainage received combined drainage, all other areas received STED reticulation. Priority was assigned by the concessionaire sewerage targets that came out of the 2003 Rate Rebasing. After the concession period of 2021 to 2025, priority was assigned according to population density, environmental sensitivity and the ability to pay. A plan was also advanced for the period well beyond the planning period of 2025.

The cost of sewerage for the planning period was Php52b ($US0.95b) in 2005 currencies, comprised of reticulation (40%), trunk main sewers (8%), 16 STPs (39%), and land of 34 ha (13%). At the end of the planning period sewerage coverage would amount to 33%. The financial analyses revealed that for sanitation, the tariff based on average increment cost (AIC) at a discount rate of 10.4% was lower that the willingness-to-pay (WTP) level and Affordability rates (i.e. 5% of household mean income for water). This was not true for the case of sewerage, where the AIC rates for both West Zone and East Zone were much higher than the WTP and Affordability rates. The total water bill when sewerage is taken into account would be about 6 percent to 9 percent of the household mean income of Php20,856 per month.

One way to resolve this apparent un-affordability of even low-cost sewerage would be employ a cross-subsidy among consumer groups. A flat fee as a percentage of the water bill could be charged to all water customers, whether they are connected to sewerage or not. The individual tariff would subsequently be lowered to a more affordable level and everyone benefits from environmental improvement. It should be noted that all options had Economic Internal Rate Return (EIRR) values that exceeded the economic opportunity cost of capital of 12%.

1. Introduction

1.1 Background

The Metropolitan Waterworks and Sewerage System (MWSS) is a Philippine government owned and controlled corporation responsible for the provision of water, sewerage and sanitation services in Metro Manila (MM). In 1997, its operations became privatized through entering into concession agreements with two concessionaires who now are responsible for the provision of water, sewerage and sanitation services: the Manila Water Company Inc.(for the East Zone of Metro Manila) and Maynilad Water Services Inc. (for the West Zone of Metro Manila).

The concessionaires are to provide water supply services to meet Philippine National Drinking Water Standards; sewerage services to meet all national and local government laws and standards; and septic and sanitation cleaning services, defined as the emptying of domestic septic tanks and subsequent sludge management at regular intervals of five to seven years, in accordance with the Concession Agreements.

The MWSS service area consists of 16 cities and 21 municipalities with a population of 12.4 million as of the year 2000. Population influx into Metro Manila, unregulated industrial development and the absence or non-implementation of zoning ordinances and environmental regulations have overloaded the infrastructure and promoted rapid environmental deterioration.

Domestic wastewater is reported to account for 50% of the total water pollution in the Philippines and about 65% of the pollution loading on Pasig River. Metro Manila is estimated to be between 8 and 12% sewered, with the Central Sewerage System in Manila City contributing over 80% of this amount. Sewage from this system discharges through an extended outfall into Manila Bay. The remaining 20% of the existing sewered areas discharge to sewage treatment plants in Makati, Dagat-Dagatan and several small, decentralized sewage treatment facilities in Quezon City. There are also various sewerage systems serving a mix of residential and commercial developments, including new systems serving new real estate property development by private developers. The rest of the population of the service area is either connected to over 2 million septic tanks that are rarely pumped out and overflow into the storm drains and ultimately to rivers and esteros and Manila Bay or Laguna de Bay, or unconnected to any form of sanitation facility but discharge directly to the storm water system.

There is a need for MWSS to produce high quality strategic planning to meet the water and sanitation/sewerage needs of an expanding service population for the next 20 years. To this end, MWSS has received a Technical Assistance (TA) financing from the World Bank, through the Japan Policy and Human Resources Development, toward the cost of the Strengthening of Planning of Water Supply, Sewerage and Sanitation Services in the service area of MWSS. Under this financing, MWSS applied part of the proceeds for consultant services that included:

a) Updating of the MWSS water supply, sewerage and sanitation master plan, including developing specific plans to address government efforts in cleaning-up of Pasig River and Manila Bay as well as the possible passage of Clean Water Act;

b) Analysis of technical options and identifying least cost options to address environmental degradation in Metro Manila;

c) Determining the appropriate policy on sewer charges, including the extent of subsidy, as necessary; and

d) Conduct of a study on willingness to pay of communities for sewerage and sanitation services.

MWSS internationally tendered the work in 2004 and work was commenced in March 2005 by the winning consultants, Sinclair Knight Merz in association with DCCD Engineering Corporation.

1.2 Scope of Report

This report presents a full update of the previous Sewerage and Sanitation Master Plans prepared for Metro Manila. The most recent was the 1996 Water Supply and Sewerage Master Plan prepared for MWSS and the Japanese International Cooperation Agency (JICA) by Nippon Jogesuido Sekkei Co. Ltd (NJS). Subsequent to this, separate sewerage and sanitation master plans for the East and West Zones were prepared for the concessionaires, viz. for the West Zone by PhilAqua Consultants (2000) and for the East Zone by NJS (2004). The West Zone Master Plan was not officially accepted and is not currently being implemented. However, the East Zone Master Plan became the basis for the Manila Third Sewerage Project (MTSP) that is funded under a World Bank loan.

The scope of this report was to develop an integrated strategy for sewerage and sanitation services across the entire MWSS service area that will take into account the targets, plans and programs of the concessionaires, including MTSP. The strategy was to address the environmental degradation of the water bodies in Metro Manila by providing affordable solutions to the disposal and treatment of domestic wastewater within and beyond the concession period.

The report therefore examined existing sewerage and sanitation facilities and the targets, plans and programs of the concessionaires in the context of recommending least cost technical solutions for sanitation, wastewater collection and treatment. Issues that have constrained the development of sewerage and sanitation facilities in Metro Manila in the past were examined in order to guide the strategy such that these constraints could be addressed. Taking into account the targets of the concessionaires, short, medium and long-term strategies for sewerage and sanitation were developed and costed. Phased development programs covering the Master Plan planning periods were prepared, based on affordability and willingness-to-pay criteria. A willingness-to-pay survey was conducted with respondents from the East and West Zones to provide input into the Master Plan. Options for charging consumers for sewerage and sanitation services were also developed.

The report also examined the institutional framework needed to support future planning and implementation of sewerage and sanitation development in Metro Manila to effectively deliver the Master Plan. Recommendations on strategies to strengthen the MWSS's capability and capacity were made to enable MWSS to more efficiently deliver their services.

The study drew heavily on the plans and knowledge of MWSS and the two concessionaires, Manila Water Company Inc. (MWCI) and Maynilad Water Services Inc. (MWSI), whose assistance in the preparation of this study is acknowledged and is greatly appreciated.

1.3 Study Objectives

The objectives of the study were to:

1. Analyze government policies, laws and regulations for the sector (including the Clean Water Act) and liaise with the regulatory agencies in the sector, including DENR and LLDA to determine the environmental and other targets for the sector.
2. Analyze the implementation constraints in the sewerage and sanitation sectors existing in Metro Manila and determine the implication of these on both a centralized or decentralized strategy for service provision.
3. Analyze different scales of potential decentralization, paying particular attention to the widely varying land use types in Metro Manila.
4. Analyze ways in which a decentralized system could be implemented in the short term such that in the future, gradual centralization can occur through, for example, connections between the decentralized systems.
5. Analyze the state of the existing sewerage and sanitation system to ensure the use of this existing system is maximized.
6. Based on the analyses carried out, establish in agreement with MWSS, the overall long-term strategy for the sewerage and sanitation sectors in Metro Manila.
7. Review MWSS' master plan prepared in 1996 prior to privatization, the subsequent wastewater strategy prepared by MWCI and other relevant existing planning documents and determine areas for updating considering progress made in service provision by the concessionaires and the targets and strategies developed for the long-term strategy.
8. Review the master plans and investment programs of the concessionaires that were prepared within the context of the Concession Agreement and subsequent rate rebasing to ensure they are consistent with the Consultant's updated master plans.
9. Conduct a full technical assessment of the pilot sewage treatment plants, communal septic tanks, septage facilities and other infrastructure already constructed by MWCI in the east zone to assess their repeatability in other areas of the city.
10. Conduct an analysis of technical options (including but not limited to those piloted by MWCI). Determine least cost options within the overall framework of the agreed master plan strategy considering global best practices.

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11. Prepare an updated MWSS sewerage and sanitation master plan to the year 2025, including cost, economic and financial analysis and with optimized five-yearly implementation plans.
12. Using a methodology that focuses on stakeholder consultation, conduct a willingness-to-pay survey of consumers presenting different levels of cost recovery and determining at what level of cost recovery private benefits could be internalized in the sewer charge.
13. Conduct an analysis of the affordability of sewer charges considering the updated sewerage and sanitation master plan and propose a policy of cost recovery, including any subsidies, as necessary.

1.4 Study Area

The study area addressed by this full update of the sewerage and sanitation master plan for Metro Manila is shown in **Figure 1.1.** This is the MWSS service area that currently covers 16 cities and 21 municipalities within the National Capital Region, the Province of Rizal and the Province of Cavite with a total land area of approximately 2,371 square kilometers.

The area comprises the two concession areas defined for water, sewerage and sanitation services delivery in Metro Manila, which makes up the total MWSS service area. The study area is essentially defined based on municipal boundaries rather than geophysical or supply limiting borders.

Further detailed description of the study area is found in Chapter 2.

1.5 Target Year

The Terms of Reference for the Study defined the time frame for the Master Plan to be up until 2020. However, there was also a requirement that a Master Plan be prepared that would consider the requirements both up to and beyond the end of the concession period in 2022. There are always risks in accurately planning for an excessive future time period, due to changes in social, economic and environmental conditions that can impact on many of the assumptions such as population projections, water demand, and affordability of services.

The National Government agencies and the LGUs limit their planning and population projections to about 20 years. This is a reasonable approach given the current residential growth rates in Metro Manila. Future population projections can be influenced by changes in government policies such as family planning and birth control programs. The spatial allocation of population may vary depending on future transportation and land development programs that cannot be foreseen at the present time.

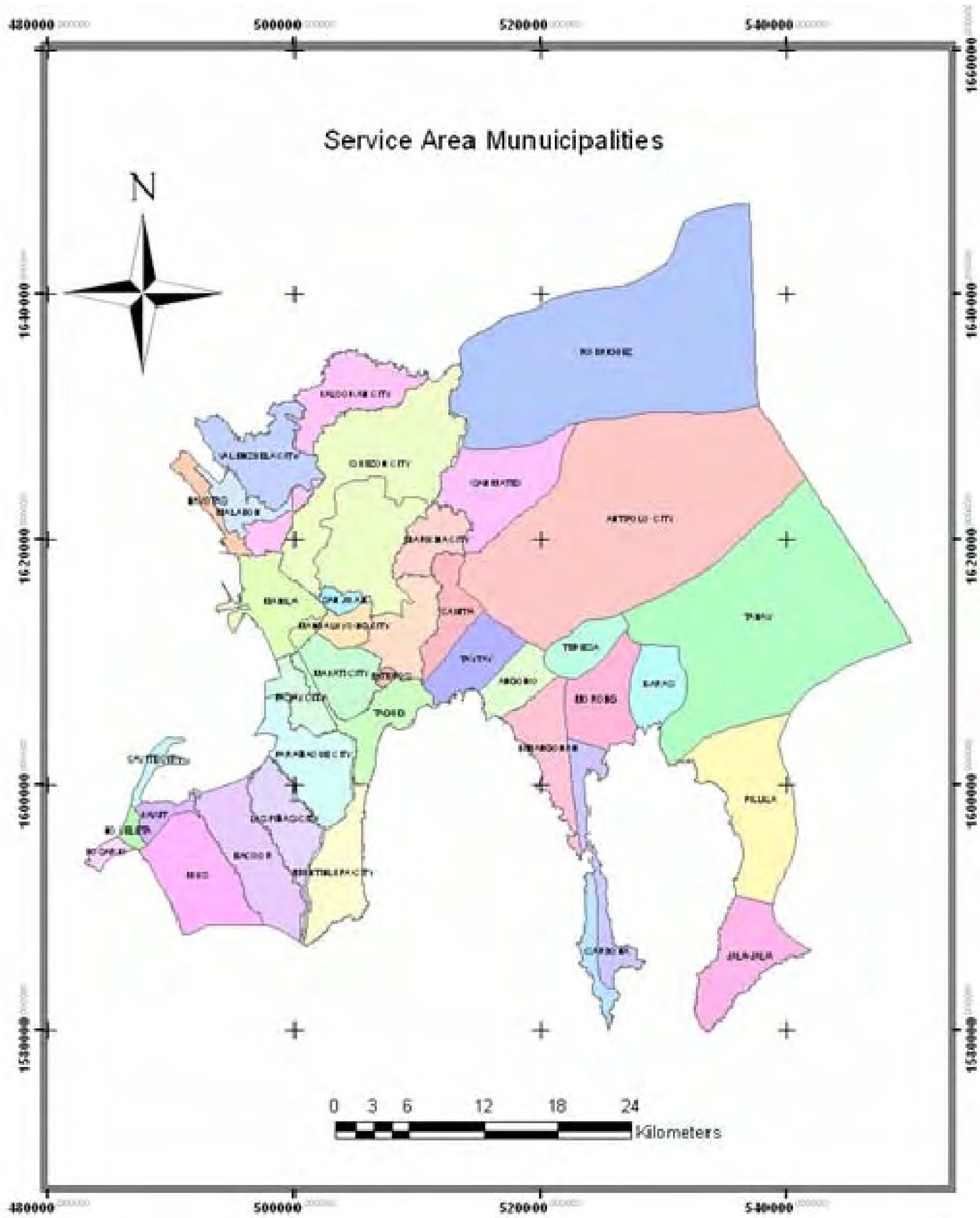

Figure 1.1 MWSS Service Area, 2000

Overall, it was considered that a timeframe of 20 years is reasonable for this update of the sewerage and sanitation master plan for Metro Manila, culminating at Year 2025.

1.6 Basis of Study

This study sourced data from previous Master Plans and studies, from information provided by the MWSS Corporate and Regulatory Offices and from the concessionaires. However, all significant existing facilities were inspected by the study team. Cost data was obtained from a number of different sources and approaches to sanitation, sewerage, and sewage treatment were developed as an independent assessment of the possible alternatives.

Some of the key documents used for reference on this study included:

- *Master Plan for a Sewerage System for the Manila Metropolitan Area – Final Report* (December 1969), Black and Veatch
- *Sewerage and Sanitation Master Plan for Metro Manila* (1979), JMMontgomery and DCCD.
- *Study on Water Supply and Sewerage Master Plan of Metro Manila in the ROP* (February 1996), Nippon Jogesuido Sekkei Co. Ltd and Tohmatsu Co.
- *West Zone Sewerage Master Plan* (October 2000), Philaqua Consultants
- *East Concession Area Master Plan Update* (April 2005), NJS Consultants
- *Comprehensive land use plans* for each of the local government units within the study area.

1.7 Overall Framework for Sewerage and Sanitation Service Provision in Metro Manila

1.7.1 General

The Metropolitan Water System was inaugurated in 1878 to supply water to the City of Manila, which then had a population of approximately 300,000 people. The service area and population was subsequently extended and expanded.

The Metropolitan Waterworks and Sewerage System (MWSS), a Philippine government owned and controlled corporation, was established in 1971 and is responsible for the provision of water, sewerage and sanitation services in Metro Manila. In 1997, MWSS was a large government owned company with almost 8,000 employees. Water supply services were being provided to approximately 70% of the potential population with availability being approximately 16 hours per day. There were frequent system failures and water system leakages and a non- revenue water (NRW) level of over 60%.

Consideration of private sector participation (PSP) in the water supply to Manila initially arose out of a change in national government in 1986, the creation of a Government Committee on Privatization in the same year and the subsequent privatization of many government owned businesses. The award in 1997 of two concurrent concession contracts for water supply and sewerage in Metro Manila was widely publicized. The concession agreements resulted in four entities being directly involved in water and sewerage service provision in the city:

- **Maynilad Water Services Inc. (MWSI),** the service provider for the West Zone;
- **Manila Water Company (MWCI),** the service provider for the East Zone;
- The **Regulatory Office,** established as the representative of the customers under provisions of the concession agreements; and,
- The **MWSS Corporate Office** that has the responsibility for the retained functions, i.e. those not passed to the concessionaires, facilitating the performance of the concessionaires of their obligations, managing the Umiray-Angat Transbasin Project, managing the loans that are in the name of MWSS but serviced under the agreements by the concessionaires and managing, and where appropriate, disposing of the 'retained assets', i.e. those assets not conceded for the duration of the concession agreement.

1.7.2 Manila Water Company Inc. (MWCI)

MWCI is a joint venture of three companies, namely, Ayala Corporation, United Utilities and Pacific Holdings B.V., a subsidiary wholly owned and controlled by United Utilities PLC of the United Kingdom and Mitsubishi Corporation of Japan, with Ayala Corporation holding majority control. The concession contract is for 25 years commencing on August 1, 1997 and to end in July 31, 2022. The total population in the East Zone at the start of the concession period was about 4.5 million.

1.7.3 Maynilad Water Services Inc. (MWSI)

MWSI was a joint venture between Benpres Holdings Corporation and Lyonnaise des Eaux of France. This concession contract was also for 25 years commencing on August 1, 1997 and ending on July 31, 2022. The total population in the West Zone at the start of the concession period was about 7.2 million. MWSI has suffered from financial problems for several years. From July 2005, MWSI was subject to restructure/ rehabilitation due to financial insolvency. A Rehabilitation Plan was submitted by the company and approved by its creditors. The rehabilitation resulted in 84% of the equity in the company being transferred to MWSS. The remaining equity remained with the Suez group (Lyonnaise des Eaux), an existing minority shareholder.

It is the intent of MWSS that its majority ownership of MWSI be on an interim basis, i.e. for a maximum of approximately 2 years, with the ownership returning to the private sector by sale of its holding or by comprehensive sale of the company.

1.7.4 Concession Areas

The MWCI East Concession Area is composed of 7 cities and 2 municipalities in NCR and the whole of Rizal Province covering a total land area of approximately 1,739 square kilometers. The MWSI Service area covers 7 cities and 9 municipalities of NCR and Cavite with over 623 square kilometers of land area.

The cities of Manila, Makati and Quezon are divided between the two concessionaires. In addition to the 3 cities mentioned, MWSI also covers portions of the City of Marikina and the municipalities of San Mateo and Rodriguez, although the service areas there are small.

The boundary between the West and East Service Areas generally runs from north to south coinciding with the MWSS water system boundaries. The boundary limits are shown in **Figure 1.2** and are defined in Schedule 1 of the Concession Agreement.

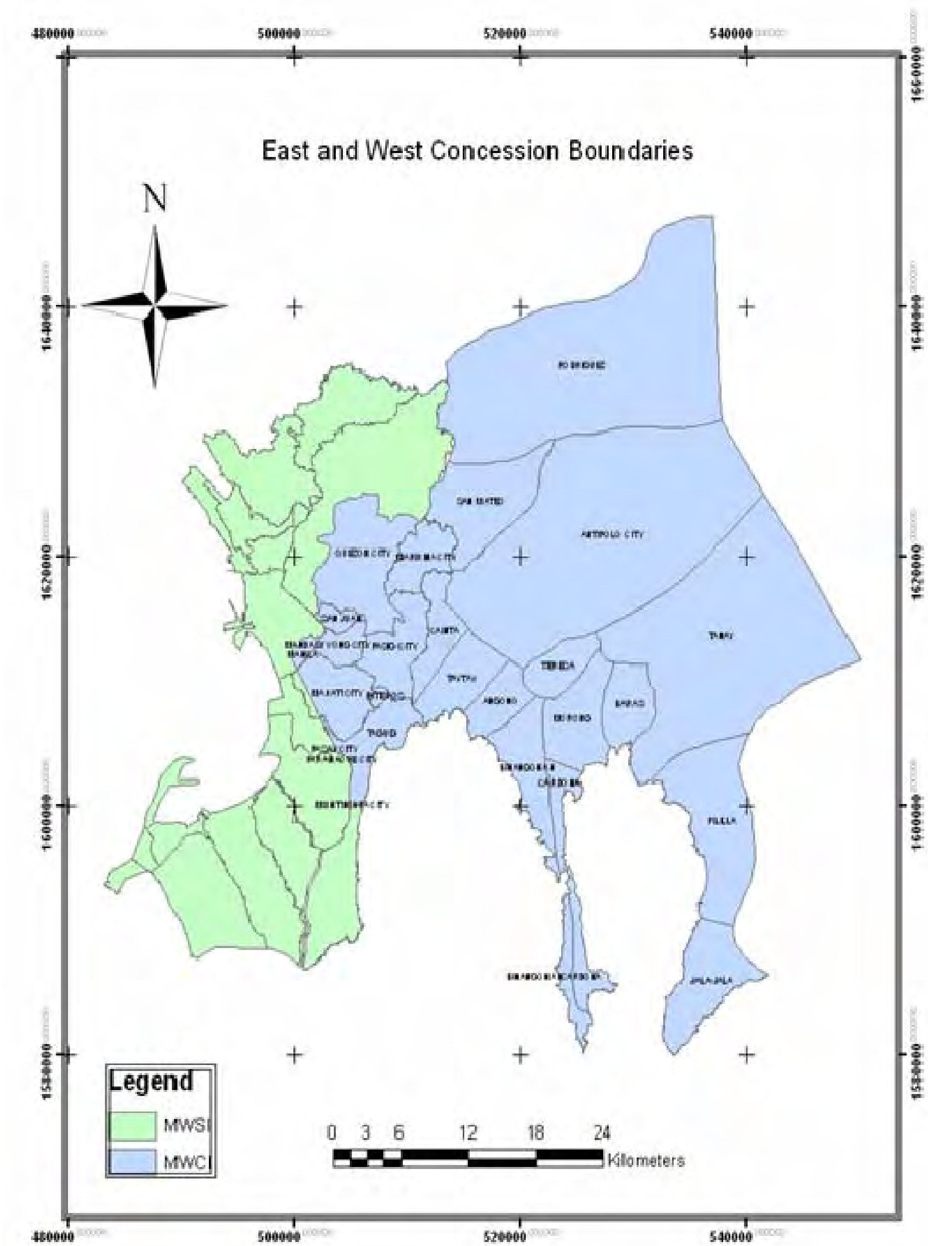

Figure 1.2 MWSS Concession Areas Boundaries

1.8 Organization of the Report

The approach to preparing this Master Plan involved three stages in which Strategic Action Papers (SAPs) and Working Papers were prepared to enable discussion with the stakeholders during the course of the Study. The findings from these papers were then consolidated into this Master Plan document. The stages and the SAPs/Working Papers prepared under each stage (which form attachments to the Master Plan) were as follows**:**

Phase 1 - Definition of Sewerage and Sanitation Targets

- Strategic Action Paper No 7 – Institutional and Environmental Targets for the Sewerage and Sanitation Sector

Phase 2 – Data Collection and Analysis

- Update of Land Use and Population Projections (Volume 1 of Strategic Action Paper No 1 – Institutional, Environmental and Physical Targets for the Water Supply Sector)
- Working Paper – Condition Report on Existing Sewerage and Sanitation Systems
- Working Paper – Implementation Constraints in the Sewerage and Sanitation Sectors
- Working Paper - Pollution Load Projections for Domestic, Commercial and Industrial Wastewater.
- Report on Willingness-to-Pay Survey
- Cost Database
- Interim Report

Phase 3 – Strategy Development and Analysis

- Strategic Action Paper No 8 – Sewerage Strategy for Metro Manila
- Strategic Action Paper No. 9 – Sanitation Strategy for Metro Manila
- Strategic Action Paper No 10 – Sludge Management and Water Recycling for Metro Manila
- Strategic Action Paper No.11 – Least Cost Technical Options for Sewerage and Sanitation Approaches
- Strategic Action Paper No. 12 – Draft Subsidy Policy on Sewer Charges
- Economic and Financial Analysis
- Formulation of Development Plan during Master Plan period
- Sewerage and Sanitation Master Plan.

This Sewerage and Sanitation Master Plan includes the results of the entire study, including the findings from all the above Strategic Action Papers and Working Papers, and is contained in three volumes:

- Volume 3 – Sewerage and Sanitation Situational Analysis (Chapters 1 – 7)
- Volume 4 – Sewerage and Sanitation Master Plan Study (Chapters 8 – 14)
- Volume 5 – Sewerage and Sanitation Master Plan Appendices

Supporting Volumes, comprising Strategic Action Paper Nos. 1 (Volume 1), 7 to 12, associated Working Papers, and Willingness-to-Pay Survey Report are also included.

A separate volume, the Master Plan Extended Summary was also prepared to summarize the whole of the study.

2. Introduction

2.1 Physical Conditions

2.1.1 Topography

The total area of Metro Manila is constantly expanding due to reclamation works being done on Manila Bay. The topography of the study area is characterized as the *Coastal Plain*, *Guadalupe Plateau* and the *Marikina-Laguna Valley*.

The Coastal Plain includes the western areas of Metro Manila. Intramuros, Fort Santiago and Fort San Antonio Abad were originally constructed along the shorelines prior to the extensive reclamation of the bay. Only a series of canals are left of the once low sandy islands found at the Pasig River delta. Most of the areas in Manila and Pasay are situated at elevations about two meters above sea level.

Guadalupe Plateau rises above the coastal lowlands, with summits reaching 90 to 100 m above sea level north of the Pasig River and 30 to 40 m in the south. Drainage is directed westward to the San Juan River in the north and directly westward to the Manila Bay down south.

The Marikina-Laguna Valley is relatively flat, having a narrow north area that becomes wider towards the south near Laguna de Bay. The flow of the Marikina River takes on a meandering course and the flow becomes slow and the cross-section becomes wider from the Sierra Madre foothills.

The topography of Rizal can be characterized by a combination of valleys and mountains. Flat low-lying areas are found on the western section of the province. To the east, rolling hills and rugged ridges form the southern foothills of the Sierra Madre Mountain Ranges. Elevations can exceed 600 m above mean sea level.

Cavite is considered flat and part of the coastal plains. Cavite City extends outwards to the Manila Bay. River systems include Imus River, Julian River and Ilang-ilang River.

In the proposed area for new water source development, namely the Agos River basin, the terrain is typically mountainous country, dropping to a coastal plain along the lowermost reach of the Agos River in the east. Elevations rise to more than 700 m above mean sea level.

2.1.2 Slope

The slopes found within Metro Manila vary for the topographic areas mentioned above. Slopes for the Coastal Plain are relatively flat (zero to one percent) with elevations ranging from zero to two meters. A one to three percent rise can be seen from the Coastal Plain to the Guadalupe Ridge. Slope drops of 20 % and greater can be seen towards the Marikina Fault. Moving towards the Marikina-Laguna Valley, slopes become flat.

About 35% and 2.5% of the land area in Rizal is situated on slopes ranging from zero to eight percent and eight to eighteen percent, respectively. More than half (51%) of Rizal land area falls under the slope classification of 18 to 50 %. A substantial percentage of the Rizal province has slopes of 12% and up. Steep slopes can be attributed to the topography of the mountainous regions of the Rizal province.

Slopes near the coastal plains of Cavite do not exceed 3% and the elevation is about sea level. The slope slightly increases to about 5 % along the southeast with elevations rising to about 70 m above sea level.

In the proposed water source catchment area, significant variation in slope is recorded. In the Kanan River sub-basin, extreme slopes characterize the extreme terrain, which has generally hampered access to the area and allowed a large portion of the catchment area to remain under virgin forest. In the Kaliwa River sub-basin, the slope of the terrain is more moderate, allowing the area to be developed through logging and farming activities.

2.2 Geology

In the Metro Manila area, the underlying rock strata are composed of three types of sedimentary rock sequentially layered as: Miocene rocks, “Alata” Conglomerate, and Guadalupe Tuff. Guadalupe Tuff is the overlaying stratum from the Marikina Valley until Quezon City where layer thickness is about 300 to 2,000 m. A change in overlaying alluvium stratum with a depth of about 25 to 50 m is seen along the coastal plains. Alluvial sediments also overlay the Marikina valley but the depth varies greatly. A simplified geological cross-section of Metro Manila is presented in **Figure 2.1**.

The Guadalupe tuff is understood to be water laid, most probably in a shallow sea during the late Tertiary or early Quaternary age. Beds of the tuff are clearly stratified and are composed mostly of comminuted, somewhat altered, vitric volcanic ash, although certain layers are composed of rather coarse fragments of volcanic pumice. The tuff layers, which are normally fine-grained and gray to brownish-gray in color, are often separated by brownish or yellowish soil which is indicative of weathering. Also gravel and sand layers have been found between tuff strata. It would seem, therefore, that deposition of these tuff layers was not a continuous process but rather may have been cycles of deposition. Uplift, weathering and erosion rather than submergence and deposition.

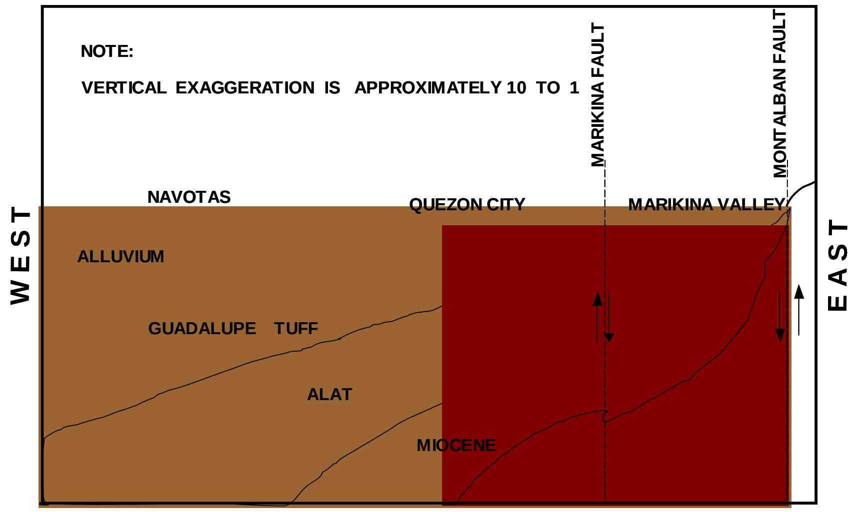

Figure 2.1 Simplified Geological Cross-Section of Metro Manila

Hydrogeology

The hydrogeologic structure in the MWSS service area was formed due to tectonic and volcanic events during the Late Tertiary and Quaternary periods, along with sea level changes.

In the coastal areas of Manila Bay, Laguna de Bay, and Marikina Valley, the groundwater systems mainly consist of alluvial sediments, while the rest of the areas are underlain by pyroclastic Guadalupe Formation. These aquifer systems extend from 1400 to 1800 sq. km.

The major aquifer systems underlying Metro Manila are as follows:

- Manila Bay Alluvium – found in Caloocan City, Manila, Pasay City, Makati City, Valenzuela, Navotas, Malabon, Parañaque, Las Piñas, Bacoor, Imus, Kawit, Noveleta, and Rosario. The Manila Bay Aquifer System is anisotropic and semi-confined with vertical permeability that is much lower than the horizontal permeability.
- Marikina Valley Alluvium – exposed in the municipalities of San Mateo, Montalban, Marikina, Pasig, Cainta, Taytay, Pateros, and Taguig.
- Guadalupe Formation – underlies Quezon City, San Juan, Mandaluyong, part of Makati, and Muntinlupa. The transmissivity coefficient in the Guadalupe Formation ranges from 50 to 100 sq m/ day, with an average of 58 sq m/ day, which means that the aquifer system has slightly moderate water transmitting properties.
- Laguna Formation and Pre-Quaternary Formations – deposited in Antipolo City, Angono, Baras, Binangonan, Cardona, Jala-jala, Morong, Pililla, Tanay, and Teresa.

The aquifer systems generally have an upper water table aquifer of up to 30 m deep. A semi-confining layer with thickness of up to 45 meters separates this upper water table

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aquifer from the lower artesian aquifer of more than 500 m thickness. Groundwater velocity within the confined aquifers averages 0.6 m/day, flowing generally from Quezon City towards Caloocan and Manila and from Laguna Lake and Las Piñas towards Makati and Parañaque.

Confined aquifers within the Guadalupe tuff are the source of groundwater for the service area. It is believed that withdrawal of groundwater from the aquifer is in excess of the recharge resulting in the following externalities:

- Aquifer depletion;
- Groundwater pollution;
- Land subsidence; and,
- Saline intrusion.

An indicator of groundwater over-abstraction is the draw down of piezometric heads. The piezometric heads in the northeast of Manila has gone down from +180 m in 1955 to only +120 m in 1994. At the coastal areas, the piezometric heads fell from –10 m to –100 m within about four decades.

Earthquakes
Several hundred tremors are recorded annually in the Philippines. Two sources of structural movement are the Philippine Deep, whose axis lies 80 km off the east cost of Luzon and Samar, and the Philippine Rift, which runs from Lingayen Gulf through Polillo Island, Sorsogon, Leyte and Eastern Mindanao. Three active volcanoes (Taal, Makiling and Banahaw) lie within 80 km of Manila.

Construction in the coastal plain alluvium is especially susceptible to seismic damage because of the soft foundation materials and the almost universal use of friction piles. No major pipeline damage has been attributed to earthquakes in the Metro Manila area, although it is possible that seismic action has damaged sewer pipes without external indication.

2.3 Climate

Rainfall
Meteorology in the study area is characterized by distinct wet and dry seasons. The dry season falls on the months of November to April during the northeast monsoon. The wet season occurs from the months of May to October coinciding with the southwest monsoon. In Metro Manila the annual average rainfall is 2164.5 mm, with an average number of rainy days of 133 per year.[1] **Figure 2.2** shows the monthly average rainfall and number of rainy days in Metro Manila.

The area covered by the Sierra Madre Mountain in Rizal is an exception since even rainfall is experienced throughout the year.

[1] Derived by averaging the annual average rainfall data recorded in three PAGASA weather stations: Port Area, Manila, Science Garden, Quezon City, and NAIA, Pasay City.

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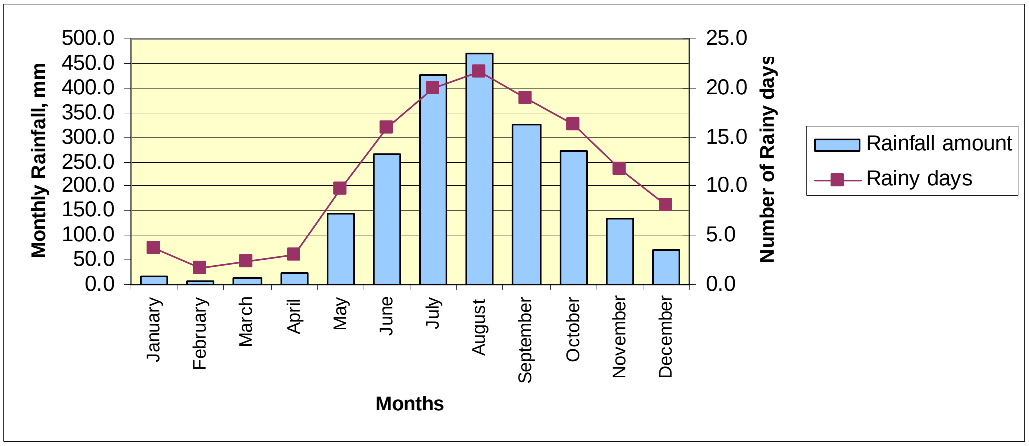

Figure 2.2 Monthly Average Rainfalls and Number of Rainy Days in Metro Manila

Temperature

The overall monthly temperature is about 27.7 ºC. Warmest days occur during the summer months of April and May with an average high temperature of 29.6ºC while the coolest month is January with low average temperature of 25.9 ºC.[2] Figure **2.3** presents the monthly average temperatures in Metro Manila.

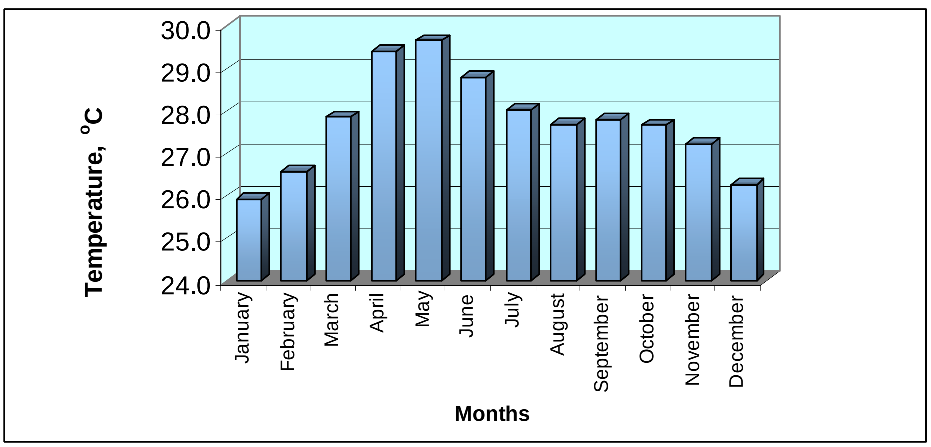

Figure 2.3 Monthly Average Temperature in Metro Manila

The average relative humidity is lowest in April (69 %) and highest in September (84 %).

[2] Derived by averaging the mean monthly temperatures recorded in three PAGASA weather stations: Port Area, Manila, Science Garden, Quezon City, and NAIA, Pasay City.

2.4 Drainage Basins

The MWSS service area, that is covered by the sewerage component of the Master Plan, was divided into nine major drainage basins. The major basins are Meycauayan, Tullahan, North Manila, San Juan, Marikina/Antipolo, South Manila, Taguig, Parañaque and Pasong Diablo/Magdaong/Sucat. The drainage basins are shown in **Figure 2.4** which includes their drainage areas. These major basins were further subdivided into sub-catchments for the development of the sewerage master plan. The proposed sewerage systems for each catchment are discussed in detail in Chapter 10.

2.5 History

The early development of Manila following the Spanish conquest largely comprised the walled city of Intramuros.

By 1875 the City had a population of 150,000 and had spread beyond Intramuros to what were then described as the 'suburbs' of Quiapo, San Miguel and Binondo and the 'villages' of Ermita, Sampaloc and Paco. A water system was constructed in 1882 and delivered water to the City from El Deposito, the reservoir near San Juan, through a 21-inch iron pipe.

During the American occupation (1898-1941) the population of the City increased from 160,000 to 700,000 and the urbanized area spread accordingly. In 1904 -1909 the initial sewerage system was constructed in Manila, serving practically all the urbanized area at that time. The port was expanded and Quezon Boulevard, Roxas Boulevard, Taft Avenue and other arteries were constructed and led to the rapidly growing suburbs. By the beginning of 1941, although the city had greatly expanded, its character and organization had not essentially changed. For example, the port still dominated the commercial activities and offices and markets were still located in Quiapo and Binondo, as they had been in 1900; industries were still located along the Pasig River; and the surrounding suburbs were still more or less separate entities.

The demolition of the city during the Battle of Manila in 1945 and the subsequent rebuilding resulted in the clustering of suburbs to form a metropolis. Suburban commercial centers were built during the 1950's and 1960's and that trend continues today with the growth of major commercial and residential centers in Makati, Ortigas and Quezon City. Many industries have moved out of the City and the suburbs have been enveloped by the City. It is no longer possible to speak of Manila without considering the entire Metropolitan Area.

In 1975, then President Marcos created an administrative region of Metro Manila to bring four cities and thirteen municipalities of the capital region under a single umbrella. Much of these were carved out from the provinces of Rizal and Bulacan. Metro Manila is an example of what geographers call the Southeast Asian primate city, a single very large city that is the center of industry, government, education, culture, trade, the media, and finance. Continued rapid population growth meant that the boundaries of Metro Manila were expected to expand in the 1990s. In March 1995, Republic Act 7924 was enacted creating the Metro Manila Development Authority (MMDA). The scope of MMDA services is defined under Sec. 3 of R.A. 7924 which says: "metro-wide services under the jurisdiction of the MMDA are those services which have metro-wide impact and transcend local political boundaries or entail huge expenditures such that it would not be viable for said services to be provided by the individual local government units (LGUs) comprising Metropolitan Manila."

Metro Manila is now one of the largest cities in the Asia-Pacific region and also one of the most crowded with a density of about 16,600 persons per sq. km, some three times that of the national average.

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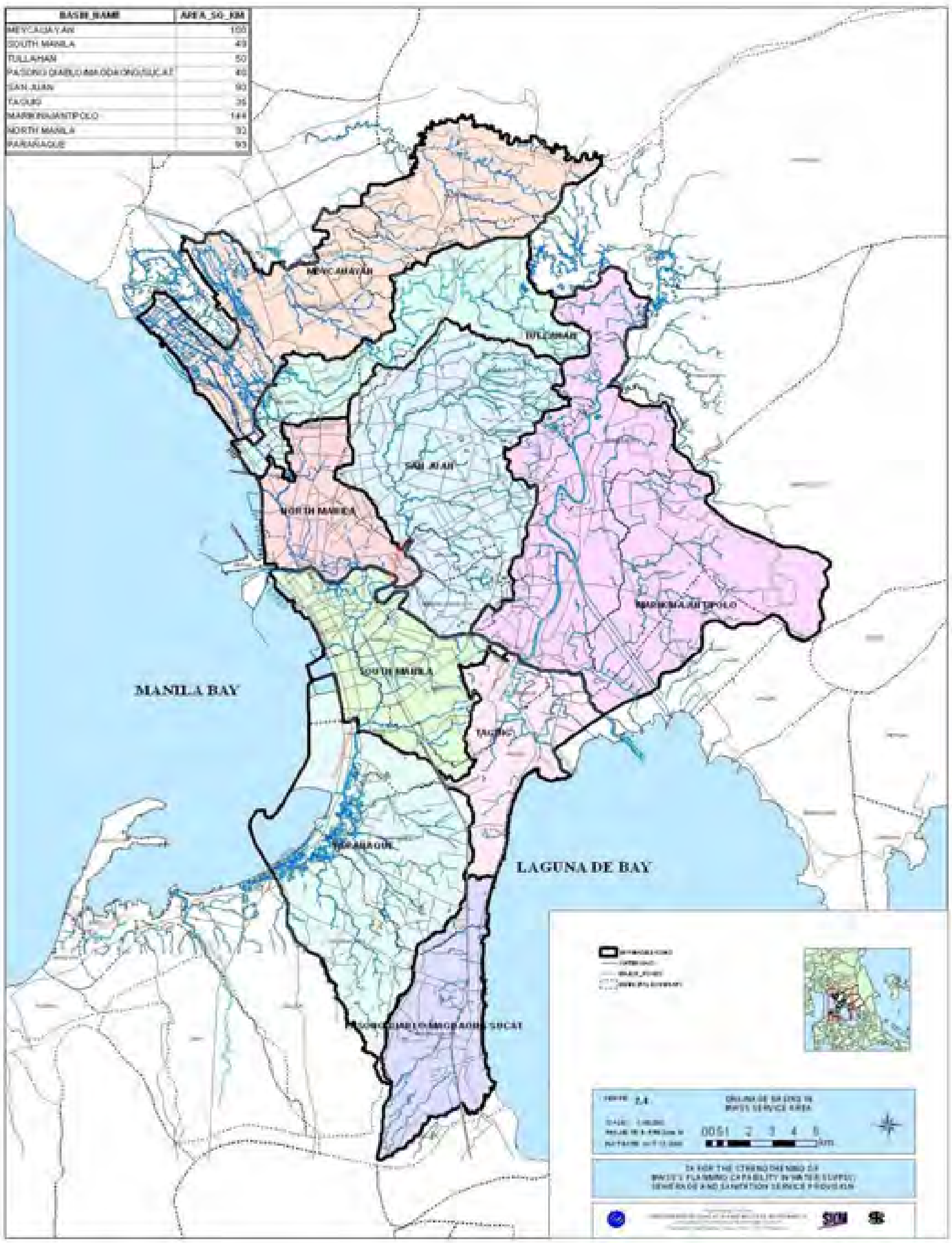

Figure 2.4 Major Drainage Catchments of MWSS Service Area

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2.6 National Economy

The Philippines has a diversified economy, with contributions of the key sectors to GDP in 2003 being: services 53%, industry 32% (of which manufacturing is 23%) and agriculture, forestry and fishing 15%. Real GDP growth has strengthened over the past three years from 1.8% in 2001 to 4.3% in 2003 and about 6% in 2004. Agricultural growth in recent years has averaged 3 – 5%, but is significantly affected by year-to-year weather changes. Inflation in the past appeared to have been under control from mid-2001 until the end of 2003, when it averaged 2.5% p.a. But in 2004, it increased sharply to a within-year rate of about 8%. It is thought that it could be a 'blip' in response to high world energy costs, and that it will decline to about 5% in the medium term.

A key issue in the Philippine economy is the level of unemployment, which is high and has been rising. In the second quarter of 2004, it was recorded at 13.7% as compared to 12.2% for the same quarter in 2003. Government, which is very much aware of this issue, is concerned and is giving high priority to the need to combat unemployment through the creation of new jobs.

A second problem in the economy is the fiscal deficit. This is running at 4-5% of GDP, and is an important reason for the relatively high interest rates in the Philippines. It has resulted largely from difficulties in raising the amount of tax collected, both with respect to enacting appropriate legislation and collection of actual taxes due. An important result of the chronic fiscal deficit has been the escalation of Public Sector Debt, which at the end of 2003 was estimated at 137% of GDP.

Table 2.1 below gives an overview of the main economic indicators for 2003-2004 and projections for 2005-2006.

Table 2.1 - Major Economic Indicators 2003-2006

Description	In Percentage Terms			
	Actual		Projected	
	2003	2004	2005	2006
Real Gross Domestic Product Growth	4.7	5.6	4.6	4.2
Gross Agricultural Production Growth	3.8	5.5	3.7	3.6
Unemployment – Average	11.4	11.6	11.0	10.6
Inflation rate	2.9	5.6	5.3	5.2
91 day Treasury Bill rate	5.9	7.3	8.0	8.5
Fiscal Balance (% of GDP)	-4.6	-4.3	-3.8	-3.2
Current Account Balance (%GDP)	4.2	3.4	2.8	1.7

Source: EIU October 2004

2.7 Poverty Situation

The 2003 Human Development Report ranks Philippines 85^{th} out of 175 countries considered. In that report, the Human Development Index has shown improvement over the past seven years from 0.735 in 1995 to 0.753 in 2002. There has also been progress in reducing the overall level of poverty in the Philippines, poverty incidence having declined from 44.2% in 1985 to 28.4% in 2000.

The country's annual per capita poverty threshold in 2000 was PhP 13, 913, an increase of 22.9% over the PhP 11,319 estimate in 1997. The National Capital Region (NCR) posted the highest poverty threshold at PhP18,001 per person or an increase of 25.9% over the 1997 estimate of PhP 14,299. There are other 8 regions with large increases in poverty lines between 1997 and 2000 including Region IV (22.9%).

Based on the preliminary results of the 2000 Family Income and Expenditure Survey (FIES), the number of families below the poverty line of PhP 13,913 increased from 31.8% or an increase of 2.4%. Urban-rural differential in poverty incidence is also notable with urban areas having lower incidence than rural areas.

Overall, the number of poor families reached 5.2 million up by 707,000 families or 16% higher than in 1997. In the urban areas, the number of families increased by 26.9%, while in the rural areas, the number of families increased by 11.6% over the 1997 estimate. The country's income gap was estimated at 32.1% in 2000, higher by 0.5% over the 1997 estimate. This means that the income of those below the poverty threshold have to be raised by 32.1% to surpass the poverty threshold. NCR consistently had the lowest income gap among all the regions in the country, but it increased to 22.4% in 2000 from 18.9% in 1997.

Because of the large disparity of poverty between rural and urban areas, many people from the rural areas migrate to urban areas, with the largest magnitude coming to Metro Manila. It is estimated that 36 % of Metro Manila's population are informal settlers. This is about 432,450 families as of 1996 (NHA-NCR), distributed as shown in **Table 2.2**. Informal settler families are distributed in about 276 major slum areas in Metro Manila.

Table 2.2 - Magnitude of Informal Settler Households in Metro Manila

Area/Location	Estimate No. of Squatter Households
North:	
Caloocan	83,638
Navotas	18,483
Valenzuela	16,551
Malabon	22,094
East:	
Quezon City	19,849
Pasig	15,978
Marikina	2,044
West:	
Manila	91,356
Mandaluyong	19,460
San Juan	1,343
Makati	15,905
South:	
Pasay	21,915
Parañaque	23,666
Muntinlupa	35,132
Las Pinas	17,527
Pateros	2,100
Taguig	25,408
Grand Total	**432,450**

Source: NHA-NCR

2.8 Sanitation, Public Health and Disease

The sewerage system in Metro Manila currently covers only about 12% of the population. The remaining population is served by on-site sanitation, primarily septic tanks or pit latrines or not at all. The willingness-to-pay survey conducted as part of this study provided the following breakdown of sewerage and sanitation facilities at the household level.

Connected directly to sewerage system	5%
Septic tank connected to sewerage system	6%
Septic tank discharging directly to drain	60%
Toilet discharging directly to drain/canal/creek	8%
Pit latrines	15%
No toilet	5%

There an estimated 2.2 million septic tanks in Metro Manila, most of which do not have appropriate leaching fields, are irregularly (if ever) desludged and many of which are inappropriately designed. The result is that the septic tanks provide minimal treatment and that most of the open drains and esteros effectively operate as open sewers with a consequent risk to public health. The drains and esteros drain in the major rivers and water bodies such as Pasig River, Marikina River, San Juan River, Manila Bay and Laguna de Bay with the result that these water bodies are unable to achieve water quality standards appropriate for their proposed use for aquatic and recreational purposes. The Pasig River Rehabilitation Program has the objective of improving the quality of water in Pasig River to Class C standard by the year 2014. However, without significant improvement in the domestic wastewater situation, this target is unlikely to be achieved. From data obtained by DENR, an increasing proportion of the pollution loading on Pasig River can be attributed to domestic wastewater (up from 45% in 1991 to 60% in 1998) whereas the proportion attributable to commercial and industrial wastes has reduced from 45% to 35% during the 1991-1998 period. Efforts have been made to control industrial discharges through the development of environmental user fee systems for industrial waste discharges and there has been some movement of industries outside Metro Manila, but little, if any, progress has been made with regard to domestic wastes.

Health statistics on morbidity and mortality were obtained from the Department of Health and from previous master plan documents and are shown in **Tables 2.3, 2.4 and 2.5**. **Table 2.3** shows that diarrhea has been the leading cause of morbidity for the past 10-15 years, albeit at a declining rate. **Table 2.4** indicates the leading causes of mortality for the entire population and is interesting in that it shows the change in diseases causing mortality over the past 70 years with an increasing emphasis on lifestyle diseases such as heart disease and vascular system disorder. However, the impact of poor sanitation is shown in **Table 2.5** where diarrhea/gastroenteritis is shown as a major cause of child mortality in the 1-4 and 5-9 age brackets. While this data is for the entire country, it can be reasonably assumed that Metro Manila with its acute sanitation problem would be represented by these trends.

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Table 2.3 - Leading Causes of Morbidity in the Philippines

Disease	1974		1990		2000		2001		2002	
	Rank	Rate	Rank	Rate	Rank	Rate	Rank	Rate	Rank	Rate
Diarrhea	2	650	1	1,520	1	1135	1	1085	2	900
Bronchitis	-	-	2	1,215	2	917	2	892	3	780
Pneumonia	4	224	4	N.A	3	829	3	837	1	905
Influenza	1	N.A	716	N.A	4	659	4	642	4	600
Hypertension	-	-	N.A	N.A	5	367	5	408	5	370
TB/Respiratory	3	343	N.A	N.A	6	162	6	147	6	120
Heart Disease	-	-	N.A	N.A	7	69	7	60	7	60
Malaria	5	66	5	69.2	8	67	8	52	8	50
Measles	6	56	N.A	N.A	9	46	9	31	10	20
Chickenpox	-	-	N.A	N.A	10	31	10	31	9	25

1. Rate is No. of cases/100,000 of population
2. N.A – Not Available
3. 1974 data is from 1979 Sewerage Master Plan (JMMontgomery)
4. 1990 data is from 1996 Sewerage Master Plan (JICA)
5. 2000-2002 data is from Department of Health

Table 2.4 - Leading Causes of Mortality in the Philippines

Disease	1935	1955	1965	1999		2000	
	Rank	Rank	Rank	Rank	Rate/100,000	Rank	Rate/100,000
Heart Disease	9	6	5	1	78.4	1	79.1
Diseases of the Vascular System	-	-	7	2	58.4	2	63.2
Malignant Neoplasm	-	10	9	3	45.8	3	42.7
Pneumonia	2	1	1	4	44.0	4	42.7
Accidents	-	8	8	5	40.2	5	42.4
Respiratory TB	1	2	2	6	38.7	6	36.1
Pulmonary Disease	-	-	-	7	20.3	7	20.8
Perinatal	-	-	-	8	17.1	8	19.8
Diabetes	-	-	-	9	13.0	9	14.1
Nephritis	-	-	10	10	10.1	10	10.4

1. Data for 1935, 1955 and 1965 from 1969 Sewerage Master Plan (Black and Veatch). Data for 1999 and 2000 is from Department of Health
2. Mortality rates cover population under 59 years
3. Adult mortality (probability of dying between 15 and 59) is 271/100,000 for males and 149/100,000 for females.

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Table 2.5 - Leading Causes of Child Mortality in the Philippines (Year 2002)

Disease	Ages 1-4		Ages 5-9		Ages 10-14	
	Rank	Rate/100,000	Rank	Rate/100,000	Rank	Rate/100,000
Pneumonia	1	37.76	2	7.03	4	4.14
Accidents	2	17.63	1	17.82	1	15.88
Diarrhea/Gastroenteritis	3	16.14	5	2.19		
Measles	4	11.50				
Congenital Anomalies	5	9.01	4	2.85	5	2.09
Malignant Neoplasm	6	4.88	3	3.97	2	4.58
Meningitis	7	4.67	7	2.14	8	1.92
Septicemia	8	4.54	10	1.41	10	1.28
Pulmonary Disease	9	4.43				
Protein/Calorie Malnutrition	10	4.30				
Nervous System			6	2.15	7	1.92
Heart Disease			8	1.87	3	4.33
Respiratory TB			9	1.41	6	2.01
Nephritis					9	1.59

1. Data from Department of Health
2. Child Mortality defined as the probability of dying within the defined age group
3. Overall Child Mortality (probability of dying under the age of 5) is 39/100,000 for males and 33/100,000 for females

The causal link between good sanitation (and hygiene) and public health has been the subject of discussion over a long period and numerous studies have been undertaken to quantify this linkage. However, it is now accepted and promoted by organizations such as the World Health Organization (WHO) whose Director-General, Dr Lee Jong-wook recently stated;

"Water and Sanitation is one of the priority drivers of public health. I often refer to it as 'Health 101' which means that once we secure access to clean health and to adequate sanitation facilities for all people, irrespective of the difference in living conditions, a huge battle against all kinds of diseases will be won."

The following statistics are also provided by WHO on a world wide basis.

- 1.8 million people die every year from diarrhea diseases (including cholera); 90% are children under 5, mostly in developing countries.
- 88% of diarrhea disease is attributable to unsafe water supply, inadequate sanitation and hygiene.
- Improved water supply reduces diarrhea by between 6% and 25%, if serious outcomes are included.
- Improved sanitation (or sewerage) reduces diarrhea by 32%.
- Hygiene interactions including hygiene education and promotion of hand washing can lead to a reduction in diarrhea cases by up to 45%.

- Improvement in drinking water quality through household water treatment, such a chlorination at the point of use, can lead to a reduction of diarrhea episodes by between 35% and 39%.

The willingness-to-pay survey conducted under this study obtained the following information related to health and hygiene issues:

- Respondents on average spent PhP 3,180 per month on medical care which was the second highest individual expense after food and represented about 15% of the average income.
- Only 5% of respondents did not have a toilet in their house, but almost 80% of these expressed a wish to have their own toilet facility and 60% were willing to pay for this.
- Over 90% of respondents placed a significant value on toilets for their health.
- About 90% of respondents were aware that if their wastewater is not disposed of properly, it may be responsible for various diseases in the community and contribute to the pollution of river systems, groundwater and waterways.
- About 87% of respondents indicated the need to improve the wastewater disposal system in the community.
- Most respondents identified the need to improve and maintain drainage systems and prevent waste from entering the drains as the highest priority for improving the waste disposal system.
- Although 70% of respondents were not familiar with the concept of wastewater treatment, 90% would like to see a wastewater treatment facility established to serve their community.
- About 70% of respondents were willing to pay on average 20% of their water bill for improvement in their wastewater disposal systems.

These responses in general indicate that the Metro Manila populace of all income levels are concerned about the current sewage management and understand the implications of inadequate sanitation and are willing to contribute to an improvement in the system.

3. Legal & Legislative

3.1 Key Agencies and Institutions Involved in Sewerage and Sanitation

3.1.1 Department of Health

The Department of Health (DOH) is the principal government organization responsible for planning, implementation, and coordination of the policies and programs for public health protection and sanitation. DOH is mandated to ensure access to basic health services to all Filipinos through the provision of quality health care services. Its mission is to guarantee equitable, sustainable, and quality health for all Filipinos, especially the poor and to lead the quest for excellence in health.

The DOH is mandated to implement Presidential Decree 856 or the Sanitation Code of the Philippines which includes regulations that impact on residential, commercial, institutional, and industrial wastewater discharges to the environment.

3.1.2 Department of Environment and Natural Resources

The DENR is the primary government agency responsible for the promulgation of rules and regulations for the control of water, air, and land pollution in the Philippines. The DENR was created through Executive Order 192, which reorganized and merged the then National Pollution Control Commission (NPCC) and the National Environmental Protection Council (NEPC). All functions of NEPC and NPCC are now being implemented by the DENR through the Environmental Management Bureau (EMB) and its regional offices.

The DENR has five (5) staff bureaus, namely: (1) Environmental Management Bureau (EMB), (2) Forest Management Bureau (FMB), (3) Land Management Bureau (LMB), (4) Ecosystems Research and Development Bureau (ERDB), and (5) Parks and Wildlife Bureau (PAWB).

EMB is a line bureau of DENR and is mandated to formulate policies on environment and implement environmental laws such as the Clean Water Act (RA 9275), Clean Air Act (RA 8749), Solid Waste Management Act (RA 9003), Environmental Impact Statement System (PD No. 1586), Toxic and Hazardous Waste Act (RA 6969), and other mandates originally assigned to NEPC and NPCC. The DENR, EMB and its regional offices have the most important regulations with respect to pollution control. The classification of water bodies and the task of water quality monitoring are being undertaken by the EMB.

3.1.3 Laguna Lake Development Authority (LLDA)

The LLDA is a quasi-government agency organized in 1966 by virtue of Republic Act 4850. The LLDA is empowered to provide regulatory and proprietary functions. The LLDA is mandated to lead, promote and accelerate the development and balanced growth of the Laguna de Bay Region within the context of national and regional plans and policies.

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LLDA reports directly through its Board of Management to the Secretary of DENR. However, unlike the DENR, the rules and regulations adopted by LLDA allow the agency to levy and retain any charges, other than fines and permit fees, for environmental protection programs.

LLDA operates an Environmental User's Fee (EUF) system in the cities and towns in its jurisdiction. In terms of environmental standards and regulations for wastewater discharges, the LLDA follows the water quality criteria and effluent standards imposed by DENR, that is, DENR Administrative Order Nos. 34 and 35, respectively.

3.1.4 Department of Public Works and Highways

The Department of Public Works and Highways (DPWH) is the government agency that is in-charge of infrastructure construction. The agency is responsible for the planning, design, construction and maintenance of infrastructure facilities, particularly national highways and water resources development systems, and other national development objectives. DPWH's responsibility extends to the major areas of infrastructure development and construction such as highways, ports, flood control, water supply, school buildings, and urban community infrastructures.

Under the Clean Water Act (CWA), the DPWH is given the lead role with regards to the preparation of the national program on sewerage and septage management.

3.1.5 Metropolitan Waterworks and Sewerage System

The Metropolitan Waterworks and Sewerage System (MWSS) was created in 1971 by virtue of Republic Act No. 6234. MWSS is responsible for domestic sewage collection, disposal, and treatment in Metro Manila and the surrounding municipalities. The agency is also responsible for septic tank desludging. MWSS is an attached agency to the DPWH.

The privatization program of the MWSS which was implemented on August 1, 1997, divided the MWSS service area into the East and West zones. The operations of the facilities of MWSS were turned over to the two private operators, namely, the Maynilad Water Services, Inc. (MWSI) for the West zone and the Manila Water Company, Inc. (MWCI) for the East zone. The operators have a 25-year concession period and have divided the overall MWSS service area.

3.1.6 Pasig River Rehabilitation Commission

The PRRC was created by virtue of Executive Order No. 54, series of 1999, as amended by Executive Order No. 65, series 1999. PRCC is mandated to ensure that the Pasig River is rehabilitated to its historically pristine condition conducive to transportation, recreation, and tourism.

PRRC is tasked to coordinate, plan, implement, supervise, monitor and/or evaluate programs, projects and activities, enforce laws, rules and regulations, where appropriate, and perform such other functions as are necessary to ensure the rehabilitation of the Pasig River system. Its plans and programs include sanitation improvement components especially within the easement areas along Pasig River presently occupied by informal settlers.

The PRRC is chaired by the Secretary of the Department of Budget and Management (DBM) and co-chaired by the chairman of the Metro Manila Development Authority (MMDA). The PRRC operates under the Office of the President. Its organizational structure is composed of other government agencies such as the DBM, MMDA, DENR, MWSS, DPWH, DOH, LLDA, and HLURB, among others. The primary structure for environmental matters is defined as the Environmental Management Committee (EMC) of PRRC that is chaired by the DENR.

3.1.7 Housing and Land Use Regulatory Board

The Housing and Land Use Regulatory Board (HLURB) is the government's regulatory body responsible for land use and housing. Its role is defined in specific legislation and directives: Letter of Instruction (LOI) 729, series of 1978, PD 933, EO 648, series of 1981 as amended by EO 90, series of 1986, PD No. 1396, RA No. 7160, EO 72, series of 1993 and RA No. 7279.

The HLURB's functions are comprehensive and include:

- prescribing the standards and guidelines governing the preparation of land use plans;
- extending technical and related forms of planning assistance to the local government units (LGUs) including programs on sanitation and sewerage;
- reviewing and approving the comprehensive land use plans of highly urbanized cities, independent component cities, provinces, and the cities and municipalities of Metro Manila;
- monitoring the implementation of such plans; and
- adjudicating and settling disputes over these plans.

These functions are complementary with the mandate of all LGUs under RA 7160, the Local Government Code, to prepare their land use plans. These plans are enacted through zoning ordinances and stand as the primary and dominant bases for the use of land resources in their respective localities.

3.1.8 Local Government Units

Through the Local Government Code of 1991 (RA 7160), the Philippines has implemented a decentralized form of government. As such, there are two main levels of government: central or national government and local government units. The policy described in the Local Government Code is to devolve authority to LGUs who will operate autonomously under the regulatory supervision of the National Government.

LGUs are responsible for the provision of basic services, such as water supply systems, sewerage, and sanitation, either directly or through contracts with the private sector. They are also empowered to collect taxes and fees necessary for providing these services.

3.1.9 Department of Agriculture

The Department of Agriculture (DA) was created by virtue of Presidential Decree No. 461 which reorganized the then Department of Agriculture and Natural Resources (DANR) into two separate departments, namely, the Department of Agriculture, and the Department of Environment and Natural Resources.

DA is principally tasked to promote the country's agricultural growth and development, including the sustainability of resource productivity over the long term and the enhancement of life of small farmers and fishermen in support of the Comprehensive Agrarian Reform Program (CARP).

The Fertilizer and Pesticides Authority (FPA), an attached agency of the DA regulates the manufacture, use and application of agricultural products such as fertilizers and pesticides. It also has regulatory function over the importation of such products to protect domestic agricultural producers from unfair competition of imports made cheap through subsidies by exporting countries. Currently, the MWSS concessionaires have licenses as fertilizer manufacturers for their domestic liquid wastes and sludges.

Under the Clean Water Act (CWA), the DA is tasked to coordinate with DENR in the formulation of guidelines for the reuse of wastewater for irrigation and other agricultural purposes and for the prevention, control, and abatement of pollution from agricultural and aquaculture activities. The DA is also tasked to review and propose guidelines for domestic sludge and septage management particularly on land application of bio-solids.

3.2 Applicable Legislation

3.2.1 Summary

Strategic Action Paper (SAP) 7 reviewed important regulations governing sewerage and sanitation programs in the Philippines. It also enumerated pertinent provisions of recently passed laws and administrative orders that may have impacts on the design and implementation of existing and future sanitation and sewerage projects of the Metropolitan Waterworks and Sewerage System (MWSS) and its concessionaires.

There are a number of government agencies, whose programs and activities have direct impacts on sanitation and sewerage in the Philippines. These agencies, their mandates and the pertinent regulatory provisions are discussed in SAP 7.

The national legislative framework governing sanitation and sewerage in the Philippines is principally governed by four (4) main laws, namely: (1) PD 856 or the Code on Sanitation of the Philippines, (2) PD 984 or the Pollution Control Law, (3) PD 1151 or the Philippine Environmental Policy, and (4) RA 9275 or the Clean Water Act (CWA).

These main laws are further supported by a number of presidential decrees, republic acts, and administrative orders. Such support regulations include: the National Building Code, National Plumbing Code, the Local Government Code, and DENR Administrative Orders 34 and 35, among others. Enforcement of these laws rests with government agencies such as the Environmental Management Bureau of the Department of Environment and Natural Resources, Department of Health, Department of Public Works and Highways and the various local government units (LGUs).

These environmental regulations and their pertinent provisions that may have impacts on the implementation of sanitation and sewerage services have been summarized for consideration in the development of the MWSS Sewerage and Sanitation Master Plans.

Critical reviews and issues on the recently passed CWA and its possible impacts on the on-going and future undertakings of MWSS and its concessionaires were conducted. The draft implementing rules and regulation of CWA, which was updated in April 2005, was also reviewed. This IRR was signed by the DENR Secretary on May 16, 2005.

In summary, the salient environmental rules that provide impact on the provision of sanitation and sewerage services are the following:

3.2.2 PD 856, 1995 IRR and 2004 Supplemental IRR (Code on Sanitation)

The Code of Sanitation (PD 856) was promulgated in December 23, 1975 by then President Ferdinand E. Marcos. Since its promulgation, it has been the basis of rules and regulations imposed for health and sanitation. Chapter XVII of the Code of Sanitation particularly contained provisions on the collection, handling, transport, treatment and disposal of sewage, domestic sludge and septage.

In 1995, the DOH issued the Implementing Rules and Regulations (IRR) of Chapter XVII of the Code. The IRR prescribed guidelines on proper handling, treatment and disposal of sewage. Specifically, the IRR contains the following:

- Approved individual excreta and sewage disposal systems
- Proposed design and construction of septic tanks, leaching tile field and house sewers
- Requirements on public sewerage systems

With the continuous degradation of the river systems due to indiscriminate dumping of septage collected from individual septic tanks and the results of pollution surveys indicating that up to 70% of pollution loading comes from domestic sources, the DOH in 2004 issued a supplemental IRR to cover stricter guidelines on collection, handling, transport, treatment and disposal of domestic sludge and septage.

The IRR and the supplemental apply to all individuals, firms, public and private operators, owners and administrators engaged in the collection, handling and transport, treatment, and disposal of excreta and sewage and domestic sludge from cesspools, communal septic tanks, Imhoff tanks, domestic sewage treatment plants/facilities and septage from household septic tanks.

Figures 3.1 and **3.2** describe the scope of the IRRs.

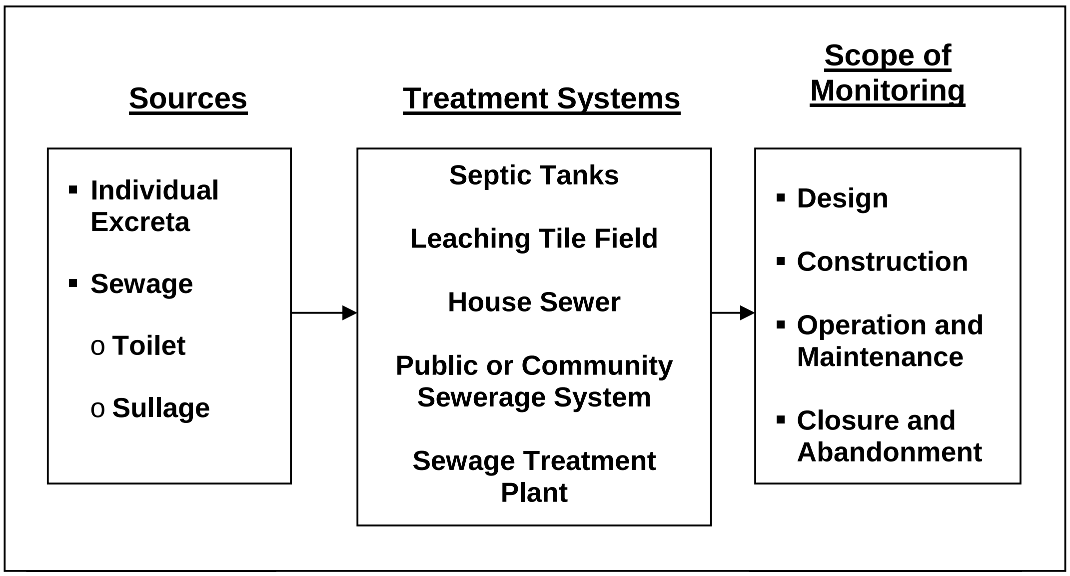

Figure 3.1 Scope of Application of the IRR of the Code of Sanitation to be Implemented by DOH

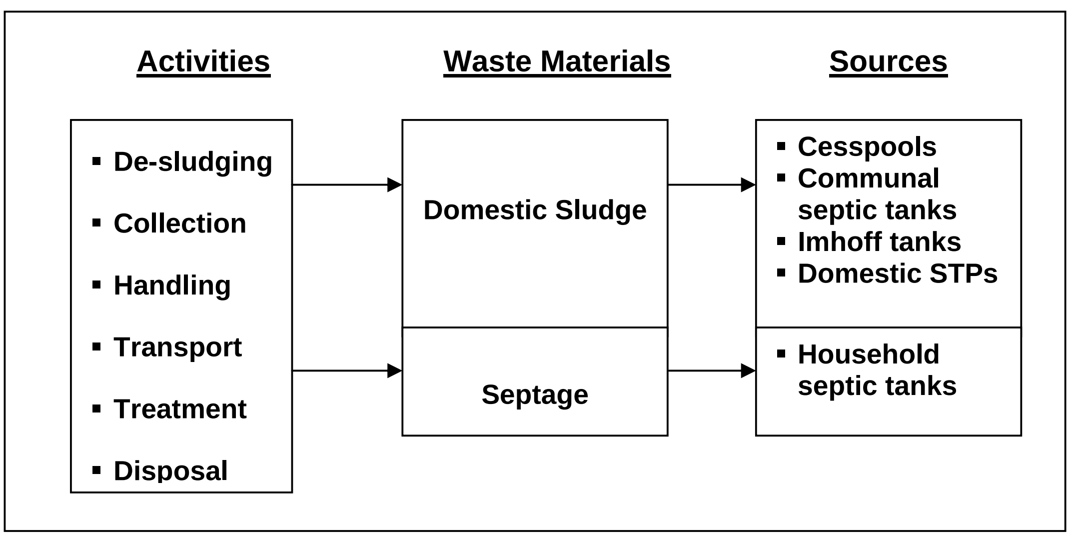

Figure 3.2 Scope of the Supplemental IRR Stipulating Provisions on Sludge and Septage Handling, Transport, Treatment and Disposal

Some of the key provisions of the Code and the 1995 IRR of Chapter XVII on sewage and sewerage systems include:

- Sewage disposal shall be by means of a municipal or city sewerage system whenever available.

- Where a public sewerage system is not available, sewer outfalls from residences, schools, and other buildings shall be discharged into a septic tank.

- The effluent from septic tanks shall be discharged into a sub-surface soil, absorption field where applicable or shall be treated with some type of purification device. The treated effluent may be discharged into a stream or body of water if it conforms to the prescribed quality standards (now prescribed by DAO 35 series of 1990).

- Properly designed grease traps shall be provided for sewers from restaurants or other establishments where the sewage carries a large amount of grease.

- Septic tanks in new subdivisions are prohibited unless the site is considered to be impractical and inadvisable to install a public sewage collection system with the required treatment.

- Septic tanks shall be cleaned before excessive sludge or scum is allowed to accumulate and seriously reduce settling efficiency. Septic tanks shall be inspected at least once per year and be cleaned when the bottom of the scum mat is within 7.5 cm of the bottom of the outlet device or the sludge and scum has reduced the liquid capacity by 50%.

- Stormwater shall be discharged to a storm sewer, sanitary sewage shall be discharged to a sewerage system carrying sanitary sewage only; but this should not prevent the installation of a combined system.

- Section 3 specifies that any individual, firm or operator, government or private, who are engaged or will be engaged in the collection/desludging, handling, transport, treatment and disposal of sludge and septage is required to secure Environmental Sanitation Clearance (ESC) prior to operation. The ESC shall be issued by the Secretary of Health or the Director of the concerned Center for Health Development (CHD) as his duly authorized representative.

- The ESC application will require the operator's submission of project description (including handling, transport, storage, treatment and disposal operations) and some environmental baseline information of the project site such as topography, geologic condition and hydrology.

- Proper septage and domestic sludge collection and transport system, including vehicle registrations and specifications i.e., vehicle must be enclosed with leak proof body and lock.

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- Mandatory septage and domestic sludge processing and treatment are required prior to disposal.

3.2.3 Presidential Decree 984 (Pollution Control Law)

PD 984 or 'The Pollution Control Law' sets up the administrative and regulatory mechanisms for pollution control and establishes air and water quality standards that define maximum allowable limits of emissions and effluents from domestic, commercial and industrial activities.

The law specifically states that:

"No person shall throw, run, drain, or otherwise dispose into any of the water, air, and/or land resources of the Philippines any organic or inorganic matter that may cause pollution."

PD 984 created the National Pollution Control Commission (NPCC) and gave them the powers with respect to control of air, water and land pollution from point sources. The function of NPCC was subsequently passed on to the DENR by virtue of the department reorganization as per Executive Order 192. P.D. 984 requires the issuance of permits for wastewater treatment facilities.

In 1967, the first set of water quality criteria and effluent standards were promulgated by the NAWAPCO. The 1978 rules and regulations of PD 984 included provisions on air, water, land, noise, and odor pollution, including the ambient water quality criteria. The Effluent Standards was developed in 1982.

After the DENR reorganization in 1987, a review/revision of the standards was again undertaken, hence, developing what we now have as the Revised Water Quality Criteria of 1990 (DENR Administrative Order No. 34) and the revised Effluent Standards (DENR Administrative Order No. 35).

3.2.4 Presidential Decree 1151 (Philippine Environment Policy)

PD 1151 or the Philippine Environment Policy defines the general state policy on the pursuit of a better quality of life without degrading the environment. One of the most important provisions of PD 1151 was the requirement for all agencies and corporations to prepare an Environmental Impact Statement (EIS) for every project or undertaking which significantly affects the quality of the environment.

PD 1151 also created the NEPC and recognized the strength on environmental protection and requirements of environmental impact assessment and environmental monitoring activities. The above functions were later transferred to the DENR as per Executive Order 192.

The law was subsequently strengthened by PD 1586 or the Environmental Impact Statement System which requires projects with potential adverse effects on the environment to obtain an Environmental Compliance Certificate (ECC) as a prerequisite for implementation.

3.2.5 Republic Act 9275 (Clean Water Act)

General

RA 9275, otherwise known as the Philippine Clean Water Act was enacted into law in March 22, 2004. The act provides a comprehensive national water quality program to protect, preserve, and revive the quality of the country's fresh, brackish, and marine waters. The act primarily addresses the abatement and control of pollution from land-based sources and covers all water bodies (natural and man-made), bodies of fresh, brackish, and saline waters, and includes but not limited to aquifers, groundwater, springs, creeks, streams, rivers, ponds, lagoons, water reservoirs, lakes, bays, estuarine, coastal and marine waters.

Provisions of PD 984 relative to wastewater discharges were subsumed by CWA. Under the CWA, development projects including subdivisions, commercial establishments and manufacturing plants which generate and discharge wastewater into the environment are required to secure from the DENR the Discharge Permit and pay the corresponding load based fees to DENR.

The computation of the discharge fee in the IRR of the CWA is based on a net waste load which considers the situation that water to be used by a facility already contains certain pollutants and therefore the discharge fee will be based on the net wastewater load to be discharged.

The CWA integrates the management and control of wastewater and water quality policies that were previously issued through various laws and are currently being implemented among various agencies. The CWA enables the creation and delegation of new regulatory, planning and infrastructure development functions to agencies and subsidiary multi-sectoral bodies and on streamlining inter-agency coordination.

Impacts on Domestic and Commercial Effluents

The following are the major provisions in the CWA-IRR that would have an impact on domestic and commercial effluents:

- Mandatory connection of establishments to existing sewerage systems which reiterates the provisions of the Sanitation Code. If establishments are tapped into the sewer lines of MWSI/MWCI, the concessionaires need to observe the provisions of the Effluent Standards of the DENR in the treatment of effluent prior to disposal into any body of water.

- For MWSS/MWSI/MWCI treatment facilities, a Discharge Permit needs to be secured from DENR or LLDA.

- Domestic and commercial establishments are required to connect sewage lines to existing sewerage systems. Although MWSS does not have the authority to sanction establishments that refuse to connect, the CWA now allows the DENR to initiate actions against these establishments in coordination with the LGUs and DOH. Regulatory actions may include the withholding of permits or denial of issuance of ECC.

- Domestic and commercial establishments that are not connected to existing sewerage systems of MWCI/MWSI should treat their own effluents and comply with the Effluent Standards outlined in DENR Administrative Order No. 35.
- Disposal of septage or domestic sludge should comply with the standards and guidelines issued by the DOH.
- Disposal of sludge through land application should comply with the standards of the DA.
- Use of low-cost sanitation options to augment the sewerage program is promoted in the CWA.

Impacts on Industrial Effluent

The provisions that would have impacts on industrial effluent are the following:

- Mandatory connection of sewage lines to existing sewer lines
- Pre-treatment standards for industrial sources that would discharge into the sewerage system needs to be developed by MWSS (See Section 5.6)

Mandatory Connection to Sewer Lines

Under the CWA, the MWSS through its concessionaires should provide the sewerage and sanitation facilities and enforce the mandatory connection of sewage lines from domestic, commercial or industrial establishments to available sewerage system. In doing so, the accountability in terms of compliance with the effluent standards and the payment of wastewater discharge fee will rest with the MWCI/MWSI as operator of the sewerage system.

In the case of commercial and industrial companies, the MWSS needs to develop discharge standards to sewers to account for the pre-treatment of wastes.

Sanctions for Refusal to Connect to Existing Sewer Lines

The provision on mandatory connection in the CWA basically supplements the Sanitation Code. Despite the presence of this provision in the Sanitation Code, there is resistance to connect due to the following:

1. MWSS has a policy that the house owner shall pay for the implementation of the connection even in the street area with surface restoration.
2. The sanitary surcharge of 50% on the water bill is only imposed if the houses are physically connected.

In implementing the mandatory connection to existing sewerage system based on the CWA, the MWSS and concessionaires should clearly identify commercial and industrial establishments and households connected to existing sewerage systems.

MWSS is not mandated to take any action against establishments refusing to connect into the system under the CWA-IRR. Meanwhile, the DENR can initiate sanctions against an establishment that would fail to connect to available MWCI/MWSI sewer lines in coordination with LGUs and DOH. Sanctions would include the following; (i) DENR can withhold permits or deny the issuance of an ECC; (ii) DENR can request LGUs and other agencies in writing about the sanctions for the establishment based on applicable laws; and (iii) DOH can refuse the issuance of the Environmental Sanitation Clearance.

The sanctions that would be initiated by DENR are relatively considered as low-impact actions in terms of implementing the mandatory connection of establishments. Given the constraints and resistance to connect, this particular provision of the law may face difficulties in implementing. Development of guidelines for the implementation of this particular provision is necessary to strengthen the enforcement and define the roles that other government agencies may render.

Pre-treatment Standards

Under the CWA, pre-treatment standards can be recommended by MWSS and the water concessionaires to DENR to manage effluents (i.e., industrial effluents) that are channeled into sewerage systems. In the absence of pre-treatment standards, the MWSS and the concessionaires can impose pre-treatment standards to establishments tapped into the system through contract with the particular establishment.

Since commercial and industrial wastes vary from domestic sewage, MWSS/MWCI/MWSI may need to consider whether their system can accommodate these sources of pollution. In this case, the design of the sewage treatment facilities should take into consideration pre-treatment standards and appropriate surcharges for non-compliance with the pre-treatment standards.

A fee system should be designed and set-up by MWSS to regulate quality from commercial and industrial sources that would be channeled into the sewerage system.

Compliance with Effluent Standards

The sewage treatment facilities of MWCI/MWSI are required to comply with the guidelines on sanitation of the DOH and the Effluent Standards of DENR. The same standards apply for domestic, commercial or industrial effluents.

In the interim, DENR Administrative Order No. 35 applies as the Effluent Standards while DENR Administrative Order No. 34 will serve as guideline for the water usage and classification and water quality criteria.

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Conflict with LGUs in Imposing Fees

The CWA underscores the role of the LGU in presenting priorities for sewerage and septage management. In the IRR, LGUs are mandated to maintain and shoulder the maintenance of sewerage facilities which overlaps with the mandates of the service providers. It is further stated that LGUs may enact ordinances to impose service fee system. The CWA creates mechanisms for funding through a fee system – property taxes and sewerage system. However, this duplicates the fee being charged by MWCI/MWSI, hence, this may need further review/study.

The fact that the CWA gives the LGUs the responsibility for the provision of rights-of-way and road access, the importance of local political support should likewise be emphasized. However, the imposition of fees to locators should be clearly defined with the LGUs.

While the MWSS can insist on implementing the right to eminent domain as embodied in its Charter, the important role of the LGUs in the implementation of sewerage projects should be taken into account.

Although Metro Manila LGUs have already a long history of good cooperation with MWSS, a pass-on fee to LGUs may be discussed to resolve any potential conflict that may occur with LGUs due to this particular provision of the CWA.

Incentives to Connect to Existing Sewer Lines

While the CWA reinforces the provision on mandatory connection of the Sanitation Code, the sanctions designed in the CWA-IRR are considered as low-impact and may once again face the usual resistance from consumers of MWSI/MWCI. The MWSS needs to discuss with the DENR and DOH stringent sanctions and more importantly attractive incentives to consumers to connect to the sewerage system.

Water Supply Disconnection

Rule 27.6 of the CWA-IRR stipulates that the DENR Secretary may issue an order to the Local Water Districts or to private water supplier such as MWCI or MWSI to disconnect the water service of a violator of any provisions of the CWA. This particular rule may need further legal analysis by MWSS and the issuance of appropriate guidelines by the DENR.

4. Study Area Status

4.1 Land Use and Urban Development

4.1.1 Existing Land Uses

A large portion of the MWSS service area is composed mainly of built-up areas, specifically in the central and southern service area and some areas in the north. The built-up areas that include residential, commercial, industrial, institutional and related infrastructure make up about 40% of the MWSS service area. The rest, which lies mostly in the northeastern portion of Rizal, is made up of agriculture, forest, open grassland and some mining/quarrying activities.

National Capital Region (NCR)

The land use trend in the NCR has largely been a response to socio-economic demands of a growing population and not necessarily according to plan. Four trends have been identified to characterize land use in the region:

- Increased density and size of informal settlements in city centers;
- Development of medium-scale residential subdivisions for the upper and upper-middle income markets up to the peripheries of the inner and intermediate cores, while low-cost housing has moved to the outer core in the provinces of Rizal, Bulacan, Cavite and Laguna;
- The growth of big commercial centers along EDSA and other major thoroughfares; and
- Infilling of the urban area with high-density housing.

Figure 4.1 shows the summary of existing land uses in the NCR.

Cavite Service Areas

The Cavite Service Areas have become highly urbanized in the past 20 years because of their proximity to Metro Manila. The largely agro-fishery base of the area was lost to residential, commercial, industrial and institutional uses. The rapid urbanization was also due to the resettlement of informal settlers in Metro Manila by the National Housing Authority in Cavite in the late 1980s. Among the Cavite Service Areas, Imus – the provincial capital has the biggest land area, followed by Bacoor and then Rosario. The smallest is Noveleta. These are all along the coast of Manila Bay.

The residential area has increased over the years, due to the conversion of agricultural lands into residential uses, resulting from increased demand for urban land brought about by high population growth. Most subdivisions in the northern portions of Bacoor are now being developed for high- and medium-cost housing, while those located on the southern portion are mostly for medium- and low-cost housing. The residential area covers an area of about 6,326 ha or about 30 % of the total land area of the six LGUs.

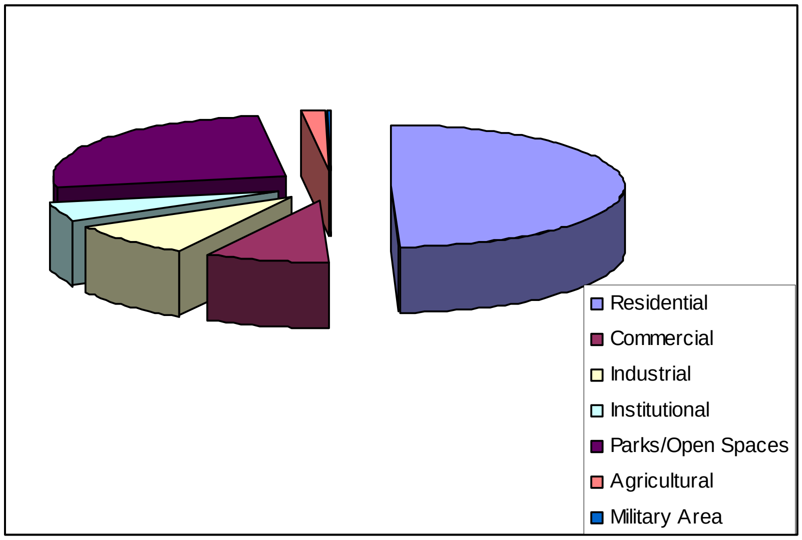

Figure 4.1 Existing Land Uses, NCR

Commercial establishments intersperse the residential areas scattered in all the municipalities, the largest being concentrated in Bacoor and Imus towns. Commercial activities within the Service Area cover an area of 319 ha (1.5% of total area).

Industrial activities cover an area of 2,200 ha (10%). Existing industrial warehouses are scattered within the Service Area particularly along the highways. The industrial activities are concentrated in Imus and Rosario.

Rizal Province

The province of Rizal has the largest land area in all the three provinces within the service area. However, most is dominated by grass and shrub lands covering at least 53% of the provincial land area. Other dominant uses were agriculture (14%), forest (14%), built-up areas (12%) and some 2% were still unclassified.

About 163 ha is devoted to built-up areas composed of urbanizing suburbs, spilling over from the Metro Manila area; flatlands bordering the Laguna Lake are intensively farmed, predominantly for rice and sugarcane production; mountainous areas where bananas and coconuts are grown; and where timber is harvested and a large patch of hilly scrub and grassland.

Rizal province contains a very important watershed providing irrigation, industrial and domestic water supply to numerous population of its surrounding communities including the NCR. The Reserve provides an important catchment area for Laguna de Bay.

The proximity of Rizal province to Metro Manila has greatly influenced its rapid urbanization. This high rate of urbanization is concentrated mostly in the municipalities near Metro Manila. The municipalities of Antipolo, Cainta, Taytay and Tanay are considered the urban centers of the province where most of the economic activities are located. Other minor urban areas are also concentrated along the coastal municipalities of Angono, Binangonan, Cardona, Baras, Pililla, Jala-jala and along the town centers of San Mateo, Rodriguez, Taytay and Teresa.

Industrial establishments are concentrated in Cainta and Taytay because of the extension of Ortigas Avenue in Pasig City, Metro Manila. Some industries may also be found in the towns of Antipolo and Binangonan. The other municipalities have very few industries.
The province is also a favorite local tourism destination with its old churches, several water falls (Daranak, Batlag and Hinulugang Taktak), resorts and a couple of golf clubs – all of which require adequate water supply and sewerage systems.

The forested areas are found in the northern part of Rodriguez and Antipolo as well as the northeastern part of Tanay and Pililla. However, of the total 686 sq. km. of forest lands, only 25% remain covered with trees while the rest are already denuded or sparsely covered by second and third growth forest vegetation. If the trend is not abated, the sparsely covered forestlands will be rendered as grasslands and will later succumb to development.

4.1.2 Proposed Land Use

National Capital Region

Historically, the strongest directions of growth have been towards the northeast, or Quezon City and the south, or Muntinlupa. These growth directions, moreover, appear to be canceling each other out, thereby leaving what planners call a “net eastward” movement in the center of the metropolitan population.

Physical development will encroach and intensify potentially in the watershed areas in Quezon City and Marikina Valley, towards Rizal. Rizal province has been experiencing approximately 10 % growth rate over the last decade and densities, particularly in the municipalities of Cainta and Taytay, are increasing.

People form an important link between the national capital region and the adjoining provinces of Rizal and Cavite, more so as the trend to relocate residences to areas outside Metro Manila continues. The people who live in these areas form a “transient” link between their place of work and the urban core. This arrangement also works the other way around. As industries relocate away from the urban core, the population becomes more transitory, traveling back and forth from their residences to their workplace, particularly since mass transport systems are being developed to further increase the link in these areas.

It is anticipated that the transient character of the workforce in both provinces and Metro Manila would subsequently be absorbed by both areas as expansion of human settlements and industries occur on the plane of reciprocity and integration.

Available data on Metro Manila shows that in view of limited urban land resources, the trend for land development – particularly for human settlements – is to move outwards beyond the region's boundaries.

According to the most recent MMDA study, there are four emerging development trends within the NCR:

- There are built-up areas within the NCR wherein the uses of certain physical infrastructures could not be maximized and are thus, suitable for redevelopment and alternative land use activities;
- There are areas in Metro Manila where physical development vis-à-vis population density has reached a level wherein additional land using activity will result in negative or adverse effects. Here, further development has to be deferred to deter additional pressure on existing amenities and infrastructure support facilities;
- There are ecologically-sensitive areas in the region which require special types of development that would ensure sustainability and prevent unnecessary loss of life and property due to disasters and adverse effects of pollution; and
- In view of expansion of land development towards Metro Manila's outer core, there is the need to plan and regulate such development to ensure that the carrying capacities of resources therein are respected.

For informal colonies, the immediate option is resettlement in suburban resettlement areas or sites outside the metropolis. The municipality of San Juan is already undertaking a Resettlement Program in Taytay, Rizal and the Pasig River Project will be relocating squatters along Pasig River in Montalban, Rizal. Other informal settlement areas, particularly those that will be affected by major infrastructure projects such as the Northrail and McArthur Highway expansion projects, will also be relocated within the region, in Bulacan or Rizal.

The differences between the existing and proposed land uses in Metro Manila as reflected in the Comprehensive Land Use Plans (CLUPs) of the LGUs is shown in **Figure 4.2**.

Cavite Service Areas

The CLUPs of the Cavite Service Areas are proposing further expansion of the built-up areas except for Kawit, Rosario and Noveleta, which up to the writing of this report have not yet prepared their CLUPs. However, based on the increasing trend of population in these areas and their adjoining LGUs, it is projected that their built up areas will likewise increase.

Proposed total residential area in the Cavite Service area is estimated to be more than 70 sq.km. or about 40% of the service area's total area – an increase of about 15 % from the existing area devoted to residential. Commercial land uses will be doubled within the Service Area with the highest commercial land area located in Bacoor.

Most of the municipalities within the Service Area are reducing their industrial land area allocation except for Cavite City which is planning to allocate 98 ha or an increase of 270 percent from the present area allocated for industrial uses. This results in a net increase of industrial areas within the Service Area.

Rizal Province

Rizal Province is also anticipating continued development of its areas particularly the service centers of Antipolo, Cainta and Taytay.

Growth corridors are being planned in various strategic locations around the province. The Rodriguez-San Mateo-Antipolo growth corridor, which includes the proposal for the establishment of San Mateo Industrial Estate, will link it with Quezon City and the northeastern part of Metro Manila. A planned Antipolo-Sampaloc, Tanay growth area, on the other hand, will focus on the development of a grand industrial estate project that is expected to hasten the eastern province's industrialization.

To support these growth plans, Rizal is planning to increase its built-up area by about 60 %, half of which are found within Antipolo City, Cainta, Taytay and San Mateo – the most rapidly urbanizing LGUs within Rizal. Most of this area will be taken from the open/grassland area.

In general, Rizal is intending to increase its forested area by about 12 % with corresponding protection strategies for forestlands. Agriculture will also allocate a slight increase in the area while the Mining/Quarrying areas will remain the same.

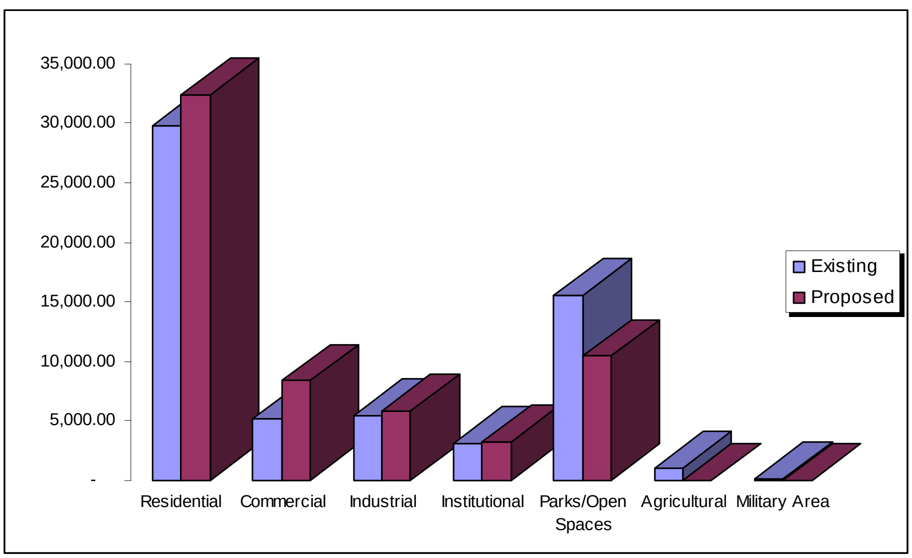

Figure 4.2   Difference between Existing and Proposed Land Uses, NCR

4.1.3 Urban Development Trends and Availability of Vacant Lands

Emerging Trends

The approved/proposed land uses within the service area are developing towards increased residential, commercial and industrial activities with corresponding increases in land allocation. The NCR is going towards mixed use high residential/commercial developments to cater to its increasing population and higher level of commercial activities in the future.

The MMDA physical framework plan intends to decongest Metro Manila and re-distribute and link growth with the suburban centers of neighboring regions and provinces such as Rizal, Cavite, Laguna and Bulacan. This is supported by specific policy areas and applicable strategies such as permitted developments and transport systems. Activities will be encouraged to reflect the corresponding zonal policies.

One of the policies is the relocation of informal settlers in suburban resettlement areas or sites outside the region specially those living in environmentally constrained areas. This supports the continued growth of population in Rizal discussed in Section 4.2.3 of this report.

There are also plans for the development of transport exchange centers where people living outside the NCR can be dropped off and commute from there to their place of work or destination in the region. This is reinforced by the promotion of mass transit systems, including other transport modes such as skyways, subterranean, railways or roads.

For land use and development, the emerging trend is that land value within the NCR, particularly in the regeneration and urban control policy areas, is rapidly rising thereby leading to changes in land using activities in order to meet demand for specific purposes, be they residential or service-oriented commercial uses. In other words, manufacturing entities will find it more practical and less costly to relocate to areas outside the inner and intermediate cores of Metro Manila. Add to this the fact that installation of anti-pollution treatment facilities will add to operating costs of industries who may opt to transfer to industrial enclaves already equipped with such facilities.

The provinces of Rizal and Cavite have assumed a suburban character due to the spillover of housing demand and supply in Metro Manila. A vast number of residents in these areas actually work in the inner and intermediate core of the metropolis.

Availability of Open Spaces/Vacant Lands

In the proposed/approved land use plans in NCR, there are about 10,700 ha of open spaces available which are mostly concentrated in Quezon City and Manila. These are planned for various uses. Most of the cities/municipalities within the region are also planning to enforce the buffer/easement along the river ways and railways, which can be developed for public utilities such as treatment plants. Moreover, derelict or abandoned industrial areas scattered around the region can be recovered for other uses such as sewage treatment plants (STPs). The PRRC plans for the development of linear parks along 10-m easements along Pasig and Marikina River are supported by the concerned LGUs (e.g. Pasig, Makati, Mandaluyong, Marikina), which have enacted new land use/zoning plans and ordinances allocating space for such easements. These easements can be considered for the installation of interceptors/trunk sewers, and even small STPs, if these are included in the strategy evaluated to be most viable.

4.1.4 Implications for Sewerage and Sanitation Planning

The approved/proposed land uses within the MWSS service area provides for a general increase in residential, commercial and industrial area with the residential area increasing with a higher rate than the two other uses. This implies increased water needs and sewage production in all three major activities. It is estimated that domestic water supply will have a higher proportion than industrial water supply requirements not only because of the high growth rate in residential areas but also because most LGUs in NCR are also limiting their industrial development to light industries with limited water consumption. In certain areas of the NCR, particularly the cities of Manila, Quezon, Makati, Pasig, Mandaluyong and Las Pinas as well as the municipality of San Juan, industrial activities will be reduced to pave way for the creation of new residential/commercial developments. These new developments will require new infrastructure systems.

New infrastructure systems may be easier installed in Rizal than in the NCR and Cavite province because the density and intensity of development there are still lower. For the latter areas, several issues such as higher costs, traffic congestion, informal settler relocation and a host of other issues may confront development/installation of new systems particularly sewerage. Further, the Manila Third Sewerage Project (MTSP) report correctly observes that there may be a resistance to putting in new sewerage systems, particularly STPs in these new residential/commercial areas. In general, industrial zones are considered to be more “compatible” with STP operations.

4.2 Demography, Population Growth and Distribution to 2025

The national and regional population and growth trends are important in this study as they are the basis for predicting the behavior or their component cities/municipalities. The population of the country in 2000 was about 76.5 Million, with an average growth rate of about 2.2 %. The ratio of NCR and Region IV with respect to the total population of the country is about 13 and 15 %, respectively. The ratios of the Province of Cavite and Rizal are 17 and 14 % respectively, out of the 10 provinces within Region IV.

The MWSS Service Area accounts for 16.2 % of the country’s total population in 2000 estimated at 12.4 Million, with an average annual growth rate of 1.5 % in 2000.

The proportionate current (Yr 2000) distribution of population is approximately 60% West Service Area and 40% East Service Area. The National Capital Region comprises about 80% of the total population in the service area; the municipalities covered in Cavite comprise 6% and Rizal Province 14%.

In the 2000 NSO Census, the biggest cities were the cities of Manila, Quezon, and Caloocan, the combined population of which is 40% of the total population in NCR and already one-third of the entire service area population. Meanwhile, the towns with the smallest population are Baras, Jala-jala and Teresa in Rizal Province where the combined population is less than 100,000 or 4.5% of the total population in Rizal or less than 1% of the total population in the service area.

The average density within the service area is about 6,000 people or about 1,300 households per square kilometer. The City of Manila registered the highest population density at about 39,000 people per square kilometer, followed by Caloocan City. The least dense municipality is Tanay, Rizal with only about 234 people or inhabited only by about 47 families per square kilometer.

It is estimated that 28% of the households in the service area are informal settlers, which is approximately 814,000 families. Informal settlement families are distributed to about 600[1] major slum areas in the service area.

Figure 4.3 indicates the population densities in the service area at the time of the 2000 census.

[1] Based on NHA reports

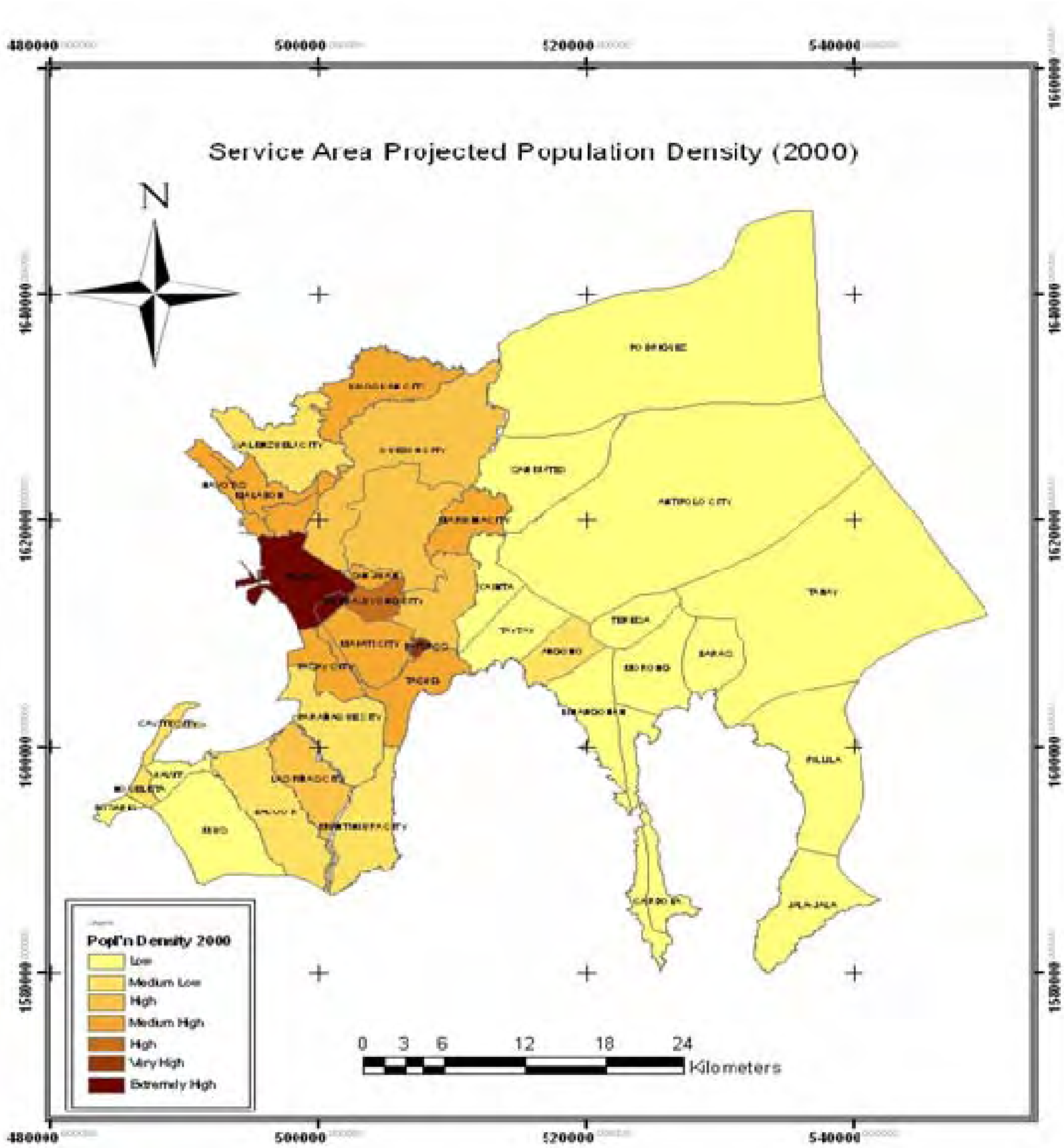

Figure 4.3 Population Densities, MWSS Service Area, 2000

4.2.1 Previous Studies and Reports

Previous Master Plans, Studies and Reports containing data and projections for the MWSS Service Area were reviewed. They were compared for methodology, proximity of projections to actual census (particularly for the earlier Master Plans), and consistency with this Study's predictions.

The ratio method has been commonly used by previous Master Plans for projecting the sub-national level populations. This is also the most widely used method in many countries because of the lack of appropriate methods yet available to project smaller areas. The ratio method simply means that the sum of the component areas cannot be more than the larger area (i.e. national), which makes use of more accurate estimates such as the rate of birth, death and migration.

It can also be observed, that the projections of the earlier years or the ones closest to the next census of the base year are very close to the actual census of that year and the variance becomes wider as the projections become longer. Hence, this Study's projections were made with precautions that the latter year projections might actually be higher than the actual population for those years. A careful study of other parameters such as land use trends and densities was made to compensate for the limitations of the methodology used for predicting future populations of smaller areas.

4.2.2 Population Projection for the Cities/Municipalities of the MWSS Service Areas

The future population in the Service Area was projected for the planning period (2005 to 2025), using the NSO population census of 2000 as base data. The projection aimed at providing data for the estimate of future water demand at city/municipal level.

The ratio method rather than the cohort component method was utilized to project populations of cities and municipalities in the coverage area because of the unavailability of data on fertility, mortality and migration at the city/municipal level. The ratio method of estimating the future population of the MWSS service areas makes use of the levels and trends in the ratios of the population of cities and municipalities to the population of their respective provinces observed in previous censuses. These ratios are then projected on the assumption that after some time stability will be attained.

4.2.3 Population Projections for Provinces (NCR, Cavite and Rizal)

The NSO has prepared a population projection for the Philippines (national level) from 2000 to 2040 using the 1995 Census. This was used as a basis for projecting the population of NCR and the provinces of Cavite and Rizal (based on their ratio with Region IV).

By the year 2025, the projected population within the MWSS service area will be 19.4 million. This is an increase of about 57% or 7 Million persons from the NSO Census of

2000. The highest growth will be experienced by Rizal, which will more than triple by 2025. Cavite will increase by 68 % and NCR by 25%. (**Figures 4.4 to 4.7**)

The projected growth and distribution in Rizal is strongly influenced by the proximity of Metro Manila. The more densely populated municipalities are located within or close to Manila. The high population growth rate is largely attributed to immigration from the other regions of the country, which results mainly from the perceived economic opportunities in Metro Manila.

Because NCR and Cavite Service Areas are highly urbanized, population growth has more or less stabilized and their development strategies focus now on mixed use and high-density residential development.

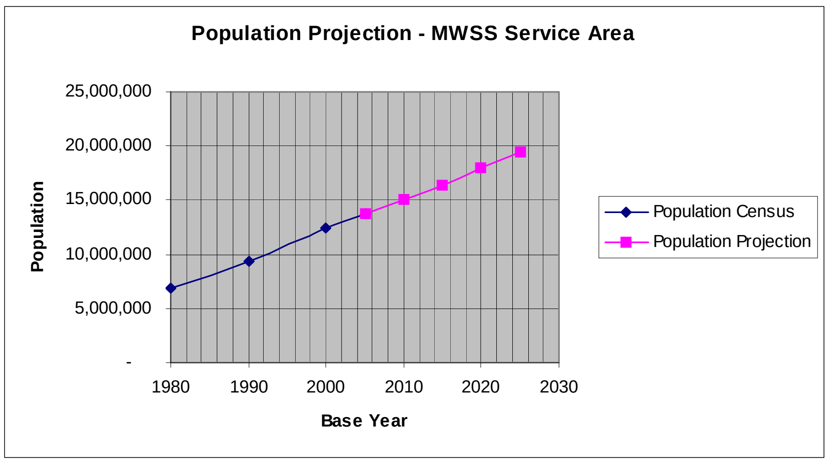

Figure 4.4 Population Projection, MWSS Service Area

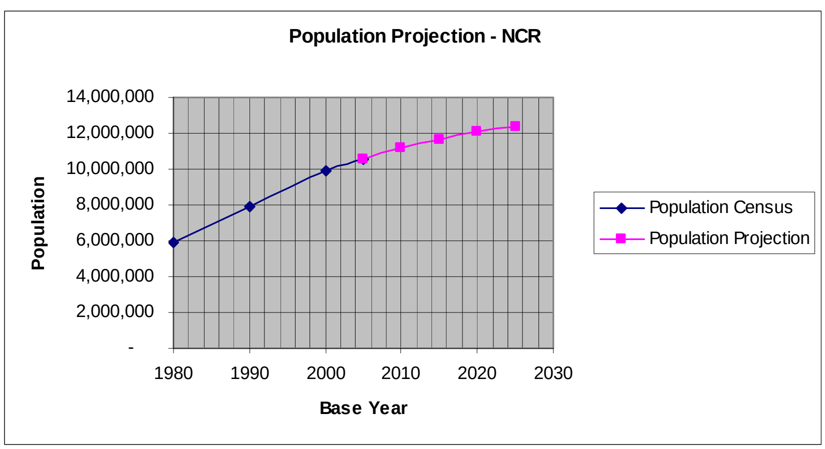

Figure 4.5 Population Projection, NCR

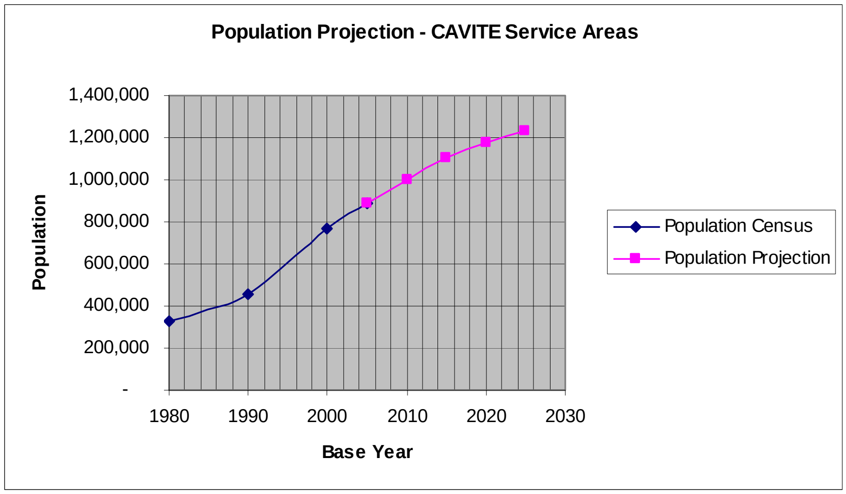

Figure 4.6 Population Projection, Cavite Service Areas

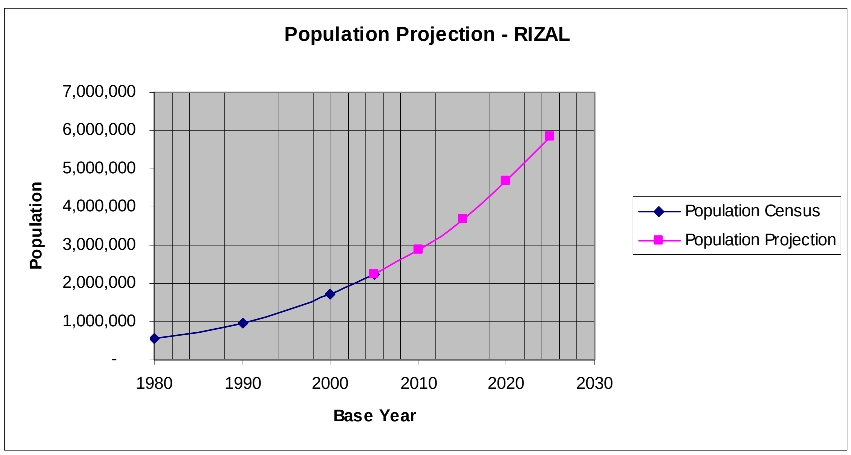

Figure 4.7 Population Projection, Rizal Province

By 2025, the approximate distribution between the East and West Service Areas is projected to be almost 50-50 % because of the high growth rates in the East Service Area.

Some projected population adjustments were made in several LGU projections because of the following reasons:

- Extraordinarily low projections for Manila and San Juan. These two LGUs continue to exhibit negative growth rates using NSO projection method, but their trend shows stabilization in the size of the population. This observation was also expressed in the development plans of Manila. Hence, the ratio base growth rate was adjusted to 0% for both cities. This resulted in a continuing but a slower rate of decline during the study period.

- Extraordinarily high projections for Antipolo, Cainta and Taytay. These three adjacent LGUs exhibited extraordinarily high growth rates during the study period, which was thought not to be matched by their government's capability to deliver basic services. Moreover, the previous high growth rates in these areas were caused by the exodus of migrants from the provinces and government's resettlement projects, which may slow down in the coming years as development plans of inner and intermediate core cities of Metro Manila are including medium and high density developments for on-site relocation of their population. Hence, in order to avoid extraordinary projection under the NSO projection method, the base rate was assumed as half the recent 5-year ratio growth rate for all three LGUs based on classification IV computation under the ratio method.

The aforementioned adjustments to the population projections naturally affected the ratio and number of population of the other cities/municipalities within the region/province as the ratio method redistributed the adjustments within the area. The observed overall effect still provided the expected general trend based on future densities and land use changes.

The projected population in each of the LGUs in the service area for the years 2000, 2005, 2010, 2015, 2020 and 2025 is shown in **Table 4.1**. The growth rate trends are shown in **Figure 4.8**.

4.2.4 Population Density Projection

The average density of population within the MWSS Service Area by 2025 is about 10,216, an increase of 30 % from the 2000 density. The highest densities will still be found within NCR with the cities of Taguig, Manila and Caloocan achieving densities over 30,000 persons per sq. km. Taguig will become densely populated because of loss of some of its lands to Makati City, particularly the Fort Bonifacio development. The least dense will be Tanay in Rizal province with about 560 persons or about 112 families per square kilometer.

Figure 4.9 presents the density projection within the service area. The growth trend continues to draw eastward with the core of Manila extending to the peripheries of Rizal and Cavite.

Although Manila has shown signs of stabilizing in the last ten years, the local government there would like to manage growth below 1 % to enable it to plan for the basic services it needs to provide and maintain for its population. Furthermore, it wants to manage migration to and from Manila and prioritizing in-city relocation and on-site development as much as possible and the promotion of medium rise building projects for on-site relocation, hence, the continuing high density.

Makati, on the other hand, would like to maintain its competitiveness with the other cities and has applied density limits to existing and proposed developments to preserve the market advantage of these areas relative to other parts of the metropolis.

Table 4.1 - Projected Population and Growth Rates, MWSS Service Area, 2005-2025

	City/Municipality	Population Projection						Projected Growth Rates (%)			
		2005	2010	2015	2020	2025	'00-'05	'05-'10	'10-'15	'15-'20	'20-'25
	NCR	**10,575,188**	**11,137,443**	**11,649,493**	**12,077,301**	**12,402,857**	1.26	1.04	0.90	0.72	0.53
1	Manila	1,572,788	1,542,856	1,498,306	1,437,495	1,361,717	(0.11)	(0.38)	(0.58)	(0.83)	(1.08)
2	Pasay	355,122	350,412	342,295	330,334	314,760	0.01	(0.27)	(0.47)	(0.71)	(0.96)
3	Quezon	2,288,816	2,376,485	2,442,754	2,480,588	2,487,164	1.04	0.75	0.55	0.31	0.05
4	Caloocan	1,305,994	1,428,308	1,546,404	1,654,073	1,746,872	2.09	1.81	1.60	1.36	1.10
5	Mandaluyong	296,293	310,882	322,918	331,374	335,752	1.25	0.97	0.76	0.52	0.26
6	Las Pinas	559,481	652,906	754,286	860,899	970,158	3.42	3.14	2.93	2.68	2.42
7	Makati	461,480	444,207	423,290	398,494	370,408	(0.48)	(0.76)	(0.96)	(1.20)	(1.45)
8	Malabon	330,538	317,956	302,785	284,860	264,608	(0.50)	(0.77)	(0.97)	(1.21)	(1.46)
9	Marikina	412,731	429,446	442,354	450,155	452,302	1.08	0.80	0.59	0.35	0.10
10	Muntinlupa	415,098	447,968	478,589	505,137	526,418	1.82	1.54	1.33	1.09	0.83
11	Navotas	245,524	258,011	268,413	275,867	279,944	1.28	1.00	0.79	0.55	0.29
12	Paranaque	498,242	544,239	588,518	628,723	663,185	2.07	1.78	1.58	1.33	1.07
13	Pasig	576,228	648,316	722,104	794,589	863,297	2.67	2.39	2.18	1.93	1.67
14	Pateros	57,438	56,673	55,357	53,419	50,897	0.01	(0.27)	(0.47)	(0.71)	(0.96)
15	San Juan	119,133	118,932	117,541	114,765	110,638	0.25	(0.03)	(0.24)	(0.48)	(0.73)
16	Taguig	551,941	642,775	741,048	844,040	949,194	3.38	3.09	2.89	2.64	2.38
17	Valenzuela	528,340	567,069	602,531	632,489	655,543	1.71	1.42	1.22	0.98	0.72
	Cavite	**889,204**	**1,001,005**	**1,100,829**	**1,179,874**	**1,231,998**	2.95	2.40	1.92	1.40	0.87
18	Cavite City	103,976	105,650	104,612	100,701	94,199	0.91	0.32	(0.20)	(0.76)	(1.33)
19	Bacoor	352,753	395,270	431,607	458,171	472,635	2.90	2.30	1.77	1.20	0.62
20	Imus	226,717	255,332	280,220	298,977	309,981	3.01	2.41	1.88	1.30	0.73
21	Kawit	72,750	81,901	89,850	95,828	99,318	3.00	2.40	1.87	1.30	0.72
22	Noveleta	38,068	44,032	49,631	54,385	57,911	3.56	2.95	2.42	1.85	1.26
23	Rosario	94,941	118,820	144,910	171,812	197,955	5.21	4.59	4.05	3.46	2.87
	Rizal	**2,230,624**	**2,878,932**	**3,686,046**	**4,672,308**	**5,859,922**	5.49	5.24	5.07	4.86	4.63
24	Angono	100,496	133,373	175,297	227,726	292,250	6.12	5.82	5.62	5.37	5.12
25	Antipolo City	639,804	857,242	1,137,491	1,491,840	1,932,861	6.32	6.03	5.82	5.57	5.32
26	Baras	31,018	38,701	47,820	58,403	70,463	4.82	4.53	4.32	4.08	3.83
27	Binangonan	237,025	295,155	363,995	443,681	534,256	4.78	4.48	4.28	4.04	3.79
28	Cainta	308,654	387,364	481,453	591,452	717,776	4.94	4.65	4.44	4.20	3.95
29	Cardona	45,233	51,727	58,582	65,576	72,515	3.01	2.72	2.52	2.28	2.03
30	Jala-jala	28,724	34,948	42,110	50,151	59,003	4.29	4.00	3.80	3.56	3.30
31	Morong	50,832	59,966	70,059	80,900	92,286	3.65	3.36	3.16	2.92	2.67
32	Pillila	56,027	68,367	82,620	98,685	116,446	4.35	4.06	3.86	3.62	3.37
33	Rodriguez	149,087	190,309	240,584	300,610	371,061	5.30	5.00	4.80	4.56	4.30
34	San Mateo	183,874	245,853	325,552	426,083	550,900	6.28	5.98	5.78	5.53	5.27
35	Tanay	95,441	114,826	136,816	161,125	187,452	4.06	3.77	3.57	3.32	3.07
36	Taytay	267,047	354,825	466,906	607,260	780,232	6.15	5.85	5.64	5.40	5.14
37	Teresa	37,362	46,275	56,761	68,816	82,420	4.67	4.37	4.17	3.93	3.67
	Grand Total	**13,695,016**	**15,017,380**	**16,436,369**	**17,929,483**	**19,494,777**		1.86	1.82	1.75	1.69

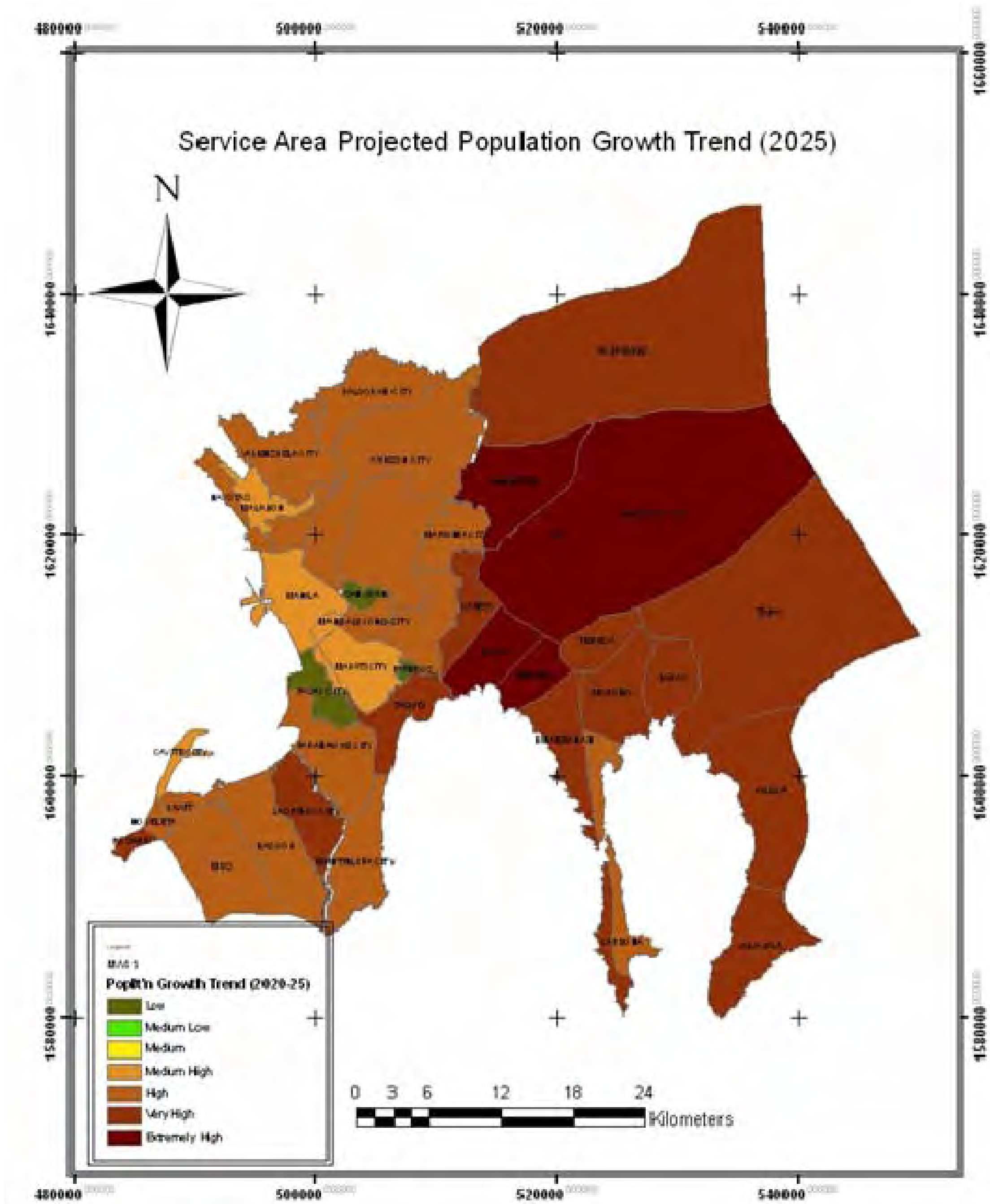

Figure 4.8 Projected Growth Trends, 2025

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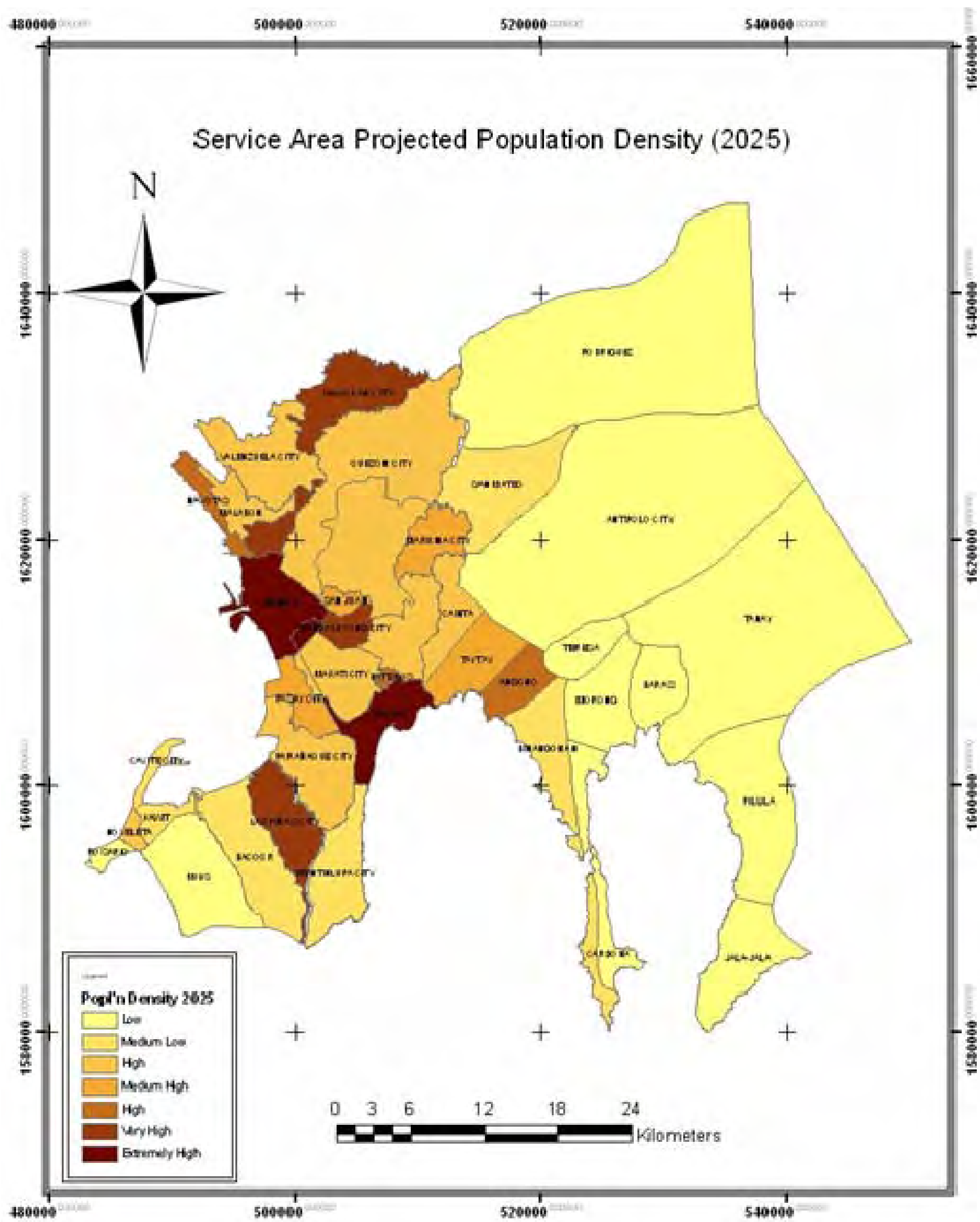

Figure 4.9 Projected Population Density in 2025, MWSS Service Area

4.2.5 Summary of Opportunities for Sewerage and Sanitation Sector Development

Approximately 19.4 Million people or approximately 4.3 Million families will need potable water supply and sewerage services within the MWSS Service Area by 2025. At present, the level of population served by water is about 7.3 Million[2] with total service connections of about 780,000. Only about 15% of these water connections are sewered.

The projected population will be housed in existing residential areas and in newly developed development of new high-density residential/commercial use spaces. Most of the LGUs are planning for medium-density socialized housing for low-income groups that will decide to stay within the region.

There will also be a general increase in commercial and industrial uses that will require new water supply and sewerage systems. Industrial activities within the NCR will likely be of the small and light industries; large, heavy industries will be relocating outside the region, most likely towards Rizal, Cavite and the adjoining provinces.

Transport projects that will link NCR with Cavite and Rizal are already underway. This will increase the movement and flow of people and goods within the Service Area and will likely promote more development within the planning period.
The new infrastructure systems required for these anticipated developments may be developed on land that is still available if the government is able to secure them as soon as possible. At least 27 % of the total area in Metro Manila is proposed as open space in the individual CLUPs of the different LGUs. These maybe recovered from lands that will be vacated by resettled families, enforcement of easements along rivers and opening up of abandoned and derelict industrial areas.

4.2.6 Summary of Issues and Constraints for Sewerage and Sanitation Sector Development

In terms of land use and development, the NCR and Cavite Service Areas will have a short supply of available land for its increasing population and economic activities. Hence, development will likely be vertical rather than horizontal. The existing systems should be assessed if they can still accommodate the additional load coming from these developments.

Rizal, on the other hand, has a large expanse of open space/grasslands but they are constrained by the availability of water in the area. With the projected growth rate and development trends leading towards this area, new water sources should be given priority for development.

In terms of developing new waste management systems, there are several factors to be considered relative to the projected land uses within the service area.

[2] Based on 2003 MWSS Regulatory Office Annual Report

It is likely that developments will be scattered all over the region and will not likely be developing in scheduled phases as it is mostly private sector led. Hence, careful consideration should be given to designing system requirements for specific sector areas.

The changing advocacies and short term tenures of Chief Executives affect the ability of LGUs to implement their CLUPs and enforce their zoning ordinances within the plan period. Consequently, it also affects the ability of LGUs to undertake the recovery of open spaces, particularly relocation of informal settlers to set the buffer easements along the rivers/creeks. Hence, in the design of new waste management systems, approved/projected land uses should be treated only as indication. It is not likely that these areas will be transformed within the time frame prescribed by the plans.

There are also external and macro-economic factors affecting the rate of development in the NCR and the rest of the country. Historically, the NCR consistently produced the highest output in the country. Cavite and Rizal are closely following the trends of NCR because they are recipient of spill over from the region.

4.3 Water Supply

4.3.1 Present Water Supply Sources

Water supply to the current MWSS service area is sourced from the Angat-Umiray-Ipo system and local groundwater. The total capacity of the existing water source infrastructure is estimated at **4,090 MLD**, of which approximately 98% (4,000 MLD) of the daily supply comes from the Angat-Umiray-Ipo source.

Angat-Umiray-Ipo Sources

The main water supply source for MWSS is the Angat-Umiray-Ipo River System, as shown in **Figure 4.10.**

The system originates in the Angat River basin with a transbasin tunnel, adding yield from the Umiray River basin. Inflow is impounded at the Angat Dam. Discharge from the dam flows down to Ipo Dam. From Ipo Dam, raw water is conveyed thru three tunnels to the Bicti interconnection structure, thence thru five raw water aqueducts to La Mesa. The conveyance from Ipo Dam to La Mesa involves some 20km of tunnel/conveyance pipes. At La Mesa, part of the raw water feeds directly to the La Mesa Treatment Plants and the rest goes to Balara or to the La Mesa Reservoir. The La Mesa Reservoir also receives inflow from Alat Dam and its own catchment.

Groundwater Sources

Sourcing of groundwater from deep wells to either fully meet local demands or augment supply capacity is widespread across Metro Manila, with significant competition existing for use of this resource.

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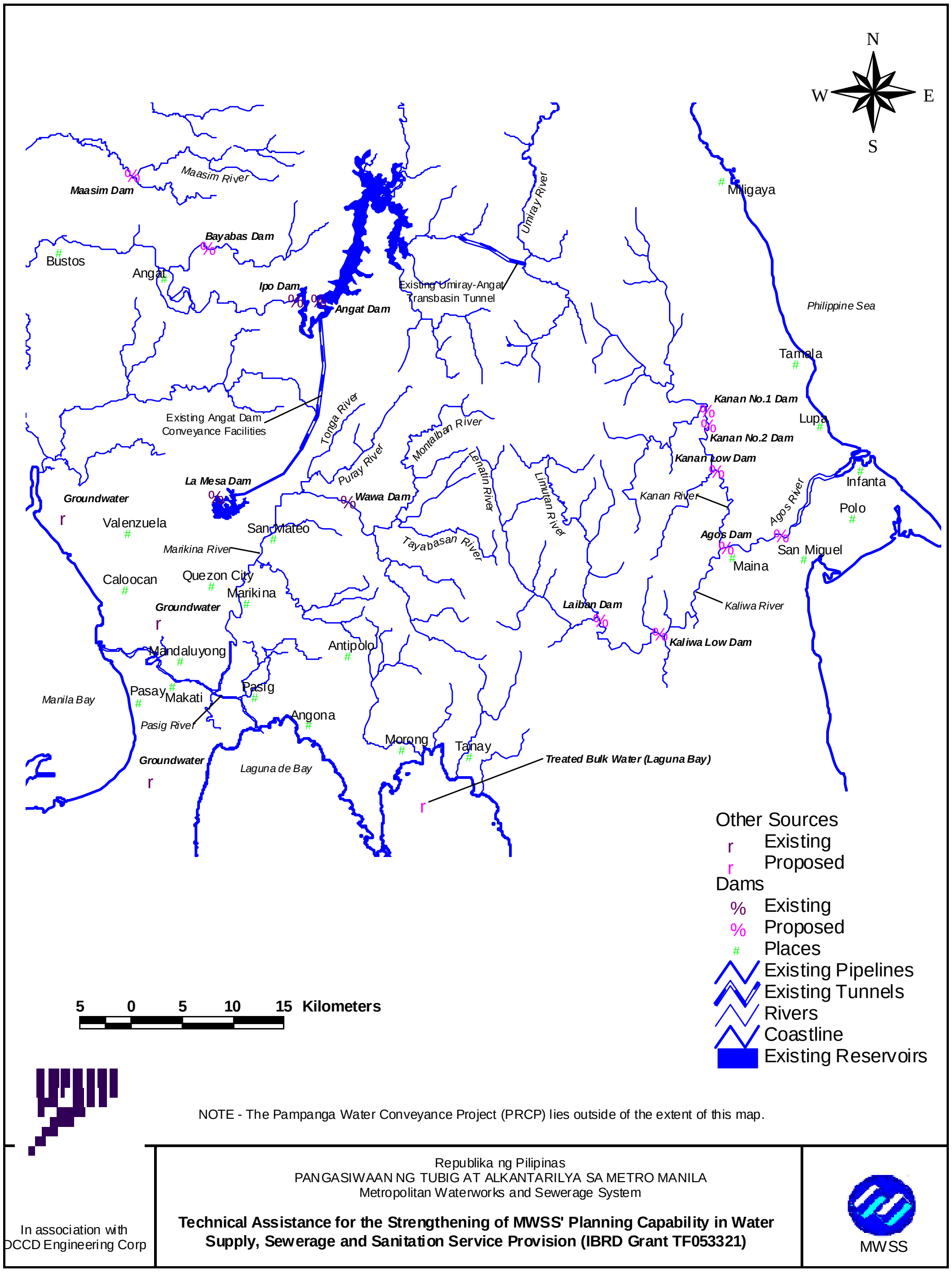

Figure 4.10 Angat-Umiray-Ipo River

In the concession areas, MWSI reportedly has 81 wells operating mainly in Parañaque, Las Piñas, Muntinlupa, Imus, Bacoor, Noveleta, and Cavite City with a total production of 57 MLD. The MWCI has some 50 wells operating in Cainta, Antipolo, Taytay, San Mateo, Rodriguez, Quezon City and Taguig, with a total production in the order of 35 MLD.

The total production capacity of 90 MLD from deep wells operated by the concessionaires represents about 70% of the installed capacity. The reduced level of production is due primarily to declines in aquifer levels and water quality resulting from over-abstraction of this resource. It is expected that these issues will continue to place increasing pressure on the use of groundwater as a resource for municipal water supply in the future.

4.3.2 Primary Distribution System

The MWSS water distribution network had its beginning in 1882 under the old Manila Water District. It has since undergone a series of expansion and upgrading through:

- The Interim Projects in the 1960's:
- The Manila Water Supply Project 2 (MWSP2);
- The Metro Manila Water Distribution Project (MMWDP);
- Angat Water Optimization Project (AWSOP); and more recently,
- The Manila South Water Distribution Project (MSWDP).

The West Zone distribution system was separated from the old MWSS system and it generally covers the influence area of La Mesa Treatment Plants 1 and 2. The pipe network has a total length of about 2,500 km, with sizes ranging from 3200 mm diameter to 50 mm. The primary distribution system (PDS), consisting of pipes 350 mm diameter and above is about 220 km.

Treated water from the La Mesa treatment plants is conveyed through a 3200 mm diameter line to the 200-ML Bagbag treated water reservoir. From the Bagbag Reservoir, the water is directed south through a 3000 mm pipe up to the vicinity of A. Bonifacio Street (Balintawak Cloverleaf area), where the pipe size is reduced to 2800 mm. The size of the pipeline is further reduced to 2200 mm in Moriones, Tondo and continues up to just upstream of the Pasay Reservoir and Pumping Station.

Through the La Mesa Pumping Station, about 24 MLD is sent to Upper Caloocan and 117 MLD is pumped to the Valenzuela area.

The distribution network of the East Zone is generally the part of the MWSS network supplied by the Balara Water Treatment Plants 1 and 2. Total length of the pipes in the system is around 2600 km. About 83.5 km of these have diameters 750 mm and larger. It is estimated that 40% of the distribution system is served by gravity flow while the remaining 60% requires pumping.

The Marikina Gravity Line, a 2200 mm steel pipe, flows by gravity from the Balara Treatment Plant Complex to Marikina, Pasig, Pateros, Makati. It feeds the Pasig, Fort Bonifacio and Makati Reservoirs and Pumping Stations.

The three Balara-San Juan Aqueducts feed the Balara and San Juan Reservoirs and Pumping Stations, as well as the Cubao Booster Pumping Station. AQ1 feeds the Balara Pumping Station, which discharges through the 1200 mm Katipunan line and the 1050 mm Tandang Sora line. AQ3 serves the San Juan Reservoirs and pumping stations, while AQ2 is currently not in use.

The 1200 mm Tanong line flows by gravity and serves parts of Cainta through the Masinag Booster pumping station.

4.3.3 Water Usage

4.3.3.1 General

Current and future water demand has been analyzed in detail in Volume 2 of this Master Plan – *Partial Update of the MWSS Water Supply Master Plan.* In that study, water demand is broken down into domestic, commercial and industrial demands.

Future water demand estimates are mainly dependent on past consumption trends and other factors such as water tariff and the socio-economic condition of the community. In the present case complete reliance on past consumption trends is inappropriate as these are affected by:

- low pressures
- supply interruptions (intermittent water availability)
- metering errors
- unauthorized connections
- use of sources other than from MWSI or MWCI (private wells)
- tariff increases

The factors enumerated above will result in the underestimation of future demand.

4.3.3.2 Domestic Water Demand and Per Capita Use

A reasonably accurate correlation between per capita consumption and per capita income or family income can be established from past consumption trends in an unconstrained supply setting. In view of the constrained supply situation and the factors enumerated in the preceding paragraph, which affected the normal growth of domestic water demand, it is likely that demand will remain constrained until a major new water source is brought on-stream and/or until non-revenue water (especially in the West Zone) is significantly reduced. Either is unlikely to occur until after 2010.

In estimating future domestic water demands, basic assumptions were made related to service coverage, household income levels and number of households per connection.

With regard to **service coverage**, the coverage targets are taken from the Rate Rebasing Submission of the two concessionaires as shown in **Table 4.2** below.

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Table 4.2 - Coverage Targets

Service Area	2005	2010	2015	2020	2025
West	90%	97%	98%	98%	99%
East	67%	73%	81%	92%	98%
Total	**81%**	**87%**	**90%**	**95%**	**98%**

It is also assumed that water demand is related to **household income**. The total number of families in each city/municipality can be categorized into three income groups: high, middle, and low, using the 2000 Family Income and Expenditures Survey by the National Statistics Office (NSO). Different per capita water demands have been set and applied to each household group. In the absence of a similar detailed survey for the cities/municipalities of the provinces of Rizal and Cavite, the provincial household income percent distribution was adopted commonly for each city/municipality.

The third assumption used in the estimation of water demands is the **number of individuals per connection**. For this study the results indicated in the Consumer Survey prepared by the Public Assessment of Water Services (PAWS) were adopted i.e. 8.1 persons per connection served by MWCI and 7.26 persons per connection for MWSI. These figures were used in computing the historical domestic per capita billed volume.

Domestic per Capita Demand for Years 2005 and 2010

Taking into account the current limitation on water supply, the following consumption rates or per capita demand (constrained) were used: 180 lpcd for the high income group, 170 lpcd for middle, and 140 lpcd for low.

A lower set of per capita demands were adopted for selected and less urbanized towns in Rizal and Cavite, i.e. 160 lpcd for high, 150 for middle and 140 for the low income group.

Using the household distribution by income level and the per capita demand above, the weighted average per capita demand were obtained per city/ municipality. The domestic demand projection for year 2005 was obtained by applying these average per capita demands to the population served resulting in a system-wide average per capita demand of about 160 lpcd.

Domestic per Capita Demand for Year 2015

As a result of the current and planned NRW reduction programs of the concessionaires and the expected recovery of physical losses as well as the availability of a new water source, more water will be available. Hence, the following per capita demands were used: 220 lpcd for the high-income group, 200 lpcd for middle, and 160 lpcd for low income.

Similar to year 2005, a lower set of per capita demands were adopted for selected and less urbanized towns in Rizal and Cavite: 180 lpcd for high, 160 for middle, and 140 for the low income group. From this new set of per capita demands by income level, the domestic demand projection for year 2010 was obtained resulting in a system-wide average per capita demand of about 180 lpcd.

The per capita demand from 2010 to 2015 was assumed to increase linearly from a system-wide average of 160 lpcd in 2010 to 180 lpcd in 2015.

Domestic per Capita Demand from 2015 to 2025

The domestic per capita water demand for each city/municipality in year 2015 was projected to remain at the same level up to 2025. The increase in per capita water consumption during this period from improved economic conditions is expected to be neutralized by price elasticity. There are indications that price elasticity may have been the reason for the decline in billed volumes in both concessions from 2001 to 2004, when water rates were raised.

The computed average per capita demand from 2015 to 2025 is approximately 180 lpcd. This level of consumption correlates well with the present level of consumption, specifically, in some areas in the east zone where there is 24-hour supply and adequate pressures.

Domestic Water Demand from 2005 to 2025

The projected domestic water demand is summarized in **Table 4.3** below. It was projected that the total domestic water demand will increase from 1,767 MLD in 2005 to 3,465 MLD in 2025.

Table 4.3 - Projected Domestic Water Demand (MLD)

Service Area	2005	2010	2015	2020	2025
East	599	734	1,071	1,372	1,653
West	1,168	1,344	1,665	1,747	1,812
Total	1,767	2,078	2,736	3,119	3,465

4.3.3.3 Commercial and Industrial Water Demand

The methodology used for projecting commercial and industrial water demand was based on establishing a relationship between Gross Regional Domestic Product (GRDP) and commercial and industrial water consumption. This methodology relies on the past consumption trends to project future consumption, assuming normal consumption growth is reflected therein. However, when the past consumption rates are affected by supply constraints like low pressures and water supply interruptions, the resulting demand projection may not reflect the true demand growth rate.

To mitigate the effects of constrained supply, this study examined billed volume records in the East Zone, where some areas have uninterrupted supply and relatively good water pressures as compared to the West Zone. The average historical commercial and industrial per capita-billed volume of the East Zone was used in computing future commercial and industrial billed volumes for both concessions. The projected commercial and industrial billed volumes were then used to obtain the non-domestic water demand by applying a correction for commercial losses, which was estimated at 15% of NRW.

This resulted in commercial and industrial water demand projections as shown in **Table 4.4**.

Table 4.4 - Projected Commercial and Industrial Water Demand

Year	Projected Commercial Water Demand (MLD)	Projected Industrial Water Demand (MLD)
2005	636	121
2010	889	172
2015	1,048	204
2020	1,244	242
2025	1,438	281

4.3.3.4 Non-Revenue Water

Non-revenue water levels have historically been high in the MWSS system and have been a major constraint to the achieving an efficient water supply system with adequate pressures and service coverage. This has affected the financial viability of the sector in Metro Manila, with a consequent impact on the ability of the utility to provide suitable sewerage and sanitation services.

Table 4.5 shows Non-Revenue Water (NRW) levels from 1975 to 1996. There was a dramatic increase in NRW starting in 1982, when system pressures increased after the commissioning of La Mesa Plant I (LMTP I), sending an additional 1000 to 1500 MLD into the distribution network. **Table 4.6** shows NRW levels that have been achieved since privatization between 1997 and 2004 and indicates that, while there has been some improvement in the East Zone, there was little overall improvement in that period with total system NRW level still at about 60%.

Table 4.5 - MWSS NRW Historical Level (1975-1996)

YEAR	NRW%	YEAR	NRW%
1975	49.7	1986	66.4
1976	50.3	1987	59.7
1977	48.1	1988	57.7
1978	45.9	1989	57.7
1979	46.8	1990	57.7
1980	47.1	1991	57.1
1981	48.9	1992	55.0
1982	52.3	1993	57.4
1983	54.0	1994	59.0
1984	56.6	1995	55.5
1985	60.6	1996	60.0

Table 4.6 – NRW Levels since Privatization (1997-2004)

YEAR	NRW% (MWCI)	NRW% (MWSI)	Overall NRW%
1997	58.9	66.2	63.4
1998	49.1	64.0	58.1
1999	51.1	69.2	62.4
2000	51.4	66.7	60.8
2001	53.2	67.0	61.6
2002	53.8	68.6	62.6
2003	52.1	69.0	62.1
2004	47.5	69.0	60.4

With the existing and planned non-revenue water (NRW) reduction programs by the East and West Concessionaires, it is projected in this study that the NRW ratios will be decreased from 62%[3] in 2005 to as low as 30% in 2025.

The projected NRW levels and physical losses are presented in the **Table 4.7** below. NRW is divided into two components: non-physical losses or commercial losses and physical losses. Non-physical losses or commercial losses, which are about 15% of the total NRW, are directly applied to the billed volumes to obtain the total water demand. On the other hand, physical losses (estimated to be 85% of the total NRW) are applied to the total water demand to derive the system demand.

Table 4.7 - Projected NRW Levels and Physical Losses

	2005	2010	2015	2020	2025
NRW Ratio (%)	62%	45%	34%	31%	30%
NRW Level (MLD)	3,258	2,292	1,920	1,928	2,088
Physical Losses Ratio (%)	52%	38%	29%	26%	26%
Physical Losses (MLD)	2,769	1,948	1,632	1,639	1,774

4.3.3.5 System Average Day Demand

Table 4.8 below shows the system average day demand, which was obtained by applying the correction due to physical losses to the total water demand.

[3] NRW ratio of 62% will occur if projected system demand is applied. If supply is limited to the existing system capacity, NRW ratio is 57%.

Table 4.8 – Average Day Demand (ADD) Forecast

Area / Demand	**2005**	**2010**	**2015**	**2020**	**2025**
East – MWCI					
Domestic demand (MLD)	599	734	1071	1372	1653
Commercial demand (MLD)	274	396	483	592	707
Industrial demand (MLD)	51	75	93	115	138
Total East demand (MLD)	924	1,206	1,647	2,079	2,498
West – MWSI					
Domestic demand (MLD)	1,168	1,344	1,665	1,747	1,372
Commercial demand (MLD)	363	493	565	652	592
Industrial demand (MLD)	70	97	111	128	115
Total West demand (MLD)	1,601	1,934	2,341	2,526	2,686
Total					
Base demand (MLD)	2,525	3,139	3,988	4,605	5,184
Physical Losses (MLD)	2,769	1,948	1,632	1,639	1,774
Total system demand (MLD)	**5,294**	**5,088**	**5,619**	**6,244**	**6,958**

4.3.4 Future Water Sources

Based on the projected water demands outlined in Section 4.3.3 and considering the current water sources and the projected reduction in non-revenue water, without the development of new water sources, there will continue to be a shortfall in water supply as shown in **Table 4.9**.

Table 4.9 - Water Production Forecast

Year	**2005**	**2010**	**2015**	**2020**	**2025**
Average Demand (MLD)	5,294	5,088	5,619	6,244	6,958
Maximum Demand (MLD)	6,617	6,360	7,024	7,805	8,698
Existing Capacity (MLD)	4,090	4,090	4,090	4,090	4,090
Shortfall (MLD)	1,204	998	1,529	2,154	2,868
New source capacity required (MLD)	-	598	1,129	1,754	2,468

The values shown in **Table 4.7** projected a reduction in non-revenue water to 26% from physical losses in both concessions by the year 2025. Demands will continue to be constrained until a major new source comes on stream after 2010. The development of a major water source is a long-term undertaking and is unlikely to be available until at least 2013. Several options are available for interim sources including:

- The currently proposed Wawa Dam development that will produce an additional 50 MLD;
- The Angat Water Utilities & Aqueduct Improvement Project that focuses on construction of AQ-6. Initially, it was assumed that this option could produce up to 750 MLD, but this would depend upon negotiation with NWRB and NIA in allocations from Angat Dam; and,
- Implementation of a proposed BOT scheme to provide 300 MLD of water, possibly from Laguna Lake.

At this stage it has been assumed that a total of 400 MLD may be provided from these interim sources.

In order to satisfy the long-term water demand, however, major development of the Agos River basin will be required. The update of the Water Supply Master Plan (2005) has proposed the development of Laiban Dam as a first stage (1,830 MLD) followed in the future by Kanan No.2 Dam and transfer scheme (3,290 MLD).

Details of the proposed Laiban and Kanan developments are shown in **Figure 4.11.**

In parallel, a program of works focusing on reduction of NRW must also form a key component of the water sourcing strategy to achieve a higher degree of sustainability.

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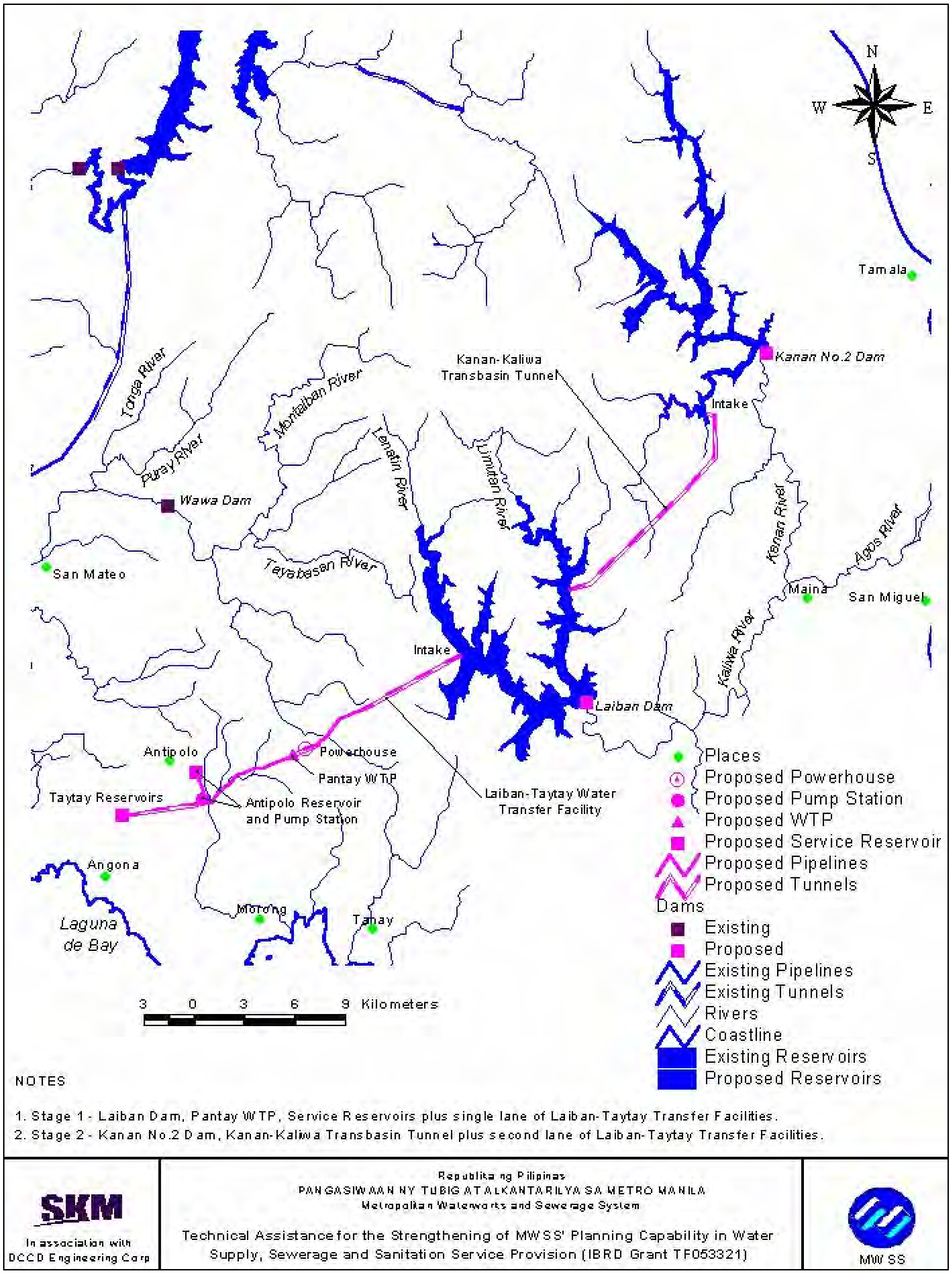

Figure 4.11 Laiban + Kanan No. 2 Dam

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Staging of Water Source Development

The Laiban Dam/Kanan No. 2 Dam development can be staged to some degree in accordance with demand growth. This staging and the corresponding water demand curve is shown in **Figure 4.12** that indicates that the development could be made in two main stages with five sub-stages between 2015 and 2036.

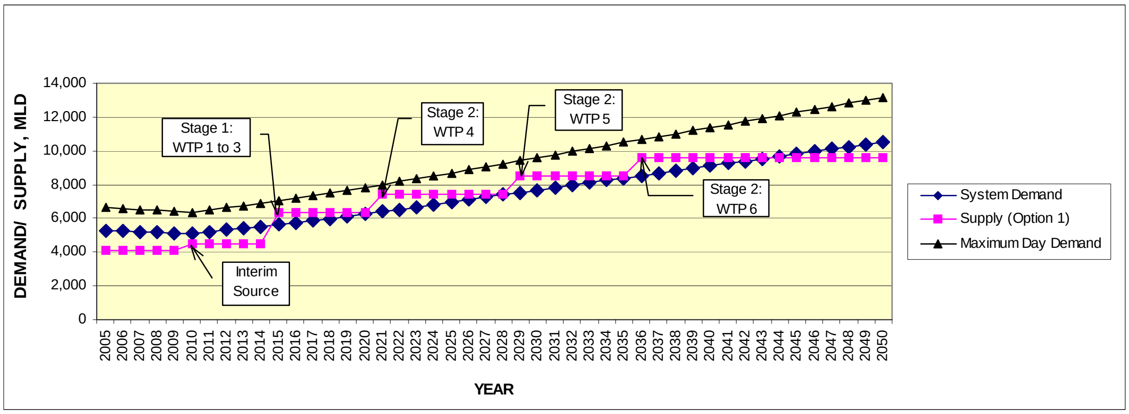

Figure 4.12 Demand and Supply Curve for Laiban Dam/Kanan No 2 Dam Development

The implication of this staging in water source development is that demand within the currently underserved parts of the service area is to likely remain constrained until about 2015 when water from Laiban Dam becomes available. This means that sewerage systems are unlikely to be established in many areas, especially in Rizal and Cavite, until sufficient water is available after 2015. This should be reflected in the sewerage targets and investment programs developed.

4.4 Drainage

4.4.1 Drainage and Public Health

The topography of much of the Metro Manila area is generally flat and stormwater drains slowly during rainfall. Stormwater finds its way into rivers and esteros. The esteros resemble open canals with variable cross-sections, frequently clogged with silt, sediments, solid waste and water hyacinths. In many instances, informal settlers build houses on stilts over many of these waterways and the esteros become effectively open sewers. Stagnant water and garbage in the esteros serve as ideal breeding grounds for flies and mosquitoes.

Most of the waste disposal systems (septic tanks) overflow to local drains or storm drains and canals. These drains discharge to rivers and esteros and add to the pollution along with the open dumping of solid waste. The water in the esteros during the dry season is generally septic. Water pollution of the water bodies in Metro Manila is discussed in more detail in Section 4.7.

Local flooding of polluted water bodies is a public health risk and flood control programs being implemented by the LGUs, MMDA and DPWH must be coordinated with the sewerage and sanitation programs to maximize the positive impact on public health. Road construction has in places intensified flooding problems on a local scale due to the practice of elevating streets above stormwater levels. In many instances, inadequate or clogged drainage facilities aggravate the flooding problems in the low-lying areas, especially in the low income/blighted areas. In the willingness-to-pay survey conducted under this study, the major sanitation improvement desired by most of the respondents was to improve the condition of the local drains.

As will be discussed later in this study, local drains are likely to form an important element of the sewerage/sanitation strategy at least for a significant period of the master plan study. Improving the condition of the drainage network to prevent flooding is a key strategy to enable improvements in public health.

If local drains are to be used as combined drainage to also carry sewage in some areas, it is important to prioritize drainage improvements in the currently flood-prone areas or provide separate sewerage systems in these areas to ensure sewage is not discharged into the streets during the rainy season. MMDA and DPWH have implemented major drainage projects in the past such as the Mangahan floodway and the Napindan hydraulic control structure that has mitigated the flooding problem in the metropolis. In 1998, the Special Assistance for Project Formation on the Pasig-Marikina River Improvement Project funded by OECF was undertaken for DPWH. In 2001, a hydraulic study was made for finalizing the design of the Marikina Control Gate Structure which is integral part of the flood control project (Mangahan floodway and Napindan hydraulic control structure are major components of this flood control project) of Metro Manila.

4.4.2 Drainage Catchments

In the 1996 NJS Master Plan, the MWSS service area in Metro Manila was initially subdivided into 27 catchments or systems, which also served for the 1979 JMM Master Plan. Further, the catchment areas as delineated in the East Concession Area Master Plan Update 2005 were considered since numerous sewerage projects serving small communities are already in the pipeline under the MTSP. The catchment areas in the Philaqua Master Plan (unofficial) also provided a basis in the delineation of the catchment areas for the West Zone. More details on the catchment areas are provided in Chapter 10.

The following considerations were used in the delineation of the catchment areas:

1. The MWSS service area was analyzed as a whole and the boundary between the West and East Zones was not considered as a constraint.
2. The existing sewered areas and the proposed sewered areas under MTSP including privately owned systems were identified and their coverage areas delineated. It was assumed that the MSSP and MTSP projects will be implemented and will become an integral part of the overall master plan.
3. The catchments were delineated based on topography and general drainage patterns.

4. Thirty-one catchments were delineated and grouped into five large clusters, namely, the northern area (Navotas, Malabon, Tullahan, Valenzuela and North Quezon City), Central Manila (Dagat-Dagatan, Caloocan, Balut, Sampaloc, Central North, Central Manila and Pandacan), south area (South Manila, NAIA, Pasay, Las Pinas, Parañaque, Muntinlupa), central area (Cubao, San Juan, Mandaluyong, Guadalupe and Ayala) and east area (San Mateo, Baho-Buli, Ortigas, West Mangahan, Bonifacio and Taguig). The 31 catchments are as shown in **Table 4.10** below:

Table 4.10 - Sub-catchment Areas

Catchment	Location	Catchment	Location
W – 1	Muntinlupa	W – 17	Valenzuela
W – 2	Las Pinas	W – 18	Caloocan B
W – 3	Parañaque	W - 19	Malabon-Tullahan
W – 4	NAIA	EW – 1	Quezon Central
W – 5	South Manila	EW – 2	Quezon North
W – 6	Pandacan	EW – 3	Quezon East
W – 7	Central Manila	E – 1	Taguig
W – 8	Central North	E – 2	Makati
W – 9	Sampaloc	E – 3	Pateros
W – 10	Balut	E – 4	Bonifacio
W – 11	Dagat-Dagatan	E – 5	Pasig
W – 12	Caloocan	E – 6	Mandaluyong-San Juan
W – 13	Malabon-Tullahan	E – 7	Taytay
W – 14	Malabon-Tullahan	E – 8	Quezon South
W – 15	Quezon West	E – 9	Cainta-Marikina
W – 16	Navotas		

5. The eastern municipalities of Rizal and the municipalities of Cavite under the MWSS service area will continue to use septic tanks in areas where there are no sewerage systems and the catchments were not delineated.

4.5 Sanitation

The three main river systems in Metro Manila, namely: (1) Pasig River with Marikina and San Juan Rivers as tributaries; (2) Navotas, Malabon,Tullahan-Tenejeros River Systems; and, (3) Parañaque-Zapote River Systems are currently heavily polluted (DENR 1991).

The Pasig River, once known for its pristine waters and aquatic resources, is now one of the world's most polluted river systems with dissolved oxygen levels dropping to zero for the most part of the year. Total coliform levels exceed standards of the Department of Environment and Natural Resources (DENR) by several log values.

4.5.1 Sanitation Facilities in Metro Manila

According to the NSO 2000 Census of Population and Housing, about 84 % of the households in Metro Manila have septic tanks but maintenance is poor. For both Rizal and Cavite provinces, about 72 % have septic tanks. The use of septic tanks is specified in the National Plumbing Code for those not connected to a sewerage system. **Table 4.11** below shows that the estimated number of households in the MWSS service area was about 2.17 million in the year 2000.

In Metro Manila, the use of septic tanks will most likely to continue, particularly in those areas not covered by a sewerage system. Even with an existing sewerage system, customers are reluctant to connect to the sewers because of the additional 50 % surcharge that is imposed on water bills for connected properties. Under existing conditions, the storm drainage system directly receives overflow of the septic tanks due to poor or non-existent absorption fields as shown in **Figure 4.13**. This is exacerbated by the design of some septic tanks that allows seepage from the bottom. The existing drainage system most often functions as a “combined sewerage system.” **Figure 4.13** also indicates the typical characteristics of sullage and septage. For those tanks not cleaned regularly, high strength septage may be discharged into the storm drains, instead of the sullage overflow from a correctly functioning septic tank.

It was estimated that 26 % of the existing septic tanks in Metro Manila (James Montgomery 1991) are inaccessible for desludging, primarily for the following reasons:

- Poor building practice (beneath other structures);
- Absence of manholes; and
- Access roads to the houses are too narrow.

In the willingness-to-pay survey conducted as part of this study, only 32% of respondents could recall having had their septic tank emptied. When asked whether their septic tank had a manhole for pumping out sludge, many appeared unaware, although 90% of those who answered the question, believed a manhole was available.

A number of master plans have been prepared since 1969 in order to address the sewerage and sanitation requirements of Metro Manila. However, none of these master plans was fully implemented due mostly to financial, social and institutional constraints. The delay in sewerage and sanitation development contributed to the rapid deterioration of the natural water systems in the region.

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Table 4.11 - Population and No. of Households with Septic Tanks (NSO 2000)

City/ Province/ Municipality	Population	Number of Household	Household with septic tanks	Average Household	% Household with septic tank
National Capital Region	9,862,978	2,132,989	1,798,672	4.6	84
Manila	1,568,092	333,547	294,902	4.7	88
Caloocan	1,174,673	249,567	212,939	4.71	85
Las Pinas	470,154	97,962	74,769	4.8	76
Makati	442,144	103,981	95,267	4.5	92
Mandaluyong	275,106	59,628	52,284	4.61	88
Marikina	389,763	80,160	70,111	4.86	87
Muntinlupa	370,333	78,016	55,910	4.75	72
Parañaque	446,766	94,109	76,840	4.75	82
Pasay	353,798	78,180	70,692	4.53	90
Pasig	503,013	107,835	93,541	4.66	87
Quezon	2,158,367	480,624	408,548	4.49	85
Valenzuela	481,047	106,382	88,350	4.52	83
Malabon	336,516	74,137	63,726	4.54	86
Navotas	229,717	49,450	36,746	4.65	74
Pateros	57,172	12,029	10,921	4.75	91
San Mateo	117,398	24,605	22,887	4.77	93
Taguig	462,591	102,723	70,239	4.5	68
Cavite	768,923	163,865	117,902	4.7	72
Bacoor	305,699	64,067	47,897	4.8	75
Cavite City	99,367	21,342	15,324	4.7	72
Imus	195,428	42,232	31,095	4.6	74
Kawit	62,751	13,510	10,759	4.6	80
Noveleta	31,959	6,934	4,208	4.6	61
Rosario	73,665	15,780	8,619	4.7	55
Rizal	1,702,110	356,578	255,776	4.7	72
Antipolo	468,123	97,415	72,087	4.8	74
Cainta	242,137	51,863	41,490	4.7	80
Rodriguez	114,859	24,524	17,167	4.7	70
San Mateo	135,357	28,162	20,277	4.8	72
Taytay	197,279	42,620	30,690	4.6	72
Angono	74,538	15,740	11,018	4.7	70
Binangonan	187,639	38,488	25,017	4.9	65
Cardona	38,994	7,953	5,170	4.9	65
Baras	24,476	4,971	3,056	4.9	61
Jala-jala	23,276	4,759	2,744	4.9	58
Morong	42,453	8,988	6,494	4.7	72
Pililla	45,254	9,001	5,978	5	66
Tanay	78,065	15,720	10,099	5	65
Teresa	29,660	5,374	4,489	4.7	70

** Based on 2000 Census of Housing and Population, 84% of the Households in the National Capital Region has individual septic tanks.

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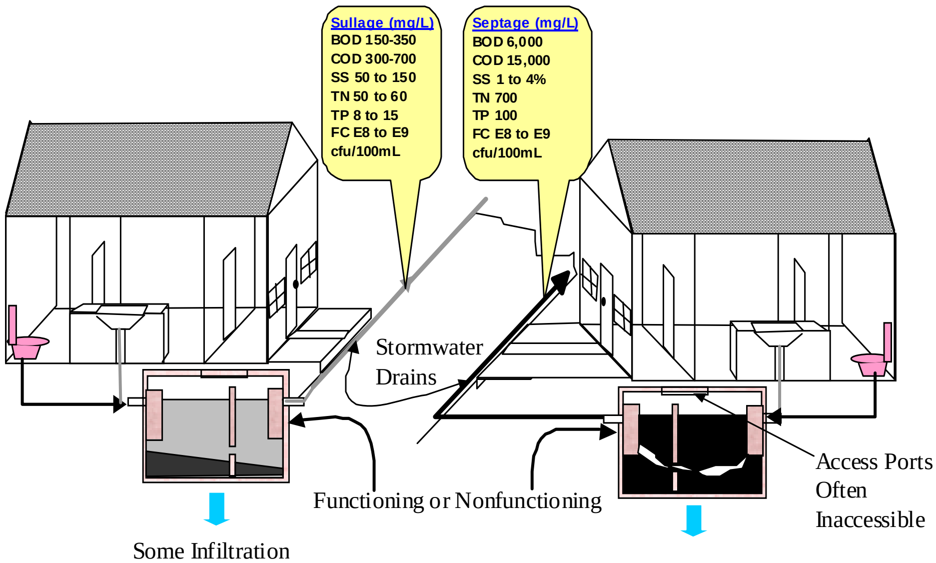

Figure 4.13 Septic Tanks in an Urban Environment

When the MWCI and MWSI Concessionaires took over the MWSS operations in August 1997, the sanitation programs of MWSS were not very well developed. At that time, the areas with sewerage service represented less than 10 % of the total MWSS service area. The sewered areas were the Manila Central System, the Dagat-Dagatan System, the Magallanes System, and isolated systems in Quezon City. Most of the MWSS service area was and is still served by individual septic tanks (see **Table 4.12**).

Table 4.12 - Major Sanitation Facilities in the MWSS Service Area

System Name	Area Served	Sewer Length (km)	Characteristics	MWSS Service	Operator
Quezon City separate systems (see Table 4.13)	Proj. 7 & 8, Quezon City	123.7	Communal septic tanks-Imhoff tanks	O&M, desludging	MWCI
Individual septic tanks	MWSS Service Area	None	Private septic tanks- estimated 2.0 million	Desludging (for water customers)	MWSI and MWCI
NHA Systems (for Zonal Improvement Projects – see Table 4.14)	MWSS Service Area 1,000 Ha.	Not specified	Communal septic tanks	None	MWSI and MWCI

Table 4.13 presents the existing communal septic tanks (CST) of MWCI and their capacities. Septage from the CSTs is collected by MWCI and conveyed to the septage holding facility in Philam Life in West Ave., Q.C. Ten of the CSTs were programmed for conversion to wastewater treatment plants. **Table 4.14** presents the NHA and the private sanitation systems (CSTs) in Metro Manila.

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Table 4.13 - Existing Communal Septic Tanks of MWCI

No.	Location	Tank Capacity (m^3)
1	Violeta St., Roxas District, Q.C.	113
2	Umbel St., Roxas District, Q.C.	53
3	Gumamela St., Roxas District, Q.C.	114
4	Gumamela St., Roxas District, Q.C.	121
5	Waling Waling St., Roxas District, Q.C.	192
6	Waling Waling St., Roxas District, Q.C.	153
7	Everlasting St., Roxas District, Q.C.	230
8	Azucena St., Roxas District, Q.C.	191
9	Azucena St., Roxas District, Q.C.	90
10	Azucena St., Roxas District, Q.C.	70
11	Champaca St., Roxas District, Q.C.	143
12	Camia St., Roxas District, Q.C.	84
13	Everlasting St., Roxas District, Q.C.	79
14	Alley nr. Rimas St., Project 2, Q.C.	338
15	J. Zobel St., Project 4, Q.C.	252
16	Near Sianghio St., Kamuning, Q.C.	410
17	Matiwasay St., U.P. Village, Q.C.	829
18	Mapagmahal St., U.P. Village, Q.C.	432

Table 4.14 - NHA Systems in Metro Manila and Private Systems

System/Location	Owner	Year Built	Service Area	Communal Septic Tank
West Zone				
1. Tangos System, Daang Hari, Tangos, Navotas	NHA	1980s		Septic Tank
2. Capri System, Novaliches, Quezon City	NHA	1980s		Septic Tank
3. Maricaban System,Maricaban,Pasay City	NHA	1980s		Septic Tank
4. Leveriza System, Malate, Manila	NHA	Now connected to Manila Central system		
5. Juan Luna System, Tondo, Manila	NHA	Now connected to Manila Central system		
6. Bangkal System, Bangkal, Pasay City	NHA	MWSS PROGRESS pilot project		
7. Quezon Institute, E.Rodriguez Ave, QC	Quezon Institute			Septic Tank
8. Veterans Memorial Hospital, QC	Veterans Memorial	1953-55	55 ha,200-600 mm dia & 2,581 length	Septic Tank
9. Philam Life, Las Pinas	Private			Imhoff Tank
East Zone				
10. Martin de Porres System, Cubao, QC	NHA			Septic Tank
11. Bagong Nayon System, Antipolo City	NHA	1977		Septic Tank
12. Camp Aguinaldo System, Camp Aguinaldo, QC	DND			Septic Tank
13. Kamuning District, QC	QC govt			Septic Tank: 5.8mx19.0mx3.4m
14. Parks & Wildlife, Quezon Ave., QC	Bureau of Forest Dev			Septic Tank: 8.0mx22.6mx5.0m

In terms of sanitation service, MWSS provided limited desludging services while the private contractors provided the bulk of the desludging services. The main constraints in the desludging program were the inaccessibility of many septic tanks, unavailability of vacuum tankers and identifying sludge disposal sites acceptable to the DENR. Since September 1995, the only inland disposal site previously used by MWSS (near Marilao, Bulacan) became unavailable and the desludging work ceased. The MWSS equipment had also exceeded their useful life with the desludging units becoming only partly operational. The Dagat-Dagatan lagoons were used for disposal of septage before it was rehabilitated in 2003 and a septage treatment plant installed.

4.5.2 Current Concessionaire Sanitation Programs

MWCI Programs

MWCI schedules the desludging services on an area basis. Provision of such services is coordinated with the barangay wherein the proposed schedule of desludging is disseminated to the households. Under the East Concession, Master Plan Update (2005) the households were asked whether they wish to avail of the services. Only around 80 % of the households in areas visited indicated their desire to avail of the desludging services. However as shown by the willingness-to-pay survey conducted under this study, most respondents appeared unaware of the schedules and 66% employed private contractors to pump out their tanks rather than avail of the services of the MWSS or the concessionaires.

The septage collected by MWCI is transported and discharged to an Imhoff tank located in Phil-Am Village, Quezon City. The Imhoff tank serves as a temporary storage for septage, with private hauling contractors of MWCI coming to collect the septage, and transporting it to lahar areas in Pampanga and Tarlac. The targeted septage collection of 200 m^3/day is unrealized. As of July 2005, the septage collection ranged from 80 m^3/day to 150 m^3/day.

The septage is spread over lahar areas, which are later planted with sugarcane. A research study by the Sugar Regulatory Administration (E.B. Estanislao et. al, 2002) indicated an increased tonnage in the range of 46-74 % as a result of septage application ranging from 40-120 tons per hectare. MWCI intends to continue the septage application until the Antipolo septage treatment plant becomes operational after which, MWCI will focus on soil application of dry biosolids produced by the various sewage and septage facilities.

MWSI Programs

MWSI is responsible for operating the Central Sewerage System, the Dagat-Dagatan System and a portion of the Quezon City system. The Quezon City System consists of several communal septic tanks serving residential developments.

Prior to the completion of the septage treatment plant at Dagat-Dagatan, MWSI continued its collection, treatment, and disposal of septage using the Mobile Dewatering Units (MDU). Private contractors transported the dry sludge to lahar areas in Pampanga and Tarlac. Starting May 2005, the septage treatment plant in Dagat-Dagatan became

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operational and can treat up to 400 m^3/day of septage on a 16-hour day basis. Seven MDUs and 25 vacuum tankers will be fully utilized for desludging activities.

As of July 2005, MWSI was in the final stage of Fertilizer and Pesticide Authority (FPA) registration. A pilot study is now on-going in Floridablanca in coordination with Luzon Agricultural Research Center (LAREC). MWSI intends to secure a permanent license as manufacturer-distributor similar to MWCI.

4.6 Sewerage

4.6.1 Existing Sewerage Systems

Upon privatization of the operations of the MWSS, various sewerage systems were turned over to concessionaires as shown in **Table 4.15**.

For the East Zone concession area, MWCI assumed operation of one sewerage system (Ayala Makati), one (1) bio-module STP in Cainta, one (1) Imhoff Tank in Phil-Am Village, and 33 communal septic / Imhoff tank systems in Quezon City and Antipolo with a total service area coverage of 1,280 ha and a total treatment capacity of 71 MLD.

For the West Zone, the MWSI took over the operations of two sewerage systems (Central Sewerage System and Dagat-Dagatan) and five separate systems in Quezon City, with a total service area coverage of 3,270 ha. For the Central Sewerage System, the sewage is disposed through the Manila Bay outfall. For Dagat-dagatan, the treatment capacity was 52 MLD and the Quezon City systems were served by CSTs.

At the time of privatization, the existing sewerage systems consisted of only the four shown in **Table 4.15**.

Table 4.15 - Existing Sewerage Systems in Metro Manila

System	City/Municipality	Service Area (ha)	Remarks
Central System	Manila City	2,620	No treatment. Outfall to Manila Bay
Ayala System	Makati City	600	
Dagat-Dagatan System	Caloocan, Malabon, Navotas Manila	333	Only STP is turned over to MWSS
Separate Systems	Quezon City	1000	
Total		4,553	

A brief description of the three major systems follows.

Manila Central Sewerage System

Built in 1902, the Manila Central Sewerage System (**Figure 4.14**) consists of two collection networks, one north and one south of Pasig River. It has about 305 km of sewers, ranging in size from 125 mm to 1425 mm and seven lift stations, i.e. Legarda, Luneta, Malate, Paco, Port Area, Sta. Ana and Sta. Cruz.

Both networks end at the Tondo pumping station, that pumps the sewage through a 1800 mm outfall into Manila Bay. Screened raw wastewater is discharged through this outfall via a 300 mm diffuser section at a depth of about 11 m. The design flow capacities of the Tondo Pumping Station are 5.0 m^3/s at peak flow and 3.3 m^3/s at average flow. Average flow equals 280 ML/s as designed.

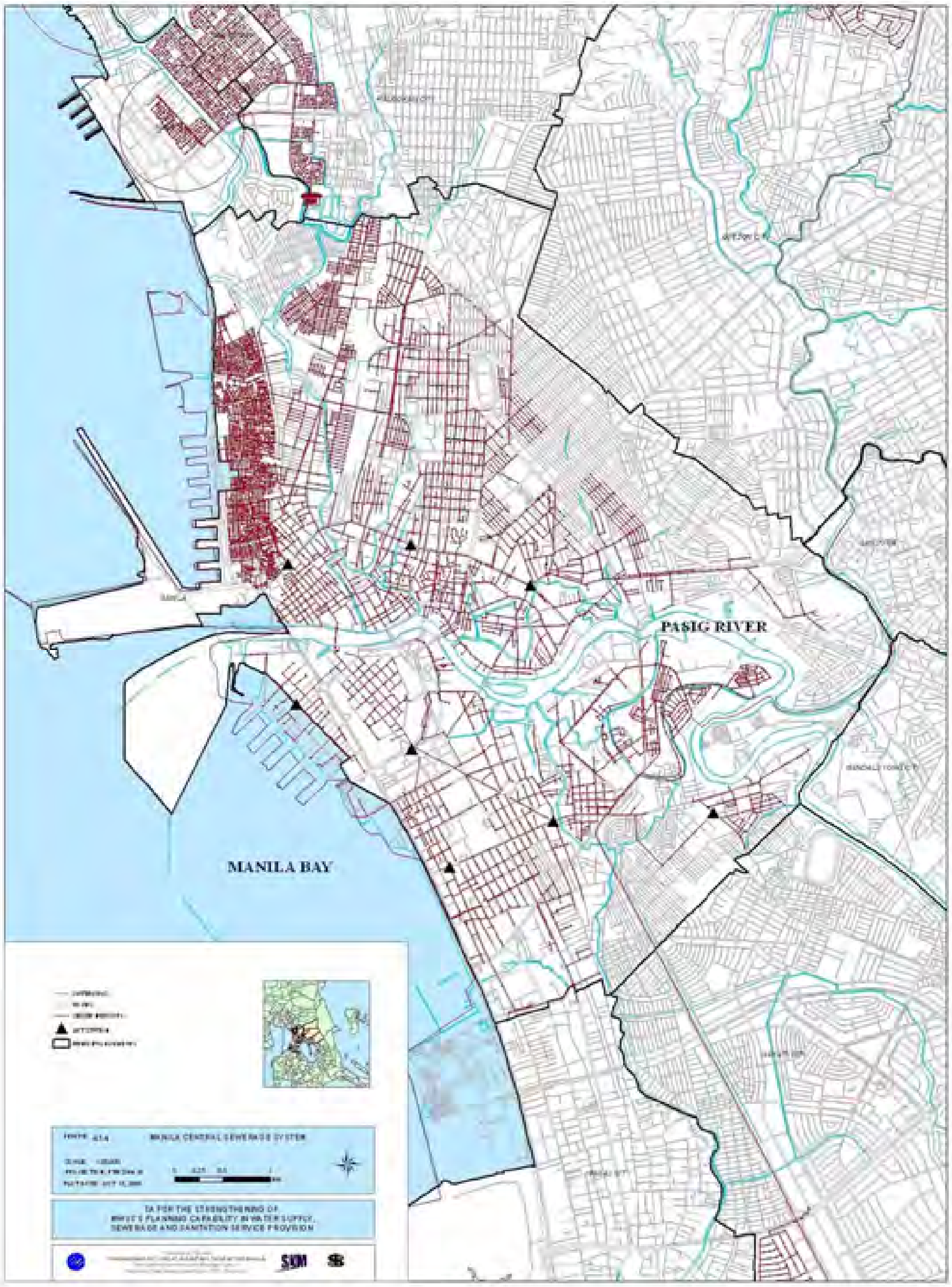

Figure 4.14 Manila Central Sewerage System

The system has undergone three major rehabilitations. The last one was carried out in 2004 under the MSSP 4 and was funded by the World Bank. The works being implemented under the MSSP rehabilitation included (i) Improvement of the Tondo Pumping Station; (ii) Rehabilitation of all 7 Lift Stations; (iii) Sewer lines improvement consisting of cleaning and CCTV inspection and repair of sewer lines and raising of buried manholes; and (iv) Installation of 10,000 service connections. Notable in this program has been the difficulty in securing the new connections, with only 730 out of the proposed 10,000 having been installed as of September 2005.

Dagat-Dagatan Sewerage System

The Dagat-Dagatan Wastewater Treatment Plant (WWTP) was originally developed by the National Housing Authority (NHA) from 1979 to 1986 and features lagoons lined with the natural clay on-site. It has a 332 ha service area on a reclaimed land. It comprises 67 km of sanitary sewers, with diameters ranging from 200 to 750 mm; a pumping station equipped with four pumps; and WWT ponds that occupy approximately 5 ha. Only two of the three planned modules of the treatment ponds were constructed. Each module consists of one aerated lagoon, one facultative lagoon, and a polishing pond. Since construction, only module 1 and the aerated lagoon of module 2 were commissioned. The design flow for the two modules is 26 MLD, with peak flow of 52 MLD. The detention time of sewage is 44 days.

Under MSSP, rehabilitation work was carried out on the Dagat-Dagatan sewerage system which included the following:

- Dewatering of and sludge removal from the four lagoons, replacement of riprap embankment and construction of baffled walls, and installation of a total of eight floating mechanical aerators on the two aerated lagoons (with an OTR of 50 kg/hr).
- Removal and replacement of four major pumps and associated piping, complete replacement of all mechanical and electrical systems, and a wide variety of general site improvements.
- Construction of a 200 m3/day Septage Treatment Plant

Sewage flow was yet to be restored (Nov. 2005) to the plant due to problems with the supply line.

Ayala Sewerage System

The Makati collection system consists of a network of local and trunk sewers ranging from 200 to 1500 mm. in diameter and a by-pass pumping station. The treatment plant is situated at the southwestern most tip of Magallanes Village, the lowest point in the service area and the effluent discharges into Dilain Creek, which runs along the southern boundary of the plant site. A trickling filter was first constructed in 1966, and operated for five years thereafter. During much of that time, the plant did not function effectively and was replaced by a 22.7 MLD activated sludge plant in June 1971. The plant was further expanded to a nominal capacity of 40MLD in 1979 to provide for a service area population of about 120,000 people. Improvements included new sludge drying beds, provision for froth spray nozzles in the effluent launder channels of the sedimentation tanks, and replacement of the propeller-type return activated sludge meters with venture or insert flow meters.

Under the Manila Second Sewerage Project (MSSP), upgrading of the Ayala sewerage system was implemented, including rehabilitation of the pumping station and sedimentation tanks to provide mechanical treatment of sewage and septage, and repair of pipes, equipment and other works.

Other Sewerage Systems

As indicated in **Table 4.16** there are now also various sewerage systems serving a mix of residential and commercial developments including new systems serving new real estate property development by private developers. Shopping malls and commercial centers located in non-sewered areas have built individual wastewater treatment plants. Examples are SM Megamall at Mandaluyong City and Greenhills Shopping Center at San Juan.

There are also various communal systems with sewer networks (**Table 4.14**) built by the National Housing Authority (NHA) which were not all turned over to MWSS (and eventually to MWCI / MWSI) for various reasons. Their conditions are not known.

The location plan of these sewerage systems is presented in **Figure 4.15.**

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Table 4.16 - Summary of Existing Sewerage Systems in Metro Manila

	Sewerage System Name	Service Coverage				Sewerage System						Wastewater Quality (mg/l)					
						Collection			Treatment Plant			BOD		SS		COD	
		Area (ha)	Service Area Land use	Equiv. Pop or Est. Population (2005)	Barangay / City	No. of Lift Stations	Sewer Pipe Length	Pipe Diameter (mm)	Design Capacity (cumd)	Present Inflow (Mld)	Process Type	Influent	Effluent	Influent	Effluent	Influent	Effluent
I - West Zone - MWSI																	
1	Manila Central system	2,617	residential / commercial	1,200,000	North & South of Pasig River; Approx 67% Manila area	7 + 1 main pump station	305 km			206,016 (Yr 1994 ave.)	None - Manila Bay outfall	100	-	88	-	300	-
2	Dagat-dagatan system	333	residential	104,000	NHA Dagat-dagatan housing development, Manila-Navotas	1				No sewage inflow due to rising main leaks	Aerated lagoons system	62	9	78	19	217	109
3	Q.C. CST-Imhoff Tank systems (presently operational)		residential		Project 7 & 8, Quezon City	-											
	Sub total	2,950															
4	Private Systems																
4a	Ayala-Alabang system	350	residential / part commercial		Brgy Ayala-Alabang, Muntinlupa City	1 (commercial area)											
4b	Filinvest Alabang system	375	residential / commercial		Filinvest Alabang, Muntinlupa City	-											
4c	Smokey Mountain system (MRH)	100	residential	15,000	Brgy Isla Balot, Tondo, Manila	1 LS per STP			2 Mld per STP	start operation in May 2005	Attached growth biological treatment	300 (design)	< 50 (Class C water body)	300 (design)	< 70 (Class C water body)	600 (design)	< 100 (Class C water body)
	Sub total	825															
5	Old NHA systems (not turned over to MWSS / MWSI)					-											
	Total																
II - East Zone - MWCI																	
1	Makati Ayala system (Magallanes STP)	600	residential / commercial	109,000	Ayala central business district & surrounding villages		73 km		40 Mld	37 Mld	Activated sludge						
2	New small systems (MCSP)																
2a	Quezon City (10 sites)	603.9	residential	73,578					609 - 7,027		Bio-contact						
2b	Karangalan Village - Pasig (3 sites)	25.6	residential	12,000					764-1,193		Anaerobic						
2c	Karangalan Village - Cainta (6 sites)	51.2	residential	24,000	Karangalan Village, Cainta & Pasig City, Rizal	Gravity sewer network with Lift station at Plant			404-1,265		Anaerobic						
2d	Mandaluyong (1 site)	2.8	residential	1,080					287		Bio-contact						
2e	Makati City (1 site)	8.7	residential	4,560					851		Bio-contact						
2d	Taguig (5 sites)	25.5	residential / commercial	26,226					4,761		Activated sludge						
	Sub total	717.6		141,444.0													
3	Private systems																
3a	Global City (Bonifacio Water Corp)	440	residential / commercial	17,500	Fort Bonifacio, Makati & Taguig cities	2	16 km	300 - 1000	5.3 Mld	1.9 Mld	Activated sludge						
4	CSTs & Imhoff Tanks (proposed for renovation / STP upgrading) - 34 NHA-built	2,176	residential	155,701	Various NHA project areas in Quezon City in 1940s-50s	all gravity systems	107 km					Effluent quality do not pass DENR standards (MWCI 2002)					
	Total	3,934		423,645													

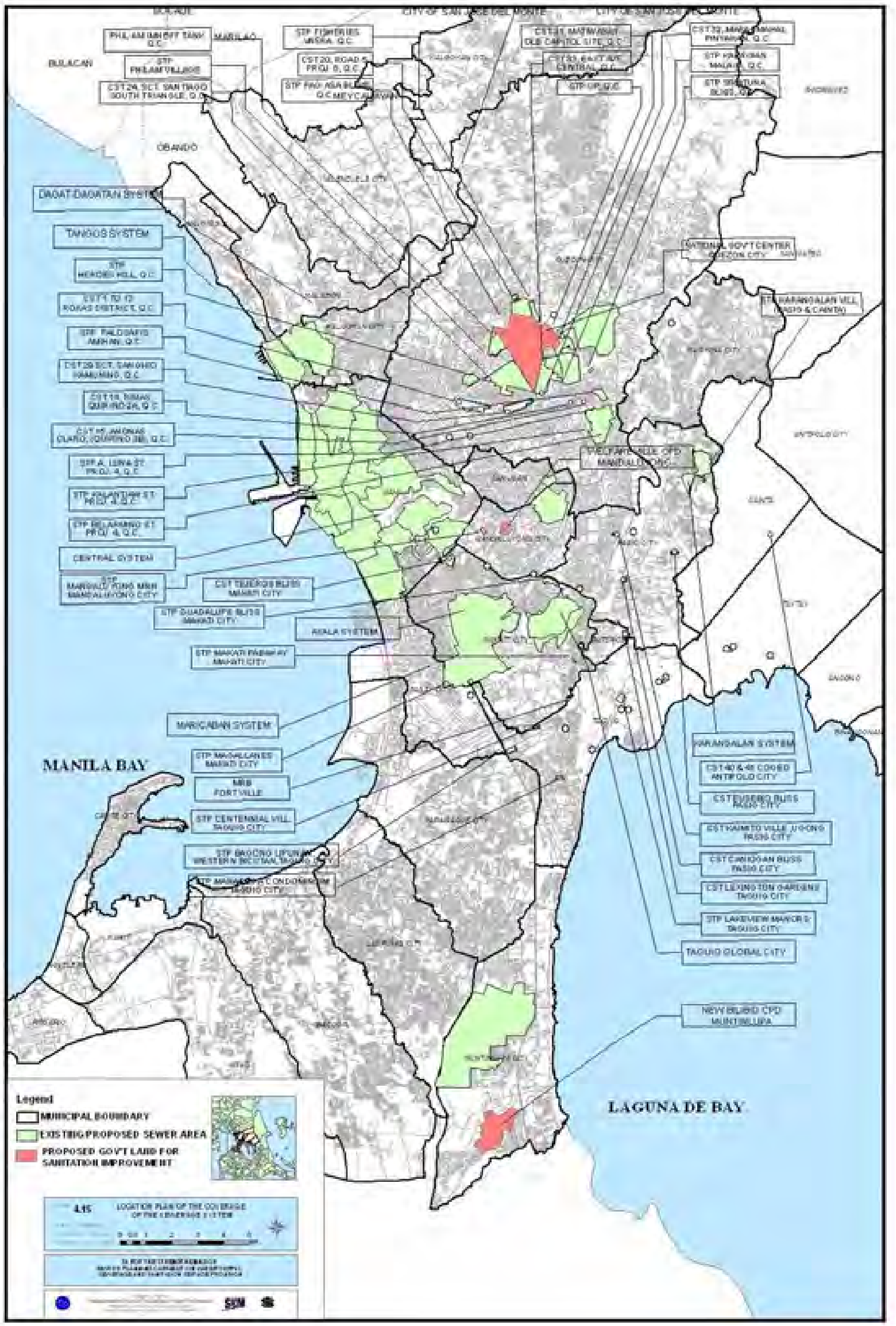

Figure 4.15 Location Plan of the Coverages of the Sewerage Systems

4.7 Water Quality of Receiving Waters in Metro Manila

The study areas' primary receiving waters include:

- Esteros
- Rivers
- Laguna de Bay
- Manila Bay

The major rivers that form the catchments in the MWSS service area are shown in **Figure 2.4** and include**:**

- Tullahan-Tenejeros River
- Marikina River
- San Juan River
- Pasig-Napindan Rivers
- Parañaque River
- Zapote River
- Imus River

Figure 2.4 also shows some of the numerous esteros in Metro Manila. The great majority of these esteros act primarily as trunk storm drains that carry stormwater from urbanized areas to the rivers or to Manila Bay. During the dry season, they have little or no fresh water. Instead their content is mostly wastewater, septic tank effluent and industrial wastes.

The Tullahan-Tenejeros River that drains the Malabon Basin is one of the more polluted river systems in Metro Manila. This river intercepts wastewater from domestic and industrial concentrations in Tenejeros, Malabon, Navotas and also from Bulacan. The river is not suitable for municipal water supply, fishing wildlife or recreation, and the only possible non-navigational use is the cultivation of fish in fishponds on the coastal plain near the river mouth.

Major portions of the Marikina River serve mostly as a wastewater conduit. Because of the relatively flat valley and easy accessibility, several large industrial establishments are still located there. Only in the upper reaches beyond Montalban is the water still relatively uncontaminated.

The Pasig River cuts across the heart of Metro Manila. It is a major recipient of domestic and industrial wastewater. With the existing degree of pollution, the Pasig River's primary use is to serve shipping and navigation in the transport of products for industries located along the river, although this industrial concentration is now declining. Major initiatives, such as the Pasig River Rehabilitation Project have been initiated to promote water quality improvements in Pasig River.

San Juan River discharges into the Pasig River and drains areas of Quezon City, San Juan and Manila with a high concentration of residential and industrial development. The river is highly polluted.

The Parañaque, Zapote and Imus Rivers drain the southern basins of the study area. These are the least polluted of the rivers within Metro Manila. Thus, their beneficial uses are not restricted to industry related activities. Fishing is a source of livelihood at the mouth of the Parañaque River. In the Zapote and Imus Rivers, shellfish cultivation and fishponds abound near the coastal plain.

Laguna de Bay is a receiving water for portions of Metro Manila and Rizal. However, the construction of the Napindan hydraulic control structure minimizes the use of Laguna de Bay as a receiving water. The Laguna Lake Development Authority has the overall responsibility for the lake and the drainage areas discharging into it and controls industrial pollution through an Environmental User Fee System (EUFS) on industries within LGUs under its jurisdiction.

Manila Bay is the final receiving water for the wastewater generated in the study area. This wastewater is either directly discharged into the Bay through existing sewer or storm drain outfalls or indirectly reaches the Bay by means of rivers in the study area. The earlier 1969 Sewerage Master Plan (Black and Veatch) conducted significant data collection and undertook analyses to ascertain the assimilation capacity of Manila Bay for untreated wastewater or wastewater with primary treatment. The subsequent 1979 Sewerage Master Plan (James M Montgomery) substantially used the earlier 1969 data together with additional data from the National Pollution Control Commission (NPCC) to make an assessment. The 1979 Master Plan concluded that wastewater discharges into Manila Bay would continue to be possible within the time frame of the Master Plan without serious or irreversible water quality degradation provided a properly designed outfall and diffuser system was constructed.

This study does not have the mandate or the resources to undertake a detailed water quality study of Manila Bay and the strategies developed in the short to medium term rely on decentralized inland treatment plants that will not significantly impact on the quality of water in Manila Bay. However, the current Manila Central Sewerage System outfall has been controversial, although the cost to provide either enhanced primary or, especially full secondary treatment upstream of the outfall is very expensive. The long-term sewerage strategy is likely to be to incrementally centralize the sewerage system such that sewage drains to Manila Bay either through several outfalls as proposed in the 1969 and 1979 Master Plan or to either enhanced primary or full secondary treatment plants located at the coast, probably on reclaimed land.

The cost of providing treatment prior to discharging into Manila Bay through an outfall will be significant and will require decisions to be made on the basis of reliable information on the assimilation capacity of Manila Bay. It is therefore essential that an intensive program of water quality monitoring be conducted in Manila Bay to enable studies to be conducted by the time decisions need to be taken regarding the need for either enhanced primary of secondary treatment of wastewater prior to discharge into Manila Bay.

The water quality assessment of various wastewater systems in Metro Manila for the past five years were reviewed and presented in the succeeding sub-sections:

Pasig River and its Tributaries

The Pasig River runs through the highly urbanized and densely populated parts of Metro Manila and is the main waterway that connects Laguna Lake to Manila Bay. The Pasig River system is comprised of the rivers of Pasig, Marikina, and San Juan and other smaller streams (esteros) and drainage canals. Pasig River has played a significant role in the metropolitan history and commerce. Through the years, it has received wastes from various sources resulting to its present foul state. Arduous efforts have been made to revive the river through projects like the Pasig River Rehabilitation Program. Despite these efforts, there has been little improvement on the water quality due to inadequate sewerage system, and the perennial problem of indiscriminate solid waste dumping.

Figures 4.16 and **4.17** present the mean dissolved oxygen and biochemical oxygen demand concentrations, respectively, at different sampling stations along the Pasig River as compiled by EMB from 1999 to 2004 (reported in the 2004 WB report). As a Class C river system, Pasig River should maintain minimum dissolved oxygen of 5 mg/l and BOD range of 7 to 10 mg/l.

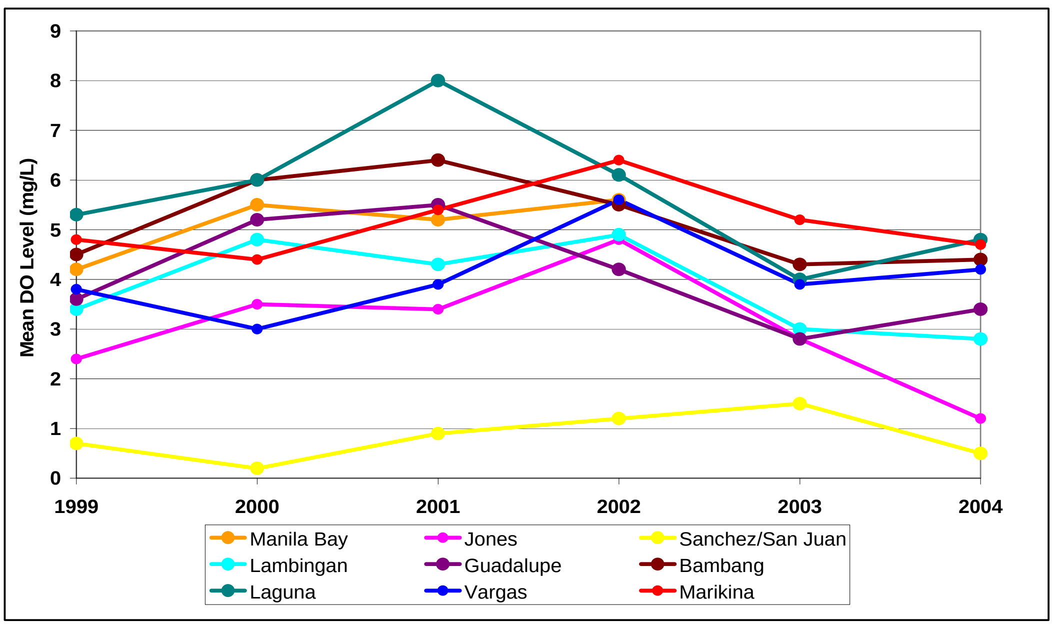

Figure 4.16 Mean Dissolved Oxygen Levels at Various Sampling Points in the Pasig River System (1999-2004) [Philippine Environment Monitor 2004, WB]

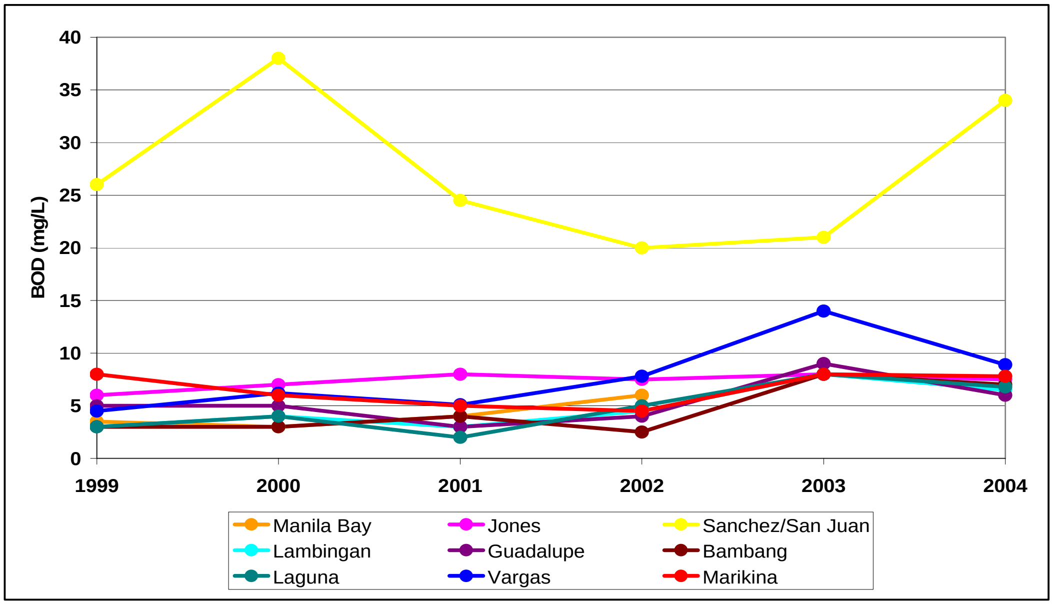

Figure 4.17 Mean Biochemical Oxygen Demand at Various Sampling Points in the Pasig River System (1999-2004) [Philippine Environment Monitor 2004, WB]

The World Bank Environmental Monitor 2003 indicated a marked improvement of water quality in terms of BOD concentrations from 1998 to 2001 in most of the sampling stations. But from its updated report in 2004 which included water quality data of 2002 to 2004, the BOD in most stations has increased from 2001 to 2004 as shown in **Figure 4.17**. BOD concentrations in most stations were even higher than those values reported in 1999.

The updated report may imply that the continuous discharge of untreated domestic wastewater is still putting pressure on the assimilative capacity of the Pasig River. As it continues to receive direct domestic discharges from Metro Manila residents, the river could not naturally cleanse itself to maintain acceptable BOD level.

It is also important to note that the very poor water quality condition of San Juan River, a major tributary of Pasig River has been a major factor affecting pollution load of Pasig River. San Juan River receives most domestic, commercial and industrial wastewater flow from San Juan and most of Quezon City, which are still largely not sewered.

Malabon-Navotas, Tullahan and Tenejeros River System

Malabon-Navotas, Tullahan and Tenejeros (MNTT) River System has consistently failed the water quality standards for Class C waters. The river system catches the drainage of northern Metro Manila including Caloocan, Malabon, Navotas and northern parts of Quezon City. The water quality along its length deteriorates from its headwater in the La Mesa Water reservoir to its downstream station near Manila Bay.

Except for some sewered areas in the northern part of Quezon City, most of the areas in its catchment are still not sewered. The EMB reported below 4 mg/l dissolved oxygen and BOD above 20 mg/l in all of the sampling periods from 2001 to 2004.

Parañaque River System

The Parañaque River System also has consistently failed water quality standards for Class C waters. The river receives the drainage of south Metro Manila particularly Parañaque and a portion of Las Piñas.

As in the case of most rivers, majority of the sampling in Parañaque River yielded BOD values way above the 10 mg/l maximum limit for Class C water.

Figures **4.18** and **4.19** indicate the average water quality of major rivers in Metro Manila as reported by EMB from 2000 to 2004.

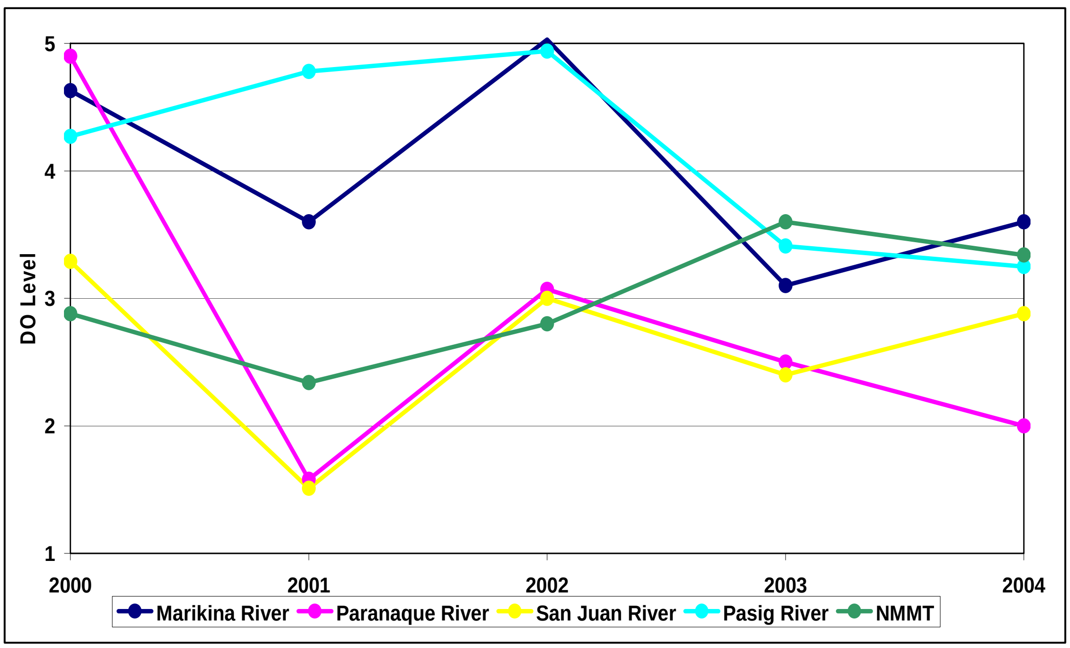

Figure 4.18 Mean Dissolved Oxygen Levels of Various Metro Manila Rivers (2000-2004) [Monitored and Compiled by EMB, WQS 2005]

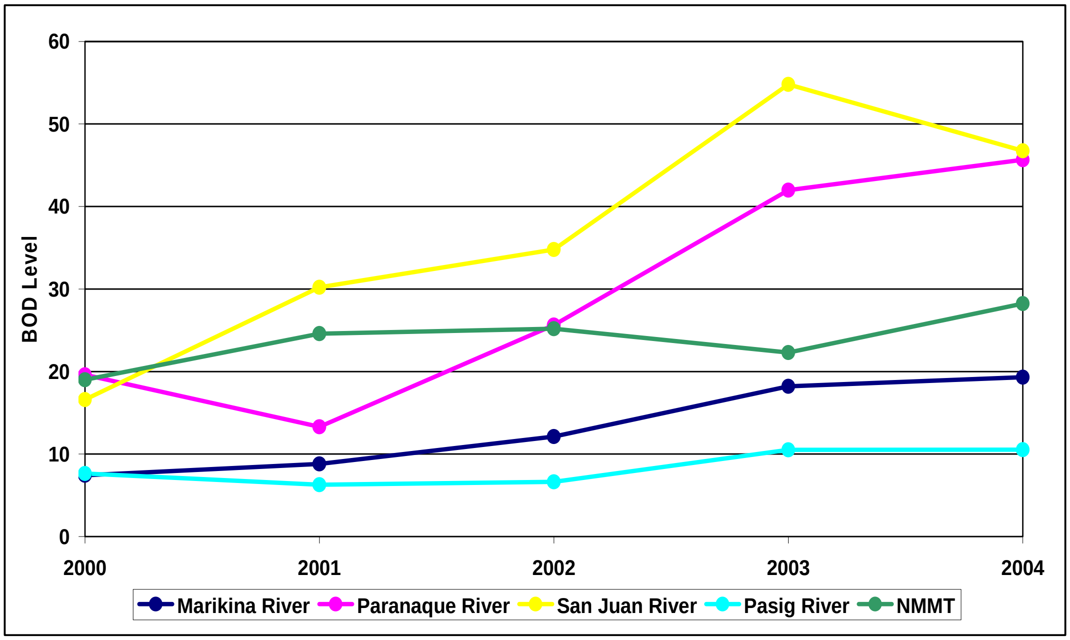

Figure 4.19 Mean Biochemical Oxygen Demand of Various Metro Manila Rivers (2000-2004) [Monitored and Complied by EMB, WQS 2005]

Manila Bay

Manila Bay is roughly 1,800 sq. km. in area, with a coastline of about 190 km and with the bottom gradually deepening at the rate of 0.1 %. As the ultimate receiving water body, it receives waste and wastewater from the Metro Manila Region and from about 17,000 sq. km. of watershed drained by 26 principal rivers. It plays a significant socio-economic role for Metro Manila and the surrounding provinces sharing its coastline. It is the center of the Metro Manila's international and domestic shipping operations; and is a major recreation and tourist area. The present state of environmental infrastructure and the conditions of the water quality of the rivers draining into Manila Bay have been the major cause of the deteriorating condition of this vital water resource.

At present, pollution loads from domestic, commercial, industrial and even agricultural sources significantly affect the water quality of the bay. In general, water quality for most of the principal rivers draining into Manila Bay is poorest during the dry season. The quality improves toward the end of the rainy season, as drainage basins are flushed, although pollution due to stormwater is still considered significant.

The eastern shore of Manila Bay adjacent to Metro Manila shows signs of significant pollution especially in the vicinity of the mouths of rivers and the openings of major storm drains. However, water quality improves rapidly in relation with the distance between the sampling and the discharge points.

One major source of pollution to the bay is the outfall diffuser from the Manila Central Sewerage System. Wastewater from major drainage areas of Manila including Balut, Pandacan, Sampaloc, Sta. Ana and Tondo are received by the bay almost untreated. The outfall with engineered diffusers terminating in the open bay water may not significantly reduce the pollution load due to lower assimilative capacity of the bay compared to its condition 20 years ago.

Manila Bay has its own water quality monitoring program under the Manila Bay Improvement Project of the EMB. Critical factors that are monitored regularly include BOD and coliform counts. BOD represents the amount of organic wastes introduced to the bay. Coliform, measured in terms of most probable number / 100 ml sample indicates the relative safeness of the bay water for primary contact recreation activities (such as swimming and diving).

Figures 4.20 and **4.21** present the fecal and total coliform count in some of the beach areas of Manila Bay. The prescribed limit for Class SC water is 5,000 MPN/100 ml. Most data show higher values than the prescribed limit. **Figure 4.22** shows the BOD level in three monitoring stations in Manila Bay. Class SC limit for BOD is 7 mg/l.

The reduction of pollutants discharged to rivers and esteros due to treatment, source control, or diversion of the wastewater will have a positive effect on water quality of the bay. Noticeable improvements on water quality will be obtained only through coordinated programs of collection, treatment and disposal of wastewater and the collection and disposal of solid waste.

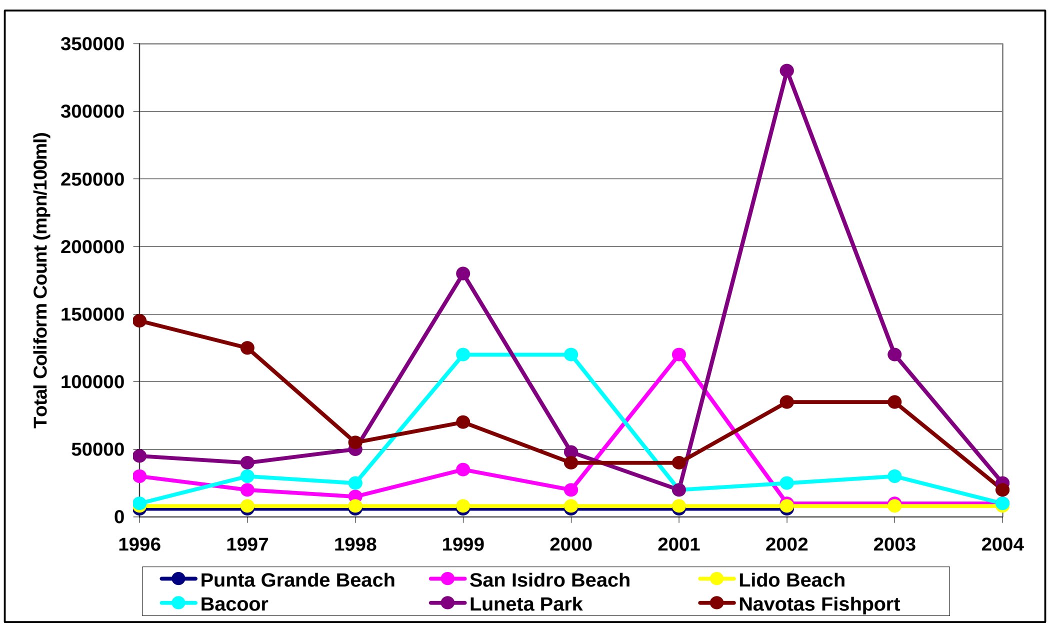

Figure 4.20 Total Coliform Count of Bathing Beaches in Manila Bay, 1996-2002 [Source: Philippines Environment Monitor 2003]

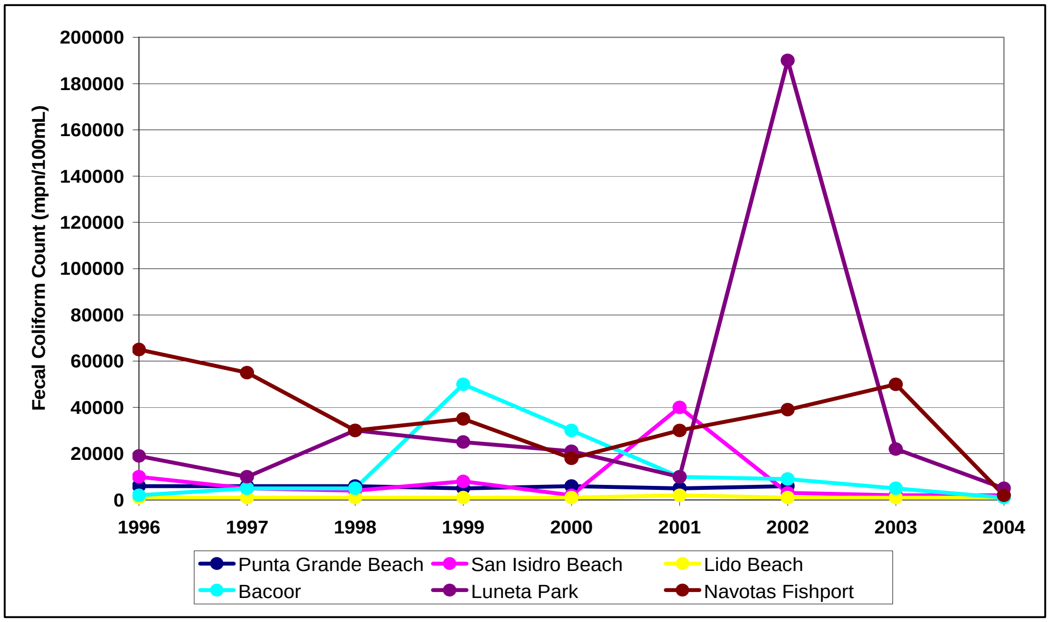

Figure 4.21 Fecal Coliform Count of Bathing Beaches in Manila Bay, 1996-2002 [Source: Philippines Environment Monitor 2003]

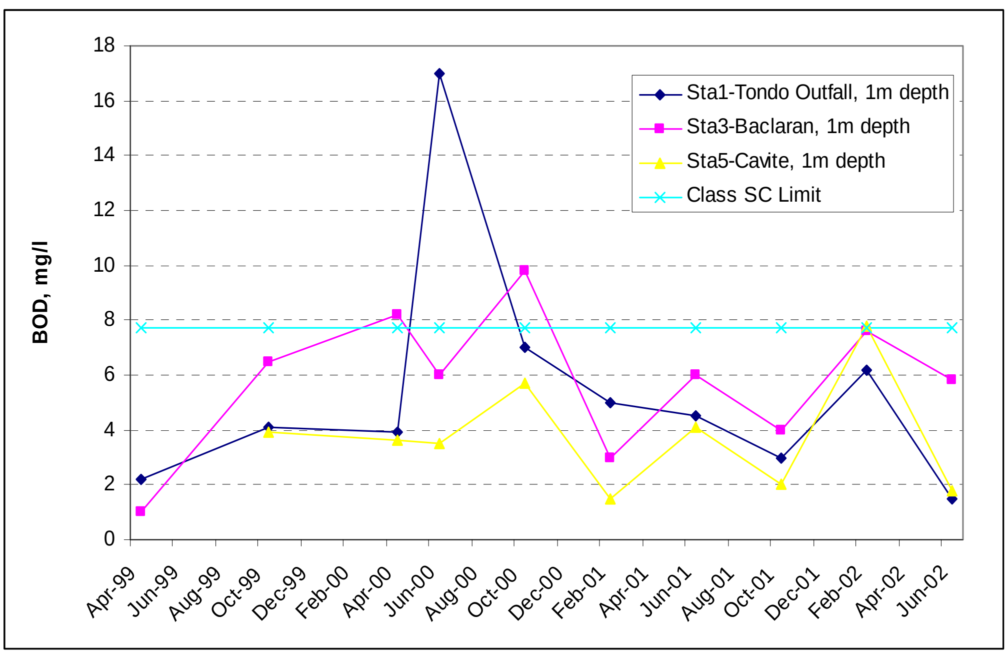

Figure 4.22 Biochemical Oxygen Demand Levels in Selected Stations in Manila Bay, 1999-2002 [Source: Philippines Environment Monitor 2003]

Laguna Lake

Laguna Lake is estimated to have a total volume of 3.2 billion cubic meters of water with an average depth of 2.8 meters. The lake receives flow from 21 rivers that meanders from five provinces.

Only few companies use the lake's water for its industrial process, but majority of the industries in its vicinity refer to the lake as its wastewater's receiving body of water. Five major industry classifications were identified as main contributors to pollution loading in the lake namely, food processing, hog raisers, slaughterhouses, beverage firms, and textile industries. In 1994, less than 70% of the industries in the Laguna Lake area have wastewater treatment facilities. These figures may have changed significantly in the present. **Figure 4.23** and **Figure 4.24** present water quality data from Laguna Lake and its tributaries as reported from 1996 to 1999 by LLDA.

Industries are not the only cause of pollution problems at Laguna de Bay. In fact, it is estimated that industrial pollution accounts for only about 30% of the deterioration in the water quality of the lake. This figure is less than the contribution of agricultural activities (40%) but as much pollution from domestic sources which is also estimated at 30%.

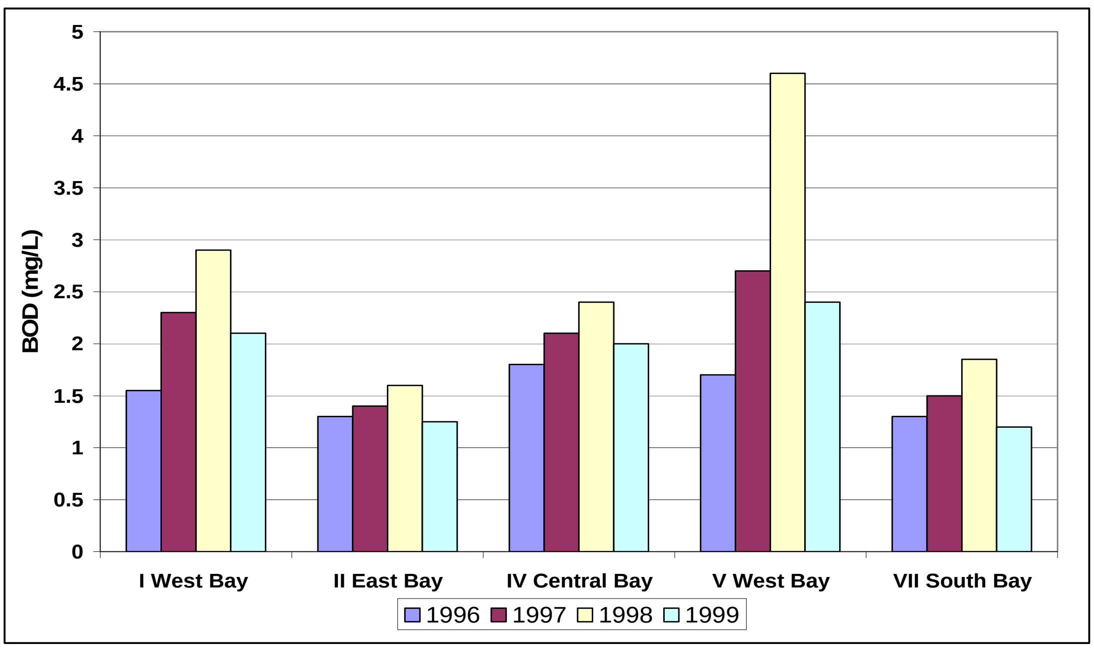

Figure 4.23 Annual Average BOD of Laguna de Bay, 1996-1999. [Philippine Environment Monitor 2003]

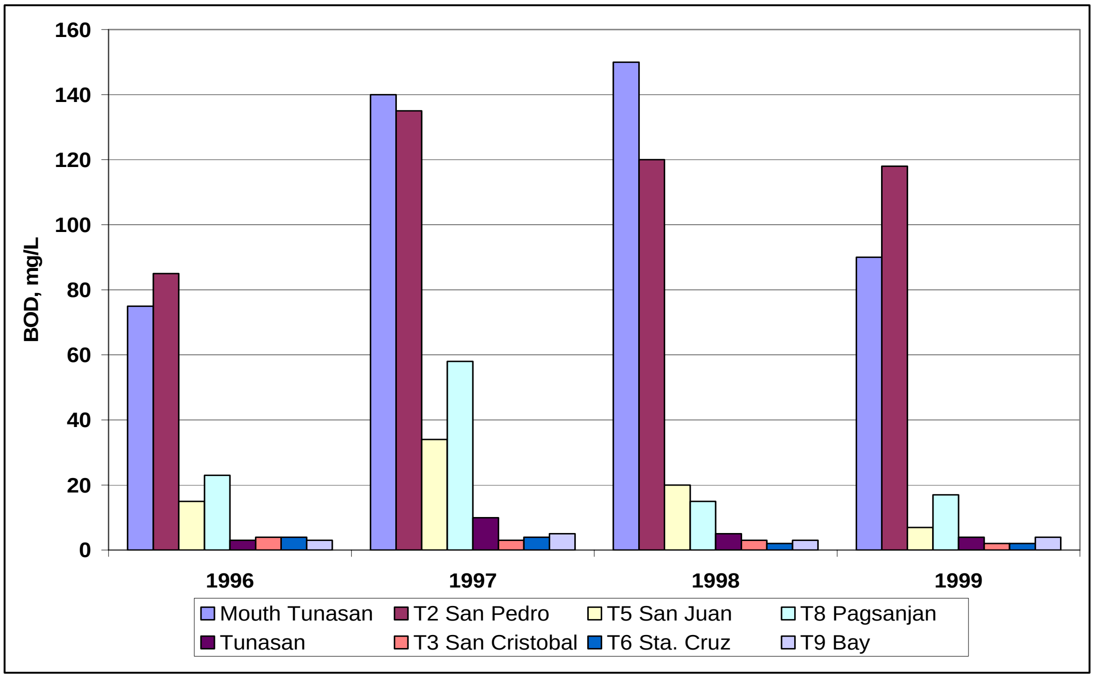

Figure 4.24 Annual Average BOD of Tributary Rivers in Laguna Lake, 1996-1999. [Philippine Environment Monitor 2003]

5. Relevant Past Studies

5.1 Earlier Master Plans and Programs

5.1.1 1969: Sewerage Master Plan for a Sewerage System for the Manila Metropolitan Area

This Master Plan was prepared by Black and Veatch during 1968-69. A diverse centralized concept for a separate sewerage system for Metro Manila was envisioned and proposed. Consideration was given to a combined sewerage system but was not recommended due to the extent of the existing sewerage system, the high intensity rainfall in Manila and the consequent increased cost of a combined system. Collection of wastewater was to be centralized at three disposal points in Manila Bay. Inland treatment was not considered due to the negligible assimilative capacity of the streams.

Major interceptor sewers were proposed adjacent to drainage paths to transport sewage to the disposal points. A significant feature of the plan was construction of a major sewer which would run along the bed of the Pasig River and intercept dry weather flows from the stormwater system. By the year 2000 it was felt that the assimilative capacity of Manila Bay would have been reached and treatment would be necessary.

It was proposed to implement the Master Plan in three stages – Phase 1 was to be the Central Sewerage System upgrade and the North and South Manila Basins, Phase 2, the lower San Juan Basin and portions of the Parañaque Basin and Phase 3, the major sewerage construction in the remainder of the Study area.

Sanitation was not considered in this Master Plan.

The Master Plan was never implemented and was superseded by a further Master Plan prepared in 1979.

5.1.2 1979: Sewerage and Sanitation Master Plan for Metro Manila

The next Master Plan was prepared by James Montgomery/Kampsax Kruger/DCCD in 1979. This plan discarded the previous plan on the basis of inadequate costing. They went on to recommend a plan based on:

- A sewerage expansion program involving rehabilitation of existing facilities and a monitoring system called METROSS. (Metro Manila Sewerage and Sanitation);
- Use of combined sewers;
- Secondary treatment of sewage with four outfalls into Manila Bay; and
- A sanitation programme comprising minor drainage projects for the depressed areas (PROGRESS) and a septic tank desludging programme (STAMP). Part of PROGRESS and STAMP were implemented as a component of METROSS – 1.

Only METROSS – 1 was implemented, although rehabilitation of the Central Sewerage System remained uncompleted.

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5.1.3 1994: Manila Second Sewerage Project

The Manila Second Sewerage Project (MSSP) was envisaged to begin addressing the increasing water pollution in Metro Manila. MWSS proceeded with the implementation of the MSSP in 1994 with World Bank assistance. Although based on the 1991 Second Manila Sewerage Feasibility Study, changes in the proposed project components were made due to the high cost of implementation.

MSSP sought to provide specific measures for the following objectives:

- Improve the quality of sanitation services;
- Reduce environmental pollution; and
- Minimize the health hazards from wastewater.

In order to achieve these goals, the project was developed into four components. These were as follows (i) Septage Management Plan, (ii) Ayala Sewage Treatment and Sewerage System Rehabilitation, (iii) Manila Central Sewerage System Rehabilitation and (iv) Supply of Laboratory Equipment, Vacuum Trucks and Other Vehicles. These components are discussed below.

Septage Management Plan

The Septage Management Plan of the MSSP provided the means for immediate action to be taken with the septage collection and hauling using specific collection vehicles. The collected septage was to be handled through interim and permanent solutions by means of open sea disposal and establishment of septage treatment plants (SpTP), respectively.

Barge loading of the collected septage for sea disposal was to be done through the use of loading stations to be constructed at Napindan and Estero de Vitas. The typical capacity of each loading station was to accommodate 760 m^3/day of septage. The sea disposal of septage was proposed to continue until 2004, when the construction and rehabilitation of proposed SpTPs were to come on-line.

The rehabilitation and upgrade of the Dagat-Dagatan Lagoons to include a SpTP was planned to ultimately have a 900 m^3/d septage treatment capacity in addition to its current 52 MLD sewage treatment capacity. Septage treatment would involve dewatering and aerated lagoons for biological treatment processes. It was projected that the Dagat-Dagatan, along with two other SpTPs, would have combined capacities of 1,700 m^3/d by 2004 when the open sea dumping operations would cease.

Ayala Sewage Treatment and Sewerage System Rehabilitation

The Ayala Sewage Treatment Plant (STP) was in need of major rehabilitation with most of the structures and equipment already past the end of their design lives. Although the plant generally met effluent standards, it was found to be overloaded especially during periods of rainfall.

The construction of a grit chamber and concrete sludge thickener tank were to comprise two phases of the plant rehabilitation. A separate structure was also included in the second phase of construction to provide dewatering of the sludge produced during treatment. Service lines such as the Amorsolo Inverted Siphon, Edsa Trunk Line Alternate Route and Valero-de la Costa Sewer Connection were also in need of proper maintenance.

These maintenance works coupled by improvements in sewer manholes, cleaning of sewer lines, and repair or replacement of damaged lines, were deemed to be adequate to enable the sewers to accommodate both dry and wet weather flows.

Manila Central Sewerage System Rehabilitation
Expansion works proposed for the existing Manila Central Sewerage System included the extension of catchments in Pasig and the retrofitting of the Manila Bay outfall to the Tondo Pumping Station. The sewer lines, equipment and pumps were assessed to be in more deteriorated states than what was observed during the inspection for the 1991 feasibility study. Other problems involved the observed backflow during high tides due to damaged flap gates and the clogged Pasig River Inverted Siphon.

Rehabilitation recommendations included for the Manila Central Sewerage System were as follows:

- Automatic gate opener to replace manual inlet and outlet gates ;
- Gate boxes to be provided for bypass for grit chamber;
- An aeration grit chamber before the main pump to be installed;
- A ventilation system for the pump pit room to be installed;
- Main pumps to be repaired and spare parts for impellers procured;
- Flow meters to be repaired;
- Installation of odor control systems; and
- Back-up electrical power to be provided.

Supply of Laboratory Equipment, Vacuum Trucks and Other Vehicles
More effective monitoring of the wastewater, from collection to final discharge, through laboratory analyses was deemed to be needed to establish proper treatment processes. Although MWSS utilized the Central laboratory, which began operations in 1983, added samples from the proposed numerous sewage and septage treatment plants was considered likely to render the laboratory overloaded.

In order to facilitate continuous effluent monitoring of the proposed treatment plants, establishment of adequate on-site laboratories for every plant was deemed to be required. The laboratories were to be outfitted with adequate testing facilities and mobile testing units. This equipment would enable testing of effluent quality from the treatment plants and would also enable samples to be tested on-site from septic tanks and sea septage dumping. In conjunction with the laboratories and other testing equipment, the addition of laboratory staff and proper training also were also proposed.

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5.1.4 1996 Study on Water Supply and Sewerage Master Plan of Metro Manila

The projected rise in the population of Metro Manila in the last decade of the millennium prompted the need for an increase in water supply. This projected increase in water consumption would result in an increase in generated sewage from the service area. Despite the rehabilitation and development being implemented under MSSP, the sewerage and sanitation programs for Metro Manila were still insufficient in terms of the increased environmental load. This 1996 Study on Water Supply and Sewerage Master Plan of Metro Manila by Nippon Jogesuido Sekkei (NJS) addressed the pressing issues on both water supply and sewage generation.

The options between separate and combined sewer systems were evaluated. Other concerns were drainage system improvement and expansion, septage management, maintenance of overflow chambers and household service connections.

Proposals for systems comprising smaller service areas were introduced to enable more immediate implementation of the plans. The proposed smaller-scale treatment plants were to be eventually integrated thereby to form a centralized system.

Sewage Treatment Development
Sewage treatment methods were narrowed to the following processes:

- Stabilization Pond (SP);
- Aerated Lagoon (AL);
- Oxidation Ditch (OD); and
- Conventional Activated Sludge (AS).

The trade-off in the selection of the above alternatives was between high capital cost for the construction, operation and maintenance for the more mechanized alternatives such as activated sludge, against the increase in required land area for treatment methods such as stabilization ponds.

Inland treatment systems as well as ocean outfall systems were also compared. Alternatives for inland treatment were based on the size of catchments for small, medium or large-scale treatment systems. Improved ocean outfall systems were studied but proved to be unacceptable in terms of environmental impacts and implementation. The Medium Scale Inland Treatment System (MSITS) was found to be more advantageous than the other options. Optimization plans for the MSITS were further explored.

Sewerage Systems
Considerations in some of the catchments were made in accordance with the improvements being done in MSSP. The development of the identified catchments and the recommended individual treatment methods were based on key priority factors such as development of the area cost per capita, cost-recovery, and environmental impact. The priority sewerage areas were individually discussed as follows (i) Ayala System, (ii) North Manila System, (iii) Central Manila System, (iv) South Manila System and finally, (v) West Mangahan. Recommended sewerage systems for the remaining catchments were

discussed collectively. **Figure 5.1** presents the sewerage catchments, proposed STP locations and the recommended treatment methods.

- **Ayala System**
  Since Makati had an existing sewerage system, which extended to residential and commercial buildings, the benefit cost was low. However, the high-income populace made this a priority area for improvement of the sewerage system.

  The importance of the rehabilitation works of the wastewater treatment plant through MSSP was emphasized. No further rehabilitation works for the treatment plant or the sewerage system were recommended.

- **North Manila System**
  Cost-recovery for improvement of this system was considered low because of the population's low ability to pay. However, the high population density of the area resulted in a lower cost per capita. The environmental impact of the development of the North Manila System was considered to have the potential to bring about an improvement in water quality of the Pasig River, considered to be the most polluted in the Metro Manila region.

  The North Manila System covers the San Juan River Basin. Communal septic tanks scattered within the boundaries of Quezon City were to be connected by an interceptor system to the treatment plant.

  Recommendations for sewage treatment were constrained by the available land area. Aerated lagoons may take up as much as 120 ha of land and so the use of an oxidation ditch was suggested.

- **Central Manila System**
  The service area of the Central Manila System was mostly covered by an established sewerage system. The high population increased the need to expand the service area due to the high environmental impact from unsewered households. Also, the large population translated into a lower cost per capita for the rehabilitation works.

  The developments in the Sampaloc, Balut, Dagat-Dagatan and Caloocan areas could be connected with the Dagat-Dagatan treatment plant, which would be upgraded in the MSSP. The upgrading included more efficient means of treatment such as aerated lagoons and an accompanying increase in treatment capacity. The Tondo Pump Station was proposed to continue its operation.

- **South Manila System**
  The South Manila System was characterized as a highly populated area with an equally high degree of commercial activity. Because of this, cost per capita was the lowest in the considered areas and cost recovery was considered easier. Development of the sewerage system was deemed important due to the high population and commerce that generated a high pollution loading for Manila Bay.

Portions of the Central Manila System were to be transferred to the South Manila System including the Pandacan area. The total area of the STP would cover about 94 ha for an aerated lagoon system while an area of only about 23 ha was specified for an oxidation ditch treatment method. The selected treatment method would depend on the available area.

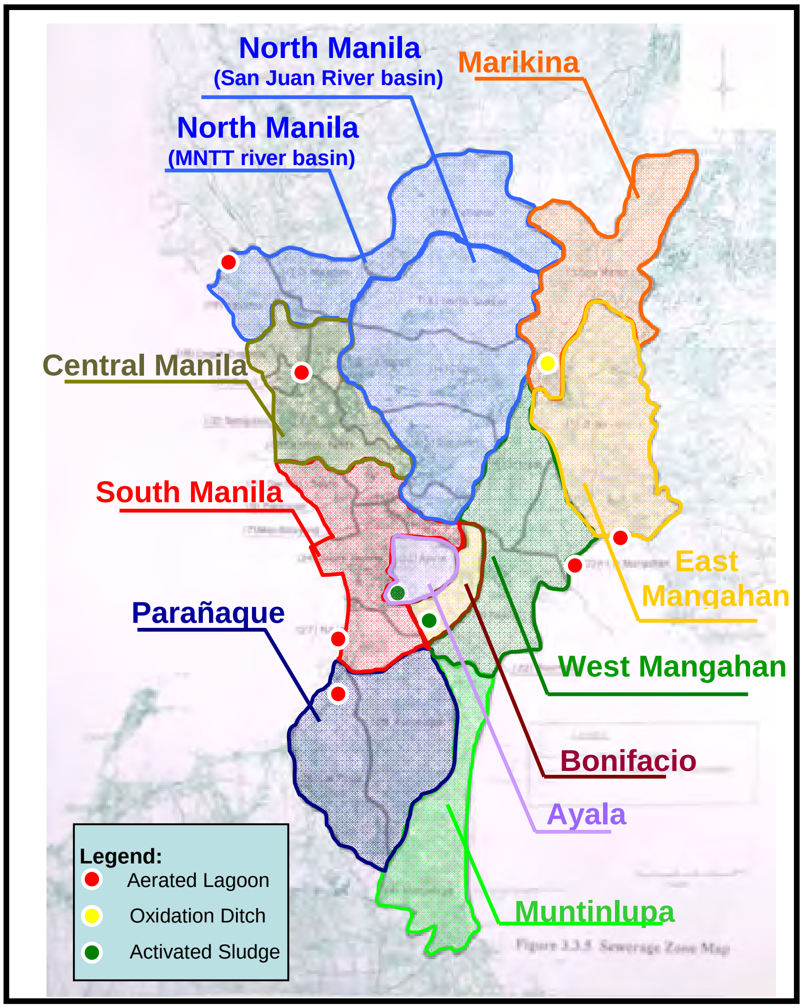
- **West Mangahan**

  The area of West Mangahan experienced a considerable increase in development, especially in the Ortigas area, which was projected to be sustained in the following years. The cost per capita and the project recovery would largely depend on the high-income capacity of the residents in the Ortigas area.

  As with other developed regions of Metro Manila, sewage from the Ortigas area was proposed to be collected via an interceptor system. Land acquisition for West Mangahan was seen to be less difficult thereby making an aerated lagoon treatment method viable.

- **Remaining Catchments**

  The use of aerated lagoons for sewage treatment of the East Mangahan, Muntinlupa and Parañaque catchments was assessed to be favorable in reducing operation and maintenance costs, due to the availability of the required land area in these catchments. The Marikina basin was proposed to utilise an oxidation ditch to reduce the required area. However, an activated sludge treatment process was proposed for the Bonifacio basin due to the intended high-density development in this area.



Source:1996 NJS MP

Figure 5.1 - Proposed Catchments, STP Location and Treatment Method

Septage Management Plan

Because sanitation is critical in any wastewater strategy, a sanitation development plan was prepared. Although drainage was considered to be part of the sanitation project, details were omitted from the study. The sanitation development plan was divided into on-site treatment facilities and the septage management plan development stages. Each is discussed accordingly.

i. **On-site treatment facilities**

A review of existing septic tanks was conducted and recommendations for the design suggested. Communal septic tanks using anaerobic processes were recommended. Other facilities based on different technologies such as the

Japanese type JOHKASOU bio module, Anaerobic Sludge Blanket Reactor, and the Korean type treatment were suggested for applicability trials.

ii. Septage Management Plan

Four SpTPs dividing the service area of the unsewered locations were considered. These were the Dagat-Dagatan, Quezon City, Taguig, and Las Piñas setpage treatment plants. The septage plan was to be continued even after the 2010 target period for sewerage coverage. The septage management plan involved the septage cycle from collection to treatment through added rehabilitation programs included as part of MSSP.

Implementation of this Master Plan was overtaken by the privatization of the operations of MWSS in 1997. Since this time the concessionaires, while taking into consideration some of the recommendations of the Master Plan especially related to sanitation, have largely pursued their own sewerage and sanitation strategies. The 2003 rate rebasing exercise resulted in a further deviation from the sewerage strategies, which in the case of the East Zone resulted in an emphasis on sanitation rather than sewerage for economic/financial reasons and in the West Zone the deferral of all sewerage targets due to financial constraints.

5.1.5 2005 East Concession Area Master Plan Update

The 2005 East Concession Master Plan Update was based on a study undertaken by NJS. The master plan integrated some of the packages proposed in the Manila Third Sewerage Project (discussed below in 5.3) to form an overall strategy in the implementation of the sewerage and sanitation programs for the service area of MWCI. The proposed sewerage and sanitation development in the East Concession master plan update is discussed briefly below.

Sewerage Development

In the updated master plan, a total of 11 catchments were delineated, based on topography, drainage patterns, and the potential STP sites. Although previous studies provided recommendations for STP locations, most of these sites gave way to other development and become unavailable. Other site locations were considered as replacements for the occupied sites.

Alternatives were chosen to allow a proper assessment of cost, tariff, technical constraints and benefits. Based on the target adjustments given by the 2003 Rate Rebasing, the implementation of an extended implementation schedule was considered. Also, separate and combined sewerage systems were compared. A reduction to seven catchments owing to the union of certain catchments was likewise considered. The sewerage alternatives were presented as:

- Alternative 1 – 1997 CA Target Service Levels and Implementation Schedule with Separate Sewerage System in 11 Catchments;
- Alternative 2 – 1997 CA Target Service Levels with Extended Implementation Schedule with Separate Sewerage System in 11 Catchments;

- Alternative 3 – 1997 CA Target Service Levels with Extended Implementation Schedule with Separate Sewerage System in 7 Catchments;
- Alternative 4 – 1997 CA Target Service Levels with Extended Implementation Schedule with Combined Sewerage System in 11 Catchments;
- Alternative 5 – 1997 CA Target Service Levels with Extended Implementation Schedule with Combined Sewerage System in 7 Catchments.

The outcome of the study evaluated the most feasible stratagem for implementation in terms of technical issues and constraints, relative cost and the benefits was **Alternative 5**. The combined sewerage system required the least capital cost due to the elimination of laterals and house connections. The tariff rate was the lowest for the alternatives considered. Reduction of the catchments also required four less STPs. **Figure 5.2** presents the locations of the STPs and their respective catchments for Alternative 5.

Water quality of the major rivers was projected to improve with the implementation of the combined sewer system in the recommended scheme. Creeks and drains, however, would not benefit from any water quality improvement.

Septage Management and Sanitation Development
Septage management programs considered the 586 m^3/day North and 814 m^3/day South SpTPs proposed in the Manila Third Sewerage Project (MTSP) complemented by a SpTP in Antipolo for the Rizal province service areas. Given that combined sewerage systems were to be implemented, the initially proposed septage capacity of 600 m^3/day for the Antipolo SpTP would eventually become inadequate. To accommodate the lack of a separate sewer system for the Rizal service area, two alternatives were proposed:

- The planned capacity of the proposed Antipolo SpTP should be increased to a total treatment capacity of 1,689 m^3/day by the year 2020.
- Construction of a separate SpTP in Binagonan or Cardona to accommodate the 1,089 m^3/day load from the projected increase in development of the Rizal service areas.

5.2 Manila Second Sewerage System Progress

5.2.1 East Zone (Manila Water Company Inc.)

Continuance of the MSSP was passed on to the concessionaires following privatization in 1997. The major component of the MSSP for the east zone was the rehabilitation of the Ayala STP to facilitate an expansion of sewerage coverage. Other components such as septage management were also to be carried out by MWCI. The following are the components of the MSSP for implementation by MWCI:

- Construction of a barge-loading station at Napindan with a capacity to transfer about 500 m^3/d of septage from collection vehicles to barges;
- Upgrading of the Ayala sewerage system, including rehabilitation of the pumping station and sedimentation tanks to provide mechanical treatment of sewage and septage, and repair of pipes, equipment and other works;

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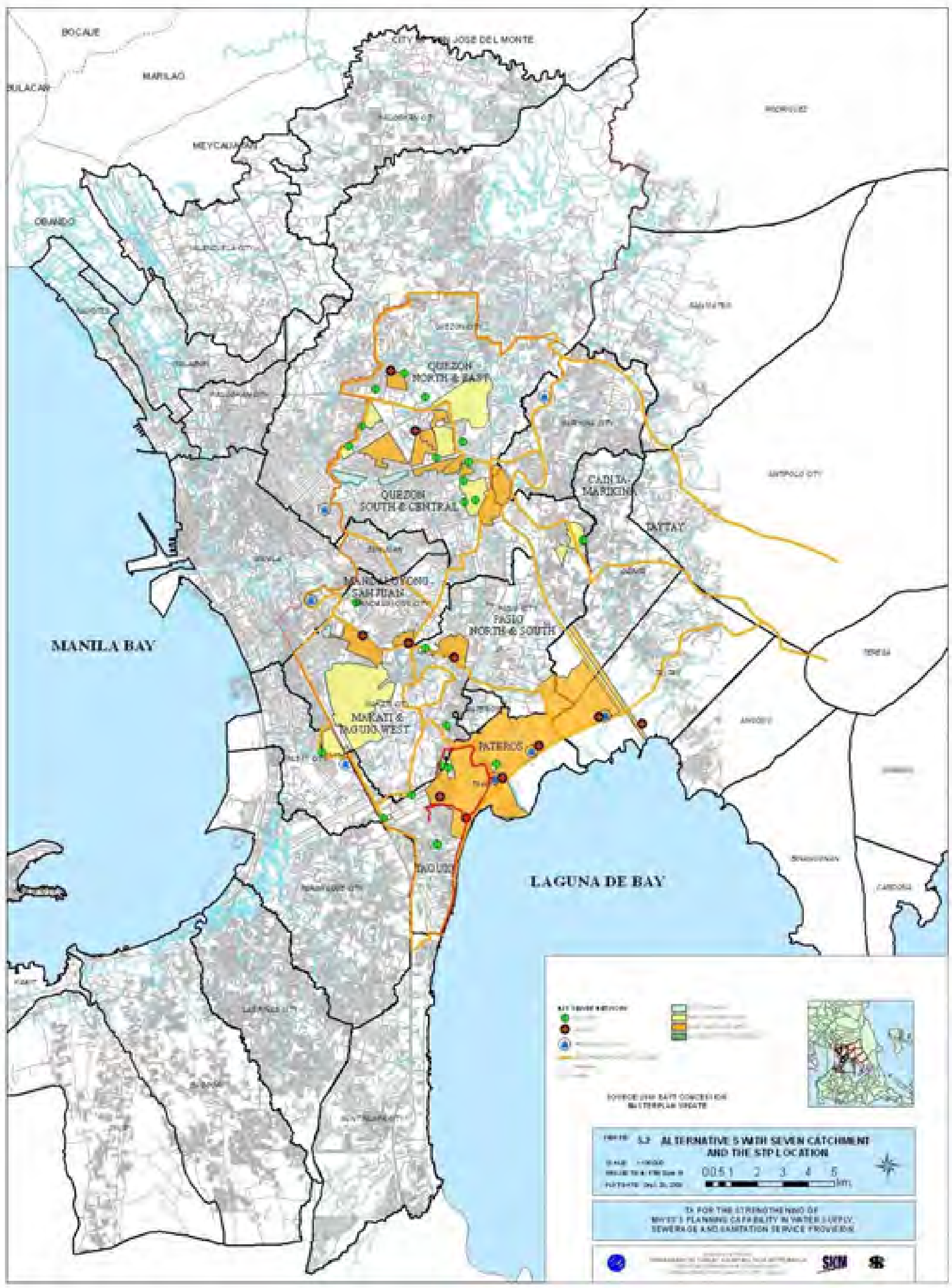

Figure 5.2 Alternative 5 with Seven Catchments and the STP Locations

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- Strengthening of MWCI's central laboratory, through the provision of specialized instrument, equipment, furniture and materials;
- Strengthening of the technical capabilities of MWCI to operate and maintain sewerage systems in the East Service Area, through the provision of vehicles, machinery and tools;
- Strengthening of the technical capabilities of MWCI in construction supervision, development of septage treatment experiments, environmental monitoring and preparation of follow-up sewerage projects, through the provision of consultants' services and the provision of software; and
- Planning and implementation of sewerage projects in the East Service Area, including the construction and rehabilitation of Karangalan Lift Station and rehabilitation and expansion of municipal sewerage systems in Taguig.

Open sea disposal of septage had been met with some public resistance. Even with the completion of the barge loading facilities and memorandum of agreements from the different local government units, the sea disposal activities have since ceased. The MSSP also introduced the MSSP Community Sanitation Program (MCSP). The project involved upgrading of the communal septic tanks (CST) into STPs with the expansion of existing coverage areas. Construction of new STPs for coverage areas were also included. **Table 5.1** shows the components of MCSP:

Table 5.1 - MCSP Components

Name of the STP	No. of Connections	Service Area (m^2)	Area of STP (m^2)	Name of the STP
Phil -Am STP	1,847	467,500	400	bio-contact treatment
Kalayaan STP	3,700	784,400	800	bio-contact treatment
Pag-asa BLISS STP	544	219,000	150	bio-contact treatment
Sikatuna BLISS STP	544	228,200	300	bio-contact treatment
Belarmino STP	411	454,000	400	bio-contact treatment
Fisheries STP	679	66,320	145	bio-contact treatment
UP Campus STP	1,673	2,900,000	5,000	bio-contact treatment
A. Luna STP	1,492	587,100	495	bio-contact treatment
Palosapis STP	1,286	127,600	218	bio-contact treatment
Heroes' Hills STP	87	204,400	270	bio-contact treatment
Karangalan Village STP No. 1				anaerobic treatment
STP No. 2				Anaerobic treatment
STP No. 3				Anaerobic treatment
STP No. 4				Anaerobic treatment
STP No. 5	6,000	768,000	500	Anaerobic treatment
STP No. 6				Anaerobic treatment
STP No. 7				Anaerobic treatment
STP No. 8				Anaerobic treatment
STP No. 9				Anaerobic treatment
Mandaluyong MRH STP	180	27,900	75	bio-contact treatment
Guadalupe BLISS STP	760	86,500	350	bio-contact treatment
Lakeview Manors STP	458	72,420	200	Activated sludge
Maharlika MRH STP	420	32,430	150	Activated sludge
Centennial Village STP	1,140	85,920	350	Activated sludge
Fortville STP	1,140	11,100	350	Activated sludge
Bagong Lipunan STP	1,213	53,370	375	Activated sludge

Source: MWCI

The original Implementation schedule of the MSSP was from 1996 to 2000. Target completion date was extended to June 2003 with the execution of the Agreement Amending Loan Agreement (AALA) in 1998. An 18-month extension was granted from June 2003 to December 2004, based on the endorsement of ICC-CC in 2003. In November 2004, a 5-month extension was requested for the MSSP to be completed in May 2005.

Components of the MSSP such as the construction of a septage management plan, upgrading of the Ayala sewer network, rehabilitation of the Ayala Wastewater Treatment Plant, implementation of Community Sanitation Projects (CSP) and strengthening of laboratory and maintenance equipment had already been completed.

Most of the CST upgrade programs of the MCSP in **Table 5.1** were likewise completed with only A. Luna, Palosapis, and Hero's Hills STP replacement projects still on-going. Construction of the UP Campus STP was completed in 2004. Belarmino and Fisheries STPs' construction are also on-going.

5.2.2 West Zone (Maynilad Water Services Inc.)

The majority of the components of the MSSP were implemented in the West Concession area. These tasks were originally targeted to be completed in 2001. However, some were completed just recently and others are still under construction.

The major tasks specified in the project included the following:

- *MSSP 1- Construction of barge-loading stations at Estero de Vitas (760 m^3/day) and Parañaque*

The barge loading station in Estero de Vitas was completed in 2002. The planned construction of the Parañaque barge station was aborted because the identified site was no longer available.

- *MSSP 2-Construction of a 200 m^3/day Pilot Septage Treatment Plant in Dagat-Dagatan*

This project had been completed and the facility became fully operational by April 2005. Running with two, eight hour shifts, the capacity has been doubled.

- *MSSP 3-Strengthening of the central laboratory through acquisition of specialized equipment and materials*

All the laboratory equipment, vehicles, and sewer maintenance equipment for both MWSI and MWCI have been delivered.

- Strengthening of the technical capabilities in the operation of sewerage systems and in the construction and supervision of a pilot septage management program.

- *MSSP 4-Upgrade of the Central Sewerage System*

Repair and construction works are currently on going.

- *MSSP 4-Construction of 10,000 new sewer connections in Metro Manil*a

This program had only minor success with very few connecting due to the 50% tariff in the water bill.

- MSSP 7 & 8- *Construction of pilot vermiculture and aerated composting facilities.*

In 2001, an invitation for a pre-qualifying bid for the vermiculture project was posted by MWSI. GHD completed the design and bid documents for this project. None of those who responded to the invitation qualified for the requirements set by the MWSI. This project has since been aborted. The composting project was aborted due to the failure in acquiring the lot intended for the facility.

The remainder of the project had been completed and the facility was fully operational by April 2005. As such, the scope of work in the West Zone as defined in the MSSP components are heavily concentrated in the Central and Dagat-Dagatan Sewerage Systems. The status of the project implementation is discussed below.

Manila Central Sewerage System

The scope of work identified in the rehabilitation of the Manila Central sewerage System under MSSP was:

- Improvement of the Tondo Pumping Station covering (i) construction of a new grit chamber, odor control facility, supply/install a stand-by generating set including a generator house, and associated mechanical and electrical works, (ii) repair of existing facilities like screen gates, pumps, flow meter and instrumentation controls, and (iii) general refurbishment of the station building;
- Rehabilitation of all seven Lift Stations consisting of: (i) replacement of pumps and associated electrical / instrumentation controls, (ii) installation of new odor control facilities, and (iii) refurbishment of station house;
- Sewer lines improvement consisting of: (i) cleaning and CCTV inspection of sewer lines including the Pasig River siphon and Bay outfall, (ii) repair of sewer lines and raising of buried manholes, and (iii) supply / install flap gates.
- Installation of 10,000 service connections including acquisition of excavation permits from concerned government agencies;
- Various additional works identified during the project construction.

As of closure of the World Bank loan on 30 June 2005, the rehabilitation works by the Contractor were substantially complete. The Contractor started work on 5 October 2001 for a contract duration of 540 days, but this was extended five times, to end similarly with the loan closure. Remaining minor works are assumed by the MWSI.

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Dagat-Dagatan Sewerage System

The system upgrade and rehabilitation of the Dagat-Dagatan wastewater treatment plant, the upgrade of the pumping system, and the construction of the Septage Treatment Plant were under the project entitled "Construction of Septage Treatment Plant and Rehabilitation/Upgrading of Existing Sewage Treatment Plant at Dagat-Dagatan". The funding for the project was part of an MWSS loan from the IBRD (Loan no. 4019 PH). Consultancy services were provided by SKM, in association with TCGI Engineers. The construction contract was awarded to the JVACC-JEMCO Joint Venture.

Rehabilitation work included the following:

- Dewatering of and sludge removal from the four lagoons, replacement of riprap embankment and construction of baffled walls, and installation of a total of eight floating mechanical aerators on the two aerated lagoons (with an OTR of 50 kg/hr);
- Removal and replacement of four major pumps and associated piping, complete replacement of all mechanical and electrical systems, and a wide variety of general site improvements; and
- Construction of the Septage Treatment Plant.

Over 20,000 m^3 of sludge was removed from the lagoons. Desludging operations were contracted to MV Vidal Co., who hauled the sludge to Batangas for application to agricultural land. Sludge removed from the lagoons in excess of the 20,000 m^3 contracted volume is currently stockpiled within the WWTP site. Only the aerated lagoon of module 1 remains undesludged. Desludging operation is expected to be completed by the end of April 2005.

The four old pumps in the pumping station were removed and replaced with four new pumps equipped with an emergency power generator. The pumping station features two rising mains: two pumps are normally allocated to the 500 mm diameter main, and the other two to the 700 mm diameter main. The normal operation of the pumps will provide alternate use of the two rising mains, with the 500 mm main directed to module 1 and the 700 mm main directed to module 2. A reconstructed inter-connecting valve array at the downstream end of the rising mains just prior to the lagoons at the WWTP allows this selection to be varied. The mains have since proven defective and MWSI has engaged a contractor for their rehabilitation.

The SpTP occupies approximately 1.2 ha within the vicinity of the WWTP. It has a design capacity to dewater approximately 200 kL of sludge in an ordinary working day (1 8-hr shift). Over a year, it can treat septage from 10,000 septic tanks. The SpTP was commissioned in 17 January 2005 and operated 5 days each week. This was part of the 3-week commissioning period, which ended in February 4, 2005. Currently four operators operate the plant on each of the (2) 8-hour shifts. The SpTP became fully operational on 1 April 2005. In all, 32 vehicles are available: 7 dewatering units, (19) 10m^3 vacuum trucks, and (6) 4m^3 vacuum trucks. Typically, a 4m^3 truck can accommodate septage from 2-3 households. The current fleet has 14 new vehicles, of which, only 5 were used during the commissioning period.

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5.3 Manila Third Sewerage Project (MTSP)

In order to improve and expand the sewerage and sanitation projects developed in MSSP, the Manila Third Sewerage Project (MTSP) was conceptualized by both MWSS and MWCI for the East Zone concession area. The objectives of the MTSP included the reduction of pollution of waterways within Metro Manila and Manila Bay, reduction of the health hazards from sewage exposure, and the gradual improvement in the sewerage services through expansion of the septage management program.

In order to achieve such goals, specific components were introduced for implementation. These are (i) Taguig Sewerage System, (ii) Riverbanks Sewerage Treatment Plans, (iii) Septage Treatment Plants, (iv) Sanitation of Low-income Communities, (v) Quezon City-Marikina Sewerage, (vi) Upgrade of Existing Sanitation Systems and (vii) Technical Assistance.

i. Taguig Sewerage System

Works for this component will involve the four flood control retention ponds near the Laguna Lake, which are being constructed by the Department of Public Works and Highways (DPWH). These retention ponds are proposed to be converted into STPs to allow proper treatment during the dry season before discharge to Laguna Lake under the MTSP.

Another component of the Taguig Sewerage System is the upgrading and rehabilitation of the drainage system. This is to facilitate the use of a combined sewerage system in this area. Interceptor sewers are to be installed for affected communities.

ii. Riverbanks Sewerage Treatment Plans

This project involves three underground treatment plants located along the banks of Pasig River. Specific locations are narrowed down to Barangay Poblacion in Makati, Barangay Ilaya in Mandaluyong and Barangay Capitolyo in Pasig.

Interceptors shall provide for collection of wastewater from drainage lines to be treated before being discharged to the Pasig River. As such, improvement of the drainage outfalls and lines may be included in the component.

iii. Septage Treatment Plants

In line with the new targets for sanitation, construction of two SpTPs is proposed to service the North and South zones of the concession area. The North SpTP is to be located in San Mateo, with a capacity of 586 m^3/d to serve Quezon City, Marikina and San Juan. Southwards, a SpTP at FTI, Taguig City with a capacity of 815 m^3/d will serve the areas of Mandaluyong, Pasig, Makati, Pateros, Taguig, as well as some of the towns in Rizal province. . An added feature of the Treatment Plant is the capability to treat 2 MLD of sewage flows from the FTI complex.

Collection of septage from the individual septic tanks in the service area is to be facilitated by the acquisition of 70 truck-mounted vacuum tankers.

iv. Sanitation of Low-income Communities

This originally involved the construction of CSTs or STPs, as appropriate, and shallow, small bore sewer lines to serve some low-income communities in the East Zone that have inadequate sanitation facilities.

This has now been reduced to two communities (Pinagsama, Taguig and East Bank, Taytay) in lieu of issues on willingness and capacity to pay for water and sewer charges. STPs will be constructed for these communities using combined systems with drainage upgrading. The feasibility of separate systems was also considered and found to be impractical and expensive.

v. Quezon City-Marikina Sewerage

A proposed STP along the Marikina River in front of Sitio Orlandes Resettlement Site is to be constructed under the MTSP. The location is to utilise portions of the legal easements established for the Marikina River Main drainage collector pipes. The main drainage collector pipes, which collect combined sewage and drainage from communities in Quezon City and Marikina, will be connected to the STP to treat the dry weather drainage/sewage flow. The treatment plant is to reduce the sewage load discharging to the Marikina River.

A low-lift station is to be constructed to carry flows from the Sitio Orlandes to the proposed STP. In order to fully utilise the combined sewerage system for the service area of the treatment plant, an upgrade of the drainage system for the Camp Atienza, Sitio Orlandes, Industrial Valley, Cinco Hermanos and Blue Ridge basins is proposed.

- **Upgrade of Existing Sanitation Systems**

Upgrades of CST sanitation systems into STPs for the East Zone are proposed, specifically those located in East Avenue, Road 5 and Matiwasay St. A separate sewer system in East and West Kamias is to be laid for the conveyance of the sewer flows to the East Avenue Regional STP.

The project also aims to transfer CST flows to nearby STPs for full treatment. Flows from Mapagmahal and Anonas CST are to be transferred to East Avenue STP, Matiwasay CST flows to UP STP and Scout Santiago to Heroes Hill STP.

- **Technical Assistance**

The components include an information campaign on proper liquid waste disposal and environmental protection and other follow-up programs on sewerage and sanitation. Low cost sanitation methodologies are still recommended.

The package components of the MTSP are to be implemented within a five year duration period. Timetable of the individual components are shown in **Table 5.2**.

Table 5.2 - MTSP Component Timetable

Component/Packages	Project Start	Target Completion
(i) Taguig Sewerage System	May 2006	April 2010
(ii) Riverbanks Sewage Treatment Plants	August 2006	January 2008
(iii) Septage Treatment Plants	June 2005	July 2007
(iv) Sanitation for Low-Income Communities	May 2007	November 2008
(v) Quezon City-Marikina Sewerage System	June 2006	February 2008
(vi) Upgrade of Existing Sanitation Systems	September 2006	March 2008
(vii) Technical Assistance	2007	2008

Source: MWCI

Due to the fact that MTSP is still in the infancy stage, no significant progress review can be made in terms of physical accomplishments. The proposed SpTPs for MTSP located North (San Mateo) and South (FTI, Taguig City) are currently near the stage of award.

5.4 2000 West Zone Sewerage Master Plan

A draft sewerage master plan (SMP) for MWSI was prepared by PhilAqua Consultants Inc. in 2000. Due to a misunderstanding between the concessionaire and the consulting firm, the draft proposal was not recognized by MWSI as an official document.

The items presented below are parts of the draft SMP. The draft report recommended the use of centralized sewerage systems in the West Zone until 2011. After this period, a decision was to be made on whether centralized or decentralized systems would be more advantageous. A comparison between sewerage and sanitation (septic tanks) was also presented as a special topic.

Sewage Management

i. Identification of New Catchments

The West Zone was delineated into relatively small catchments in parts where sewerage coverage was specified in the Concession Agreement. A total of 150 new catchments were identified based on the following guidelines:

- the catchment should each have a resident population of about 50,000;
- the sewer lay-outs identified in previous master plans are to be followed where appropriate; and
- trunk sewers or interceptors were expected to follow natural waterways in order to avoid the need for small pumping stations.

ii. Construction of Sewage Treatment Plants

The draft SMP recommended the construction of sewage treatment plants (STPs) for treatment of sewage collected from the various identified catchments. Many combinations of alternative sites and processes were reviewed.

Under the proposed plan, the existing Dagat-Dagatan STP would continue to operate until 2016. The Dagat-Dagatan site was found to be too small for a regional STP. It was also deemed inappropriate, the site being residential with constrained access. In the medium term, a new Central STP would have to be constructed. In the absence of available land with sufficient area, reclaimed land in Manila Bay would be utilized for the development of this Central STP. Alternative decentralized fallback options in the North and South were also proposed.

From a roster of twenty choices, five short-listed alternatives were compared. No specific cost advantage was identified for any of the options. All ranked similarly with the Net Present Value analysis based on the 2000 cost data. For the medium term, the North and South STP option was identified to be most expensive.

The proposed sewage treatment process was to include primary & secondary treatment and disinfection. The identified primary treatment consisted of screening, de-gritting, oil/grease removal, and primary settling. Secondary treatment could either be using activated sludge, trickling filters, or bio-aerated filters. Enhanced Primary Treatment, the addition of a chemical flocculants, was proposed for STPs that would discharge into Manila Bay. Secondary Treatment would be required for STPs that would discharge to inland bodies.

Treatment alternatives for the bio-solids accumulated from the sewage treatment process were: gravity thickening, stabilization, and dewatering. Some combinations of processes were proposed for both on-site and off-site sludge treatment facilities.

The draft SMP recommended that sludge from primary treatment processes be thickened prior to its transfer to an off-site treatment facility. The off-site treatment facility should be located where transport costs could be minimized and where market for the treated bio-solids could be optimized.

It was also recommended that MWSI should plan to accept industrial wastewater as the sewers are extended to areas where these industries are located provided that the industries treat their effluent to strengths equivalent to those found in typical domestic sewage.

Septage Management Program

The septage management program adopted by MWSI was part of the implementation of the MSSP components. Throughout the concession period, septage removed from the septic tanks in the concession area would be treated at the recently completed Dagat-Dagatan Septage Treatment Plant (SpTP). Except for this facility, no other SpTP was proposed for construction.

In the draft SMP, two septic tank gravity system (STGS) alternatives were presented and compared with conventional sewerage, viz. STGS requiring construction of new septic tanks and STGS requiring new interceptors but utilising the existing septic tanks. Cost comparison of the three alternatives revealed there was no clear leader in terms of required financing. Other criteria for comparison were risks involved and technical & operational requirements. Both STGS options were not recommended because of the need for a septage desludging program, which would be required even after the laying out of the sewers.

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5.5 Existing Infrastructure Condition Report

5.5.1 Inspection of Systems and Facilities

Various sewerage and treatment systems and sanitation facilities operated by MWCI, MWSI, NHA and private firms were visited in April 2005 by the Study Team. For the sewerage systems, the wastewater treatment plants visited included the following:

1) East Zone Systems of MWCI consisting of Magallanes Wastewater Treatment Plant and several STPs built under the MSSP such as Karangalan Village STP#1, Guadalupe Bliss, Sikatuna Village, Phil-Am Village and UP Campus.
2) West Zone systems of MWSI consisting of Manila Central Sewerage System and Communal Septic / Imhoff Tanks in Project 7 & 8, Quezon City.
3) Private and NHA systems that included the sewage treatment plants at Ayala Alabang Village, Filinvest Alabang and Smokey Mountain Housing Development of NHA.

For the sanitation facilities, the rehabilitated Dagat-Dagatan Septage Treatment Plant that commenced operation in March 2005 was visited.

Details of the evaluation of the existing systems resulting from the field inspections is shown separately in SAP 8-Sewerage Strategies.

5.5.2 Evaluation of the Systems and Facilities

The site visits indicated that expansion of existing sewerage systems by increasing the capacity of treatment plants and service areas appeared viable. Expansion of the private sewerage systems is feasible due to high affordability of the served population. The served population for large public systems such as the Manila Central Sewerage System can be substantially increased by infilling service connections, i.e. requiring all households and establishments in an existing sewer line to be connected to the system.

Conditions of these existing systems were as follows:

(a) Although the residents of the prime Magallanes Village oppose the expansion of the Magallanes WWTP, there is ample space in the 3.4-hectare site for plant expansion and enhancing the existing high fence and tree-lined buffer from adjoining residential houses for improved odour mitigation. Considering the difficulty in finding suitable large land areas as well as the high cost of acquisition, the expansion of the Magallanes WWTP is a viable option. The continuing build-up of the Makati Business District by mixed-use high-rise buildings and the need to provide sewerage services to several villages (e.g. San Lorenzo, part Bel-Air) in its catchment area make the option to expand the plant capacity a viable alternative.

The system covers 600 ha of the 1000-ha Ayala subdivision development area, comprising 370 ha residential, 300 ha commercial/institutional and 30 ha open spaces. The other 400 ha remains unsewered due to geographic and/or economical reasons.

(b) The 10 MLD Ayala Alabang WWTP site of 2 ha has adequate space for plant expansion. Such a plant expansion could service adjoining residential villages and the additional wastewater flows from further development of the Ayala Alabang Town Center;

(c) Under the MSSP, plans were developed for the Manila Central Sewerage System (MCSS) to increase the service coverage by infilling, i.e. install laterals and service connections to households and establishments. Under the MSSP4 project component, some 10,000 service connections were to be installed by the Contractor, but actual connections were less than 10%, due mostly to the cost those that connected to the sewer would incur.

It is estimated that about 20,000 households within the service area are not connected to the system.

(d) With roughly 25% occupancy of the 440-hectare Global City since it was developed in the late 1990s, the present wastewater generated is about 1.9 MLD for the 3.5 MLD WWTP. There is sufficient space in the 2.0 ha treatment plant site for plant capacity expansion.

Strategies to significantly expand sewerage coverage should consider the following:

a) The existing sewerage systems should be the nuclei of the proposed centralized systems within defined catchment areas. Current projects such as MSSP and MTSP should be considered in the development of the Sewerage Master Plan.

b) Acquire private sewerage systems for eventual integration to the central system.

It has been part of MWCI's sewerage strategy to acquire the operation and maintenance of private systems, particularly those built by the NHA in its housing developments. Existing communal septic tanks and Imhoff tanks are upgraded to STPs, sewers cleaned and repaired, and additional service connections installed.

A similar upgrading of small sewerage systems currently operated by MWSI in the West Zone could be undertaken.

Large real estate development for prime residential, commercial and mixed-use development and industrial parks have sewerage systems built and operated by the private developer. From diligent system evaluation and discussions with the developer, mutually beneficial arrangements can be made to integrate the private system into the central system, which is considered to be more efficient.

Sewerage systems built by the NHA which were not turned over to MWSS (and eventually to MWCI & MWSI) should be inspected / assessed for improvement / rehabilitation potential. Rehabilitation of an existing system will be less expensive as the plant sites could be utilised (less expensive than new land acquisition) and the sewer network could be cleaned and repaired.

c) Build small systems in the short-term for centralization in the long-term. Small parcels are land likely to be more available and since the concessionaires have to buy the land; this could emphasize the de-centralized approach that MWCI is now pursuing.

The approach to sewerage for Metro Manila in the short-term has to fit with a longer-term plan, past the Concession period to the year 2025. This may mean that smaller decentralized systems in the short term should be able to accommodate (or be converted to) a centralized system in the future.

d) All wastewater treatment systems should be upgradeable in the future to cope with possibly tighter environmental restrictions. In dense housing developments, communal septic tanks or other low-cost sanitation systems could be installed (instead of individual septic tanks). Integration of such CSTs in a central system will be more convenient in the future.

e) Application of the appropriate treatment technologies should be systemic and standardized to allow ease of understanding and maintenance.

f) Provisions of the Clean Water Act 2004 (IRR promulgation in early 2005), Presidential Decree No. 856 – Sanitation Code of the Philippines Sec. 74, Revised National Plumbing Code of the Philippines, 30 Sept 99, PD 856, DOH and DENR requirements for Class C discharges (e.g. maximums of BOD of 50 mg/L, TSS of 70 mg/L, oil & grease of 5 mg/L, total coliforms of 10^5 MPN/100mL) should be followed.

All relevant CLUPs will have to be considered in any sewerage plan. The general trend is an increase in residential and commercial areas and a decrease in industrial areas. This provides opportunity for new sewerage systems that can be integrated into a central system in the future.

5.6 Provision of Sewerage and Sanitation Facilities for the Urban Poor

5.6.1 Responsibility for Services to the Urban Poor

It is currently estimated that over 20% of the population of Metro Manila, i.e. over 2 million people, live either below or near the poverty line and 35% of the population resides in informal slum settlements, many of which are gateways for a continuous influx of poor rural migrants. The growth of these settlements and the demand for services have overwhelmed the capacity of the government and NGOs to respond effectively.

Resettlement programs that have relocated the urban poor to remote sites away from established sources of livelihood have generally failed. Many of the 2 million residents in the blighted areas live in dense and abject conditions, with poor quality housing. Drainage is generally poor and the areas are subject to severe flooding during rains.

In order to address the results of this rapid unplanned urbanization, in particular in Metro Manila, HUDCC and the LGUs have developed a 15-year slum eradication policy to provide a renewed commitment to the urban asset reform. This includes on-site urban upgrading and integrated urban development approaches to address urban poverty and improve access to basic services, while avoiding complicated off-site resettlement schemes that are prone to failure. While the available land under the control of the LGUs in Metro Manila is in short supply, national government land parcels have been identified for privatization.

The development of new sewerage and sanitation programs for the urban poor communities will by necessity relate to the housing improvements. Urban upgrading projects will incorporate infrastructure improvements, including sewerage and sanitation. The Medium Term Development Plan 2004-2010 (MTDP) estimates a new housing need of almost 500,000 households in NCR during the Plan period and targets a housing provision of socialised and low cost housing of 1.15 million Philippine wide and about 150,000 in NCR. Priority relocation programs for the North Rail, South Rail, Pasig River Rehabilitation and the *Esteros* Program would account for a total of about 70,000 families.

There are various programs from a range of government and non-government agencies that address the housing and infrastructure needs of the urban poor in Metro Manila. The MTDP develops a strategic framework anchored on multi-stakeholder, market based, private sector and LGU led reforms and approaches to meet the goals of improving the living conditions of the urban poor. The strategies include:

- Expand private sector participation in socialised housing finance and construction;
- Continue to address the housing requirements of the formal and informal sectors, particularly the socialized and low cost housing categories;
- Strengthen the institutional capacity of the housing agencies; and
- Enhance the capacity of the LGUs.

The principal agencies involved in providing services to the urban poor are described below.

Housing and Urban Development Coordinating Council (HUDCC)

HUDCC, created through E.O 90, is the highest policy making and coordinating office in the housing sector. It is an umbrella organization under the Office of the President that consists of:

- The heads of four housing agencies; National Housing Authority (NHA), Home Guaranty Corporation (HGC), National Home Mortgage Finance Corporation (NHMFC) and the Housing and Land Use Regulatory Board (HLURB);
- The heads of three funding agencies; SSS, GSIS and HDMF;

- The heads of several government agencies; PMS, DOF, DBM, NEDA, DBP, MMDA; and
- Two private sector organizations – an NGO and a private developer.

HUDCC is in the business of coordinating the formulation and application of a national urban policy framework and enabling the delivery mechanisms/markets of affordable and accessible housing with special concern for urban households qualified for social housing, namely informal settlers, homeless and the urban poor.

National Housing Authority (NHA)
NHA is an agency with nationwide responsibility for improving housing for the people of the Philippines. The national housing policies recognize slum improvement as an approach to deal with squatter areas and blighted communities in urban areas. Slum improvement includes upgrading or introducing roads, footpaths, drainage, sewerage, water and power systems, and other community service. In the context of slum upgrading, NHA is involved in resettlement programs, sites and services development, medium rise housing and community based housing programs.

Local Government Units (LGUs)
Through the Local Government Code of 1991 (RA 7160), LGUs are responsible for the provision of basic services, such as water supply systems, sewerage, and sanitation, either directly or through contracts with the private sector. They are also empowered to collect taxes and fees necessary for providing these services. In addition to the sewerage and sanitation services provided through MWSS and the concessionaires, LGUs develop in coordination with NHA and other national government agencies as well as through their own initiative, slum upgrading and housing for the urban poor including sewerage and sanitation infrastructure.

LGUs also provide for development of sanitation for communal facilities such as public markets, bus terminals and the like. The current program to provide sewerage and treatment facilities for Muntinlupa Public Market is an example. The existing public toilets are also under the jurisdiction of the LGUs. In the City of Manila, however, the policy is to remove public toilets when they are no longer considered necessary.

Other Agencies
A range of other government and non-government agencies are responsible for slum upgrading programs, usually in coordination with NHA and the LGUs, and often through development assistance programs from multi-lateral and bilateral agencies or the private sector. Examples are the Pasig River Rehabilitation Commission through its urban renewal program in MACDA (Guadalupe, Makati), BASECO and Parola, the relocation of informal settlers from the banks of the Pasig River and tributaries, and NGOs such as Gawad Kalinga and Habitat for Humanity.

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5.6.2 Strategies for Improving Sewerage and Sanitation for the Urban Poor

Existing Slum Communities

The current housing condition in the slum communities makes it difficult to address sanitation improvements through the provision of sewerage systems. On-site ‘drop and store’ sanitation is most appropriate in these areas where sufficient space is available. Flush and discharge sanitation, such as the use of the traditional septic tank is generally not appropriate for these communities due to insufficient space to construct the septic tank and lack of access for desludging. Communal septic tanks may be appropriate, but this requires pipes to be laid in the narrow alleys to collect sewage from individual households. Except possibly for the maintenance of communal septic tanks, sanitation in the current urban poor communities is best left as a responsibility of the LGUs at the barangay level. Installation and operation of public toilets and of drop and store sanitation facilities could be funded through the barangay and remain outside the jurisdiction of the MWSS and the concessionaires.

Public Toilets

An inspection of a sample of public toilets in the City of Manila was conducted by the 1979 Master Plan study team. In 1970 about 70% of the public toilets located in the MWSS service area were located in the City of Manila. During the period 1957 to 1979, the number of public toilets in Metro Manila had dropped from 172 to 54 and no public toilets have been constructed since 1962. Between 1970 and the present, the percentage of households without toilet facilities has dropped from 11.2% to 5%.

In the 1979 survey, an inspection was made of seven public toilet facilities in the Tondo area. While only two of the facilities were in a relatively clean condition, most received an extremely high degree of use, up to 20 times the design capacity. It was recommended in the Master Plan that consideration should be given to rehabilitating the relatively large number of existing public toilets in the depressed areas that are still in relatively good structural condition. It was also recommended that the public acceptance be assessed of the usefulness of public toilets that are maintained in a clean and serviceable condition.

In October 2005, the Manila City Hall provided a list of their public toilets within the city. **Table 5.3** shows the locations of the public toilets with their corresponding sanitary conditions. Out of the 43 public toilets, 29 are operating and are rated from poor to very satisfactory conditions, 12 are closed and two are under construction. Twenty-two (22) or 51 % were assessed to be satisfactory to very satisfactory.

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Table 5.3 - Public Toilets in the City of Manila

District I	Location	Sanitary Condition
1	Llallana St. nr. F. Varona St., Tondo (Bgy 95, Zone 3)	No longer exists
2	Llallana St. nr. Velasquez St., Tondo (Bgy 95, Zone 8)	No longer exists
3	Tayuman St. nr. Rizal Elementary School (Bgy 95,Zone 4)	No longer exists
4	Dagupan St. nr. Gabriela St., Tondo (Bgy 50, Zone 4)	No longer exists
5	Near T. Paez Elementary School (Bgy 139, Zone 11)	No longer exists
District II		
1	J. Planas St. back of Gagalangin Fire Station (Bgy 163,Zone 14)	Poor
2	Ma. Guizon St. corner Perfecto St. (Bgy 152, Zone 14)	Satisfactory
3	Old Antipolo St. nr Narra St. (Bgy 217, Zone 20)	Poor
District III		
1	605 T. Alonzo St., Binondo (Bgy 300)	Satisfactory
2	Del Pan St. nr Delpan Sports Complex (Bgy 272)	Satisfactory
3	Del Pan Island (Bgy 286)	Satisfactory
4	Lacson Underpass, Quiapo	Satisfactory
5	New Antipolo, Talipapa, Sta. Cruz (Bgy 365)	Satisfactory
6	1224 Anacleto St., Sta. Cruz (Bgy 332)	Satisfactory
7	Reina Regente St., Binondo (Bgy 293)	Poor
8	Kusang Loob St., Sta Cruz (Bgy 353)	Poor
9	Pista St. corner Becena St., Sta. Cruz (Bgy 351)	Poor
10	258 Isla de Romero St., Quiapo	Closed/for demolition
11	P. Ducos St. nr. Quinta Market, Quiapo	Closed/for demolition
12	1806 New Antipolo St., Sta. Cruz (Bgy 369)	Closed/for demolition
13	1863 Leonor Rivera St., Sta. Cruz (Bgy 370)	Under construction
District IV		
1	R. Papa St. nr. Morayta St. (Bgy 464, Zone 46)	Permanently closed
2	Ma. Clara St. (Bgy 485, Zone 48)	Under construction
3	Espana Blvd. (Bgy 472, Zone 47)	Satisfactory
4	Palawan St. (Bgy 453, Zone 56)	Satisfactory
5	Lavanderos St. (Bgy 410, Zone 42)	Satisfactory
6	190 Loreto St. (Bgy 417, Zone 43)	Satisfactory
7	1447 San Diego St. (Bgy 499, Zone 49)	Satisfactory
8	Algeciras St. (Bgy 484, Zone 48)	Permanently closed
9	Sta. Teresita St. (Bgy 409, Zone 42)	Permanently closed
District V		
1	1922 Taft Ave., Malate (Bgy 692, Zone 75)	Satisfactory
2	Taft Ave. in front of Phil. Christian University	Satisfactory
3	Plaza Lawton in front of Metropolitan Theater	Satisfactory
4	Sta. Monica St. corner Guevarra St. (Bgy 668, Zone 72)	Satisfactory
5	Baywalk, Roxas Blvd., Ermita (Bgy 701, Zone 77)	Very satisfactory
6	Roxas Blvd. nr. US Embassy (Bgy 666, Zone 72)	Very satisfactory
7	Padre Faura St. nr Supreme Court (Bgy 670, Zone 72)	Satisfactory
8	1949 F. Munoz St., Paco (Bgy 735, Zone 80)	Satisfactory
9	1207 Interior Anakbayan St., Paco (Bgy 740, Zone 80)	Permanently closed
10	PNR Compound, Paco (Bgy 825, Zone 89)	Poor
11	1475 Fabie St. (Bgy 815, Zone 88)	Poor
District VI		
1	Sikat St., San Miguel (Bgy 645, Zone 67)	Satisfactory
2	Lamayan St., nr. Old Panaderos St., Santa Ana (Bgy 891,Zone 98)	Satisfactory

Note: Remarks on the sanitary condition of each public toilet were based on the Assessment Report of each District Sanitation Officer to the City Sanitation Officer.

Although the percentage of households without toilet facilities has continued to decrease and is now down to 5%, this still represents a substantial number of households. The willingness-to-pay survey indicated that over 60% of households without toilets would like access to a public toilet and that about 70% of these were willing to pay an average of P3 per visit. Most respondents believed bathing facilities could also be incorporated in the public toilets.

A program of rehabilitation of existing public toilets on the basis of that recommended in the 1979 Master Plan is therefore considered warranted, together with construction of new public toilets in existing slum areas where access to toilet facilities is limited. It is considered that the installation and operation of public toilets should be the responsibility of the LGU/barangay but that they may be connected to a MWSS sewerage system where available.

Urban Upgrading Projects

As discussed above, urban upgrading projects are implemented through a number of agencies, but most will include improved sewerage or sanitation infrastructure including provision of sewage treatment facilities. Although funding is from various sources, the projects are generally coordinated with HUDCC/NHA and/or the LGUs. Infrastructure from these projects is best absorbed into the MWSS system and operated by the concessionaires.

(a) NHA Housing Projects

As indicated in **Chapter 4** and **Table 4.14**, there are a large number of NHA urban upgrading projects that have been implemented that incorporate sewerage and sewage treatment systems, only some of which are now currently operated by MWSS/Concessionaires. Many of these are projects from the Metro Manila Zonal Improvement Program (ZIP) that had been implemented by NHA since the late 1970s. It is recommended that an inventory and condition survey be conducted of those systems that have not been turned over and negotiations be conducted with NHA or the owners associations as appropriate regarding the conditions for turn over for eventual operation by MWSS/concessionaires.

Advice from NHA is that the single dwelling style programs such as ZIP are not now being implemented and the current emphasis is on medium rise buildings (MRBs) that it could be expected would be provided with a common sewage treatment facility. It is recommended that, when operational, these facilities be also turned over to MWSS/concessionaires and could eventually be incorporated into a sewerage system once it is available in the locality. There is probably a need for closer cooperation between NHA/MWSS/concessionaires during the development stage of urban upgrading projects to ensure appropriate and compatible sewerage and treatment facilities are provided that can be effectively operated and maintained in the future by the water utility.

(b) Pasig River Rehabilitation Program

The Pasig River Rehabilitation Project includes two types of urban upgrading programs as follows:

- Resettlement of an estimated 10,000 families from the banks of Pasig River and tributaries to new sites located in Montalban and Cavite; and
- Urban renewal projects adjacent to the Pasig River focussed on improvement of low-income housing.

The Pasig River resettlement areas in Cavite are located outside the MWSS service area and are not relevant to this study. The resettlement area in Montalban is within the service area, but there are no sewerage targets for Montalban within the concession period. While sanitation facilities within the Montalban resettlement area will be serviced by MWCI, sewerage facilities are likely to remain the responsibility of the owners association during the master plan period.

Several plans have been prepared for various urban renewal areas to be funded through the ADB Sector Development Plan loan. These include MACDA in Guadalupe, Makati, BASECO, Parola and Punta in Manila, Pineda in Pasig and Joriz in Mandaluyong. None of these have yet been developed, but all are within areas where sewerage systems may be available during the master plan period and the Pasig River Rehabilitation Commission (PRRC) should liaise closely with MWSS and the concessionaires regarding the opportunity for sewage from these developed being incorporated into existing and planned sewerage systems.

(c) Metro Manila Urban Services for the Poor Project

This is a proposed ADB funded project, not yet approved by ADB or the Philippine Government, for which the project preparation study has only now commenced. If approved, it would commence in 2006 and would provide assistance to HUDCC in their strategy for slum eradication. It would be a major project to support and initiate a phased slum eradication project in support of decentralization and devolution whereby local governments and the private sector will assume responsibility for urban upgrading, renewal and regeneration.

The thrust of the project will be to emphasize on-site urban upgrading and improvement of basic services, while avoiding complicated and unpopular resettlement schemes that have been prone to failure largely due to livelihood issues. Lack of available land under the control of the LGUs in Metro Manila has been a constraint in the past for on-site slum upgrading, but there are national government lands available that have been identified for privatization, which are currently occupied by squatters. LGUs have expressed interest in on-site upgrading of these land parcels or in using them as in-city relocation sites for their squatter populations.

National government land slated for privatization includes the 76-hectare Welfareville property in Mandaluyong, the 450-hectare New Bilibid Prison property in Muntinlupa, and the National Government Center in Quezon City, among others. The location of these sites is shown in **Figure 4.15**. An important aspect of the slum upgrading will be the provision of services including sewerage and sanitation. The Master Plan will consider the incorporation of these projects in the strategy and it is important that MWSS and the concessionaires are part of the multi-stakeholder effort required should these projects be implemented.

(d) Manila Third Sewerage Project (MTSP)

One component of MTSP is the provision of sanitation for low-income communities. This originally involved the construction of CSTs or STPs, as appropriate, and shallow, small diameter sewer lines to serve some low-income communities in the East Zone that have inadequate sanitation facilities.

This has now been reduced to two communities (Pinagsama, Taguig and East Bank, Taytay) in lieu of issues on willingness and capacity to pay for water and sewer charges. STPs will be constructed for these communities using combined systems with drainage upgrading. The feasibility of separate systems was also considered and found to be impractical and expensive.

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6. Sanitation & Sewerage System Constraints

At a global level, it has been reported (DFID 2005) that the major constraint for general sanitation is by lack of political will: "activities that fail to establish sustainable and hygienic facilities and behaviour, a high rate of abandonment of existing infrastructure, and clear linkages with illness rates."

All previous Metro Manila Master Plans have recognized that a centralized sewerage system would eventually solve most of the environmental degradation and health issues caused by polluted waters. Some also recognized some of the limitations or constraints for implementation of such a system within Metro Manila.

A review of previous sewerage and sanitation master plans, of past and current projects of MWSS, MWCI and MWSI and from site visits have identified issues which have constrained or are constraining the development of the sewerage and sanitation infrastructure in Metro Manila. Earlier master plans have only been partially implemented at best. Physical, fiscal and cultural limitations all ultimately determine and direct the implementation of an environmental agenda in the Philippines in general but particularly in Metro Manila.

6.1 Lessons Learned from On-going Sewerage and Sanitation Projects

Close coordination with LGUs, housing agencies and the beneficiary communities impact positively on project implementation. Intensive and regular consultations with affected communities are necessary to ensure cooperation during project implementation as well for liaison with homeowners regarding any fees associated with the management of dirty water, e.g. sewer connection fees. However, proper consultation does not ensure a willingness to pay as evidenced by the following case studies.

Case 1 MSSP Community Sanitation Project (MCSP)

The MCSP involved the construction of 26 on-site STPs. The rationale was that existing facilities in the target communities were unable to meet the DENR effluent standards and directly contributed to the pollution of inland rivers and waterways.

During the project conceptualization, the communities were consulted and provided with project details. Memoranda of Agreement (MOA) were executed for easements on the lots for the STPs as well as for sewer charging. However, even with due consultation, six out of 26 projects were cancelled. At the time when construction was about to commence, the communities reneged on the MOA due to the issue of sewer charging.

Case 2 MSSP-4

One of MWSI's MSSP commitments was the installation of about 10,000 new sewer service connections, the cost of which shall be chargeable to a World Bank loan. Within the period of October 5, 2001 to September 2005, MWSI was able to connect only 730 households. Again, sewer charges (water bills would be increased by 50%) coupled with absence of direct recognizable benefits were the people's main contention for not connecting.

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Case 3 Pateros Sewer System

As part of the original Concession Agreement sewer targets, MWCI was supposed to install a separate sewer system for Pateros and portions of Taguig. The Pateros LGU, having communities belonging to the low-middle income class, out rightly rejected the proposal due to unavailability of land, potential traffic disruptions and issues on ability of residents to pay. The LGU suggested that improvements and low-cost sanitation services be provided for pocket areas where there is little or no access to sanitation facilities.

Case 4 Septage Sea Disposal Trial (2001-2002)

In the absence of proper septage disposal facilities, the MSSP also included a septage sea disposal trial. However, full operation of the septage sea disposal component did not eventuate due to social pressure from the LGUs and an NGO. They expressed unwillingness to allow the dumping of septage into Manila Bay. MWSS had to immediately cease the septage sea disposal operations, which were originally planned up to 2015. The issue even merited the World Bank's Inspection Panel, which recommended action plans on septage management. The action plans, included a septage management program with focus on the provision of sanitation services and construction of septage treatment plants.

On June 16, 2003, MWCI formally wrote to MWSS regarding its position to cease all sea dumping operations. MWCI completed a one-year septage trial from April 2001 to June 2002 and dumped a total volume of 26,000 cubic meters of septage. MWCI submitted all monitoring data to DENR-EMB and the PCG.

From July 2002 up to present, MWCI hauls collected septage to lahar areas in Tarlac and Pampanga for use as soil conditioner in enhancing the growth of sugarcane. Previous to these lahar operations, MWCI had been conducting experiments for using dried and liquid sludge as soil conditioner and composting material. As of end-September 2003, MWCI had hauled about 25,000 cubic meters of septage, which was applied in 282 ha of lahar land. The experiments are monitored by the Sugar Regulatory Administration (SRA). The lahar operations have been televised on national television and have been witnessed by MWSS and the WB.

In September 2003, MWSI formally wrote MWSS regarding its position not to pursue the septage sea dumping operations. MWSI completed the Estero de Vitas barge loading station in September 2002 but was not able to sail any barge. MWSI was dumping collected septage in the Dagat-Dagatan lagoon in Navotas prior to its renovation as a SpTP.

6.2 Disease Prevention

Sewerage and Sanitation

The chief purpose of sanitation, sewerage and treatment is to prevent the spread of human diseases from the discharge of their waste, particularly from dense concentrations of human habitation.

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Poor water supply and sanitation-related diarrhea cause the deaths of 3,900 children globally every day (UNICEF-WHO JMP 2004). Areas, where negative pressures within the water supply system occur are most susceptible to drinking water contamination by sewage infiltration.

The spread of water-borne diseases is brought about by human contact with sewage or dirty water. Diarrhea was the 2nd and 3rd cause of morbidity in Metro Manila for the 5-year average period of 1996-2000 and in 2001, respectively (DOH 2005). According to a World Bank publication (Philippines Environment Monitor 2003), 31% (5.2 M cases) of illnesses for the five-year period from 1996 to 2000 were related to water. Avoidable health costs were estimated at PhP 3.3B per annum.

Better sanitation/sewerage translates into benefits for the community which result in real economic return such as (DFID 2005):

- Reduced health sector costs;
- Reduced patient expenses;
- Increased time savings;
- Productive days gained;
- Days of school attendance gained;
- Child days gained; and
- Deaths avoided.

The lack of maintenance of septic tanks all over Metro Manila inadvertently releases relatively raw sewage into the drainage system. Drains are in practice combined sewers. In the low-lying areas of Manila, where the onset of flooding is experienced during the rainy seasons, there is a high probability of human contact with raw sewage. The floodwater carries with it not only sewage but also solids from submerged septic tanks. Raw sewage and septic tank wastes are highly pathogenic and can transmit a variety of human diseases.

6.3 Protection of the Environment

Sewerage and Sanitation

The quality of the environment and the state of the human condition, both health wise and the quality of life, have always been directly related.

The adverse environmental effects of the discharge of sewage, either directly to the creeks, esteros and rivers or through the approximately 2.17 million septic tanks significantly contributes to the degradation of the water systems in Metro Manila. According to the Philippine Environmental Monitor 2003 (World Bank), the Class C water quality parameters for the river systems within Metro Manila are not met and the Philippine economy loses PhP 17B annually due to the degradation of the marine environment.

The failure to desludge the septic tanks is tantamount to not having them and simply discharging untreated sewage into the drainage system. Although proper maintenance (i.e. regular desludging) would reduce this problem, an overall septage management plan is needed. With the continued use of existing drainage systems for the collection of sewage, pollution levels will not be lowered in the esteros, creeks and rivers until entire drainage flows are intercepted and treated. Odor emissions from these combined sewers are also deleterious to residents and should also be considered.

In general, the lack of an overall sanitation management plan in combination with the use of drains as combined sewers with no treatment are the major sources of environmental degradation to inland water systems and major water bodies within and around Metro Manila.

6.4 Land Availability

Sewerage and Sanitation

Land availability for sewerage and septage treatment plants is a major consideration in implementation of sewerage and sanitation programs. Most free areas in Metro Manila are already heavily inhabited by formal and/or informal settlers and large open areas are scarce. If ever there are available spaces, these parcels of land would be costly and would be reserved for profit-oriented type of development.

There is an obvious need for management of dirty water but only minimal land areas are available for the required larger treatment systems. Lands identified as available in previous master plans as sites for treatment plants have mostly been developed for other purposes. Manila is developing too quickly for vacant areas over 0.5 ha to remain available for any length of time.

Ideally, the site for a treatment plant should preferably have some isolation from residential communities to avoid nuisance from odor, noise and truck traffic. Also, the site should ideally be near main waterways, receiving bodies of water or areas where recycling is possible and be at a low elevation. These requirements would further limit the ideal parcels of land available for this purpose.

6.5 Traffic Disruption

Sewerage

The works required in installing a centralized sewerage network would involve excavation of major and minor thoroughfares. Many of the Metro Manila roads are narrow or heavily congested. If conventional methods of construction will be used, the time to complete the project would take years, depending on the extent and the location of the network. In areas where the water table is high, sheet piling and dewatering would be required. With narrow streets, there would be a need to support the structures along the streets to prevent settlement and damage to property. This would result in great public inconvenience.

Any kind of excavation in roadways or footpaths (sidewalks) will be disruptive to the area's normal flow of human and vehicular traffic. In areas with a high population density (e.g. most of the NCR, Bacoor, and Cainta, some with greater than 20,000 persons/km^2), this disruption can degrade to simple chaos. The excavation of certain roads is banned in some cities/municipalities, so special methods like tunneling would be required. The construction schedule includes processing of permits which may also be difficult and time consuming to obtain. Manila City for example issues excavation permits good for only for two weeks. Every time they expire, they have to be renewed.

Presence of Utilities in Roads

In the planning of a centralized sewerage system, a major constraint would be the existence of utility infrastructure for water supply, storm drainage and outfalls, electricity distribution, gas, and telecommunications. The sewer pipes are installed deeper than the other utilities, but they may intercept these utilities. Also, for the old and narrow streets of Metro Manila, the utilities may not easily be located. Close coordination with the various utility owners is necessary to obtain the as-built plans. However, the as-built plans are not always available.

During the construction of other infrastructure facilities, existing sewer lines can be accidentally damaged by other contractors, even if the sewer pipes are buried deep in the ground. During the implementation of MSSP4, damages to sewer pipes were confirmed. One was along Taft Ave., which was damaged when the LRT was being constructed. The other was along Onyx St. which was hit during pile driving for the slope protection works at Estero Tripa de Gallina (field visit to MSSP4 project office on March 17, 2005).

6.6 Cultural Preferences

Sewerage and Sanitation

A project may be technically and financially feasible, but if the project is not socially acceptable, it will not be implemented. Sewerage and sanitation projects cannot be "socially" acceptable because of their cost. Customers do not receive direct benefits by connecting to the sewerage system and paying the corresponding sewer charges. There are also social stigmas and preferences that identify technologies or approaches, which are more acceptable than others.

6.7 Inaccessibility of Septic Tank Systems

Sanitation

In many instances, the septic tanks cannot be accessed because they are built under structures or have illegal structures built over the septic tanks. There are many cases wherein the septic tanks cannot be desludged for the alleys leading to the houses are too narrow and cannot be accessed by the vacuum tankers.

The Second Manila Sewerage Project Feasibility Report (JMM 1991) cited a 1980 survey, which estimated that about 50% of the septic tanks within four cities (Manila, Quezon City, Caloocan and Pasay) and about 80% of the septic tanks in the remaining municipalities are fully accessible. Due to the increased population and a general policy that each new residence shall be served with an individual septic tank, the report assumed increased rates of 60% for the four cities and 90 % for the municipalities. For the same study, around 74% of the septic tanks were assumed accessible for the whole of MWSS service area.

6.8 Septic Tank Design

Sanitation

In 1980 (JMM 1991), a survey of 20 septic tanks in the MWSS service area recorded gross volumes from 1.2 m^3 to 6.04 m^3 with persons served ranging from four to 16 persons per septic tank. The water consumption for each tank ranged from 20 lpcd to 260 lpcd. The survey showed no correlation among the septic tank volumes, number of persons in the household and the unit water consumptions. The Implementing Rules and Regulations of the Code on Sanitation of the Philippines specify the design of septic tanks. Even then, over the years, there were household septic tanks that had most likely been under-designed. In certain areas, one septic tank may serve multiple households. On the average, the gross septic tank volume (including the leaching pit) had been estimated to be 6 m^3 and the effective septage storage capacity is 1.8 m^3.

Other common design deficiencies of septic tanks are:

a) No access manholes; and
b) Unlined bottom which allows percolation into the ground.

6.9 Transport System

Sewerage

Metro Manila utilizes a system of roads, railways and navigable waterways. A major consideration in sewerage planning is the main roads which are heavily traveled. These roads are also likely the sewer trunk routes.

Sanitation

The distance of the septage treatment plant and the disposal/reuse site are factors to consider. The distance would impact fuel and lubrication costs. Increased fuel and lubrication costs of the tankers would also be incurred due to the relatively heavy traffic situation within Metro Manila itself.

6.10 Affordability: Financial Constraints

6.10.1 Lack of National Government Financial Support

The National Government of the Philippines does not provide significant grants for sewerage systems. It cannot afford to pay for the major cost of such projects because of the huge capital investment. Annual investment in sewerage on a national level is a very small percentage of the total investment in water supply and sanitation. Since 1970, for every PhP 97 spent on water, only PhP 3 has been spent on sanitation and sewerage.

6.10.2 Willingness-to-Pay for Sanitation and Sewerage Services

6.10.2.1 Background

A Willingness-to-Pay (WTP) survey was conducted during April 2005. The survey covered a total of 2000 respondents across the MWSS service area and included 1200 respondents within the West Zone and 800 respondents within the East Zone. Respondents were asked if they would be willing to contribute to the costs of three alternatives to improve the environmental effects of sewage discharges. The three alternatives for respondents with toilets (95% of respondents) were:

1. Improve and expand the existing separate sewerage system that discharges into a sewage treatment plant – this would require households with septic tanks to connect their wastewater facilities to the MWSS sewerage system.
2. Improve the combined sewerage system – this would maintain the current situation whereby household septic tanks discharge to a storm drain, but in this option the storm drain would discharge to a treatment plant prior to entering a major water body.
3. Improve the effectiveness of septic tank cleaning by strengthening the periodical cleaning program – this would require regular pumping out of the septic tank.

In addition to the survey, twelve Focus Group Discussions (FGD) were conducted with representatives from various groups such as the LGUs, barangay officials, Sangguniang Kabataan, women and people's organizations, at the following locations:

- Barangay Wawa, Taguig
- East Kamias, Cainta
- Maggahan, Taytay
- Karangalan Annex, Cainta
- Pulo, Valenzuela City
- Pasolo, Valenzuela
- Barangay NBBS, Malabon
- Barangay 705, Malate, Manila
- Barangay Sn Rafael 4, Noveleta
- Centennial Village, Taguig City
- Maharlika Village, Taguig City
- Barangay 123, Moriones, Tondo, Manila

The groupings of the FGDs were based on the type of water service delivery, sanitation conditions and sewerage coverage within the sampling areas. These FGDs were used to deepen the consideration of the sewerage and sanitation options. They enhanced the understanding of the benefits and advantages of each service option including costs or service fees. The FGDs also provided significant feedback on the current situation of the sewerage and sanitation systems and the consumers' concerns and issues.

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6.10.2.2 Survey Participant Characteristics

The selected sample sites for the survey comprised the service delivery area of MWSI and MWCI. A total of 67 sample sites were covered in the survey, specifically 40 sites for MWSI and 27 sites for MWCI. Each sample site had a minimum of 30 respondents. The sample sites are the proposed areas where improvement of the sanitation and sewerage systems under MSSP and MTSP will be undertaken. A map showing the location of the sample sites is shown in **Figure 6.1**.

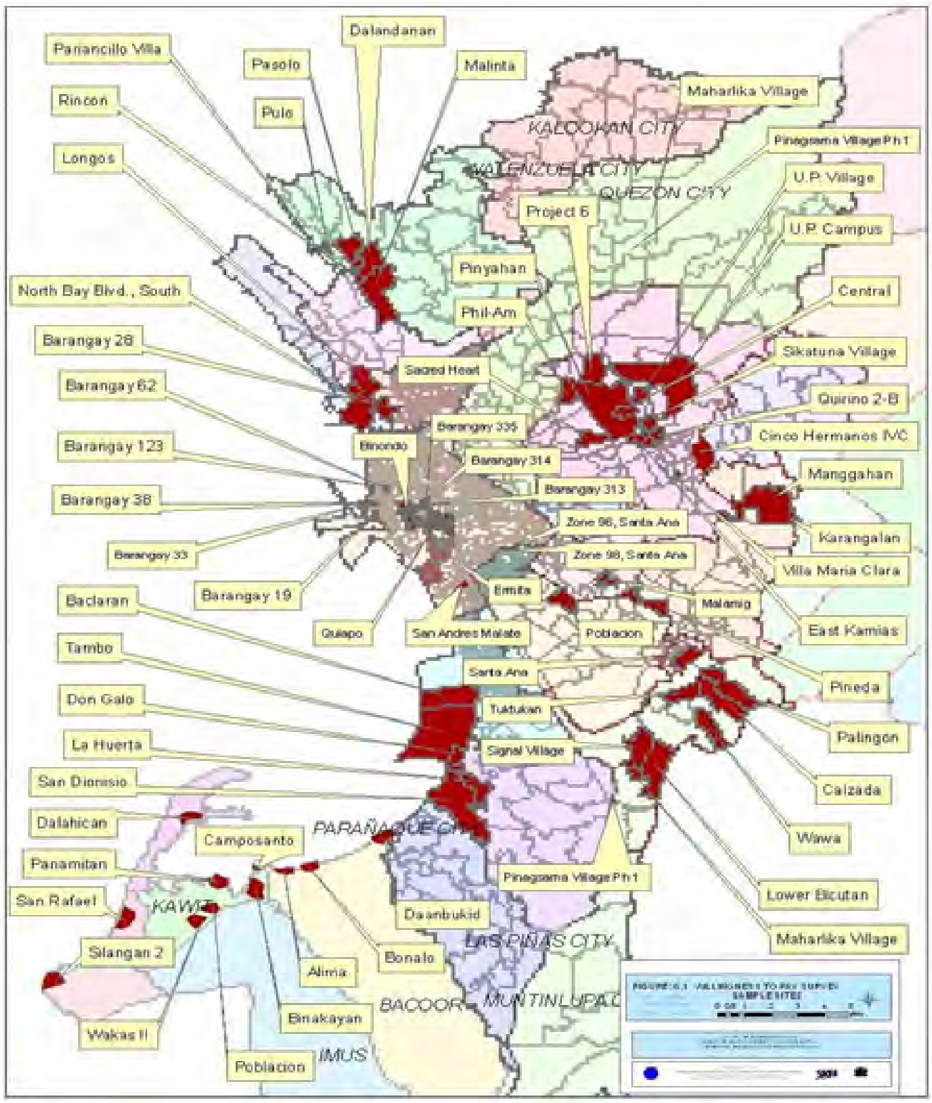

Figure 6.1 Willingness-to-Pay Survey Sample Sites

The respondents were placed in three categories based on the location and standard of housing.

Blighted/Low Income Area –	temporary structures, squatter's area and similar (50% of respondents)
Middle Income –	semi-permanent/permanent structures/low cost housing, renting apartments/small houses/cheap cars (30% of respondents)
Upper Income –	living in better/classy subdivisions, big houses, high fences and have more than one car (20% of respondents)

The actual selection of respondents on site was randomized, either by block or by streets.

The majority of respondents were female (66%) and above 35 years of age (78%) with 40% having either graduated or spent some years in college and another 40% having some secondary education. There was a wide range of occupations of household heads, but overall 70% were self-employed, and 15% were employed. The majority of the respondents owned their houses (70%)

A summary of the household income and expenditure for the three household groups is shown in **Table 6.1**.

Table 6.1 – Total Income, Total Expense and Net Income in PhP (Monthly)

HH Type		Total Income	Total Expenses	Net Income
Blighted/Low Income	No. of Respondents Mean	954 10,007	954 7,566	931 2,470
Middle Income	No. of Respondents Mean	568 20,613	606 13,015	560 7,690
Upper Income	No. of Respondents Mean	343 51,429	386 21,054	338 31,148
Total	**No. of Respondents** **Mean**	**1865** **20,855**	**1971** **11,883**	**1829** **9,368**

During the interview, respondents were presented with three sewerage/sanitation options as follows:

Option 1: Toilet connected with sewerage system discharging to a wastewater treatment plant (separate system).

Option 2: Toilet connected to septic tank discharging effluent to a storm drain leading into a wastewater treatment plant (combined system utilizing existing drains).

Option 3: Toilet discharging to septic tank that is cleaned out frequently as required, but no piped sewerage system (sanitation only).

The respondents' choice was:

Option 1 – 54%
Option 2 – 29%
Option 3 – 16%

Respondents without toilets were also given the option of choosing to use a public toilet. Fifty-seven per cent (57%) of respondents without toilets chose to use a public toilet, while 33% opted for a separate sewerage system. The breakdown of respondents selecting each option and their respective willingness-to-pay is shown in **Figures 6.2** and **6.3**.

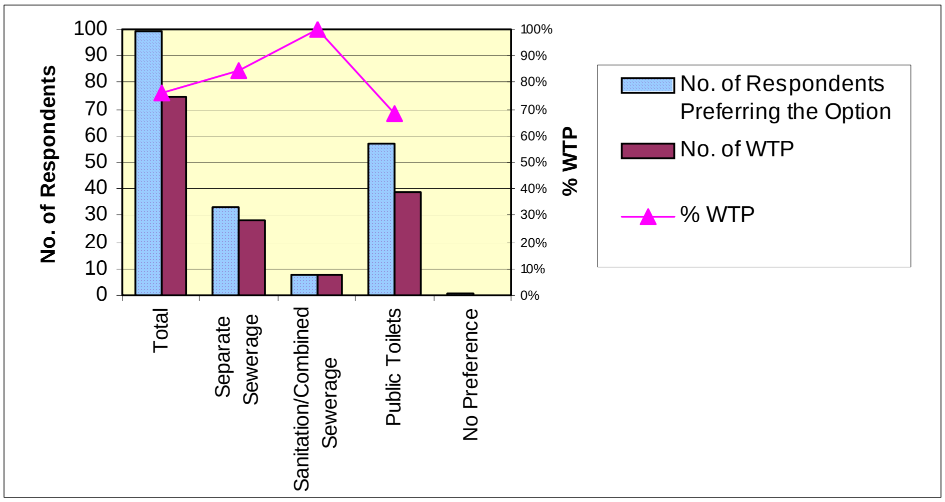

Figure 6.2 Preferred Service-HH without Toilets

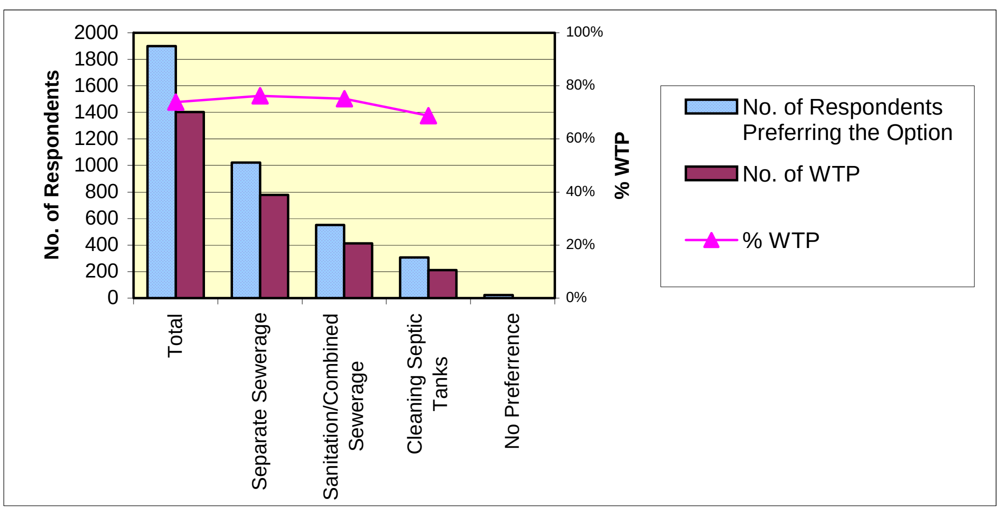

Figure 6.3 Preferred Service-HH with Toilets

6.10.2.3 Sewerage (Separate System)

A total of 215 respondents reported that they were currently connected to a sewerage system.

More than 50% of respondents preferred a separate sewerage system where waste from toilets is to be discharged directly to a sewer that is separate from the stormwater and to be treated prior to discharge to the major rivers, streams or Manila Bay.

Seventy-six percent (76%) of those who chose separate sewerage system were willing to pay for services associated with this option (see **Figure 6.3**). Sixty eight percent (68%) of those willing to pay were prepared to pay 20-40% of their water bill for the service, with most willing to pay around 20%. Most of those unwilling to pay believed that MWSS should bear the entire cost, others believed the cost was too high or they did not believe MWSS can make any improvements.

Of those willing to pay, 40% would pay whatever charge is imposed for a sewer connections, 18 % did not know while most of the remainder were willing to pay up to P500 for connection. Sixty percent (60%) of respondents wanted payments for connections to be incorporated into their water bill.

6.10.2.4 Sanitation

Current Situation

Ninety-five percent (95%) of the respondents have toilets of their own, while the remaining either use communal toilets or share with others. Fifty-three percent (53%) of those who have toilets have the flush type connected to a septic tank while 34% of households use a pour flush toilet. While 80% of the upper income group has flush toilets connected to a septic tank, only 38% of the low-income groups have this facility; the majority uses the pour flush latrine. The type of toilets owned and used is highly dependent upon income groups as shown in **Chapter 7**, **Figure 7.2**.

Of the five percent (5%) of households that do not own a toilet, 60% claim to have no space for installation. Those without a toilet usually go to a public toilet (27%) use the neighbor or landlord's toilet (29%) or wrap and throw (27%). Only 6% of those without toilets pay for the use of public toilet facilities. Seventy-nine percent (79%) of those who do not have toilets expressed a desire to own a toilet and 60% expressed a willingness to spend for a private toilet.

Ninety-two percent (92%) of respondents place a very significant value on toilets for their health. Eighty six percent (86%) were aware where their waste/toilet water goes with 52% saying it goes from the septic tank to the drains and 10% saying it goes into a sewerage system either directly or via a septic tank. Eight percent (8%) believed it went directly to an open canal/creek/river and 11% were unsure to where the septic tank was connected.

Of those using septic tanks, 62% reported that these had never been emptied and 56% stated that their septic tank has a manhole for pumping sludge. The most common practice of emptying septic tanks is once every five years, although some were more frequent.

***Willingness to Pay for Connecting Septic Tanks to the existing drainage system with treatment prior to entering major water courses (Combined System*)**

Of the 29 % of respondents who preferred to connect their septic tanks to the existing drainage system with provision for treatment prior to entering the major water courses (Option 2), 75% were willing to pay the costs incurred (see **Figure 6.3**). There was no significant difference in the response of the various household types. Eighty-eight percent (88%) of the respondents were willing to pay in the range of 20-40% of their water bill for the services, although most responses were close to 20%. The majority of respondents from all geographical locations, except Malabon and Navotas, registered a positive response regarding payment. Those unwilling to pay believed that MWSS should bear the entire cost, some stated they could not afford to pay and some believed that MWSS could not make the necessary improvements.

Willingness to Pay for Frequent Emptying of Septic Tanks

Frequent emptying of septic tanks (Option 3) was the choice of 16 % of the respondents with toilet facilities. It was presented to respondents as the least costly among the three options. Respondents were not aware that the environmental fee that they are paying monthly entitles them to a septic tank cleaning service; rather they are aware of a fee of P800 being charged for this service. Concessionaire schedules for desludging of septic tanks, which is covered by the environmental fee, were unknown to the respondents.

Sixty-nine percent (69%) of the respondents who chose this option were willing to pay for regular septic tank emptying (see **Figure 6.3**) and 85% of these are willing to pay between 20% and 40% of their water bill for such a service (although most of these were willing to pay close to 20%). Respondents in Sta. Ana, Caloocan, Malabon and Tondo were the most likely to be unwilling to pay (although the sample was small). Reasons for unwillingness to pay were that MWSS should bear the entire cost, they cannot afford to pay and they have a lack of belief that MWSS could improve the system.

6.10.2.5 Public Toilets

Sixty-eight percent (68%) of respondents without toilets who preferred to use a public toilet were willing to pay for the use of such a facility. The amount that respondents are willing to pay ranged between PhP 1-20 per visit. Thirty-five percent (35%) expressed the view that PhP 2.00 would be appropriate, while 14% would pay PhP 1.00 or less. Concerns about the use of a public toilet related to hygiene and sanitation as well as privacy and convenience. Most respondents experienced the need to clean and maintain public toilets and made suggestions such as the need to clean every day, prepare a schedule for cleaning, develop joint responsibilities for cleaning, providing a payment for a cleaner, the need to have water for the operation of the toilets and the need for users to contribute for the cleaning of toilets.

Fifty-seven percent (57%) of respondents suggested that the LGUs should be responsible for installing the public toilets, 15% suggested a role for the community, while some respondents considered private contractors could be used. Sixty-one percent (61%) of respondents considered that the government should shoulder the expenses related to the construction of the public toilets. Eighty-two percent (82%) of respondents indicated their willingness to cooperate in the conduct of a fund raising activity to finance the construction of a public toilet and 75% believed that the public toilet should include amenities for washing and bathing activities.

6.10.2.6 Environmental Awareness

A total of 215 of the 2000 respondents were connected to a sewerage system. However, almost of the 2000 respondents made an assessment of their perceived system of wastewater disposal. Opinions ranged from poor to very poor (35%); average (35%) and good to very good (29%). A large majority indicated the need to improve their wastewater disposal system, specifically the need to construct and expand canals and drains and clean clogged drains/pipes.

While most of the respondents (71%) were not familiar with the concept of a wastewater treatment plant, after explanation of the concept, 91% favored such an installation in their area. The remaining 9% believed that there were already suitable facilities that just needed improved operation and maintenance, that it was not affordable or that the government cannot satisfactorily operate such a facility. Most respondents (69%) believed that the government should shoulder the expenses for improvements in the sewerage system. Only 5% believed consumers should pay for improvement of services. However, 91% of respondents expressed willingness to cooperate if their barangay sponsors activities that will raise funds for system improvements. The local government was identified by 65% of the respondents as the most suitable organization to be responsible for O&M of a wastewater treatment facility. Only 2% saw this as a responsibility of NGOs or the private sector.

6.10.2.7 Implications of Findings of Willingness-to-Pay survey

A significant number of respondents (74% of 2000) were willing to pay for different options of sewerage and sanitation services as shown in **Table 6.2**.

Table 6.2 – Willingness-to-Pay for Preferred Service

Service	HH With Toilets	HH Without Toilets	Total
Separate sewerage system with treatment	779	28	807 (40.4%)
Septic tanks discharging to drains with treatment	414	8	422 (21.1%)
Frequent cleaning of septic tanks	211	N.A	211 (10.6%)
Public Toilets	N.A	39	39 (2.0%)
Total Willing to Pay	1,404	75	1,479 (74.1%)
Unwilling to Pay	497	24	521 (25.9%)
Total	1901	99	2,000

This situation may be attributed to the following key factors:

- The significant value accorded by respondents on the importance of sewerage and sanitation for them to sustain health and cleanliness; and
- The respondents' recognition of the need to improve the sanitation and sewerage systems for them to sustain health and cleanliness.

The respondents, however, while being willing to pay for the service, consider that the improvement costs should be shouldered by the government as part of its responsibility. Very few saw a role for the private sector in the delivery of sewerage and sanitation services.

Respondents who were willing to pay considered that a payment equivalent to 20% of their water bill was reasonable for the provision of sewerage and sanitation services. This value was constant across all income classes. Based on the 75% of respondent who was willing to pay 20% of their water tariff for sewerage/sanitation, it can be projected that all respondents would pay an average of 15% of the water bill.

Table 6.3 shows the percentage of income that each of the income categories is willing to pay for water and sewerage, based on the stated mean incomes and current water bills. This shows that the low income groups willingness to pay is very close to the accepted value of 5% of income, whereas the upper and to a lesser extent, the middle income have a greater capacity to pay than their stated willingness.

Table 6.3 – Capacity to Pay for Income Groups

	Low Income	Middle Income	Upper Income
Mean Monthly Income	PhP 10,007	PhP 20,613	PhP 51,429
Av. Monthly Water Bill	PhP 423	PhP 723	PhP 1,031
Willing to Pay for Sewerage/Sanitation	15% of water bill (PhP 63)	15% of water bill (P108)	15% of water bill (PhP 154)
Total Monthly Water Bill	PhP 486	PhP 818	PhP 1,185
% of Income	4.8	4.0	2.3

As a lesson learned from the implementation of the past MWSS/MWSI/MWCI sewerage projects, it is difficult to convince people to connect and pay for the corresponding additional sewer charges. The 50 % increase in water tariff upon connecting to the sewer is a definite disincentive. The advantages and benefits of the sewerage and sanitation projects are not immediately felt and seen.

6.10.3 Affordability of Sewerage and Sanitation

Cost of Sewerage System

The capital cost of a conventional gravity sewerage system and treatment is substantial as has been shown by previous master plans. The cost includes the trunk mains and the sewerage reticulation, lift stations, sewage treatment plants, land acquisition and land development costs and house connections. It is therefore important to identify more affordable approaches.

The early stage of the system as conceptualized by MTSP is a combination of separate sewer systems and combined drainage with interceptors. Essentially, the combined drainage includes interceptors, pump station(s), sewage/ septage treatment plant(s), and land. The sanitation system would retain the individual or community septic tanks to serve as the primary treatment and would use the existing storm drainage pipes to convey the wastewater to the interceptors. The reduction of the capital investment is the non-installation of the laterals and the house connections. However, there may be a need for street drainage improvements.

Cost of Sanitation

The cost of sludge management and disposal will require initial capital investment for fleets of vacuum tankers to collect septage from septic tanks and waste sludge from small STPs. Trucks would also be needed to haul the final product to the final reuse/disposal site(s).

The estimated costs of the vacuum tankers (NJS 2005) are:

Capacity (m^3)	PhP Million
3	4.0
5	5.28
10	6.6

The cost of hauling dewatered sludge to lahar areas in Pampanga is placed at PhP 123 per m^3 (NJS 2005).

There are many alternatives for sludge reuse/disposal. It may be reasonable to first establish the final reuse/disposal options before considering the treatment processes needed. Costs would vary depending on the final disposal option chosen and the method of treatment selected, if any. The septage may be treated in septage treatment plants using the stages of preliminary processing, thickening, blending-storage, stabilization, dewatering-drying and disposal. Depending on the method of disposal, land may be an additional investment cost if the sludge will be disposed in landfill sites. The more economical and sustainable use of sludge is to reuse it for application to agricultural areas or to lahar areas.

Cost of Sewage Treatment

The operation and maintenance of central sewage treatment plants is substantial. Costs include power, chemicals, maintenance of trucks and equipment, fuel, waste solids management, and personnel. The cost of power, oil and lubrication, and chemicals are also sensitive to foreign exchange fluctuations. The more mechanized the technology, the higher would the operation and maintenance cost.

With decentralized STPs, the most suitable STP technology can be selected for each of the catchments considering constraints on land availability and local conditions. For catchments where land is available and inexpensive, the less or non-mechanized options maybe selected, such as waste stabilization ponds, which would reduce the operation and maintenance cost.

In general, the long-term cost of repair, maintenance and operation of many STPs is likely more expensive than one centralized STP. In addition, each STP would have to be managed and operated by a manager and support staff.

6.11 Technology Constraints

6.11.1 Inadequacy of Existing Facilities

As of 1996, about 12% (in terms of land area) of Metro Manila was sewered (SKM 2003). This includes the Manila Central Sewerage System wherein the raw sewage is discharged into Manila Bay through an outfall. The other systems are treated by the Ayala Wastewater Treatment Plant at Magallanes, Dagat-Dagatan treatment plant and by communal septic tanks-Imhoff tanks in Quezon City. Since 1996, privately owned separate sewerage systems have been developed in Global City (Ft. Bonifacio) in Taguig, Filinvest Corporate City in Alabang, Smokey Mountain in Tondo, and in the various malls all over Metro Manila. By now, an estimated 15% of the land area of Metro Manila is sewered.

According to the NSO 2000 Census of Population and Housing, about 85% of the households have septic tanks but maintenance is inadequate. For Rizal and Cavite provinces, about 79% and 84%, respectively, have water-sealed sanitary toilets. In most cases, the septic tank effluent is discharged directly into the storm drainage system or even to open canals and creeks. Most, if not all, of the depressed and low income areas do not have access to basic sanitation facilities.

Presently, there is only one septage treatment plant (SpTP) in Metro Manila, a new one in Dagat-Dagatan located on the West Zone, which became operational in March 2005. It has a design capacity to dewater approximately 200 kL of sludge in an ordinary working day (one 8-hr shift, double for a 16-hr shift). The plant is scheduled to treat septage from 10,000 septic tanks over the course of a year.

There are three SpTPs being tendered in year 2005 for the East Zone. In addition, there are new sewage treatment plants (STPs) that were constructed for subdivisions in Cainta, Pasig and Quezon City and for communities like the Guadalupe Bliss Housing on the East Zone.

The sanitation component of the Pasig River Rehabilitation Project (PRRP), which will be implemented by MWSS and MWCI, will involve provision of septic tank maintenance services through the procurement of 36 vacuum tankers and the construction of a 600 m^3/day septage treatment plant in Antipolo. With this project, approximately 37,000 septic tanks will be emptied annually.

The current fleet of vacuum tankers is inadequate for pumping out substantial number of septic tanks. Presently, MWCI is providing sanitation services by desludging septic tanks in the East Concession Area, complementing a number of private desludging companies. MWCI has a fleet of one 5 m^3 and fourteen 10 m^3 vacuum trucks. One-half was delivered in 2001 and the other half in 2004. Through an ADB loan, MWCI is increasing its fleet by six 5-m^3 and thirty 10-m^3 trucks that will be delivered in years 2006 and 2007. Also under a WB Loan, additional 70 units of vacuum tankers will be procured and expected to be delivered in 2008.

For MWSI, there are 32 vehicles available with breakdown as follows: 7 dewatering units, 19 No.10-m^3 vacuum trucks, and 6 No. 4-m^3 vacuum trucks.

6.11.2 Limited Information

The LGUs have limited information on available low cost sewerage and sanitation technologies (CDM 1994). There is a need to disseminate information on the applicability of and proper design criteria of low cost technologies.

6.12 Management of Flow / Pollution Load

Focus on stormwater infiltration is one of the primary concerns for a separate sewerage system. In combined drainage, the stormwater and sewage flow mixes in a single conduit like a storm drain or pipe. This can lead to the overloading of the transport conduit as well as hydraulic difficulties at any intercepting facility like an STP. Flow oscillations occur seasonally and can dictate the use of equalization facilities to even out flows. The use of designed bypasses and overflows can eliminate the need for equalization but increases environmental pollution as well as the risk of greater contact with the diluted sewage.

6.13 Management / Recycle / Disposal of Residuals

Management of residual is currently not much of a problem as there are few biological solid residuals (sludges) generated by the present treatment plants. However, as the number of SpTPs and STPs increase in the future, management and reuse of biological solids will become an important issue.

In 2004, the consultant GHD prepared a Bio-solids Management Strategy Study for MWCI. Disposal of septage and sludge via application (septage of 80 to 120 m^3/ha/yr) to the lahar (volcanic ash and soil) areas in parts of Pampanga and Tarlac in Central Luzon has been shown to be beneficial (National Engineering Centre, 1998). Application of septage and sludge to lahar areas is unique and new to the Philippines and guidelines are required to regulate their application.

The removal of the sludges can be either by truck or by barge, depending on where the STPs are to be located. When evacuated by trucks, there are constraints on land transport within Metro Manila.

The bio-solids can be handled by thickening, dewatering and stabilization. Generally, the management of the sludges and bio-solids will require sizeable land areas, which is a major constraint in Metro Manila. For example, the proposed Eastern Concession 600

m^3/d SpTP in Antipolo is expected to generate about 38 m^3/d to 90 m^3/d of sludge depending on the type of solids stabilization used (SKM 2003). Preferably, the location should be far from any human settlement. Other environmental issues have to be addressed like preventing groundwater pollution and soil contamination. If mechanical methods are to be employed, there would be more expensive capital investment and a corresponding increase in power consumption.

6.14 Planning Constraints

6.14.1 Low Priority Given to Sewerage

The National Government has high interest in protecting urban health and the environment. However, due to the magnitude of the capital investment for sewerage projects, it cannot afford to pay for any major part of the cost for such projects on a wide-ranging basis. More so for the LGUs, who do not have the financial resources to build a sewerage system. Basically, for this reason, the sewerage projects are given low priority.

MWSS implemented the first Rate Rebasing under the Concession Agreement in 2003. In the Rate Rebasing, MWCI reduced its sewerage targets and increased its sanitation targets. MWSS agreed that the combined sewers can be utilized as a means of achieving the sewerage targets, whereas prior to 2003, only separate sewers with direct connections were allowed. MWSI, on the other hand, deferred sewerage investment due to their financial difficulties.

6.14.2 Need to Optimize Funds

There may be cities or municipalities that have some interest and some capability to participate in sewerage and sanitation programs. If funds are available from the National Government, the local government can pool its resources with the National Government and identify priority areas within its jurisdiction in order to pursue such projects.

6.14.3 Lack of Public Awareness for Sewerage/Sanitation Facilities

There is a lack of public awareness of the need for sanitation facilities. Thus, the general public may not be conscious of its importance to public health and environmental well being (CDM 1994).

6.15 Concessionaire Planning

The MSSP was passed on to the concessionaires after privatization. MWCI and MWSI have completed and also have on-going projects under the MSSP as discussed in **Chapter 5**. In order to improve and expand the sewerage and sanitation projects developed in MSSP, the Manila Third Sewerage Project (MTSP) was conceptualized by both MWSS and MWCI for the East Zone concession area. The current MTSP was developed to comply with the 2003 Rate Rebasing targets for sewerage and sanitation, in particular with the service targets of 2010 of MWCI.

Since there are two independent concessionaires, there was a need to develop an overall strategy for the whole MWSS service area. Some of the catchments are currently divided between the East and West Zones. Also, some municipalities/cities have areas both in the East and West Zones. With the different plans of the East and West Zones, there is a need to consider and incorporate these plans in order to develop a sanitation and sewerage master plan for the whole MWSS service area. However, the plans of the Concessionaires impose their own constraints for master planning as detailed below.

The 2003 Rate Rebasing converted many of the sewerage targets for MWCI into increased sanitation targets. MWSI sewerage targets remained as per the 1997 Concession Agreement but were moved forward by five years, starting in 2006. No change was made to the MWSI sanitation targets to compensate for the delays in sewerage coverage.

MWCI

The meeting by MWCI of their 2003 Rate Rebasing targets for sanitation and sewerage is mostly tied to implementation of the MTSP. Achieving contractual targets does not necessary promote those design options that provide the lowest cost sewerage per unit area. Lower costs are often achieved by approaching the design from a wider drainage catchment perspective. Drainage catchments often cross municipal boundaries and can also cross concession zones.

The below excerpt from *Strategic Action Paper 11* of this study illustrates that small STPs and catchments are only implemented at considerably higher per capita costs, particularly if little or no space is available (see the underground Riverbank STPs - Poblacion STPs with a catchment of 30 ha; Ilaya STP with a catchment of 49 ha; Capitolyo STP with a catchment of 100 ha).

The Riverbank STPs may meet 2003 Rate Rebasing contractual targets, but in a short time (i.e. fifteen years or just beyond the concession period) these plants will be beyond their economic service life. The STPs will have to be decommissioned in favor of an interceptor leading to a larger STP. Sites for this larger STP will likely be more scarce than present due to increasing population pressures.

Much of the analyses in this 2005 Master Plan concurred with what was done in the 2004 NJS Master Plan for the East Concession. Combined drainage was selected as the least cost / preferred option in both studies. This study proposes to use combined drainage (i.e. the use of the storm drains) where it is appropriate but proposes to decommission those systems on a “greatest human risk” basis when the financial ability is available to do so.

SKM

Table 6.4 – Comparison of Dirty Water Treatment Technologies[1]

Dirty Water Treatment System	Dirty Water Flow Range	Dirty Water Flow BOD	Estimated Const.Cost[1] per kg BOD Rem. per Year		Estimated Annual O&M Cost[1] per kg BOD Rem	
	(MLD)	(kg/d)	($US)	(PhP)	($US)	(PhP)
Sequencing Batch Reactors						
Foess (2003)	0.4	102	$18.71	P1,029	$3.23	177.65
MTSP: Poblacion Riverbank STP[2]	1.5	142	$14.01	P771	$1.06	58.46
MTSP: Ilaya Riverbank STP[2]	2.3	266	$7.10	P391	$0.87	47.84
MTSP: Capitolyo Riverbank STP[2]	3.9	693	$3.17	P175	$0.56	30.67
MTSP: Taguig Low Income Scheme[2]	6.1	1,775	$2.81	P155	$0.36	19.55
Cost Estimate 2005 MP Study	10.0	3,000	$6.82	P375	$0.56	30.93
MTSP: Quezon City – Marikina sewerage system[2]	10.4	3,120	$5.73	P174	$0.29	15.97
Bradford, California[3]	27.0	3,436	$5.73	P267	$1.03	56.65
MTSP: Alternative Option of Stand-along SBRs for Treating Pollution from Hagonoy, Taguig, Labasan and Tapayan Rivers into Laguna Lake (alternative to conjunctive use of flood ponds); for 2025 flows[4]	151.9	34,411	$2.56	P141	$0.38	21.12

The use of the low-cost methodologies for sewerage adopted in this study (i.e. combined drainage and STED systems) requires a strong sanitation program to keep the existing septic tanks in working order. New septage treatment plants and truck fleets are proposed to meet this demand. Moreover, new sewage treatment facilities should be capable of treating not only sewage but also septage. There are too many septic tanks to decommission in favor of pure gravity sewerage. The approach is pragmatic and economically sound.

MWSI

The effect of moving sewerage targets five years forward without moving sanitation done in (2003 Rate Rebasing) will adversely affect the management of pollution as illustrated by the examples in **Figures 6.4**, **6.5,** and **6.6** for the municipalities of Pasay, Quezon and Caloocan, respectively.

The total sanitation and sewerage coverage for Caloocan City in the original concession agreement by 2021 was 100%. The 2003 Rate Rebasing reduced this 2021 total to 53% or a decrease of 47% (**Figure 6.4**).

[1] 1 All costs have been escalated to 2005.
2 NJS et al (2004)
3 http://www.town.bradfordwestgwillimbury.on.ca/articles/MasterServicingStudy
4 MTSP Feasibility Study by NJS et al (2004); flow represents a population of 732,411; assumes 80% H20 use, 7.3 m3/ha/d infiltration, 47g BOD/p/d by 2025.

SKM

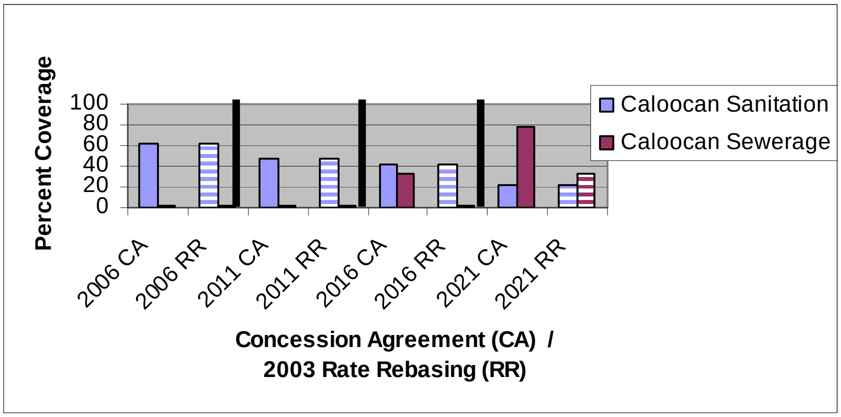

Figure 6.4 Sewerage and Sanitation Targets for Caloocan

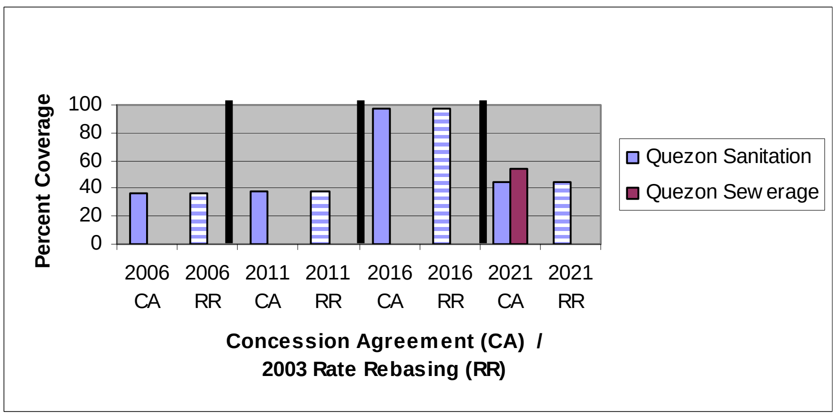

Figure 6.5 Sewerage and Sanitation Targets for Quezon

This coverage is worse for that portion of Quezon City in the West. The total sanitation and sewerage coverage in the original concession agreement by 2021 was 99%. The 2003 Rate Rebasing reduced the 2021 total to 45%. By 2021 there will be no sewerage coverage, yet reduced sanitation coverage from 2016 to 2021 of 54% (**Figure 6.5**).

Another example is the case of Pasay City. The total sanitation and sewerage coverage in the original concession agreement by 2021 was 95% sewerage. The 2003 Rate Rebasing reduced this by 2021 to 16% sewerage; at the same time, sanitation coverage disappears entirely from 2016 to 2021 (**Figure 6.6**).

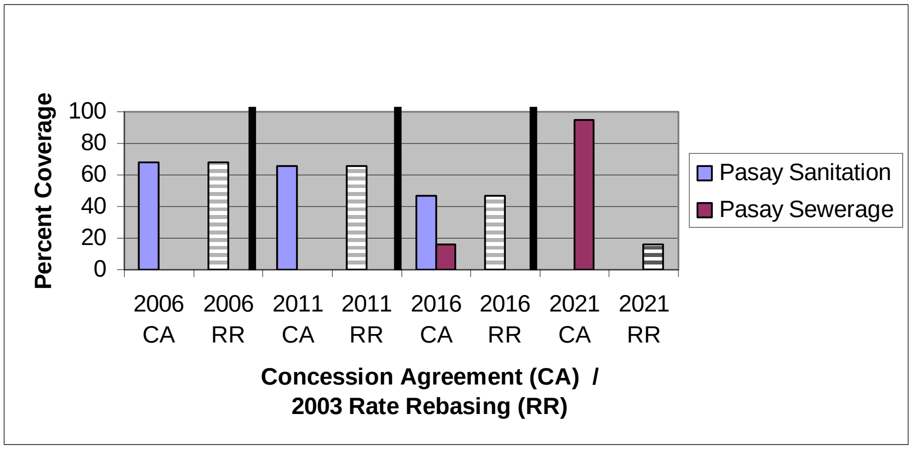

Figure 6.6 Sewerage and Sanitation Targets for Pasay

Sanitation and sewerage were taken as inseparable in the original 1997 CA but considered separately in the 2003 Rate Rebasing. As a result some areas were greatly disadvantaged.

SKM

7. Review of Relevant Technical Options

7.1 Dirty Water Characteristics

Over the course of a year, each person can produce some 400 to 500 litres of urine (containing 4 kg of N and 0.9 of P and 0.4 kg K (Jönsson 1997) and 50 litres of faeces. If waste management is via the common flush toilet, 15,000 litres of potable water is used per person each year for conveyance of this waste. Greywater or sullage, the aqueous discharge from the bath, kitchen and laundry, accounts for another 15,000 to 30,000 litres for each person every year (Esrey et al. 1998). Stormwater and industrial discharges also add to this volume of dirty water. Urine is usually sterile and contains from 50 to 90% of the nitrogen, phosphorus and potassium of human waste (Ciba Giegy 1977).

7.1.1 Sewage

The recent Master Plan Update for the East Zone used the BOD per capita load presented in Chapter 8, **Table 8.6** BOD loads and sewage volume calculations are also presented in Chapter 8.

For the sake of this analysis for evaluating and comparing dirty water treatment technologies, the characteristics below were assumed for domestic dirty water:

- $BOD_{influent}$ = 300 mg/L
- $BOD_{influent}$/EP = 40 g/EP/d
- Flow Peaking Factor = 1.5
- $(COD/BOD)_{influent}$ = 1.8
- Total Solids $(TS)_{influent}$ = 300 mg/L
- Effluent Standard = DENR Class C

7.1.2 Septage

Septage is that wastewater and solids that results when conventional septic tanks are de-sludged and cleaned. Septage contains grit, plastics, rags, hair, grease, scum and other solid wastes. It is highly malodorous due to the anaerobic conditions and the presence of hydrogen sulfide.

Septage may contain over thirty (30) times the BOD concentration of domestic wastewater, 70 times the amount of solids and 80 times the amount of grease. The COD to BOD ratio in domestic wastewater typically ranges from about 1.8 to 2.2. Septage has a COD to BOD ratio of 4 to 9, indicating the presence of a significant non-biodegradable/inorganic component (SKM, 2003).

Mean concentrations values were reported in the 2003 Feasibility Study for the Antipolo Septage Treatment Plant and are in **Table 7.1**. Additional data reported for Metro Manila septage characterisation can be seen in **Tables 7.2 to 7.4**.

SKM

Table 7.1 - Average Chemical and Physical Properties of Septage (SKM, 2003)

Parameter	USEPA Mean	MM 1994 Data*	USEPA Design Concentration	Parameter	USEPA Mean	MM 1994 Data*	USEPA Design Concentration
(mg/L)				(wt %)			
BOD5	5,000	4,338	7,000	**pH**	6.9 units		6.0
COD	42,850	23,250	15,000	**LAS**	157 mg/L		150
TKN	677		700	**TS**	3.9		4.0
NH3-N	157		150	**TVS**	2.5		2.5
TP	253		250	**TSS**	1.3	5.3	1.5
Grease	9,090		8,000	**TVSS**	0.9		1.0
				TVS/TSS	0.65	0.56 to 0.60	0.63

*Data taken from Design Report of Dagat-Dagatan Septage Treatment Plan, Dec 1994. (as reported by SKM in 2003)

Table 7.2 - Additional Data on Metro Manila Septage (as reported in SKM, 2003)

		No Tests	Low	Mean	High	No Tests	Low	Mean	High
pH	units	13	6.9	7.0	7.5	12	6.7	7.0	7.8
BOD	mg/L	13	198	5,532	22,000				
COD	mg/L	13	845	12,807	55,200				
TS	mg/L	6	1,165	31,376	152,828	13	1,512	37,419	312,747
TVS	mg/L	5	764	19,245	82,742	13	860	24,608	210,166
			0.66	0.61	0.54				
TSS	mg/L	13	328	26,517	112,000				
TVSS	mg/L	13	98	11,965	54,328				
TDS	mg/L	12	188	7,030	72,288				
Settleable Matter	mL/L	1	750	750	750				
NH3-N	mg/L	14	44	209	725	1	134	134	134
TP	mg/L	14	4.3	12.8	29.5	1	4.6	4.6	4.6
S(2-)	mg/L	12	4.0	29.8	80.1				
O&G	mg/L	9	200	1,493	5,640				
Fe	mg/L	2	1,130	1,160	1,190				
Cu	mg/L	2	13	29	45				
Zn	mg/L	2	196	218	240				
Ni	mg/L	2	2.2	3.1	3.9				
Mn	mg/L	2	10	15	20				
Cd	mg/L	9	0.002	0.257	0.851				
Ag	mg/L	2	0.080	0.100	0.120				
Hg	mg/L	9	0.000	0.004	0.028				
Pb	mg/L	7	0.014	1.988	8.777				

SKM

Table 7.3 Results of Sampling Septage in Metro Manila (SKM, 2003)

Parameter	Units	No Samples	Montgomery (1991) MEANS from Individual Septic Ranks in Manila	No Samples	PIA (2001) MEANS from Vacuum Trucks in Manila	No Samples	PIA Tests, MINIMUM % Removal, upon 30 min Septage Settling	USEPA Design Values for Septage	PIA (2001) Suggested Design Values for Manila Septage
pH	units	13	7.0	7	7.5		n/a	6	7.5
BOD	mg/L	13	5,532	7	4,641	8	50%	7,000	6,000
COD	mg/L	13	12,807	7	16,005	8	48%	15,000	15,000
COD/BOD	mg/L		2.3	7	2.6		n/a	2.1	2.5
TS	mg/L	6	31,376	7	19,541	1	95%	40,000	40,000
TVS	mg/L	5	19,245	7	11,133	1	91%	25,000	25,000
TVS/TS	mg/L		0.61	7	0.54		n/a	0.63	0.63
TSS	mg/L	13	26,517	7	16,775	2	76%	15,000	20,000
TVSS	mg/L	13	11,965	7	5,301		n/a	10,000	10,000
NH3-N	mg/L	14	209	7	115	7	70%	150	150
TKN	mg/L	n/a	n/a	7	678	7	26%	700	700
TP	mg/L	14	12.8	7	74	7	41%	250	100
O&G	mg/L	9	1,493	7	215	8	57%	9,100	1,500
Settleable Matter	mL/L	1	750	1	800		n/a	n/a	n/a

n/a: not analyzed or not applicable

The SKM 2003 report indicated that septage varies in strength considerably from various septic tank sources. It was also noted from the septage analyses that lower volatile ratio indicates the solids are older in the septic tanks in Metro Manila than what the USEPA had measured as an average. It was also reported that septage from Metro Manila did not contain significant levels of heavy metals that would end up in the dewatered solids **(Table 7.4).**

Table 7.4 - Heavy Metals in Metro Manila Septage (SKM, 2003)

Parameters		Sample	Sample 1 Split	Sample 2	Sample 3	Sample 4	Sample 4 Split	Sample 5	Sample 6	Average
S^{2}	mg/L									
SO_4^{2-}	mg/L	858	284	900	153	69	21.3	483		395
MBAS	mg/L		36				0.4	7.09		14.6
WholeFe	mg/L							278.25	9.8	278
Cd	mg/L	0.090	0.000	0.090	0.007	0.015	0.000			0.034
Hg	mg/L	0.0350	0.01800	0.0360	0.0050	0.0040	0.0002			0.0164
Pb	mg/L	4.08	0.0008	4.08	0.30	0.70	0.02			1.53
Cr^{6+}	mg/L	0.010	0.000	0.010	0.010	0.010	0.000			0.007
Sn	mg/L	0.500	0.033	0.500	0.500	0.500	0.231			0.377

7.2 Sanitation

7.2.1 Definitions

Sanitation Facilities are those facilities utilized for the purpose of receiving and disposing of human excreta and urine, located "on-site" within the household and/or residential plot. Examples are pit latrines, pour flush toilets, septic tanks, soakage pits and field absorption systems or leaching fields. Sullage water (kitchen, laundry and bathing wastewater) is sometimes directed to the septic tank with eventual disposal in soakage pits or field absorption systems but in MM mostly in the storm drains. Communal sanitation facilities include public toilets or latrines.

Septage refers to the mixture of scum, sludge (solids) and liquid removed from a domestic septic tank. Septage is characterized by a high BOD_5 and total solids content and has little volatile organic matter compared to sewage sludge.

7.2.2 Types of Sanitation Facilities

Sanitation practices promoted today fall into one of two broad types:

- "Flush-and-discharge" (for example the flush toilet), and
- "Drop-and-store" (for example the pit toilet).

Since the last century, the flush-and-discharge method has been regarded as the ideal management approach, particularly for urban areas. As with other developing countries, the Philippines has endeavoured to emulate this model despite scarce capital, often sourced from development loans. The two concessionaires for Manila have also indirectly tapped development loans to provide sanitation services.

The provision of water to greater numbers of people in Manila, in combination with the preferred use of flush-and-discharge methods of waste disposal, has accelerated environmental degradation and increased the health risk to certain population sectors, mostly those economically disadvantaged.

Globally, some 80 countries, representing 40% of the world's population, are already suffering from water shortages at some time during the year (Union of Concerned Sci, 1992; UNCHA, 1996; UNDP, 1996). This pending water scarcity / shortage will inevitably encourage [where possible] the use of drop-and-store sanitation methods.

Drop and store sanitation

This is the least expensive and simplest type of sanitation and involves sitting and excreting the waste. There are various methods of receiving and storing the waste products. Examples include:

- Dehydration Toilets
- Ventilated Improved Pit Latrine
- Composting Toilet

- Sanitation Privy
- Aqua Privy
- Pail System/Vault Toilet

Flush and discharge sanitation
This sanitation method is the most common in Metro Manila and includes:

- Traditional Septic Tank;
- Septic Tank/Anaerobic Filter; and
- Multi-baffled Septic Tank.

7.2.3 Evaluation of Sanitation Options

An evaluation of the various types of sanitation facilities was undertaken by using a multi-criteria analysis (MCA). In the MCA approach, relevant constraints were "*weighted*" to reflect their importance when considering a particular group of options. Weightings changed from one group of options to another, depending on their perceived importance. The total weighting for any group would sum to 100%.

Each option within a group was then judged against its rivals, and a "*judgment ranking*" (on a scale of 0 to 10) assigned. Judgment rankings multiplied by the weightings for each constraint resulted in a score for each option within a group. The highest score identified the preferred option(s) within a particular group. Changing the weightings has the greatest effect on the MCA outcome. The preferred option in any one group may not be universally applicable around all of MM. In this case, the top two (2) or three (3) options were taken as "preferred".

The MCA for sanitation, both Drop-and-Store and Flush-and-Discharge methods described above are shown in **Tables 7.5** and **Table 7.6**, respectively. A more thorough description of the weightings and judgement criteria selected can be found in *Strategic Action Paper 11 – Least Cost Technical Options for Sewerage and Sanitation Approaches*).

SKM

Table 7.5 - Multi-criteria Analysis of Drop-and-Store Sanitation

SANTIATION: DROP & STORE		Selected Weighting	Judgement Ranking					
			Dehydration Toilets	Ventilated Pit Latrine	Composting Toilet	Pit Privy	Aqua Privy	Pail System/Vault Toilet
No.	Multi-criteria Analysis of Constraints	(x / 100)	(1 to 10)	(1 to 10)	(1 to 10)	(1 to 10)	(1 to 10)	(1 to 10)
1	Cultural Acceptability in MM	10	2	2	2	2	8	1
2	Affordability (Capital Requirement)	10	2.4	5	1.1	4	3.3	10
3	Disease Prevention	15	9	6	8	6	4	3
4	Protection of the Environment	10	9	5	8	5	5	3
5	Consistency with MWCI and/or MWSI Plans	10	5	4	5	4	10	10
6	Land Availability	10	9	9	9	9	9	10
7	Traffic Disruption	10	10	10	10	10	10	10
8	System Design & Complexity	10	5	7	5	8	6	10
9	Operations & Maintenance	10	7	9	6	4	9	2
10	Management/Recycle of Residuals	5	10	4	10	4	6	2
	TOTAL WEIGHTING (should be 100):	**100**						
	INDIVIDUAL SCORES (x / 1000 max):		**679**	**620**	**631**	**570**	**693**	**615**

HIGHEST SCORE: Aqua Privy

Table 7.6 - Multi-criteria Analysis of Flush and Discharge Sanitation

SANTIATION: FLUSH AND DISCHARGE		Selected Weighting	Judgement Ranking		
			Traditional Septic Tank	Septic Tank / Anaerobic Filter	Multi-Baffled Septic Tank
No.	Multi-criteria Analysis of Constraints	(x / 100)	(1 to 10)	(1 to 10)	(1 to 10)
1	Cultural Acceptability in MM	10	10	10	10
2	Affordability (Capital Requirement)	10	10	4.3	8
3	Disease Prevention	15	5	6	6
4	Protection of the Environment	10	5	7.5	7.5
5	Consistency with MWCI and/or MWSI Plans	10	10	10	10
6	Land Availability	10	7	8	5
7	Traffic Disruption	10	10	10	10
8	System Design & Complexity	10	10	8	8
9	Operations & Maintenance	10	7	8	7
10	Management/Recycle of Residuals	5	6	6	6
	TOTAL WEIGHTING (should be 100):	**100**			
	INDIVIDUAL SCORES (x / 1000 max):		**795**	**778**	**770**

HIGHEST SCORE: Traditional Septic Tank

The MCA yielded the Aqua Privy as the most preferred of the Drop and Store methods considered and Traditional [single baffle] Septic Tank as the most preferred of the Flush-and-Discharge Sanitation methods considered. The lower economic cost of the Traditional Septic Tank greatly favours its use over other technologies, in spite of its higher environmental cost.

Selected Sanitation Approach for Metro Manila

- If Drop & Store is to be utilized, the Aqua Privy was the preferred option. This option would mostly be used for low income / informal settlement areas as appropriate.
- Construct public serviced flush and discharge pay toilets in larger informal settlement areas.
- Where septic tanks are to be used in future developments, they should be mostly of a two (2) chamber design (with collection of their overflow for treatment). Areas were land is greatly restricted, a vertical, anaerobic filter design can be employed.
- All septic tanks should be regularly desludged. A network of Septage Treatment Plants (or sewage/septage treatment plants) and truck fleets should be assigned for specific areas.
- A program should be established to address the estimated 30% of "Inaccessible Septic Tanks", which cannot currently be accessed for sludge removal.

7.2.4 Introducing Sanitation Approaches to the Community

The major aim of a sanitation program should be to improve the health and quality of life of the population as a whole, especially the more vulnerable lower-income families. Proper sanitation must form a barrier against the spread of diseases caused by human pathogens in human excreta.

Flush-and-discharge is not particularly efficient at pathogen destruction by itself. Human waste in water mimics an intestinal environment, i.e., rich in nutrients and organic matter, constant temperature (in the Philippines, nearly human temperature) and the absence of light or UV.

In the Philippines, the type of toilet a family uses is often dependent on their income level (**Figure 7.1).**

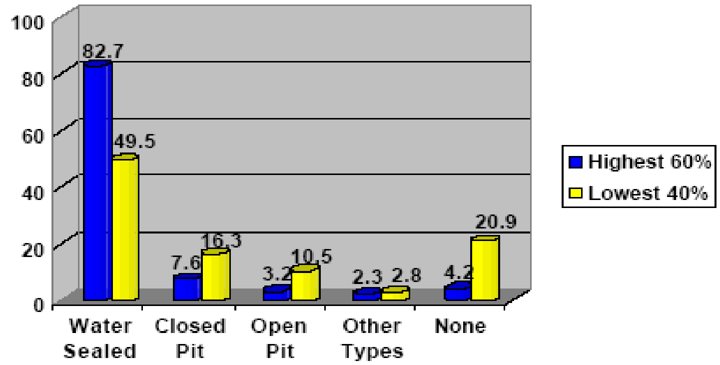

Figure 7.1 Percentages of Philippine Families by Types of Toilets and Income strata in 1998 (Robinson 2003)

The willingness-to-pay survey conducted under this study showed a similar relationship between income and type of facility as shown in **Figure 7.2.** Overall, the survey showed that only 5% do not have toilet facilities, but this corresponds to about 10% of the low income group, an improvement on the 1998 data.

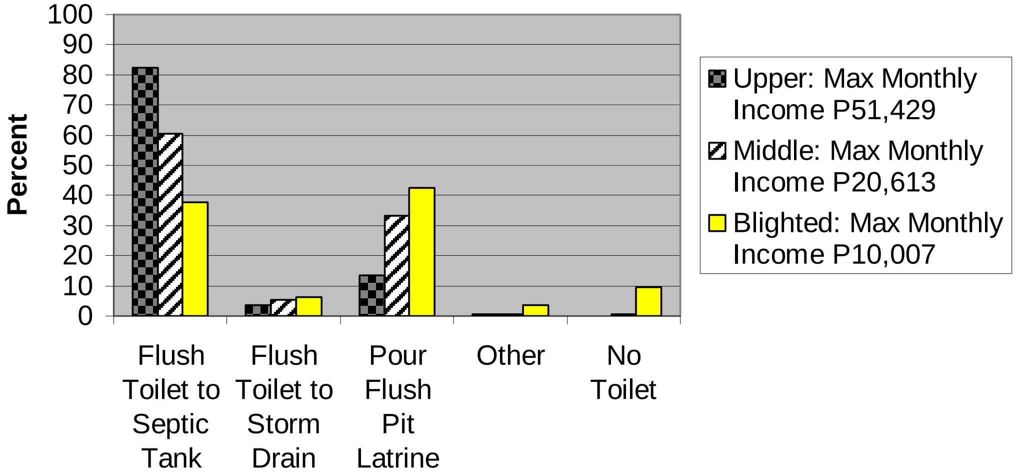

Figure 7.2 Types of Toilets Used in Manila (2005 survey)

Cultural Awareness

Health education activities include person-to-person communication for the purpose of changing individuals' behavior. In conditions where there are no sanitary facilities, door-to-door field work may be required to make people aware of alternatives to the "wrap and throw" practice as well as to introduce possible programs for communal toilets and other sanitation services.

Homeowner's Responsibility

The operations and maintenance requirements for on-site facilities will continue to be the responsibility of the property owners, with additional inspection, regulation, and assistance being provided to improve performance. For latrines and pour flush facilities, owners are currently responsible for cleaning the premises, vector control, periodic redirection of discharge to fresh pits, and removal of cured humus (optional). Owners are also responsible for septic tank maintenance and repair, although they generally need private contractors or public agencies to provide desludging services.

The basic policy of owner responsibility for operations and maintenance of on-site facilities is sound and should be retained by all local government program participants. Operations and maintenance performance can be improved, however, through the use of more aggressive monitoring and control programs. Local governments should be encouraged to employ contract organisations to provide sanitation advisors/inspectors to conduct scheduled periodic inspections, identify needed repairs, assist the owner to determine when to relocate to a new discharge site, and provide advice and assistance to owners on all aspects of operations and maintenance (Philippine Urban Sewerage and Sanitation: National Strategy and Action Plan 1994).

Community Participation and Public Awareness Campaign

Involving consumers in the sanitation program is an essential element of urban sanitation strategy. Community education and participation are intended to counter the perception that the government provides services at no direct expense to the public. This idea has prevailed for many years, and it will require considerable effort to change. One of the best ways to changing public thinking is through community education and participation programs. These are important in informing the public about the benefits of sanitation and are essential to the long term objective of full cost recovery from program beneficiaries.

There is a special need for such coordinated community participation especially in informal settlements. Residents will not use or maintain facilities unless they participate fully in planning and are committed to the program. It is proposed that voluntary organizations sponsor and coordinate the inputs of defined groups of informal settlers for the purpose of developing sanitation services.

7.3 Sewerage

For many centuries sewers have been installed to collect and transfer aqueous human waste away from constant human contact via gravity, either via a pipe or open conduit or drain. Babylonia has been documented by many as one of the first places to mould clay into pipes (via potter's wheel). Tees and angle joints were produced and then baked to make drainage pipes, all as early as 4000 BCE (Schladweiler 2005).

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7.3.1 Gravity Sewerage

The early gravity drainage systems were eventually developed into what today is known as conventional [gravity] sewerage. Large bore pipes are usually buried and the hydraulic design is such that sewage is collected from properties at the their lowest point and conveyed into the main conduit. Intermittent pump stations are used to prevent extreme excavation depths. At each change of direction and at a maximum typical 90 metre spacing, manholes are located to provide access points for maintenance such as for unblocking obstructions and removing tree root intrusions. Property owners have to connect their properties to a junction (boundary riser) and have no responsibility other than to flush dirty water into the sewer and avoid dumping toxic or harmful pollutants.

Sewers can either be devoted to conveying only sewage (a “separate” system) or also include stormwater (a “combined” system). The latter use would require larger pipe diameters and complicated hydraulics at the end of the system. Combined sewerage conveys water from stormwater runoff from house roofs, parking lots, and streets in addition to household dirty water to eventual treatment and/or disposal. Storm drains in MM are used as combined drains. During severe storms, there may be more rainfall than the sewers can handle. Management of combined sewers is via emergency overflows to allow excess water to be discharged into a nearby watercourse.

Traffic disruption and the depth some sewers have to be laid to maintain the correct hydraulic gradients are among the chief disadvantages of a separate gravity sewerage system. Combined sewers, particularly those that employ stormwater drains, also suffer from human health issue disadvantages. The chief advantages for separate sewers are that they are well known and understood and can be long lived if well maintained. The chief advantage of combined sewers is their low cost.

7.3.2 Vacuum Sewerage Systems

Vacuum sewerage does not rely on gravity to transport liquid wastes. In regions difficult to sewer by gravity, the vacuum system has proven a useful alternative. A vacuum sewerage transport system has vacuum valves at each household, a single plant room that supplies vacuum to a central collection tank, and a pumpout system that discharge to the sewer mains or a treatment plant. A valve monitoring system within the plant room monitors the activity of all valves within the vacuum sewerage network.

There are three basic components to any Vacuum Collection System: the valve pit, the vacuum lines, and vacuum collection station.

The sewage enters the lower part of the valve pit fed by gravity from a number of homes, typically 4 to 15. At a pre-determined level, the pneumatic valve in the pit, via a controller, opens for several seconds and its dirty water is sucked into the pipeline or vacuum transport conduit. The vacuum transport conduit is laid in narrow trenches in a series of high and low points and the profile is likened to a saw tooth shape. The saw-tooth profile is designed to ensure that any waste liquid in the pipe will not block the pipe at low flow periods when the liquid may be at rest.

Sewage is moved through the vacuum conduits by these same valve cycles until it reaches the vacuum collection tank, which is maintained under vacuum by a vacuum pump(s). Each vacuum pump typically runs 2 to 3 hours per day (4 to 6 hours total). The pumps do not run continuously since the vacuum interface valves are normally closed and the vacuum gradually decreases from -70 kPa to -50 kPa. The vacuum pumps are sized to increase the system vacuum from 50 - 70 kPa in 3 minutes or less. Typical vacuum pump sizes are 7.5, 12 and 15 kW.

As potential vacuum loss is associated with every lift, the length of each vacuum conduit is often limited to about 3 to 5 km. The laying of lines can include detours to avoid obstacles such as around buildings, trees or rocks. Elevation changes can extend or reduce this range.

When the collection tank is full, a sensor activates a sewage pump. The waste is subsequently pumped to its next destination (e.g. a treatment plant or to the conventional gravity system). The collection station equipment is generally housed in a small building, although several systems have been constructed without a building.

The chief advantages of a vacuum sewerage system are substantial cost savings in difficult terrain and the need for only shallow trenching with minimal traffic disruption. The chief disadvantage of a vacuum system is the lack of experience by water authorities and developers and the overall cost of the system.

7.3.3 Pressure Sewerage System

This system operates through the use of a pump. Pumped lines are smaller diameter than gravity lines and create less traffic disruption when laid in streets or walkways. Two pressure sewer systems that do not require modification to plumbing inside the house include:

- The septic tank effluent pump (STEP) system; and
- The grinder pump (GP).

In STEP systems, dirty water flows into a conventional septic tank to capture solids and the liquid overflow is directed a holding tank, containing a pump and control devices. The effluent is subsequently pumped to another location for treatment. The STEP system would be most applicable to MM due to the large number of septic tanks. In a GP system, household sewage flows to a vault (no septic tank) where a grinder pump grinds the solids and discharges the sewage into a pressurized pipe system.

Pressure sewer systems that connect several residences to a “cluster” pump station can be less expensive than conventional gravity systems. On-property facilities represent a major portion of the capital cost of the entire system and are shared in a cluster arrangement. This can be an economic advantage since on-property components are not required until a house is constructed and are borne by the homeowner.

Pressure sewerage systems have several advantages, including ability to be independent of gravity that eliminates the strict alignment and slope restrictions for conventional gravity sewers, the use of shallow trenching and the fact that several hundred systems are in use in the US, Australia and elsewhere. The chief disadvantages are the need for greater institutional involvement due to the number of mechanical components, the need for involvement of lot owners (each has to purchase and maintain their own pump) and the overall O & M costs.

7.3.4 Simplified Sewerage

These are low-cost sewerage technologies (SC 2005) that have been used in South American countries and some Asian countries. The size of the sewer pipes is by intent smaller due to the use of other design criteria than what is used for conventional gravity sewerage.

7.3.4.1 Settled or Small-bore Sewerage

Settled sewerage is a means of conveying domestic sewage by gravity that has been settled in a septic tank (Septic Tank Effluent Disposal or STED system). STED was developed in Zambia in 1960 and now is used around the world in over 300 different schemes.

Design criteria for drains included a minimum diameter pipe of 100 mm and a grade of 0.4%. Conventional separate sewerage would require a minimum pipe of 150 mm diameter and a grade of 0.7% (earthenware) and 0.5% (PVC). Manholes are replaced with flushing points for network access. The STED design reflects the advantage of removing gross solids in the septic tanks prior to liquid conveyance.

It has been found in studies (Venhuizen 2005) that when pumping is required, generally the most cost efficient system would route effluent from several septic tanks through STED sewers into a collective STEP tank, an effluent pump station. In a very flat terrain this strategy will be more cost efficient than either conventional sewers with a central lift station or a STEP system with individual pump tanks at each septic tank as shown in **Figure 7.3**.

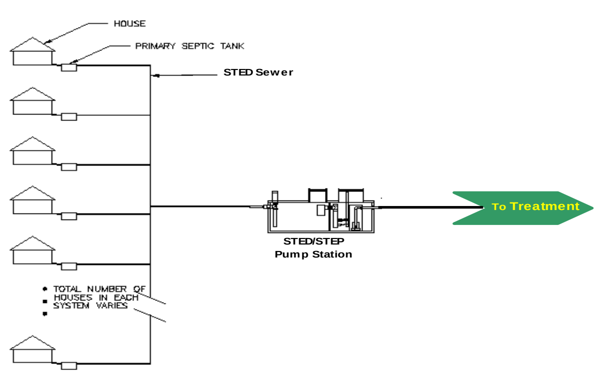


Figure 7.3 A STED/STED System Configuration

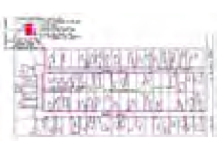
Each pump well in a simplified sewerage scheme collects all settled household dirty waters (toilet wastes and sullage) from the small pump wells in small-diameter pipes (eg 100 mm dia.) laid at fairly flat gradients such as 0.5%. The sewers can be laid like water lines or inside the housing block, or in the front garden or under the pavement (sidewalk), rather than in the centre of the road as with conventional sewerage. There must be an overall fall from the upstream end of the sewer to its downstream end. In sections where there is pressure flow, the hydraulic gradient cannot rise above the level of the invert of any interceptor tank outlet (if it does, then either select the next larger pipe diameter or increase the depth at which the sewer is laid) (SC 2005). It is suitable for existing unplanned low-income areas and new housing estates with a more regular layout.

The sewerage authority in charge, e.g. LGUs or concessionaires, has to ensure that only connections from septic tanks are made to the settled sewer, and it also has to be responsible for desludging the septic tanks regularly. At the start of the scheme the sewerage authority should desludge and, if necessary, renovate the existing septic tanks, and then regularly, as required, arrange for them to be desludged.

7.3.4.2 Condominial Sewerage

Condominial sewerage is basically small-bore conventional gravity sewerage attained via a minimum hydraulic design. sewerage collects all household dirty waters (black and grey waters) to small-diameter pipes laid at fairly flat gradients. A 100 mm diameter sewer for example, laid at a gradient of 1 in 200 (0.5%), will serve around 200 households of 5 people with a dirty water flow of 80 litres per person per day. In northeast Brazil, the earliest 100 mm diameter sewers were laid at 1 to 167 (0.006 m/m). Schemes based on minimum tractive tension, rather than minimum cleaning velocity, are now laid at 1 in 255 or 0.004 m/m (Azevedo Netto 1992).

The sewers are often laid inside the housing block or in the front garden or under the pavement or sidewalk, rather than in the centre of the road as with conventional sewerage. It is suitable for existing unplanned low-income areas and new housing estates with a more regular layout (SC, 2005). CAESB, the water and sewerage company of Brazília and the Federal District, started implementing simplified sewerage in poor areas in 1991 and now considers simplified sewerage as a “standard solution” for rich and poor areas alike. CAESB has the largest example of simplified sewerage in the world (SC, 2005), with over 1,200 km of Condominial sewers in operation.



Example of STED system in Texas (Venhuizen 2005)

Failures have occurred, mainly due to poor construction and/or poor institutional commitment, and especially due to poor maintenance. Laying small diameter (commonly 100 mm diameter) pipes at fairly flat gradients of 0.5% requires careful construction techniques. Plastic pipes are best used as they are easily jointed correctly, and this essentially eliminates dirty water leakage from the sewer and groundwater getting into it. As with the STED there is no need to have manholes of the type used for conventional sewerage but simple brick or plastic junction chambers (SC, 2005).

The biggest advantage of these two simplified sewerage approaches is that in areas with existing septic tanks, the cost reduction over conventional sewerage can be as high as 40 to 70 percent (SC, 2005). STED systems obviously aid solids management at the treatment plant and both STED and condominial systems do not require conventional manholes but merely rodding access. The biggest disadvantage for simplified sewerage is the increased maintenance requirements; blocks do occur and equipment and personnel have to be available for remedy. STED of course depends on functioning septic tanks. Condominial sewerage requires specialized installation contractors to be fully functional. Sound cooperation between the sewerage agency, community leaders, and users is a must for both systems.

A septic tank effluent disposal (STED/STEP) scheme would seem to be the most natural fit in MM (and the least expensive) as there is an estimated 2.17 million septic tanks. The 26% of septic tanks that are inaccessible (JMM 1991) would require replacement or installation of a STEP tank. Moreover, some septic tanks will be unsuitable for STED and will require replacement. All septic tanks would be pumped out for solids on a regular basis and the septage taken to treatment plants. In many drainage catchments, the overflow from septic tanks would be caught by small bore sewerage, other catchments could use the storm drains as a “combined drainage”. All of MM could gradually be sewered by a phased approach.

7.3.5 Evaluation of Sewerage Options

Estimated unit costs of the aforementioned sewerage options are given in **Table 7.7**. Simplified and combined sewerage have a big capital cost advantage over conventional gravity sewerage. The annual O&M, however, costs do not reflect the increased institutional requirements of simplified sewerage.

Table 7.7- Estimated 2005 Costs from the Literature of Sewerage Systems

Sewerage System	Estimate Percent Cost of Gravity Sewerage*	Estimated Cost per Household ($US)	Estimated Cost per Household (PhP)	Estimated Annual O & M ($US)	Estimated Annual O & M (PhP)
Escalated 1979 Estimate for Conventional Gravity Sewerage[1]	100%	$3,700	P203,500	$26	P1,430
Combined Gravity Sewerage[2]	32%	$1,184	P65,120	$13	P715
Vacuum Sewerage[3]	116%	$4,300	P236,500	$52	P2,860
Pressure Sewerage: Grinder Pump[4]	88%	$3,256	P179,080	$228	P12,540
Pressure Sewerage: STEP[5]	50%	$1,850	P101,750	$114	P6,270
STED / STEP Sewerage[6,7]	42%	$1,554	P85,470	$14	P784
Condominial Sewerage[8]	62%	$2,294	P126,170	$18	P990

*All costs except vacuum sewerage are proportioned against conventional gravity sewerage

[1] Costs of Montgomery et al (1979) report were escalated via the Philippine Retail Price Index of Selected Materials of Construction in the National Capital Region; NJS et (2004) estimated cost of sewerage for the Riverbanks STPs at $US2,050 / household (61% was for household connections)

[2] NJS et al (2004); operating cost extracted from Taguig Sewerage System and includes treatment via ponds

[3] Based on costs from a development in Sydney (Envr. Tech. Case Studies, 2005)

[4] Based on worst case cost from Australia (Shoalhaven Water 2005); Tedwill (2005) estimated 52% from US development

[5] Bounds (2005)

[6] Venhuizen (2005) costed STED/STEP for Texas area at $US2,500 (42% of conventional sewerage), which included new septic tanks; Palmer et al (2005) estimated $3,225 per household in country Australia but 31% of conventional sewerage

[7] Operating cost from Palmer et al 2005

[8] Azevedo Netto 1992; NJS et (2004) costed a simplified sewerage system at Manggahan (Manila) with smaller diameter sewers under the sidewalks for 80% of the cost of conventional sewerage.

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A multi-criteria analysis (MCA) of the various sewerage systems was performed as shown in **Table 7.8**. The MCA yielded that the **Combined**, **Condominial**, and **STED/STEP** methods are the most preferred methodologies for MM of those considered. The MCA scores were heavily weighted towards affordability and were close. Moreover, one system would not be universally applicable to the whole of MM; as such the top three were considered as 'preferred'.

Table 7.8 - Multi-criteria Analysis of Sewerage Alternatives

SEWERAGE for Metro Manila			Judgement Rankings						
No.	**Multi-criteria Analysis of Constraints**	**Selected Weighting** (x / 100)	**Conventional Sewerage: Separate** (1 to 10)	**Conventional Sewerage: Combined** (1 to 10)	**Vacuum Sewerage** (1 to 10)	**Pressure Sewerage: GP** (1 to 10)	**Pressure Sewerage: STEP** (1 to 10)	**Simplified Sewerage: STED / STEP** (1 to 10)	**Simplified Sewerage: Condominial** (1 to 10)
1	Cultural Acceptability in MM	0	10	10	10	10	10	10	10
2	Affordability (Capital Requirement)	25	3.2	10	2.8	3.6	6.4	7.6	5.2
3	Disease Prevention	10	9	6	9	9	9	9	9
4	Protection of the Environment	10	7	5	9	9	8	8	9
5	Consistency with MWCI and/or MWSI Plans	10	5	9	4	4	4	4	9
6	Land Availability	5	6	9	7	7	7	7	7
7	Traffic Disruption	10	3	9	8	8	8	8	8
8	System Design & Complexity	5	7	8	5	6	6	7	7
9	Operations & Maintenance	10	9	9	6	6	6	7	7
10	Management of Flow / Pollution Loads	10	7	5	8	8	9	9	9
11	Management/Recycle of Residuals	5	9	6	9	9	6	6	9
	TOTAL WEIGHTING (should be 100):	**100**							
	INDIVIDUAL SCORES (x / 1000 max):		**590**	**795**	**614**	**641**	**695**	**740**	**754**
	HIGHEST SCORE:		**Conventional Sewerage: Combined**						

7.3.6 The Selected Sewerage Approach for Metro Manila

- A Combined Drainage System (i.e. storm drainage and dirty water) should be mostly employed where possible for conveyance of dirty water to a treatment plant. The combined system should be gradually passed out in favor of a separate system for the protection of human health.
- The separate sewerage system that should be combined sewerage should be small bore and STED / STEP systems.
- The appropriate sewerage design should be suited for each drainage catchment.

7.4 Dirty Water (Sewage) Treatment

The principal objective of dirty water treatment is generally to detoxify/remove human and anthropogenic and industrial effluents impurities to allow their environmental disposal and/or reuse of the water without danger to human health or unacceptable damage to the environment.

The most appropriate [dirty water treatment] process has to be one that produces a final effluent that meets the relevant / appropriate microbiological and chemical quality guidelines, preferably at a low cost and with minimal operational and maintenance requirements.

The history of dirty water treatment has mostly relied on gravity conveyance of sewage, via neighbourhood reticulation systems into larger ring mains, terminating at a centralized treatment plant. Whilst this approach is still mostly preferred, its large initial capital requirements have encouraged consideration of smaller reticulation systems and decentralized treatment plants. This has especially been true in a developing country context.

Decentralized Dirty Water Systems (DEWATS) is one designation for this approach and is defined as the collection, treatment, and disposal / reuse of dirty water from individual homes, clusters of homes, isolated communities, industries, or institutional facilities, as well as from portions of existing community at or near the point of waste generation (Tchobanoglous, 1995). DEWATS can be composed of anaerobic or aerobic treatments, with the objective of removing impurities from the water flow in the most economical and space conscious manner (in addition to addressing other constraints).

7.4.1 Dirty Water Treatment Process Train

7.4.1.1 Preliminary Treatment

Preliminary treatment is the first stage of dirty water treatment for the removal of coarse solids and other large materials often found in untreated dirty water. Pretreatment operations typically include coarse to fine screening, grit removal and, in some cases, comminution of large objects. Grit removal is mostly used for sewage (as opposed to industrial or commercial effluents) and often not included as a preliminary treatment step in many of the "package" or smaller dirty water treatment plants. Comminutors are sometimes adopted to supplement coarse screening and serve to reduce the size of large particles so that they will be removed in the form of sludge in subsequent treatment processes. Flow measurement devices, often standing-wave flumes, are most always included at the preliminary treatment stage.

7.4.1.2 Primary Treatment

Preliminary treatment is followed by Primary treatment. Primary treatment is to remove settleable organic and inorganic solids by sedimentation as well as impurites like oil, grease and scum that float by skimming. Approximately 25 to 40% of the incoming biochemical oxygen demand (BOD_5), 50 to 70% of the total suspended solids (TSS) (Tchobanoglous & Burton, 1991), and 65% of the oil and grease are removed during Primary treatment.

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7.4.1.3 Secondary Treatment

Secondary biological treatment is a biological process and follows the first two physical treatments. It is designed for removing dissolved organics, nitrogen and phosphorous as well as suspended solids. Secondary treatment can involve either anaerobic (without the use of added air) and / or aerobic (use of added air) biological processes. Those biological processes considered as "high-rate" are characterized by relatively small reactor volumes, greater process complexity and high concentrations of microorganisms. Conversely, "low-rate" biological processes employ are less complicated processes, resulting in larger reactor volumes (with larger land takes) and low biomass concentrations.

The growth rate of new organisms is greater in high-rate systems because of the well controlled environment. Common high-rate aerobic processes can include some activated sludge processes (like those using MF membranes), advanced trickling filters or biofilters, oxidation ditches, rotating biological contactors (RBC) and processes using plastic media, either in a static or fluidized configuration. High-rate anaerobic processes include Upflow Anaerobic Sludge Blanket (UASB) reactors, anaerobic filters, stirred tank anaerobic tanks and fluidized [media] anaerobic processes to name the most prevalent.

7.4.1.4 Tertiary Treatment

This process step follows secondary treatment and usually involves final disinfection by chlorine, ultra-violet irradiation, ozone, chlorine dioxide or other oxidant. Tertiary treatment can also include sand filtration to help remove additional suspended solids.

7.4.1.5 Advanced Tertiary Treatment

Advanced Tertiary processes are often the last and most complex processes in the treatment train. These processes are mostly used to give the treated water purity enough for reuse. Processes can include finer pore filtrations like microfiltration (0.2 μm), down to reverse osmosis (0.0001 μm). Also included are those processes for advanced nutrient removal as well as advanced oxidation processes for the removal of more recalcitrant dissolved pollutants such as residual human pharmaceutical products and / or pesticides and herbicides.

7.4.2 Biological Treatment

The greatest costs and largest land takes when upgrading any dirty water for reuse and / or environmental discharge occur for the secondary and advanced tertiary treatment processes. Substantial costs lie with biological treatment. The chief tertiary process of interest for the purposes of the Manila Master Plan would be disinfection and in some instances filtration. Advanced tertiary processes are mostly considered for use under special circumstances, often involving water reuse, salinity issues, or removal of recalcitrant chemicals.

7.4.2.1 Anaerobic Biological Treatment

Anaerobic biological treatment is an energy efficient process for usually the removal of large amounts of carbon as is often found in food processing effluents. The use of anaerobic reactors for domestic sewage dirty water treatment has mostly been restricted to the use of the common [anaerobic] septic tank. However, larger anaerobic reactors have been increasingly used at centralized treatment plants since the 1980s.

Anaerobic reactors may be classified as *suspended growth,* where the active treatment bacteria are suspended in the bulk liquid, or *attached film*, where the active treatment bacteria are attached as dense films to a solid media within the reactor. Advanced designs such as the upflow anaerobic sludge blanket reactor or UASB reactor would be considered a medium to high-rate suspended growth reactor has great potential for treating sewage in developing countries, particularly those with tropical climates.

This technology does not require the input of air as well as producing far less waste biomass that also needs to be environmentally managed. The major differences between an anaerobic and aerobic biological treatment can be seen by their process yields as seen in **Figure 7.4**.

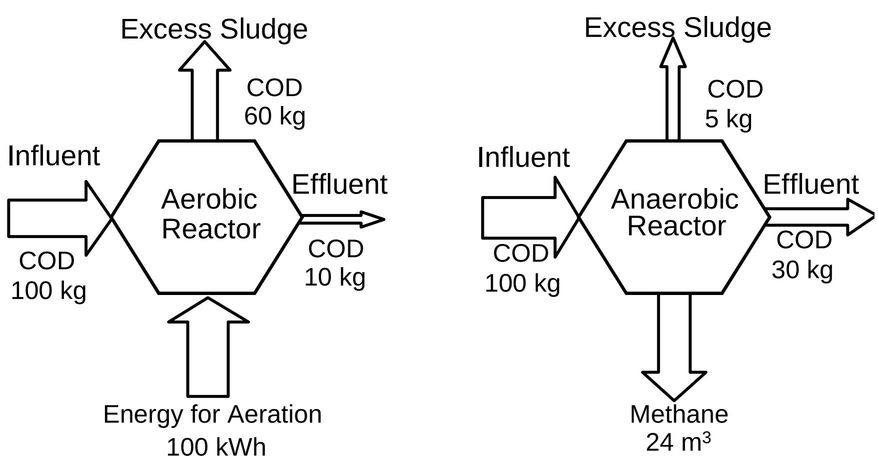

Figure 7.4 Yields from Aerobic and Anaerobic Biological Treatment (Jewell 1994)

Screened and degritted dirty water can be introduced at the bottom of the UASB and distributed evenly across the base of the reactor. "Flocs" of anaerobic bacteria (often as granules) are continually suspended as a blanket by the incoming dirty water flow. Particulate matter is trapped as it passes upward through the sludge blanket, where it is eventually digested. Anaerobic digestion of the retained particulate and soluble organic material generates "biogas" (~65% methane, ~20% carbon dioxide & ~5% other gases) and relatively small amounts of new sludge (<5% of incoming COD to new biomass). The rising gas bubbles are part of a three-phase mixture (gas, liquid and solids or GLS) that is ideally well mixed.

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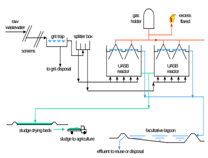
The GLS mixture is separated via a phase separator, consisting of the gas collector dome(s) or hoods and a separate quiescent settling zone. The settling zone is relatively free of the mixing effect of the gas, allowing the solid particles to fall back into the reactor. Some designs employ a settler after the UASB to settle the biomass and return it to the UASB reactor. The clarified effluent overflows into launders at the top of the reactor for removal. The biogas is collected and can be used as a fuel for generating power for the treatment plant or simply flared.



Example of UASB treatment train.

A properly designed UASB reactor eliminates the need for mechanical mixing and has few moving parts. For dirty water with high concentrations of suspended solids, sedimentation of the solids is biggest main concern. The design criteria are largely dictated by the maximum upflow velocity that the solid particles can withstand before being washed out of the reactor, generally between 0.5 and 1.0 m/hour for municipal effluents (Haskoning 1995).

There are several case studies of UASB reactors, or similar anaerobic units, being used for domestic sewage treatment systems as seen in **Table 7.9** (Journey and McNiven, 1996). The UASB reactor units treating sewage are operated at ambient temperature, normally higher than 20°C, at a hydraulic detention time in the range of 6 to 10 hours, and organic loading rates lower than 3.0 kg COD/m^3/d (Foresti 2002). They have presented removal efficiencies in the range of COD: 55% to 75%, BOD 60% to 85% and total solids of 60% to 80%. The main problems have been identified as construction imperfections and some complaints about odours in those cases that did not adequately allow for malodour management.

Table 7.9 - Multi Comparison of Four UASBs Treating Municipal Dirty Water

Parameter	Municipal Dirty Water			Mixed
	Bucaramanga, Colombia	**Mirzapur, India**	**Kanpur, India**	**Kanpur, India**
Design Peak Capacity (MLD)	42	14	5	36
Operating Capacity (MLD)	36	10	4.8	21.8
Average organic loading				
COD (mg/l)	400	360	560	1,183
BOD_5 (mg/l)	150	180	210	484
TSS (mg/l)	230	360	420	1,000
Average Removal Efficiency				
COD (%)	65	61	74	57
BOD_5 (%)	75	66	75	63
TSS (%)	70	70	75	56
Average HRT (hour)	5	8	6	5.2
Influent temp. Range (^{o}C)	23-25	21-30	20-30	22-30
Gas production (m^3/day)	3,300	500	480	

Cited advantages by many include costs of 3 to 6 times less than aerobic secondary plants (Journey et al, 1996), few moving parts and smaller footprints, production of biogas that can be converted to electricity, and low production of waste solids. The major disadvantages are the need for an aerobic secondary process to meet Class C, longer start up times and less operating experience by water authorities, although substantial use of the technology has occurred in India and South America.

7.4.2.2 Aerobic Biological Treatment

Aerobic biological treatment for removal of dissolved impurities from domestic sewage are also classified as *suspended growth,* where the active treatment bacteria are suspended in the bulk liquid, or *attached film*, where the active treatment bacteria are attached as dense films to solid media within the reactor.

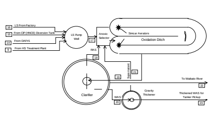
Conventional Activated Sludge (CAS)

The activated sludge process was developed in England during early 1900’s. Organic and inorganic waste is introduced into an environment with a culture of aerobic and facultative bacteria, fungi and other species. Carbon and nitrogenous compounds are broken down / oxidized and converted into new bacterial cells, carbon dioxide, and gaseous nitrogen compounds, depending on the redox environment. Bacterial cells will also consume each other under what is termed endogeneous respiration.

After the reactor tank, a clarifier or settler separates the activated-sludge biomass from the treated water. A portion of settled cells from the clarifier is recycled (the return activated sludge or RAS) into the influent for initial absorption of carbon and to maintain the desired concentration of the microorganisms in the reactor. Another portion of the settled cells, termed the waste activated sludge or WAS, is wasted to a digester (for more treatment) or for dewatering.

Activated sludge is well known to most water authorities, recovers quickly from shock loadings, usually not considered malodorous and can biologically remove phosphorus and nitrogen pollutants. The major disadvantages are the high operating cost due to the need for a continuous oxygen supply and the fact that up to 75% of the influent BOD is converted into sludge, which has to be itself managed.

Oxidation Ditch (OD)


Typical oxidation ditch configuration

The oxidation ditch is also activated sludge but with a slightly different design configuration. An oxidation ditch uses a ring- or oval-shaped channel and is equipped with mechanical aeration devices that encourage a linear velocity of about 0.25 to 0.35 m/s (Metcalf and Eddy, 1991) in addition to supplying oxygen. Screened and degritted dirty water enters the ditch where it is aerated. Oxidation ditches typically operate in an extended aeration mode with long hydraulic and solids retention times.

After biological treatment in the oxidation ditch, a clarifier is again used to settle out the biomass and to recycle RAS to the influent stream. Nitrification and denitrification is achieved inside the oxidation ditch due to the aerobic zones near the aerators and anoxic zones away from it.

The oxidation ditch process is flexible and reliable and will also biologically remove nutrients. The mechanical aeration is also quite dependable. The design does require a large land take and there is also the energy requirement because of aeration and the production of a large volume of sludge.

Sequencing Batch Reactor (SBR)

In a sequencing batch reactor configuration, all processes in the activated sludge system take place in a single reactor. Whilst processes for the SBR and AS are identical in principle, the *fill and draw* configuration of the SBR enables the mixed liquor to remain in the reactor during all cycles. This eliminates the need for separate secondary sedimentation tanks.

The 5-phase operation sequence in an SBR (**Figure 7.5**) consists of (1) fill, (2) react (aeration), (3) settle (sedimentation/clarification), (4) draw (decant of supernatant), and (5) idle. During the treatment process, sludge wasting typically occurs during the settle or idle phases, thus eliminating the need for return sludge. Multiple reactors are used to ensure an over-all continuous process.

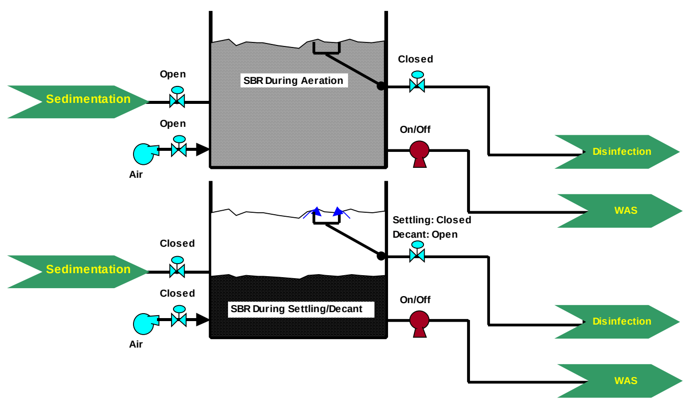


Figure 7.5 Operational Sequence of a Sequencing Batch Reactor

An SBR requires less space than a CAS or OD and is less expensive to build as there is no need for a clarifier. Aerobic to anoxic conditions inside the SBR allow biological nutrient removal and most operators find the process easy to understand and manage. The design is highly dependent on a good settling biomass; the predomination by filamentous bacteria can promote high suspended solids in the effluent. The system is essentially a batch process and effluent quality can be less consistent than a continuous process like CAS or an OD.

Aerobic Lagoons

Aerobic lagoons or ponds are large, shallow earthen basins that are used for the treatment of dirty water by natural and mechanical processes, involving the use of both algae and bacteria. The shallow depth or mechanical mixing ensure aerobic conditions throughout the basin. Except for the inclusion of the algal population, the treatment processes in the aerobic lagoon are very similar to those in an activated-sludge system. Bacteria aerobically degrade/oxidize solid and dissolved organic matter, using dissolved oxygen from algal photosynthesis. Resident nutrients and the carbon dioxide by-product

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of the degradation are subsequently used by the algae. This forms a symbiotic relationship between algae and bacteria.

They are mentioned herein for completeness but are mostly inappropriate for MM because of their large land take. The aerobic lagoons currently at Dagat-Dagatan treatment plant will likely be converted to a more intensive process in the future.

Rotating Biological Contractor (RBC)

The rotating biological contactor is an attached biomass system, consisting of a series of closely spaced, polystyrene or polyvinyl chloride circular disks. The disks are rotated slowly while submerged by about 40%. As a result, sessile biological growth occurs on the disk surfaces, forming a slimy layer over the entire surface area.

The rotating motion of the disks alternates the contact of the biomass with the organic material in the dirty water and with oxygen from the atmosphere. Liquid running through the packing also picks up oxygen. The revolution rate of the disks determines the rate of oxygen transfer and maintains aerobic condition for microbial growth. This motion also removes excess solids from the disks by creating shearing forces. The sloughed solids are conveyed to a clarifier for separation. RBCs can be used for secondary treatment as well as more advanced processes such as biological nitrogen and phosphorus removal as seen in **Figure 7.6**.

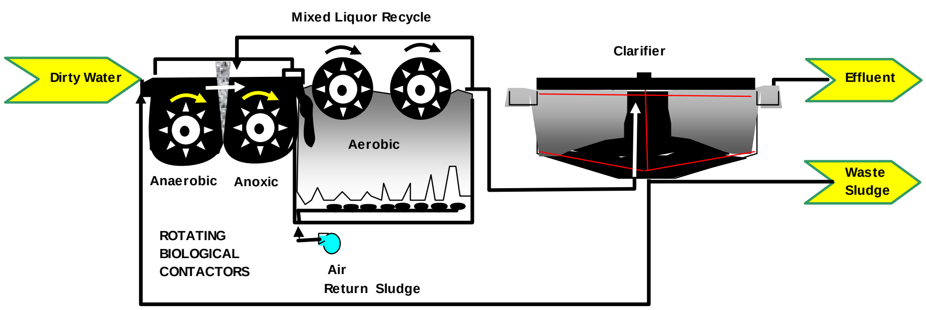

Figure 7.6 An Anaerobic, Anoxic and Aerobic RBC Configuration

The RBC design reduces operating cost and sludge production but the substantial space is required for larger STPs. The design is rarely used for flows over 10 MLD and constant mechanical maintenance is required because of the rotating components.

Trickling Filter (TF)

V-Valley Granular TF, Bangalore, India (May 2001)

Trickling filters (TF) have been in existence for over a century and have been used for carbonaceous BOD (CBOD), COD and NH_3 (ammonia or NBOD).

Granular media ("sand") filters have been known for about 50 years since from studies conducted at the University of Florida. It was found that using larger media and doing more frequent dosing enables sand filters to perform better than what was quoted in the EPA literature. Over 25 years ago, it was shown that employing recirculation enhanced the efficiency of the process. These characteristics have been confirmed in many efforts over the past several years. Recently, alternative types of media-textile and foam have been researched. These media can be loaded much more heavily than a granular media filter, offering the potential for smaller and a more cost efficient biofiltration bed (Venhuizen 2005). Most rock media can provide approximately 149 m^2/m^3 transfer area per unit media volume (USEPA 2000).

Many of the old rock trickling filters are being replaced in the US with plastic media. Plastic cross-flow media type is now commonly used in TFs. Good nitrification requires a second filter after the primary TF or a NTF. Research has shown that cross-flow media may offer better flow distribution than other media, especially at low organic loads (USEPA 2000).

The Philippine National Housing Authority (NHA) opted to utilize trickling filter STPs to service the low-cost medium rise development of Smokey Mountain, a former garbage dumpsite. At the time of the site visit in April 2005, final stages in construction were being completed. The treatment processes consist of two covered trickling filters Figure 7.7 (a), each with a capacity of treating 2 MLD, with a rotary liquid distributer (b), plastic media imported from the US (c and d), and two aerobic sludge digesters.

Figure 7.7 Smokey Mountain Sewage Treatment Plant

The Trickling Filter is a simple, reliable and proven process. A second in-line filter is employed for nitrogen removal and a clarifier is needed post the filters to separate out the sloughed biomass from the filter. Land take can be small if plastic media is employed. Operating costs are lower than AS and sludge production is about one-third that of an AS process (sludge ages of >75 days are common). Modern designs are covered to contain odor and to reduce vector problems. The filters require periodic intensive hydraulic dosing to promote biomass sloughing to prevent the media from clogging and developing anaerobic pockets.

Fixed Bed

Fixed beds employ a biofilm attached to a plastic carrier (often polyethylene) as a base for sessile (i.e. clinging to the surface) microorganisms. The oxygen supply is provided externally, usually by a fine bubble diffused aeration system that delivers air to the bottom of the bed.

Fixed Bed technology (submerged and aerated fixed bed) has been employed for dirty water treatment since 1989 in Europe. This system combines the best characteristics of trickling filter technology with those of the activated sludge procedure, whilst avoiding many of their disadvantages. Successful applications in the field of decentralized domestic dirty water treatment led to an increasing number of installed units around the world. More than 6,000 plants have been put up in Germany in the last ten years (EGL 2005).

Submerged fixed bed systems can be classified into two basic categories for BOD_5 removal, nitrification, and denitrification (MOP 1992) as follows.

- *Fixed film elements submerged in mixed liquor where there is sludge return from the secondary clarifier*. These elements may be suspended in the mixed liquor (for example, Captor, KMT, and Linpor-C) or fixed (for example, Ringlace, submerged RBCs, Bio 2, and Sludge). The fixed film may or may not play the dominant role in biological treatment.
- *Fixed film elements and attached biomass are the primary mechanisms of the treatment process*. Liquid may be recycled, but clarified sludge is not. These processes may use floating (Biostyr), subsided bed (for example, BioCarbone, Biofor), or fluidized-bed (for example, Oxitron, Biolift) media.

Pure fixed beds can be configured in cylindrical or rectangular vessels. Plastic media is available often in blocks and are easily installed. Surface areas (per unit volume of media) between 100 and 200 m^2/m^3 or greater are available. Floating biofilm chambers can also be employed with specific surface ranges from 200 – 1200 m^2/m^3, depending on the specific model of media (EGL 2005). Dirty water is either introduced to the bed in an upflow (Biofor) or downflow configuration (Biocarbone). A study on twelve plants showed that COD removal was proportional to the hydraulic loading as per COD = - 8.6 (hydraulic loading, $m^3/m^2/h$) + 89.56, regardless of the flow direction (detailed in MOP 1992).

Fixed bed processes are designed similarly to activated sludge principles that allow for simple tank construction. Fixed bed biofilm reactors for the treating of sewage are suitable for most sizes, but are commercially attractive up to 20,000 EP (EGL 2005).

The fixed film process is uncomplicated to operate like the TF. Unlike the TF, however, air is mechanically forced through the filter, thus increasing its operating costs. The system is fully contained, allowing easy management of vector problems and odor. A clarifier is again used for settling out the excess biomass sloughed off of the packing. Designs are mostly proprietary and can be expensive.

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Fluidized Bed

Fluidized beds also use attached growth treatment processes. The media on which the bacteria grow can be as traditional as molded [modified] Lessing rings (cylinders with internal divisions) and Pall rings to proprietary designs that are often extruded. Most are made of polypropylene or polyethylene to reduce density. Other carriers such as sand have also been used but require more aeration to maintain fluidisation.

Bacteria attach to the internal structures of the packing (erosion often sloughs sessile growth from the outside surfaces) and the packing is in turn "fluidized" through the force of the incoming air. Treatment intensity is achieved through extreme liquid turbulence in combination with the large surface area of bacteria. Attached sessile bacterial microorganisms are known to be more tolerant than free floating biomass to toxicity changes (e.g. pH, chemicals, temperature, etc) and often produce less than one-half to one-third the amount of waste biomass.

A fluidized, attached biomass system can often be anywhere from 5 to 30 times more intensive than a suspended biomass system such as activated sludge. They are consequently one-fifth to one-thirtieth the volume. Fluidized beds are commonly used as a tertiary treatment for denitrification processes.

Fluidized systems are mostly designed as several in-series reactors, usually a minimum of two. Heavily polluted water (COD in excess of 20,000 mg/L) may require as many as three in-series reactors. This configuration allows for different bacteria populations to exist in each reactor, each interested in a particular fraction of the pollution mixture (e.g. sugars, starches, fats, etc). Instrumentation usually consists of dissolved air meters in each reactor and sometimes thermal couples (high temperatures are often experienced). Air is provided via blowers, usually distributed into the reactor through coarse aeration grids. The presence of fluidized packing also improves the oxygen transfer from the incoming air.

Fluidized systems produce less waste biomass but biomass that can be difficult to settle. The "Kaldness" configuration fluidized bed at the Shoalhaven Paper Mill near Nowra, NSW (Australia) is followed by an activated sludge reactor and a clarifier and subsequently with a dissolved air flotation (DAF) system to ensure removal of the biomass prior to [sensitive] river discharge of the effluent. The "Cranos" configuration, pioneered by ACTEW (now ACTEW-AGL) in Canberra (Australia) employs sand media and operates under pressure (in a pressure vessel). The waste biomass is separated by dropping the pressure (from the system pressure to atmospheric), thus creating a dissolved air flotation (DAF) like environment. To date, this system has been used mostly with municipal dirty waters. In Europe, particularly in colder Scandinavian countries, many STPs have been upgraded via fluidized bed systems.

Fluidized beds are capital intensive but have small land takes and provide good process reliability. There are several Philippine examples, mostly for industrial wastewater treatment.

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7.4.3 Evaluation of Dirty Water Treatment Options

The most promising of the aforementioned biological treatment methodologies for Manila were taken and processes designed for 10 MLD treatment plants. The designs were analysed for both capital and operating costs. These costs were put into a ten-year Net Present Value analysis at 6% for comparison. Biogas from the anaerobic-aerobic process was assumed utilized for electrical generation as shown in **Figure 7.8**.

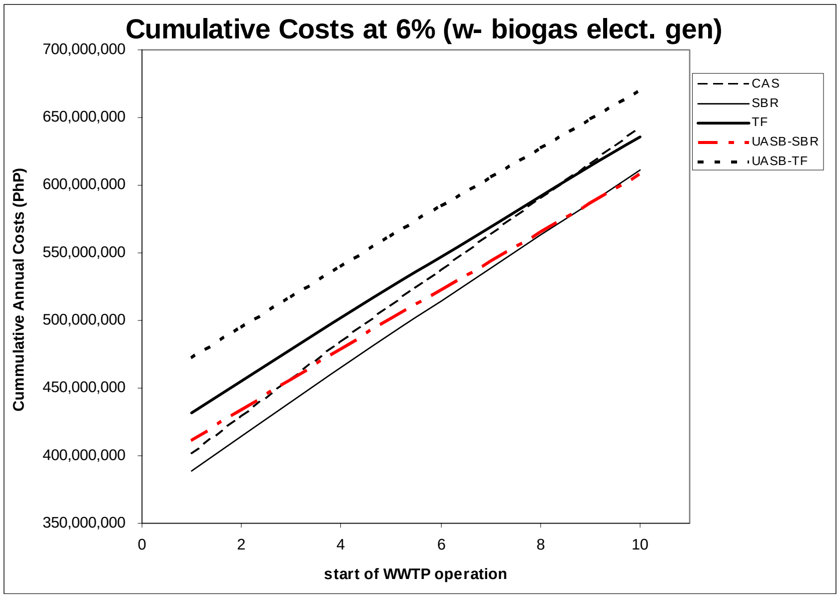

Figure 7.8 NPV analyses for dirty water treatment options

The UASB-SBR combination and the full SBR turned out most economically favourable at the end of 10 year analysis period. The lower operating costs of the UASB eventually overtake its initial higher capital cost. The TF suffered from the expense of its imported [oil-based] plastic packing.

Costs from other references of some of the treatment systems mentioned previously are shown in **Table 7.10**. This also shows the cost benefit of using an anaerobic system and the increased costs associated with nutrient removal.

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Table 7.10 - Comparison of Dirty Water Treatment Technologies

Dirty Water Treatment System	Dirty Water Flow Range	Dirty Water Flow BOD	Reactor Activity kgBOD /	Reactor Activity kg COD /	Estimated Construction Cost* Capita		Estimated Const.Cost* per kg BOD Rem. per Year		Estimated Annual O&M Cost* per kg BOD Rem	
	(MLD)	(kg/d)	m3 / d	m3 / d	($US)	(PhP)	($US)	(PhP)	($US)	(PhP)
Anaerobic										
UASB[1]: Mirzapur, India (1994), 2 x 2,400 m3 reactors	14.0	2,700	0.42	0.73	$7.85	P432	$1.39	P76	$0.01	0.55
UASB[1]: Kanpur, India (1991), 2 x 5,016 m3 reactors, 9 MLD of tannery effluent	36.0	17,400	1.10	2.44	$10.84	P596	$2.29	P126	$0.34	18.70
UASB[1]: Bucaramanga, Colombia (1991), 3 x 3,350 m3 reactors	42.0	6,300	0.48	1.00	$17.83	P981	$2.32	P128	$0.13	7.15
Continuous Activated Sludge										
Cost Estimate 2005 MP Study	10.0	3,000			$92.02	P5,061	$7.00	P385	$0.60	33.00
Bradford, California[8]	27.0	3,436			$100.53	P5,529	$0.06	P3	$0.92	50.60
Oxidation Ditch Activated Sludge										
MTSP: Manggahan Floodway Scheme (catches Laguna Lake flow)[2]	7.8	2,332			$33.49	P1,842	$2.36	P130	$0.33	18.13
MTSP: Alternative Option of Stand-along ODs for Treating Pollution from Hagonoy, Taguig, Labasan and Tapayan Rivers into Laguna Lake (alternative to conjunctive use of flood ponds); for 2025 flows[3]	151.9	34,411			$34.61	P1,903	$2.02	P111	$0.29	15.85
Thornside STP, QLD, Australia (BNR)[4]	7.5	1,680			$319.00	P17,545	$15.63	P860	$1.17 to $1.56	65 to 86
Coolum STP, QLD, Australia (BNR)[4]	5.0	650			$579.00	P31,845	$36.59	P2,012		
Cleveland STP, QLD, Australia (BNR)[4]	9.5	2,500			$243.00	P13,365	$10.14	P558		
Sequencing Batch Reactor										
Foess (2003)	0.4	102			$177.03	P9,737	$18.71	P1,029	$3.23	177.65
MTSP: Poblacion Riverbank STP[2]	1.5	142			$192.78	P10,603	$14.01	P771	$1.06	58.46
MTSP: Ilaya Riverbank STP[2]	2.3	266			$93.45	P5,140	$7.10	P391	$0.87	47.84
MTSP: Capitolyo Riverbank STP[2]	3.9	693			$46.31	P2,547	$3.17	P175	$0.56	30.67
MTSP: Taguig Low Income Scheme[2]	6.1	1,775			$39.65	P2,181	$2.81	P155	$0.36	19.55
Cost Estimate 2005 MP Study	10.0	3,000			$89.61	P4,928	$6.82	P375	$0.56	30.93
MTSP: Quezon City – Marikina sewerage system[2]	10.4	3,120			$83.30	P4,581	$5.73	P174	$0.29	15.97
Bradford, California[8]	27.0	3,436			$157.22	P8,647	$5.73	P267	$1.03	56.65
MTSP: Alternative Option of Stand-along SBRs for Treating Pollution from Hagonoy, Taguig, Labasan and Tapayan Rivers into Laguna Lake (alternative to conjunctive use of flood ponds); for 2025 flows[3]	151.9	34,411			$43.98	P2,419	$2.56	P141	$0.38	21.12
Rotating Biological Contractors										
Foess (2003)	0.4	102			$200.12	P11,007	$21.15	P1,163	$2.89	158.95
Trickling Filters										
Smokey Mountain (Plastic Media)[5]	4.0	1,200			$117.70	P6,474	$3.10	P171	$0.10	5.61
Cost Estimate 2005 MP Study (Plastic Media)	10.0	3,000			$100.76	P5,542	$7.67	P422	$0.50	27.59
USEPA Fact Sheet (rock media)[6]	3.8	680			$89.69	P4,933	$4.25	P234	$5.89	323.93
USEPA Fact Sheet (rock media)[6]	37.8	6,804			$74.82	P4,115	$3.55	P195	$1.40	77.11
USEPA Fact Sheet (rock media)[6]	189.0	34,020			$59.00	P3,245	$2.80	P154	$1.31	71.97
USEPA Fact Sheet (rock media)[6]	378.0	68,040			$74.82	P4,115	$3.55	P195	$1.22	66.83
Fluidized Beds										
Lakefield, Canada[9] (incl. 134 m3/d septage)	2.4	306			$110.67	P6,087	$3.71	P204	$0.99	54.45
Aerated Lagoon										
Westmorland, California[7]	1.9	305			$114.12	P6,277	$3.76	P207	$1.58	86.90

*All costs have been escalated to 2005

[1] Journey et al. (1996)

[2] NJS et al (2004)

[3] MTSP Feasibility Study by NJS et al (2004); flow represents a population of 732,411; assumes 80% H20 use, 7.3 m3/ha/d infiltration, 47g BOD/p/d by 2025

[4] De Haas (2005); BNR denotes STPs that biologically remove N & P; 1AUD=0.76USD

[5] Smokey Mountain personal communication; data provided by contractor

[6] USEPA Fact Sheet (Martin and Martin 1990), traditional designs. A dirty water strength of 180 mgBOD/L and 321 L/p/d was assumed. Numbers were adjusted using US Consumer Price Index.

[7] Westmorland, California http://www.cocef.org/aproyectos/Westmorland_Step_final.pdf

[8] http://www.town.bradfordwestgwillimbury.on.ca/articles/MasterServicingStudy

[9] RAL Engineering LTD. (2004),

The MCA for the treatment technologies in **Figure 7.8** is shown in **Table 7.11**.

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Table 7.11 - Multi-criteria Analysis of Dirty Water Treatment Options for MM

No.	Dirty Water Treatment for Metro Manila Multi-criteria Analysis of Constraints	Selected Weighting (x / 100)	Continuous Activated Sludge (1 to 10)	Sequencing Batch Reactor (SBR) (1 to 10)	Trickling Filter w- Plastic Media (TF) (1 to 10)	Anaerobic (UASB) - SBR (1 to 10)	Anaerobic (UASB) - TF (1 to 10)
			Judgement Rankings				
1	Cultural Acceptability in MM	0					
2	Affordability (NPV @ end of 10yr @ 6%)	25	9.2	9.6	9.3	10.0	9.0
3	Disease Prevention	10	10	10	10	10	10
4	Protection of the Environment	10	8	8	9	9.5	10
5	Consistency with MWCI and/or MWSI Plans	10	10	10	10	9	9
6	Land Take	20	8.5	9.2	7.6	10	7.0
7	Traffic Disruption	0					
8	System Design & Complexity	5	7	7	8	6	6
9	Operations & Maintenance Costs	10	8.1	8.8	9.6	10.0	10.0
10	Management of Flow / Pollution Loads	5	10	10	10	10	10
11	Management/Recycle of Residuals	5	8.5	8.5	9	9.5	10.0
	TOTAL WEIGHTING (should be 100):	**100**					
	INDIVIDUAL SCORES (x / 1000 max):		**888**	**920**	**904**	**963**	**885**
	HIGHEST SCORE:		**Anaerobic (UASB) - SBR**				

The MCA was weighted heavily (25%) toward affordability and yielded that the **UASB-SBR** and **SBR** methods are the most preferred methodologies for dirty water treatment in MM of those five processes considered. The MTSP Master Plan (NJS, 2004) also preferred the use of SBRs and oxidation ditches of the treatment trains they considered. The UASB-SBR also came up with the smallest requirement for land.

7.4.4 The Selected Dirty Water Treatment Approach for Metro Manila

- Generally use an Anaerobic-Aerobic biotreatment (UASB – SBR) for a system of Decentralized Treatment Plants.
- Employ a simple SBR biotreatment where the UASB – SBR combination is inappropriate: example would include dilute sewage feed.
- Eventually convert the smaller Decentralised Treatment Plants into larger Centralised Treatment Plants.

7.5 Solids Management

7.5.1 Background

In Metro Manila today, there are four sewage treatment plants with total capacity of 67 MLD, serving residential-commercial-institutional and mixed-use development with a total catchment area of 1,765 ha. These operating plants produce digested sewage sludge that is air dried on beds at their respective plant sites. Private entities haul most of the dried sludge to be used for fertilizer mix. Grits, plastics and other debris screened from the influent sewage are collected and co-disposed with other solid wastes.

The large Manila Central Sewerage System disposes sewage via a 2 km outfall pipe offshore into Manila Bay. The Dagat-Dagatan Sewerage System utilises waste stabilization ponds. These two plants essentially generate no sewage sludge for regular disposal, except for the screened debris at the pumping stations and coarse solids at influent grit chamber of the Tondo Pumping Station. Considering the small volumes generated, these wastes are disposed together with garbage.

At present, there is also one Septage Treatment Plant (200 m^3/d capacity for 8 hours or double for 16 hr/day) operating and three proposed plants (total capacity of 2,000 m^3/d) under bidding process and expected to be operational in mid 2007. Treatment of septage is discussed in Chapter 9, but solids generated from septage treatment plants can be considered as sludge/biosolids and are covered in this section.

The rapid urbanisation in Metro Manila and the increasing awareness of degrading environment, make it imperative that sludge production from treatment plants be properly regulated. Rules and regulations (including the recent Clean Water Act) for the environmental discharge of treated effluent are currently covered but it appears not to be the case for the residuals produced from the treatment plant operations.

7.5.2 Definitions

Sludge and Biosolids - The **residuals** of dirty water (sewage) treatment are commonly termed **sludge** or **biosolids**. The Water Environment Federation (WEF) promotes the use of the term biosolids to reflect the fact that wastewater solids are organic products that can be beneficially used. A decision as to when sludge meets beneficial use criteria is determined by compliance with the US EPA 40 CFR Part 503 regulation. The term **sludge** is only used before beneficial use criteria have been achieved, e.g. primary sludge, waste activated sludge, secondary sludge, etc. These sludges are residuals before any stabilization process is made to attain beneficial use criteria. The term **biosolids** is used to describe the residual after beneficial use criteria have been achieved through processes such as stabilization or composting. When it is uncertain whether the beneficial use criteria have been met, the term **solids** is used.

The generation of dirty water treatment **residuals** depends on the treatment process, i.e. the amount and characteristics of solids generated in a treatment plant is affected by how the liquid streams are processed. Biological nutrient removal processes typically produce secondary solids that are harder to dewater. Centrifuge dewatering of anaerobically digested sludge produces centrate with a high ammonia concentration that will increase the ammonia loading to a biological nitrogen removal process.

7.5.3 Sludge Production / Treatment / Disposal by Existing Plants

Several sewerage systems in Metro Manila were visited in March – April 2005 to observe the current operation of the treatment plants and facilities, clarify / update information obtained from reports, and inquire on current problems of the systems. The visits included observations on the treatment / disposal of sludge, septage, and effluent water. A detailed report on the plant visits is presented in *Strategic Action Paper No.10 – Sludge Management and Water Recycling for Metro Manila.*

Table 7.12 presents a summary of the treatment processes and theoretical estimates of the generated sludge from the wastewater treatment plants in Metro Manila.

Table 7.12- Estimate of Sludge Output of Existing Treatment Plants

System	Service Area (ha)	Plant Capacity	Treatment Process	Dry Sludge Estimate (tons/day)	Remarks
Sewage Treatment Plants (STP)		MLD			
1. Magallanes WWTP	600	40	Activated sludge	11	At maximum capacity with BOD_{in}=400 mg/L
2. Ayala Alabang STP	350	10	Activated sludge	3	
3. Filinvest Alabang WWTP	375	11.7	Activated Sludge	3	At maximum capacity with BOD_{in}=400 mg/L Plant capacity is for partial development
4. Global City	440	5.3	Activated Sludge	2	At maximum capacity with BOD_{in}=500 mg/L. Present capacity for partial development
Small Community STPs					
5. Quezon City (10 sites)	604	22.2	Activated Sludge	3	At maximum capacity with BOD_{in}=250 mg/L
6. Makati/Mandaluyong (2)	11.5	1.1	Activated Sludge	0.2	
7. Karangalan Village (9) (Cainta & Pasig)		7.5	Activated Sludge	1	
8. Taguig City (5)		4.8	Activated Sludge	1	
9. Smokey Mountain NHA		4	TrickLing filter	1	At maximum capacity with BOD_{in}=300 mg/L
Septage Treatment Plants (SpTPs)					
1. Dagat-Dagatan	MWSI	200 m^3/d	Screening, dewatering, biological	31	Started operating March 2005
2. Antipolo SpTP	MWCI	600	-do-	93	For construction,

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System	Service Area (ha)	Plant Capacity	Treatment Process	Dry Sludge Estimate (tons/day)	Remarks
Sewage Treatment Plants (STP)		MLD			
3. South SpTP, Taguig City	MWCI	800 2000 (sewage)	-do- + SBR	124 +0.4	expected to operate mid 2007
4. North SpTP, San Mateo	MWCI	600	-do-	93	

Notes:
- (i) Present sewage / septage influent are below plant capacities
- (ii) Waste stabilization pond system for Dagat-Dagatan and Bay outfall of Manila Central Sewerage System do not generate sludge for regular disposal.
- (iii) Private wastewater treatment plants serving commercial establishments are not included.
- (iv) Biosolids production in SpTP is based on the F/S of the 600 kL Antipolo SpTP assuming septage treatment by lime stabilization and dewatering.

7.5.4 Previous Studies on Sludge Management

The most recent relevant studies that address sludge management were the 2000 West Zone Sewerage Master Plan, prepared by PhilAqua and the 2004 MWCI Biosolids Management Strategy prepared by GHD. The outcomes of these two studies are discussed briefly below.

(a) 2000 West Zone Sewerage Master Plan (PhilAqua)

The proposed sewerage master plan for the West concession area comprised sewer networks draining into trunk mains leading to three STPs at the shores of Manila Bay, where enhanced primary treatment of sewage was proposed.

Sludge Disposal - To reduce the amount of land required at the proposed STPs, sludge was to be transported off-site for further treatment at locations where the price of land is lower. Since STPs were to be located along the Bay, barges would be used to transport the thickened liquid sludge to treatment and disposal sites located along Manila Bay north of Manila. Buffer storage tanks should have sufficient capacity to store the thickened sludge for four days. These buffer tanks should normally be kept almost empty so sludge could be transported as soon as possible. Several potential sites had been identified where biosolids maybe developed for reuse.

The sludge was to be pumped from the barges into the deep lagoons where it would be held for a period of up to 12 months, during which time it would be stabilized by the anaerobic digestion process. A small proportion of the stabilised sludge might be re-used in slurry (liquid and solid mix) form for application to agricultural or forestry land. It would also be beneficial if the biosolids were to be marketed in solid or cake form.

Since there might not be a large market for the re-use of all the biosolids produced, the excess could either be disposed in a landfill site or retained for possible future re-use. There is no known opportunity for co-disposal of biosolids with municipal solid waste. Bunded and lined monofill landfill areas could be developed for disposal of surplus de-watered biosolids.

Sludge quantities generated by the enhanced sewage primary treatment for processing by the Biosolids Treatment Works (TW) were estimated and shown in **Table 7.13** below.

Table 7.13 – Estimated Sludge Generated by West Comcession MP STPs

Period **<u>TW Type</u>** ***Location***	**Design Population Equivalent**	**Tons of Dry Solids per Day**	**Required Land Area for TW (ha)**	**Treatment Works (TW) Process**
2001 to 2006 <u>Biosolids TW</u> *1 Site*	2,787,000	108	53	BUF – Barge Unloading Facility ADL – Anaerobic Digestion Lagoons BDP – Biosolids Dewatering Plant CTL – Centrate Treatment Lagoons BSA – Biosolids Storage Area
2007 to 2011 <u>Biosolids TW</u> *1 Site*	4,202,000	176	97	Site 1 - Extend: ADL, CTL, BSA
2012 to 2016 <u>Biosolids TW</u> *2 Sites*	6,103,000	281	198	Site 2: New BUF. ADL. BDP, CTL, BSA
2017 to 2021 <u>Biosolids TW</u> *3 Sites*	7,969,000	614	382	Site3: New: BUF, ADL, BDP, CTL, BSA

(b) 2004 MWCI Biosolids Management Strategy: Options Study (GHD Pty Ltd)

The Study commissioned by MWCI aimed to improve and streamline current biosolids management practices in anticipation of the significant increases in the rate of biosolids generation (from 95 m^3/d to around 400 m^3/d of dry solids) from the current and future sewage / septage treatment plants.

The Study had the following conclusions:

- Biosolids produced from the MWCI Plants are unstabilized. The use of biosolids should be restricted and applied to land, adopting international practices;
- Current viable markets (i.e. disposal options) include the rehabilitation of the lahar fields and in extensive agriculture in nearby provinces;
- In the short-term, management of the application of biosolids in these markets needs to be improved for health and safety reasons, and to avoid potential environmental harm in the long-term. This should include reviewing the current practice of distributing dried sludge to third parties;
- The production of higher quality biosolids will create alternative markets, which are likely to be closer to Metro Manila and transportation costs will be lower;
- Having a range of viable markets will reduce risks for MWCI in case the current options are restricted, like potential disruption due to storms and other unforeseen events; and
- A landfill option would play a significant role in contingency planning.

Based on the outcomes of the Study, strategies for a short-term (up to 2005), medium-term (2005-2010) and long-term (beyond 2010) were proposed.

The strategies identified the biosolids markets and the appropriate technologies for sludge stabilization. The biosolids markets include: lahar application, extensive or intensive agriculture, transport/management, and disposal. The identified technology for sludge treatment include stabilization and dewatering. The markets and technologies are developed progressively.

The Study identified the potential biosolids reuse market sectors as follows:

- Extensive agriculture such as livestock and pasture production, broad cropping or plantation forestry;
- Intensive agriculture such as nurseries, fruit and orchard growing, market gardening, turf grass growing, etc;
- Land rehabilitation such as land/mine-site reclamation, landfill, erosion stabilization;
- Landscaping such as domestic horticulture, municipal parks, sports ground, etc;
- Energy recovery such as gasification, pyrolysis, anaerobic digestion, etc; and
- Bioremediation for contaminated soils.

The Study recommended high priority for extensive agriculture and land rehabilitation considering the lower quality sludge for these markets. Low priority is recommended for landscaping and intensive agriculture due to the higher quality sludge required and the demand is not as large as for extensive agriculture and land reclamation.

The estimates of the dry solids by the sewage treatment plants (shown as STPs below) and septage treatment plants (shown as SpTPs below) are given in **Table 7.14** below.

Table 7.14 – Estimate of Dry Solids Generated by MWCI Treatment Facilities

Source	Dry Solids (kg/d)	Transport Volume (m^3 / day)	Type of Biosolids	Remarks
Magallanes STP	1,500 to 2,000	4 to 7	Stabilised and Dried Sludge	Anaerobic Digester and sludge drying beds
Pabahay Village STP	8	1	Liquid Sludge	Sludge holding tanks on-site. To septage tanks
Villa Verde STP	1.5	0.15	Liquid Sludge	Sludge holding tanks on-site. To septage tanks
Karangalan Village STP	7	0.4	Liquid Sludge	Sludge holding tanks on-site. To septage tanks
MSSP STPs	550	2.2	Liquid Sludge	Plate filter pressed on site. No stabilization
MTSP STPs	31,300	125	Liquid Sludge	Plate filter pressed on site. No stabilization
MTSP STPs	794	32	Liquid Sludge	Thickening only
MSSP STPs (JFE)	1,276	160	Liquid Sludge	Holding tanks prior to transport to STP
PRRC SpTP	90,000	90	Stabilised	Screw press and lime stabilization
Payatas SpTP	22,200	74	Wet Septage	Limited to dewatering of septage
Taguid SpTP	31,000	103	Wet Septage	Limited to dewatering of septage

7.5.5 Sludge Treatment and Disposal (Biosolids Management)

7.5.5.1 General

There are various sources of sludge in the sewage treatment process as illustrated in **Figure 7.9**. The grit (sand, broken glass, plastics, etc) collected in the grit chamber is solid materials and are not considered sludge. Raw sludge settled at the bottom of primary clarifiers contains about 3% to 8% solids (approximately 70% organic). It rapidly becomes anaerobic and highly odiferous. This sludge is usually thickened using gravity thickeners. Secondary sludge, or wasted sludge from secondary treatment processes, consists of microorganisms and inert materials that are about 90% organic. In the absence of air, it becomes anaerobic and emits noxious odors. Trickling filter sludge has higher solids content (2 to 5%) than wasted activated sludge (0.5 to 2%). When the aeration tank also serves as a reaction basin for phosphorus removal, the secondary sludge produced contains large amounts of chemical precipitates (Davis and Cornwell 1995).

The characteristics of tertiary sludge vary depending on the tertiary treatment process involved. In the removal of phosphorus, the sludge produced is difficult to handle and treat. In nitrogen removal by denitrification, the resulting biological sludge has properties similar to those of waste activated sludge.

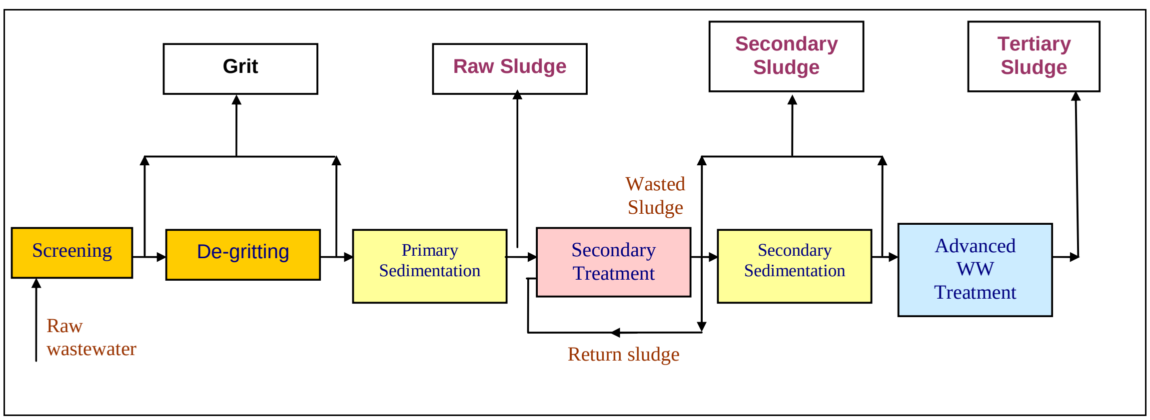

Figure 7.9 - Solids Flow in a Dirty Water Treatment Process

7.5.5.2 Biosolids Handling

The basic treatment processes for sludge/biosolids include the following:

a) Thickening

Sludge thickening is the process of reducing the water content of sludge to about 4% (secondary sludge) or 7% (primary sludge). The primary objective of this process is to remove as much water as possible prior to sludge digestion or final dewatering. This can be achieved using gravity thickeners or flotation units. In gravity thickening, the sludge that settles to the bottom is scraped into a hopper. In the flotation process, pressurized air

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is injected into the sludge. As the sludge flows into an open tank at atmospheric pressure, solid particles attach to the minute air bubbles coming out of the sludge. This sludge layer can be removed by skimming.

b) Stabilization

Stabilizing the sludge eliminates the unpleasant odors emitted during putrefaction through biochemical breakdown of organics in the sludge. Sludge stabilization techniques include anaerobic/aerobic digestion, lime stabilization, composting, and thermal drying. Currently, there is no requirement to stabilize sludge prior to disposal.

c) Conditioning

Sludge conditioning is the treatment of sludge with chemicals or heat to enhance water separation. In chemical conditioning, the coagulants (such as ferric chloride, lime, cationic/anionic polymers, and ash from incinerators) added to the sludge act to clump the solids together. In sludge conditioning by heat treatment, the sludge is subjected to high temperatures (175 to 230°C) and pressures (1000 to 2000 kPa) thereby releasing the bound liquid in the sludge. Sludge conditioned through this process dewaters better than chemically conditioned sludge. However, the operation and maintenance of thermal conditioning units is more complex.

d) Dewatering

The final separation of water and solids in sludge can be achieved by subjecting the sludge to vacuum, high pressure, or drying. Common equipment include: drying beds, vacuum presses, belt filters, and centrifugal filters.

7.5.5.3 Sludge Production Estimates

Considering the projected population during the planning period years 2005-2025 and the concession area targets, the estimated sludge/biosolids production in the MWSS service area is shown in **Table 7.15.** Sludge/biosolids generation in the sewered areas exhibits an increasing trend but is much smaller compared to that from non-sewered areas, which is relatively constant. These trends are attributed to the increasing sewerage targets and decreasing sanitation targets, as reflected in the concession targets.

Table 7.15 - Estimated sludge/biosolids production

Design year	Served Population	Sludge from sewered area, in metric tons/day	Sludge from non-sewered area (septic tanks), in metric tons/day
2010	**15,017,380**	48.85	1, 473.3
2015	**16,436,369**	88.69	1, 487.9
2020	**17,929,483**	111.8	1, 170.6
2025	**19,494,777**	197.2	1, 304.5

7.5.5.4 Sludge/Biosolids Disposal Alternatives

There are a number of disposal/management options for the residuals in sewage treatment. Some of the important and practical alternatives are discussed below:

a. Disposal to landfill

In landfilling, the sludge is buried in excavated trenches and covered with soil. The sludge can be buried either wet or dewatered. Incinerated sludge can also be disposed to a land fill. In general, the highest disposal costs are associated with the disposal of untreated wet sludge. Disposal costs decline with the reduction of sludge volume.

Septage collected from septic tanks may be co-disposed with solid waste at controlled proportions. This option is limited to areas with precipitation rates of less than 90 cm/year. The disadvantages of this method include: possible vector attraction issues, foul odors, and leachate production and requirement for treatment. Advantages include biological activation of the landfill with increased disposal volume created.

b. Lagooning

When STPs are located in remote areas, untreated or digested sludge can be deposited in lagoons (earthen basins). The solids settle to the bottom of the lagoon. Any excess liquid from the sludge may be returned to the treatment plant. When cleaning is to be done by scraping after lagoon is dried, the lagoon should be shallow, with depths of about 1-1.5 m.

c. Ocean dumping

Sea disposal of sludge is based on the premise that marine water can naturally assimilate and degrade most organic contaminants in sludge. This is practiced by some Asian countries like Japan and Korea. In the Philippines, the permit to dump is issued by the Philippine Coast Guard.

d. Incineration

If sludge as soil conditioner is impractical, or if a site is not suitable for landfill using dewatered sludge, the sludge may be incinerated. To minimise fuel costs, the sludge must be dewatered before it is incinerated.

Sludge may be incinerated when beneficial use is impractical or a landfill site is not suitable for dewatered sludge. Incineration is capital and energy intensive. To reduce fuel costs, it is recommended that sludge be dewatered prior to incineration.

e. Aquaculture Disposal

Sludge is utilized either as a primary or as a secondary food substance for fish stocks in controlled aquaculture programs. When used as a primary substance, sludge becomes a food stock for fish which are harvested for direct human consumption. When used as a secondary substance (frequently to overcome social stigmas) sludge is used as food stock for fish which are harvested and processed into fish meal. The fish meal is then used as a high protein food supply for carnivorous fish.

f. Beneficial Use as Soil Conditioners

Biosolids can be used as soil conditioner. The most important consideration in this method is the cost of hauling the sludge to a suitable site. Within Metro Manila, this cost is expected to be very high as suitable agricultural areas are distant from the cities. The primary concern in applying the biosolids to soil is the possible presence of residual pathogenic organisms, helminth ova and heavy metals.

Depending on its grade (classification), the biosolids can be applied on top soil or at the sub-surface level. High-grade biosolids can usually be applied on top soil with minimal consideration. Lower-grade biosolids need to be applied at the sub-surface to minimize potential foul odor emissions and vector attraction. In the case of septage applied at the sub-surface level, the nitrogen removal rate is significantly reduced because ammonia volatilization is eliminated.

g. Land Spreading

Land spreading is the process of applying residuals to land for the purpose of recovering nutrients and water, and reclaiming despoiled land such as mine spoils.

7.5.6 Relevant Philippine Rules and Regulations on Biosolids Management

7.5.6.1 Code of Sanitation

The Code of Sanitation (PD 856) has been the basis of rules and regulations imposed for sludge/biosolids management. Chapter XVII of the Code particularly contains provisions for management of sewage, domestic sludge and septage.

With the continuous degradation of the river systems due to indiscriminate dumping of septage collected from individual septic tanks, the DOH in 2004 issued supplemental IRR for Chapter XVII to cover stricter guidelines on collection, transport, treatment and disposal of domestic sludge and septage.

Section 6 of the supplemental IRR recommended mandatory septage and domestic sludge processing and treatment prior to disposal. Treated or processed domestic sludge and septage must be properly disposed off via landfill and land application. However, the Code did not specify pertinent standard limits for the characteristics of sludge prior to disposal. The DOH-approved treatment methods include, but are not limited to the following: thickening, stabilization, conditioning, disinfection, and heat drying.

Prior to disposal, the sludge must be analyzed for nitrogen, phosphorus, potassium, pathogens, essential and heavy metals. In the absence of Philippine set of standard limits, the DOH and DA recommend the adoption of US EPA procedures for biosolid processing and disposal.

7.5.6.2 Clean Water Act

The Clean Water Act (CWA) reiterates the requirement of the PD 856 on mandatory connection of domestic wastewater sources to existing sewerage systems. The CWA mandates the Department of Public Works and Highways to prepare the National Sewerage and Septage Management Program. The program shall include guidelines on sludge management for companies engaged in desludging operations, which would fortify existing guidelines prescribed by the supplemental IRR of PD 856.

Section 8 of the CWA also tasked the DOH to develop standards and guidelines for the disposal of septage and domestic sludge. For land application, the DA is tasked to develop necessary standards prior to land application of the biosolids.

The Bureau of Soil and Water Management (BSWM) of the Department of Agriculture has yet to establish allowable and acceptable limits for biosolids characteristics for the purpose of agricultural productivity enhancement. The DOH is also mandated to develop similar limits (both for sludge and biosolids) for protection of public health and the receiving water environment.

7.5.6.3 USEPA Guidelines Recommended by the DA and DOH

The USEPA, in response to the US Clean Water Act Amendments of 1987, adopted "*The Standards for the Use or Disposal of Sewage Sludge (Title 40 of the Code of Federal Regulations [CFR], Part 503*". It establishes the minimum requirements for biosolids intended for land application. Sludge that exceeds the concentration limits for nine trace elements (listed in **Table 7.16**) may not be directly applied to soil.

Table 7.16 - USEPA Concentration Limits for Trace Elements

Pollutant	CCL [a,b] ppm[f]	PCL [a,c] ppm	CPLR [a,d] lbs/acre
Arsenic	75	41	36
Cadmium	85	39	35
Copper	4600	1500	1340
Lead	840	300	270
Mercury	57	17	16
Molybdenum	75	[e]	[e]
Nickel	420	420	375
Selenium	100	100	89
Zinc	7500	2800	2500

[a] dry weight basis
[b] CCL (Ceiling Concentration limits) = maximum concentration permitted for land application
[c] PCL (Pollutant Concentration Limits) = maximum concentration for biosolids whose trace element pollutant additions do not require tracking (i.e. calculation of the CPLR)
[d] CPLR (Cumulative Pollutant Loading Rate) = total amount of pollutant that can be applied to a site in its lifetime by all bulk solids meeting CCL.
[e] The February 25, 1994 Part 503 Rule amendment deleted molybdenum PCL for sewage sludge applied to agricultural land but retained molybdenum CCL.
[f] ppm = part per million

The Part 503 regulation requires the reduction of pathogens (virus, bacteria, and worms) and vector (rodents, birds and insects) attraction properties of sludge/biosolids. Two types of biosolids, Class A and Class B, are specified based on the levels of pathogen present. Pathogen requirements (**Table 7.17**) for Class A aim to reduce the pathogen levels to below detectable levels. Requirements for Class B are intended to ensure that pathogens have been reduced to levels that are unlikely to cause threat to public health and environment, especially after its disposal. The 503 *Regulations* also enumerate eleven alternatives for vector attraction reduction. These include 38% reduction of volatile biosolids, achievement of oxygen uptake rate of 1.5 mg O_2 per hour per gram dry solids at 20°C, and alkaline stabilization.

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Table 7.17: US EPA Pathogen Requirements for Biosolids

Class A Pathogen Requirements
• Fecal coliform density of less than 1000 most probable number (MPN)/g total dry solids • A Salmonella sp. Density of less than 4 MPN per 4 g dry solids
Class B Pathogen Requirements
• Treatment by processes to significantly reduce pathogens or equivalent processes • At least seven samples should be collected at the time of use or disposal and analyzed for fecal coliform during the monitoring period. The geometric mean of the densities of these samples will be calculated and should meet the following criteria: less than 2.0 x 10^6 MPN/g total solids or less than 2.0 x 10^6 colony forming units (CFU)/g total solids.

The quality of biosolids is classified in terms of the pollutant (trace element) concentrations, pathogen levels, and vector attraction reduction control. The classification determines which land application requirements must be met. Biosolids that meet the Part 503 PCLs, Class A pathogen reduction, and vector attraction reduction option that reduces organic matter are classified as *exceptional quality* or *EQ biosolids*. *Pollutant concentration (PC) biosolids* satisfy the same PCLs as EQ biosolids but it usually meets class B rather than Class A pathogen requirements. *Cumulative Pollutant Loading Rate (CPLR) biosolids* requires tracking of the cumulative metal loadings other than just meeting the PCLs

7.5.6.4 Existing Permitting Procedure in the Philippines for Disposal of Sludge/Biosolids

a) Disposal via Ocean Dumping

The disposal of sludge/biosolids via ocean dumping must secure the following permits shown in **Table 7.18**.

Table 7.18 - Requirements for ocean dumping

Permit	Designated Office	Remarks
Permit to Dump	Philippine Coast Guard	The proponent must submit permit to dump application indicating method of dumping, frequency, volume and the anticipated impacts.
Environmental Compliance Certificate	Environmental Management Bureau	This maybe required by PCG when disposal site is considered environmentally critical.
LGU Endorsement	Affected LGU (provincial offices)	This is part of the ECC documentation but may be required by PCG independent of the ECC.
Certificate of Exemption from RA 6969 (Toxic and Hazardous Waste Act)	National Solid Waste Management Commission	This is required by PCG to certify that wastes being dumped re exempted from RA 6969

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b) Disposal via Landfill

Landfilling of sludge is a DOH approved method of disposal. The environmental and technical criteria on the design and operation of such landfill accepting sludge are stipulated in the 2004 supplemental IRR of PD 856.

The disposal of sludge/biosolids via landfill must conform to the following permitting procedures shown in **Table 7.19.**

Table 7.19 - Requirements for Landfilling the Biosolids

Permit	Designated Office	Remarks
ECC	EMB-DENR	The sanitary landfill must have a valid environmental compliance certificate.
Certificate of Exemption from RA 6969 (Toxic and Hazardous Waste Act)	National Solid Waste Management Commission	This maybe required by the LGU or operator of the landfill to certify that wastes being disposed off are exempted from RA 6969. The proponent must prove this by a comprehensive characterization of their sludge and comparison with existing USEPA standards.

c) Disposal via Land Application for Soil Conditioning

Sludge/biosolids may be applied to land both as a soil conditioner or an organic fertilizer. In both cases, the manufacturer of such products must register with the Fertilizer and Pesticide Authority (FPA), an attached agency of the DA, as a fertilizer manufacturer/distributor. Each product must then be submitted for registration with the same office prior to sales and distribution to end users.

The disposal of sludge/biosolids via land application must conform to the following permitting procedures shown in **Table 7.20**:

Table 7.20 - Requirements for Land Application

Permit	Designated Office	Remarks
ECC with Proof of Social Acceptability	EMB-DENR	The ECC will be required and may be applied in the appropriate EMB regional office.
License as Fertilizer Manufacturer	Fertilizer and Pesticide Authority	The proponent must register as both manufacturer and distributor of fertilizer (organic or soil conditioner).
Certificate of Product Registration	Fertilizer and Pesticide Authority	The proponent must register every product manufactured prior to sales and distribution.

At present both MWCI and MWSI are registered with the FPA as fertilizer manufacturers. MWCI has already registered their domestic dried sludge and domestic liquid sludge as soil conditioners for corn and sugarcane, respectively. MWSI is on the process of securing permanent registration of their products.

The registration took MWCI almost three (3) years prior to securing a permanent product registration. The registration involves the following procedure shown in **Table 7.21.**

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Table 7.21 - MWCI Registration Procedure for Permit to Dispose Biosolids

Procedure	Activities Involved
Initial Phase – Laboratory	• Sludge/septage and soil characterization • Laboratory scale studies • Comparison with US EPA limits
Temporary Registration	• Pilot application on proposed site • Monitoring of soil characteristics (pre and post amendments) for heavy metals, pathogens and nematodes/helminth eggs • Groundwater and surface water monitoring • Crop/ agricultural productivity evaluation • Comparison with US EPA limits for biosolids and sludge-amended soils
Permanent Registration	• Commercial distribution to end users i.e., farmers • Distribution must be supported by manifest. • Annual monitoring of soil • Regular monitoring of surface and groundwater

7.5.7 The Selected Biosolids Management Approach for Metro Manila

Following the non-renewal of the permit to dump septage at sea, the options for biosolids managements are limited to land spreading, beneficial use (soil conditioner), and landfilling. These disposal options are currently practiced by the MWSS Concessionaires, and the operators of private STPs. In the absence of a septage treatment plant, MWCI mixes and spreads collected septage with lahar at a site in Pampanga. The sludge that accumulated in the aerated lagoons at Dagat-Dagatan over its 20-year operation was applied to a farm site in Batangas. Private-owned and managed STPs at the Global City and at Ayala Alabang dispose digested/dried biosolids by on-site land application.

7.5.7.1 Short term

On-site land application of biosolids produced in sewage treatment is recommended for STPs with sufficient land area. The Ayala Alabang, Global City, and Dagat-Dagatan STPs currently adopt this option. In most of the new small STPs built within the east concession area, land space is limited and sludge disposal should be off-site, either by application to nearby agricultural lands or by landfilling. Similarly, septage collected from septic tanks may be land applied after sufficient treatment (drying, digestion, composting and stabilization) is done.

7.5.7.2 Medium term

With the increasing demand for landfills that will accommodate the solid waste generated in Metro Manila, the management options for biosolids should rely less on landfill disposal. Sludge management options should take advantage of the high organic and nutrient content of the residuals from wastewater and septage treatment processes.

A biosolids grading system should be recommended for residuals intended for land application and landfilling. This grading system should consider the local conditions (soil type, climate, land use) in the Philippines. As an alternative to the USEPA guidelines currently being followed, the DOH may consider the South Australian biosolids classification system that govern the re-use of the biosolids as indicated in **Table 7.22.**

Table 7.22 Australian Biosolids Re-use Classification

Biosolids Classification	Allowable Land Application Use	Minimum Quality Grades	
		Contaminant Grade	Stabilization Grade
Unrestricted Use	Home Lawns and gardens Public contact sites and Urban landscaping Agriculture and Forestry Soils and Site rehabilitation Landfill disposal Surface land disposal[2]	A	A
Restricted Use 1	Public contact sites and Urban landscaping Agriculture and Forestry Soils and Site rehabilitation Landfill disposal Surface land disposal[2]	B	A
Restricted Use 2	Agriculture and Forestry Soils and Site rehabilitation Landfill disposal Surface land disposal[2]	C	B
Restricted Use 3	Forestry Soils and Site rehabilitation Landfill disposal Surface land disposal[2]	D	B
Not Suitable for Use	Landfill disposal Surface land disposal[2]	E[1]	C[1]

[1] biosolids products which are not contaminant or stabilization graded are automatically classified *Not suitable for Use*
[2] to be applied within the boundaries of the sewage treatment plant site

7.5.7.3 Long term

The establishment of a management program and marketing strategies for the biosolids will address the disposal issues in the years to come. These program and strategies should address biosolids regulation issues, land availability, economic factors involved, and promotional/information drives among end-users (farm owners).

7.6 Water Recycling & Reuse

Reclaimed or recycled water is not a new development. Historically, rivers have been used to receive effluents from community, agricultural and industrial activities at an upstream location and be drawn downstream for the same water uses. In this study, recycled water is defined as given by the California Water Code as "water which as a result of treatment of waste, is suitable for direct beneficial use or a controlled use that would not otherwise occur."

The effluent from treatment plants (STP & SpTP) is the main source of water for recycling purposes. The reuse of water from these plants reduces (i.e. replaces) demand of potable water for non-potable means. This ensures that sources are reserved for public drinking which is considered as the highest priority of water use.

7.6.1 Trends and Needs for Water Reuse

Recycled water can replace potable water for a multitude of applications. Applicable treatment for the various water requirements, depending on human contact, for each should be made. The need for recycled water in different sectors is listed below.

(a) Agricultural Irrigation
- Irrigation of food and non-food crops
- Pasture and fodder for gazing animals
- Stock water
- Washdown water for stockyards and non-food contact areas of dairies

(b) Municipal
- Irrigation of public parks and gardens, sports fields, school ovals and median strips
- Irrigation of golf courses including those incorporating residential development
- Ornamental landscapes including decorative ponds
- Dust suppression at construction sites and mines

(c) Residential (Non-Potable)
- Garden watering
- Toilet flushing
- Car washing
- Path/wall washing

(d) Industrial
- Cooling system and make-up water
- Boiler feed water
- Process water
- Washdown water
- Fire protection
- Dust control

The prevalent practice in most of the STPs within the service areas of MWCI and MWSI is direct discharge of the plant's effluent to nearby creeks, streams or rivers. Smaller STPs built by MWCI as part of the MSSP Community Septage Program (MCSP) are using recycled water for the flushing of toilets inside the plants. Water recycling methods were being proposed or practiced by only a number of the STPs visited by the study team. These STPs and their water reuse are as follows:

(a) Ayala Alabang STP

The water effluent of the plant is used for irrigation to sustain a variety of flora within the STP grounds. Water hoses are used for irrigation. Benefits of the use of recycled water for irrigation can be seen in the growth of the plants and trees even during the dry season. Chlorinated effluent water is also used for golf course irrigation.

(b) Fort Bonifacio STP

The development in the Fort Bonifacio included purple water pipes for recycled water, in particular, for irrigational purposes. Previous requirements for the locators included recycled water piping for toilet uses. The main pipe from the STP to Fort Bonifacio has yet to been laid.

(c) Guadalupe Bliss STP

The STP at Guadalupe Bliss has made provisions for the collection of Metro Manila Development Authority (MMDA) water trucks. Water is being use to irrigate plants along and in the road islands.

(d) UP Diliman STP

The newly constructed UP Diliman STP also constructed a truck refilling system to accommodate MMDA trucks. Water from the lagoon surrounding the STP is also pumped back to the UP main campus lagoons for polishing (nutrient removal) which also serves as ornamental ponds.

7.6.2 Quality Standards / Rules and Regulations for Disposal / Constraints

The quality standards for water reuse come from the applicable uses. The minimum treatment is preliminary sedimentation or any equivalent solid removal process followed by stabilization process (i.e. lagoon) or full secondary treatment. The recommended detention period for lagoons after preliminary sedimentation should be a minimum of 25 days. This is to remove Helminth eggs as well as reduce effluent concentrations of 1000 thermotolerant (or E.*coli*) /100 mL. Detention period of 60 days removes intestinal protozoa and viruses (EPA, 1999). The treatment processes involve any of the following: Primary Treatment; Secondary Treatment; Tertiary Treatment; Treatment Lagoons; and Disinfection.

The classification of water reuse shall determine the amount of treatment and the usage. In the Philippines, there is no legislation for treatment and reuse of recycled water. The classification is crucial in the determination of health risks involved in the handling of recycled water.

The main constraints in recycled water stem from public perception of it. Locally, the standards set are those only for the attainment of the quality of the receiving body of water for discharge effluents. Further treatment to attain high recycled water reuse is a matter of economic viability.

7.6.3 Estimates of Effluent Volume and Quality (Present and Design Periods)

The amount of wastewater losses inside STPs is concentrated only in the solids removed through the various treatments such as settling and sludge production. The total volume of the losses is but a small percentage of the volume of the wastewater. For this study, the total capacities of the STPs shall be considered the effluent production. The effluent volume of existing STPs is shown in **Table 7.13.**

The effluent qualities of the STPs mentioned are mostly discharging to creeks and rivers within Metro Manila classified under Department of Environment and Natural Resources (DENR) standards as Class C. The effluent quality of the STPs adheres to the effluent standards set under DENR Administrative Order (DAO) 35 for class C inland waters. It is therefore assumed that the quality of effluent from these STPs meet the requirement.

7.6.4 The Selected Water Reuse Approach for Metro Manila

The development of potable water sources and the means to bring it to Metro Manila significantly lags behind the water needs of the demand centers. Besides water conservation, the re-use of effluent from wastewater treatment plants can narrow the gap of supply and demand for water.

Municipal uses such as irrigation for parks and landscapes should be encouraged. The on-going collection of the recycled water from the STPs should be continued on a larger scale. The use may not be limited to roadway irrigation but for road construction and rehabilitation works. Nearby fire departments may also use recycled water as added reserve for fire trucks.

The potential use of recycled water for processes should also be further investigated. The water demand of applicable non-sensitive processes, i.e. boiler feed and cooling systems, may be satisfied by the use of recycled water. Further enhance treatment such as decrease in the level of microorganisms (pathogens and coliform counts) should occur at high temperatures associated with the said processes. Return system of recycled water for industrial uses may restrict expandability to the vicinity of the STPs.

The largest demand for recycled water in Metro Manila may be for irrigational purposes. Nitrogen, phosphorous and potassium removal is not part of sewage and septage treatment currently, making the effluent from the STPs rich in nutrients. Golf courses and agricultural land can benefit from the added nutrients being supplied by the recycled water. Cost savings from a decrease in required fertilizer is also an advantage of using recycled water. Reuse of effluent water will also prevent the effects of eutrification such as water hyacinth and algal bloom in the receiving bodies of water.

The following strategies for water re-use are proposed in the short, medium and long term.

(a) Short Term

The short term plan for the reuse of water should be concentrated on irrigation and other municipal uses. This produces the most immediate and least-cost alternative to be readily implemented.

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(b) Medium Term

The marketing of recycled water to agriculture and industrial uses may be addressed as the medium term. Establishment of recycled water return systems for toilets and other non-potable domestic uses can expand recycled water demand.

(c) Long Term

The establishment of a recycled water management program can address the need, treatment, and standards required for the safe distribution and use of recycled water. This should encompass the long term viability of the reuse of water.

Abstract

The Metropolitan Waterworks and Sewerage System service area consists of 16 cities and 21 municipalities with a 2000 population of 12.4 million that is projected to increase to 19.5 million by 2025. Domestic sewage is reported to account for 60 to 65% of the pollution loading on the Pasig River as Metro Manila is only about 12% sewered. Those in Metro Manila not connected to sewerage are served by over 2 million ill-maintained septic tanks, with almost no pump out services, which overflow into the storm drains. Up to 30% of these septic tanks are estimated to be inaccessible for pumpout.

Storm drains ultimately terminate in local esteros, to rivers (Pasig River being the major one) and eventually to either Manila Bay or to the potential future water source Laguna de Bay. These three main receiving waters in Metro Manila exhibit varying degrees of environmental degradation in spite of being a source of food, livelihood, employment, and recreation to an estimated 23 million Filipinos within its 17,000 km^2 watershed (World Bank). A World Bank report in 2003 indicated that water pollution costs the Philippine economy P67b ($US1.22b) per year, inclusive of health costs, fishery damage and loss of tourism.

MWSS received a Technical Assistance (TA) grant from the World Bank to affect a partial update of the Water Supply Master Plan and the preparation of a comprehensive Master Plan for Sewerage and Sanitation for the MWSS service area, covering the planning time horizon of 2005 to 2025.

There were three sewerage and sanitation master plans prepared prior to MWSS being privatized in 1997 to two private concessionaires: Manila Water Company, Inc. for the East Zone of the MWSS service area and Maynilad Water Services Inc. for the West Zone. All the master plans were either not implemented or only partially due to proposing conventional, large-bore, gravity sewerage systems that were too expensive to implement. This was been compounded by the fact that in the last few years dirty water (sewage) management has had a low priority as evidenced by the fact that only three percent (3%) of the budget allocated for water projects in the Philippines is channelled to sanitation and sewerage. A willingness-to-pay survey conducted as part of this study, however, indicated that around 75% of the 2,000 participants, spread across the service area, were willing to pay 20 to 40% on top of their water bills for improved sewerage and sanitation.

The most suited options for Metro Manila for sewerage, sanitation and treatment were identified by evaluating the options for each with a multi-criteria analysis (MCA). Amongst the constraints considered in the MCA, affordability was heavily weighted. The MCA identified:

- *Sanitation*- the Aqua Privy was the most suitable sanitation for lower income, informal settlements with no public toilets and the two chamber septic tank was preferred over other septic tank designs,
- *Sewerage*- combined drainage scored the highest due to its lower capital cost but was followed closely by the small-bore sewerage options such as Septic Tank Effluent Disposal or STED and condominial, and
- *Treatment*- a system that contains a combination anaerobic-aerobic biological treatment scored the highest due to its lower operating costs. A purely aerobic biological treatment was second ranked for use with dilute sewage.

The MCA, consultation with MWSS and the two concessionaires, and a review of the available documentation helped identify the overall strategy for the Sewerage and Sanitation Master Plans:

- Keep Septic Tanks (over 2m already); Pump Out Tanks Regularly, Catch Overflow for Treatment;
- Use Combined Drainage & Small-bore Sewerage for decentralised systems; and
- Move Sewage from East to West (away from Laguna Lake Water Source) in Continually More Centralised Plants.

The Sanitation Master Plan recognized that the keeping of septic tanks and the use of STED would have to involve an active sanitation program, which includes active septic tank pumpouts and subsequent treatment of septage to DENR Class C standards. Three septage treatment plants were being bid as of November 2005. To cover the whole of the planning period of 2005 to 2005, additional trucks will have to be purchased as will additional treatment capacity constructed. The Sanitation Master Plan proposed a schedule for these activities at a cost of Php7.02 b ($US128 m) in 2005 currencies. O & M costs would rise from P196m ($US3.6m) per annum in the first five years to P484m ($US8.8m) by 2025.

Dirty water (sewage) flows were taken as 80% of water consumption plus infiltration for the study. The MWSS service area was split up into 31 separate drainage catchments and each was analysed for the best system to suit its particular circumstances. Areas that had good drainage received combined drainage, all other areas received STED reticulation. Priority was assigned by the concessionaire sewerage targets that came out of the 2003 Rate Rebasing. After the concession period of 2021 to 2025, priority was assigned according to population density, environmental sensitivity and the ability to pay. A plan was also advanced for the period well beyond the planning period of 2025.

The cost of sewerage for the planning period was Php52b ($US0.95b) in 2005 currencies, comprised of reticulation (40%), trunk main sewers (8%), 16 STPs (39%), and land of 34 ha (13%). At the end of the planning period sewerage coverage would amount to 33%. The financial analyses revealed that for sanitation, the tariff based on average increment cost (AIC) at a discount rate of 10.4% was lower that the willingness-to-pay (WTP) level and Affordability rates (i.e. 5% of household mean income for water). This was not true for the case of sewerage, where the AIC rates for both West Zone and East Zone were much higher than the WTP and Affordability rates. The total water bill when sewerage is taken into account would be about 6 percent to 9 percent of the household mean income of Php20,856 per month.

One way to resolve this apparent un-affordability of even low-cost sewerage would be employ a cross-subsidy among consumer groups. A flat fee as a percentage of the water bill could be charged to all water customers, whether they are connected to sewerage or not. The individual tariff would subsequently be lowered to a more affordable level and everyone benefits from environmental improvement. It should be noted that all options had Economic Internal Rate Return (EIRR) values that exceeded the economic opportunity cost of capital of 12%.

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1. Introduction

1.1 Background

The Metropolitan Waterworks and Sewerage System (MWSS) is a Philippine government owned and controlled corporation responsible for the provision of water, sewerage and sanitation services in Metro Manila (MM). In 1997, its operations became privatized through entering into concession agreements with two concessionaires who now are responsible for the provision of water, sewerage and sanitation services: the Manila Water Company Inc.(for the East Zone of Metro Manila) and Maynilad Water Services Inc. (for the West Zone of Metro Manila).

The concessionaires are to provide water supply services to meet Philippine National Drinking Water Standards; sewerage services to meet all national and local government laws and standards; and septic and sanitation cleaning services, defined as the emptying of domestic septic tanks and subsequent sludge management at regular intervals of five to seven years, in accordance with the Concession Agreements.

The MWSS service area consists of 16 cities and 21 municipalities with a population of 12.4 million as of the year 2000. Population influx into Metro Manila, unregulated industrial development and the absence or non-implementation of zoning ordinances and environmental regulations have overloaded the infrastructure and promoted rapid environmental deterioration.

Domestic wastewater is reported to account for 50% of the total water pollution in the Philippines and about 65% of the pollution loading on Pasig River. Metro Manila is estimated to be between 8 and 12% sewered, with the Central Sewerage System in Manila City contributing over 80% of this amount. Sewage from this system discharges through an extended outfall into Manila Bay. The remaining 20% of the existing sewered areas discharge to sewage treatment plants in Makati, Dagat-Dagatan and several small, decentralized sewage treatment facilities in Quezon City. There are also various sewerage systems serving a mix of residential and commercial developments, including new systems serving new real estate property development by private developers. The rest of the population of the service area is either connected to over 2 million septic tanks that are rarely pumped out and overflow into the storm drains and ultimately to rivers and esteros and Manila Bay or Laguna de Bay, or unconnected to any form of sanitation facility but discharge directly to the storm water system.

There is a need for MWSS to produce high quality strategic planning to meet the water and sanitation/sewerage needs of an expanding service population for the next 20 years. To this end, MWSS has received a Technical Assistance (TA) financing from the World Bank, through the Japan Policy and Human Resources Development, toward the cost of the Strengthening of Planning of Water Supply, Sewerage and Sanitation Services in the service area of MWSS. Under this financing, MWSS applied part of the proceeds for consultant services that included:

a) Updating of the MWSS water supply, sewerage and sanitation master plan, including developing specific plans to address government efforts in cleaning-up of Pasig River and Manila Bay as well as the possible passage of Clean Water Act;

b) Analysis of technical options and identifying least cost options to address environmental degradation in Metro Manila;

c) Determining the appropriate policy on sewer charges, including the extent of subsidy, as necessary; and

d) Conduct of a study on willingness to pay of communities for sewerage and sanitation services.

MWSS internationally tendered the work in 2004 and work was commenced in March 2005 by the winning consultants, Sinclair Knight Merz in association with DCCD Engineering Corporation.

1.2 Scope of Report

This report presents a full update of the previous Sewerage and Sanitation Master Plans prepared for Metro Manila. The most recent was the 1996 Water Supply and Sewerage Master Plan prepared for MWSS and the Japanese International Cooperation Agency (JICA) by Nippon Jogesuido Sekkei Co. Ltd (NJS). Subsequent to this, separate sewerage and sanitation master plans for the East and West Zones were prepared for the concessionaires, viz. for the West Zone by PhilAqua Consultants (2000) and for the East Zone by NJS (2004). The West Zone Master Plan was not officially accepted and is not currently being implemented. However, the East Zone Master Plan became the basis for the Manila Third Sewerage Project (MTSP) that is funded under a World Bank loan.

The scope of this report was to develop an integrated strategy for sewerage and sanitation services across the entire MWSS service area that will take into account the targets, plans and programs of the concessionaires, including MTSP. The strategy was to address the environmental degradation of the water bodies in Metro Manila by providing affordable solutions to the disposal and treatment of domestic wastewater within and beyond the concession period.

The report therefore examined existing sewerage and sanitation facilities and the targets, plans and programs of the concessionaires in the context of recommending least cost technical solutions for sanitation, wastewater collection and treatment. Issues that have constrained the development of sewerage and sanitation facilities in Metro Manila in the past were examined in order to guide the strategy such that these constraints could be addressed. Taking into account the targets of the concessionaires, short, medium and long-term strategies for sewerage and sanitation were developed and costed. Phased development programs covering the Master Plan planning periods were prepared, based on affordability and willingness-to-pay criteria. A willingness-to-pay survey was conducted with respondents from the East and West Zones to provide input into the Master Plan. Options for charging consumers for sewerage and sanitation services were also developed.

The report also examined the institutional framework needed to support future planning and implementation of sewerage and sanitation development in Metro Manila to effectively deliver the Master Plan. Recommendations on strategies to strengthen the MWSS's capability and capacity were made to enable MWSS to more efficiently deliver their services.

The study drew heavily on the plans and knowledge of MWSS and the two concessionaires, Manila Water Company Inc. (MWCI) and Maynilad Water Services Inc. (MWSI), whose assistance in the preparation of this study is acknowledged and is greatly appreciated.

1.3 Study Objectives

The objectives of the study were to:

1. Analyze government policies, laws and regulations for the sector (including the Clean Water Act) and liaise with the regulatory agencies in the sector, including DENR and LLDA to determine the environmental and other targets for the sector.
2. Analyze the implementation constraints in the sewerage and sanitation sectors existing in Metro Manila and determine the implication of these on both a centralized or decentralized strategy for service provision.
3. Analyze different scales of potential decentralization, paying particular attention to the widely varying land use types in Metro Manila.
4. Analyze ways in which a decentralized system could be implemented in the short term such that in the future, gradual centralization can occur through, for example, connections between the decentralized systems.
5. Analyze the state of the existing sewerage and sanitation system to ensure the use of this existing system is maximized.
6. Based on the analyses carried out, establish in agreement with MWSS, the overall long-term strategy for the sewerage and sanitation sectors in Metro Manila.
7. Review MWSS' master plan prepared in 1996 prior to privatization, the subsequent wastewater strategy prepared by MWCI and other relevant existing planning documents and determine areas for updating considering progress made in service provision by the concessionaires and the targets and strategies developed for the long-term strategy.
8. Review the master plans and investment programs of the concessionaires that were prepared within the context of the Concession Agreement and subsequent rate rebasing to ensure they are consistent with the Consultant's updated master plans.
9. Conduct a full technical assessment of the pilot sewage treatment plants, communal septic tanks, septage facilities and other infrastructure already constructed by MWCI in the east zone to assess their repeatability in other areas of the city.
10. Conduct an analysis of technical options (including but not limited to those piloted by MWCI). Determine least cost options within the overall framework of the agreed master plan strategy considering global best practices.

11. Prepare an updated MWSS sewerage and sanitation master plan to the year 2025, including cost, economic and financial analysis and with optimized five-yearly implementation plans.
12. Using a methodology that focuses on stakeholder consultation, conduct a willingness-to-pay survey of consumers presenting different levels of cost recovery and determining at what level of cost recovery private benefits could be internalized in the sewer charge.
13. Conduct an analysis of the affordability of sewer charges considering the updated sewerage and sanitation master plan and propose a policy of cost recovery, including any subsidies, as necessary.

1.4 Study Area

The study area addressed by this full update of the sewerage and sanitation master plan for Metro Manila is shown in **Figure 1.1.** This is the MWSS service area that currently covers 16 cities and 21 municipalities within the National Capital Region, the Province of Rizal and the Province of Cavite with a total land area of approximately 2,371 square kilometers.

The area comprises the two concession areas defined for water, sewerage and sanitation services delivery in Metro Manila, which makes up the total MWSS service area. The study area is essentially defined based on municipal boundaries rather than geophysical or supply limiting borders.

Further detailed description of the study area is found in Chapter 2.

1.5 Target Year

The Terms of Reference for the Study defined the time frame for the Master Plan to be up until 2020. However, there was also a requirement that a Master Plan be prepared that would consider the requirements both up to and beyond the end of the concession period in 2022. There are always risks in accurately planning for an excessive future time period, due to changes in social, economic and environmental conditions that can impact on many of the assumptions such as population projections, water demand, and affordability of services.

The National Government agencies and the LGUs limit their planning and population projections to about 20 years. This is a reasonable approach given the current residential growth rates in Metro Manila. Future population projections can be influenced by changes in government policies such as family planning and birth control programs. The spatial allocation of population may vary depending on future transportation and land development programs that cannot be foreseen at the present time.

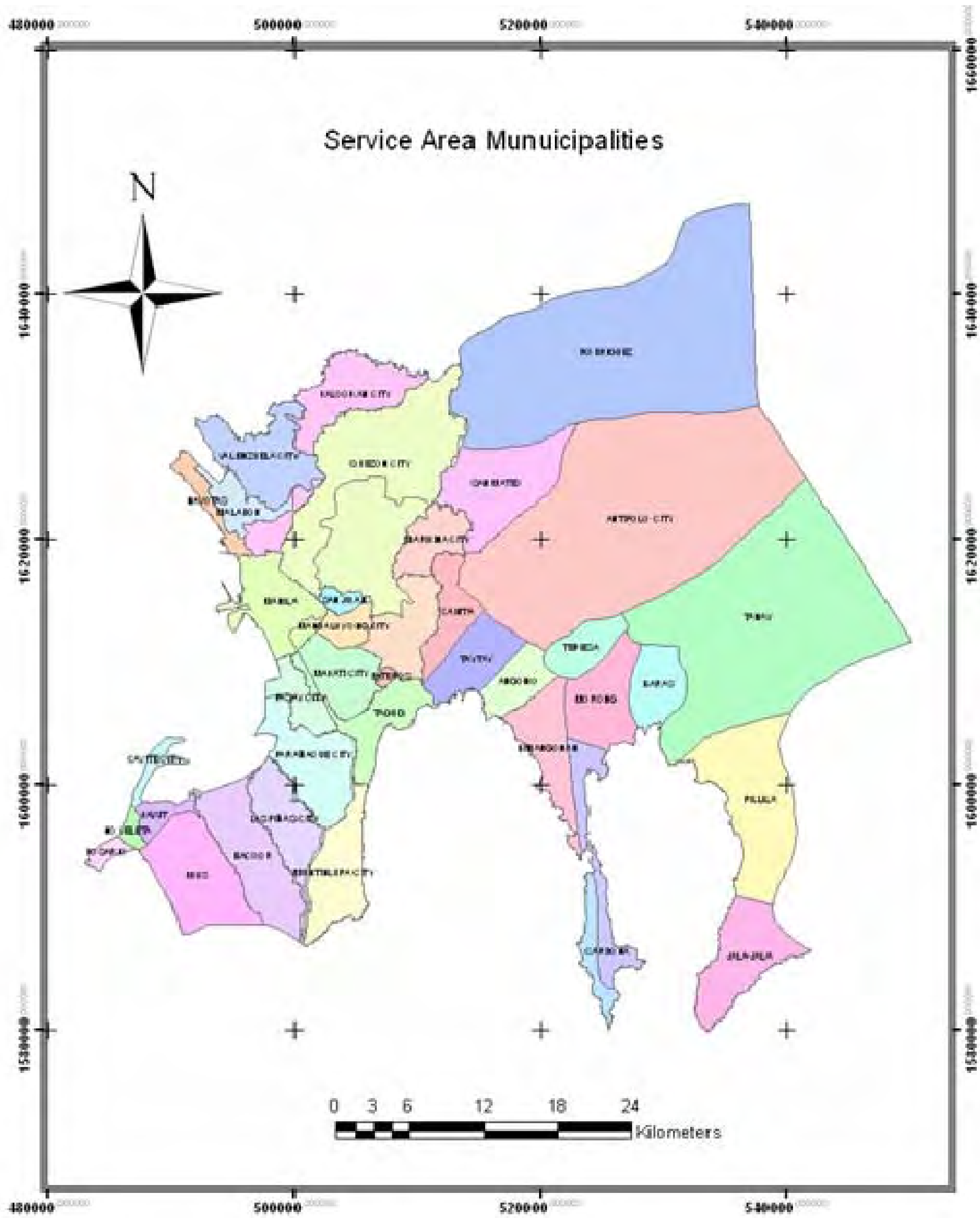

Figure 1.1 MWSS Service Area, 2000

Overall, it was considered that a timeframe of 20 years is reasonable for this update of the sewerage and sanitation master plan for Metro Manila, culminating at Year 2025.

1.6 Basis of Study

This study sourced data from previous Master Plans and studies, from information provided by the MWSS Corporate and Regulatory Offices and from the concessionaires. However, all significant existing facilities were inspected by the study team. Cost data was obtained from a number of different sources and approaches to sanitation, sewerage, and sewage treatment were developed as an independent assessment of the possible alternatives.

Some of the key documents used for reference on this study included:

- *Master Plan for a Sewerage System for the Manila Metropolitan Area – Final Report* (December 1969), Black and Veatch
- *Sewerage and Sanitation Master Plan for Metro Manila* (1979), JMMontgomery and DCCD.
- *Study on Water Supply and Sewerage Master Plan of Metro Manila in the ROP* (February 1996), Nippon Jogesuido Sekkei Co. Ltd and Tohmatsu Co.
- *West Zone Sewerage Master Plan* (October 2000), Philaqua Consultants
- *East Concession Area Master Plan Update* (April 2005), NJS Consultants
- *Comprehensive land use plans* for each of the local government units within the study area.

1.7 Overall Framework for Sewerage and Sanitation Service Provision in Metro Manila

1.7.1 General

The Metropolitan Water System was inaugurated in 1878 to supply water to the City of Manila, which then had a population of approximately 300,000 people. The service area and population was subsequently extended and expanded.

The Metropolitan Waterworks and Sewerage System (MWSS), a Philippine government owned and controlled corporation, was established in 1971 and is responsible for the provision of water, sewerage and sanitation services in Metro Manila. In 1997, MWSS was a large government owned company with almost 8,000 employees. Water supply services were being provided to approximately 70% of the potential population with availability being approximately 16 hours per day. There were frequent system failures and water system leakages and a non- revenue water (NRW) level of over 60%.

Consideration of private sector participation (PSP) in the water supply to Manila initially arose out of a change in national government in 1986, the creation of a Government Committee on Privatization in the same year and the subsequent privatization of many government owned businesses. The award in 1997 of two concurrent concession contracts for water supply and sewerage in Metro Manila was widely publicized. The

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concession agreements resulted in four entities being directly involved in water and sewerage service provision in the city:

- **Maynilad Water Services Inc. (MWSI),** the service provider for the West Zone;
- **Manila Water Company (MWCI),** the service provider for the East Zone;
- The **Regulatory Office,** established as the representative of the customers under provisions of the concession agreements; and,
- The **MWSS Corporate Office** that has the responsibility for the retained functions, i.e. those not passed to the concessionaires, facilitating the performance of the concessionaires of their obligations, managing the Umiray-Angat Transbasin Project, managing the loans that are in the name of MWSS but serviced under the agreements by the concessionaires and managing, and where appropriate, disposing of the 'retained assets', i.e. those assets not conceded for the duration of the concession agreement.

1.7.2 Manila Water Company Inc. (MWCI)

MWCI is a joint venture of three companies, namely, Ayala Corporation, United Utilities and Pacific Holdings B.V., a subsidiary wholly owned and controlled by United Utilities PLC of the United Kingdom and Mitsubishi Corporation of Japan, with Ayala Corporation holding majority control. The concession contract is for 25 years commencing on August 1, 1997 and to end in July 31, 2022. The total population in the East Zone at the start of the concession period was about 4.5 million.

1.7.3 Maynilad Water Services Inc. (MWSI)

MWSI was a joint venture between Benpres Holdings Corporation and Lyonnaise des Eaux of France. This concession contract was also for 25 years commencing on August 1, 1997 and ending on July 31, 2022. The total population in the West Zone at the start of the concession period was about 7.2 million. MWSI has suffered from financial problems for several years. From July 2005, MWSI was subject to restructure/ rehabilitation due to financial insolvency. A Rehabilitation Plan was submitted by the company and approved by its creditors. The rehabilitation resulted in 84% of the equity in the company being transferred to MWSS. The remaining equity remained with the Suez group (Lyonnaise des Eaux), an existing minority shareholder.

It is the intent of MWSS that its majority ownership of MWSI be on an interim basis, i.e. for a maximum of approximately 2 years, with the ownership returning to the private sector by sale of its holding or by comprehensive sale of the company.

1.7.4 Concession Areas

The MWCI East Concession Area is composed of 7 cities and 2 municipalities in NCR and the whole of Rizal Province covering a total land area of approximately 1,739 square kilometers. The MWSI Service area covers 7 cities and 9 municipalities of NCR and Cavite with over 623 square kilometers of land area.

The cities of Manila, Makati and Quezon are divided between the two concessionaires. In addition to the 3 cities mentioned, MWSI also covers portions of the City of Marikina and the municipalities of San Mateo and Rodriguez, although the service areas there are small.

The boundary between the West and East Service Areas generally runs from north to south coinciding with the MWSS water system boundaries. The boundary limits are shown in **Figure 1.2** and are defined in Schedule 1 of the Concession Agreement.

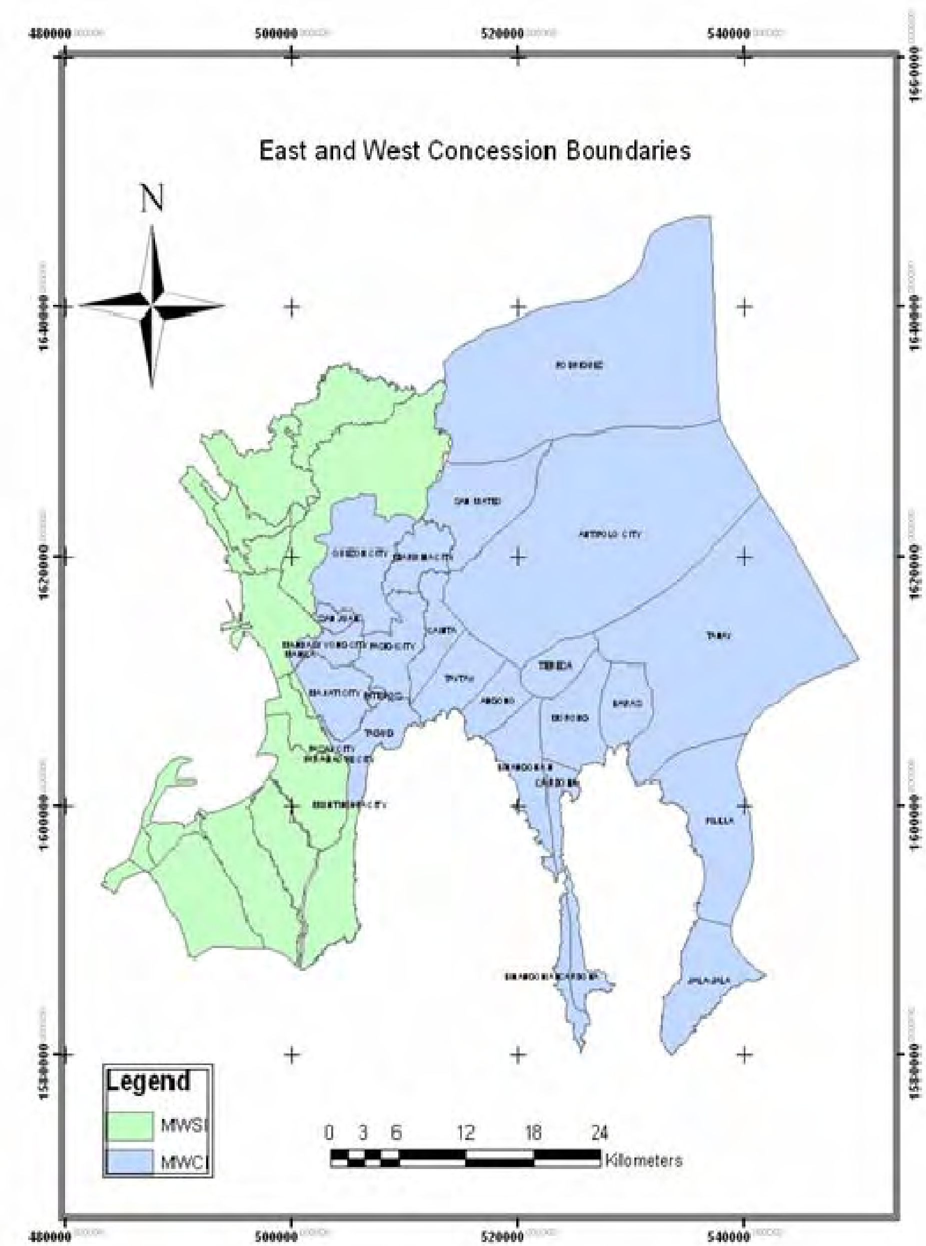

Figure 1.2 MWSS Concession Areas Boundaries

1.8 Organization of the Report

The approach to preparing this Master Plan involved three stages in which Strategic Action Papers (SAPs) and Working Papers were prepared to enable discussion with the stakeholders during the course of the Study. The findings from these papers were then consolidated into this Master Plan document. The stages and the SAPs/Working Papers prepared under each stage (which form attachments to the Master Plan) were as follows**:**

Phase 1 - Definition of Sewerage and Sanitation Targets

- Strategic Action Paper No 7 – Institutional and Environmental Targets for the Sewerage and Sanitation Sector

Phase 2 – Data Collection and Analysis

- Update of Land Use and Population Projections (Volume 1 of Strategic Action Paper No 1 – Institutional, Environmental and Physical Targets for the Water Supply Sector)
- Working Paper – Condition Report on Existing Sewerage and Sanitation Systems
- Working Paper – Implementation Constraints in the Sewerage and Sanitation Sectors
- Working Paper - Pollution Load Projections for Domestic, Commercial and Industrial Wastewater.
- Report on Willingness-to-Pay Survey
- Cost Database
- Interim Report

Phase 3 – Strategy Development and Analysis

- Strategic Action Paper No 8 – Sewerage Strategy for Metro Manila
- Strategic Action Paper No. 9 – Sanitation Strategy for Metro Manila
- Strategic Action Paper No 10 – Sludge Management and Water Recycling for Metro Manila
- Strategic Action Paper No.11 – Least Cost Technical Options for Sewerage and Sanitation Approaches
- Strategic Action Paper No. 12 – Draft Subsidy Policy on Sewer Charges
- Economic and Financial Analysis
- Formulation of Development Plan during Master Plan period
- Sewerage and Sanitation Master Plan.

This Sewerage and Sanitation Master Plan includes the results of the entire study, including the findings from all the above Strategic Action Papers and Working Papers, and is contained in three volumes:

- Volume 3 – Sewerage and Sanitation Situational Analysis (Chapters 1 – 7)
- Volume 4 – Sewerage and Sanitation Master Plan Study (Chapters 8 – 14)
- Volume 5 – Sewerage and Sanitation Master Plan Appendices

Supporting Volumes, comprising Strategic Action Paper Nos. 1 (Volume 1), 7 to 12, associated Working Papers, and Willingness-to-Pay Survey Report are also included.

A separate volume, the Master Plan Extended Summary was also prepared to summarize the whole of the study.

2. Introduction

2.1 Physical Conditions

2.1.1 Topography

The total area of Metro Manila is constantly expanding due to reclamation works being done on Manila Bay. The topography of the study area is characterized as the *Coastal Plain*, *Guadalupe Plateau* and the *Marikina-Laguna Valley*.

The Coastal Plain includes the western areas of Metro Manila. Intramuros, Fort Santiago and Fort San Antonio Abad were originally constructed along the shorelines prior to the extensive reclamation of the bay. Only a series of canals are left of the once low sandy islands found at the Pasig River delta. Most of the areas in Manila and Pasay are situated at elevations about two meters above sea level.

Guadalupe Plateau rises above the coastal lowlands, with summits reaching 90 to 100 m above sea level north of the Pasig River and 30 to 40 m in the south. Drainage is directed westward to the San Juan River in the north and directly westward to the Manila Bay down south.

The Marikina-Laguna Valley is relatively flat, having a narrow north area that becomes wider towards the south near Laguna de Bay. The flow of the Marikina River takes on a meandering course and the flow becomes slow and the cross-section becomes wider from the Sierra Madre foothills.

The topography of Rizal can be characterized by a combination of valleys and mountains. Flat low-lying areas are found on the western section of the province. To the east, rolling hills and rugged ridges form the southern foothills of the Sierra Madre Mountain Ranges. Elevations can exceed 600 m above mean sea level.

Cavite is considered flat and part of the coastal plains. Cavite City extends outwards to the Manila Bay. River systems include Imus River, Julian River and Ilang-ilang River.

In the proposed area for new water source development, namely the Agos River basin, the terrain is typically mountainous country, dropping to a coastal plain along the lowermost reach of the Agos River in the east. Elevations rise to more than 700 m above mean sea level.

2.1.2 Slope

The slopes found within Metro Manila vary for the topographic areas mentioned above. Slopes for the Coastal Plain are relatively flat (zero to one percent) with elevations ranging from zero to two meters. A one to three percent rise can be seen from the Coastal Plain to the Guadalupe Ridge. Slope drops of 20 % and greater can be seen towards the Marikina Fault. Moving towards the Marikina-Laguna Valley, slopes become flat.

About 35% and 2.5% of the land area in Rizal is situated on slopes ranging from zero to eight percent and eight to eighteen percent, respectively. More than half (51%) of Rizal land area falls under the slope classification of 18 to 50 %. A substantial percentage of the Rizal province has slopes of 12% and up. Steep slopes can be attributed to the topography of the mountainous regions of the Rizal province.

Slopes near the coastal plains of Cavite do not exceed 3% and the elevation is about sea level. The slope slightly increases to about 5 % along the southeast with elevations rising to about 70 m above sea level.

In the proposed water source catchment area, significant variation in slope is recorded. In the Kanan River sub-basin, extreme slopes characterize the extreme terrain, which has generally hampered access to the area and allowed a large portion of the catchment area to remain under virgin forest. In the Kaliwa River sub-basin, the slope of the terrain is more moderate, allowing the area to be developed through logging and farming activities.

2.2 Geology

In the Metro Manila area, the underlying rock strata are composed of three types of sedimentary rock sequentially layered as: Miocene rocks, “Alata” Conglomerate, and Guadalupe Tuff. Guadalupe Tuff is the overlaying stratum from the Marikina Valley until Quezon City where layer thickness is about 300 to 2,000 m. A change in overlaying alluvium stratum with a depth of about 25 to 50 m is seen along the coastal plains. Alluvial sediments also overlay the Marikina valley but the depth varies greatly. A simplified geological cross-section of Metro Manila is presented in **Figure 2.1**.

The Guadalupe tuff is understood to be water laid, most probably in a shallow sea during the late Tertiary or early Quaternary age. Beds of the tuff are clearly stratified and are composed mostly of comminuted, somewhat altered, vitric volcanic ash, although certain layers are composed of rather coarse fragments of volcanic pumice. The tuff layers, which are normally fine-grained and gray to brownish-gray in color, are often separated by brownish or yellowish soil which is indicative of weathering. Also gravel and sand layers have been found between tuff strata. It would seem, therefore, that deposition of these tuff layers was not a continuous process but rather may have been cycles of deposition. Uplift, weathering and erosion rather than submergence and deposition.

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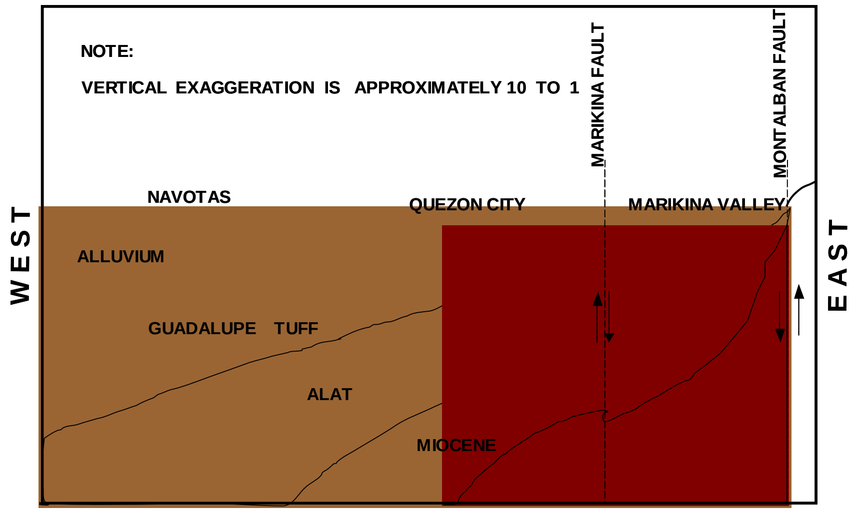

Figure 2.1 Simplified Geological Cross-Section of Metro Manila

Hydrogeology

The hydrogeologic structure in the MWSS service area was formed due to tectonic and volcanic events during the Late Tertiary and Quaternary periods, along with sea level changes.

In the coastal areas of Manila Bay, Laguna de Bay, and Marikina Valley, the groundwater systems mainly consist of alluvial sediments, while the rest of the areas are underlain by pyroclastic Guadalupe Formation. These aquifer systems extend from 1400 to 1800 sq. km.

The major aquifer systems underlying Metro Manila are as follows:

- Manila Bay Alluvium – found in Caloocan City, Manila, Pasay City, Makati City, Valenzuela, Navotas, Malabon, Parañaque, Las Piñas, Bacoor, Imus, Kawit, Noveleta, and Rosario. The Manila Bay Aquifer System is anisotropic and semi-confined with vertical permeability that is much lower than the horizontal permeability.
- Marikina Valley Alluvium – exposed in the municipalities of San Mateo, Montalban, Marikina, Pasig, Cainta, Taytay, Pateros, and Taguig.
- Guadalupe Formation – underlies Quezon City, San Juan, Mandaluyong, part of Makati, and Muntinlupa. The transmissivity coefficient in the Guadalupe Formation ranges from 50 to 100 sq m/ day, with an average of 58 sq m/ day, which means that the aquifer system has slightly moderate water transmitting properties.
- Laguna Formation and Pre-Quaternary Formations – deposited in Antipolo City, Angono, Baras, Binangonan, Cardona, Jala-jala, Morong, Pililla, Tanay, and Teresa.

The aquifer systems generally have an upper water table aquifer of up to 30 m deep. A semi-confining layer with thickness of up to 45 meters separates this upper water table aquifer from the lower artesian aquifer of more than 500 m thickness. Groundwater velocity within the confined aquifers averages 0.6 m/day, flowing generally from Quezon City towards Caloocan and Manila and from Laguna Lake and Las Piñas towards Makati and Parañaque.

Confined aquifers within the Guadalupe tuff are the source of groundwater for the service area. It is believed that withdrawal of groundwater from the aquifer is in excess of the recharge resulting in the following externalities:

- Aquifer depletion;
- Groundwater pollution;
- Land subsidence; and,
- Saline intrusion.

An indicator of groundwater over-abstraction is the draw down of piezometric heads. The piezometric heads in the northeast of Manila has gone down from +180 m in 1955 to only +120 m in 1994. At the coastal areas, the piezometric heads fell from –10 m to –100 m within about four decades.

Earthquakes
Several hundred tremors are recorded annually in the Philippines. Two sources of structural movement are the Philippine Deep, whose axis lies 80 km off the east cost of Luzon and Samar, and the Philippine Rift, which runs from Lingayen Gulf through Polillo Island, Sorsogon, Leyte and Eastern Mindanao. Three active volcanoes (Taal, Makiling and Banahaw) lie within 80 km of Manila.

Construction in the coastal plain alluvium is especially susceptible to seismic damage because of the soft foundation materials and the almost universal use of friction piles. No major pipeline damage has been attributed to earthquakes in the Metro Manila area, although it is possible that seismic action has damaged sewer pipes without external indication.

2.3 Climate

Rainfall
Meteorology in the study area is characterized by distinct wet and dry seasons. The dry season falls on the months of November to April during the northeast monsoon. The wet season occurs from the months of May to October coinciding with the southwest monsoon. In Metro Manila the annual average rainfall is 2164.5 mm, with an average number of rainy days of 133 per year.[1] **Figure 2.2** shows the monthly average rainfall and number of rainy days in Metro Manila.

The area covered by the Sierra Madre Mountain in Rizal is an exception since even rainfall is experienced throughout the year.

[1] Derived by averaging the annual average rainfall data recorded in three PAGASA weather stations: Port Area, Manila, Science Garden, Quezon City, and NAIA, Pasay City.

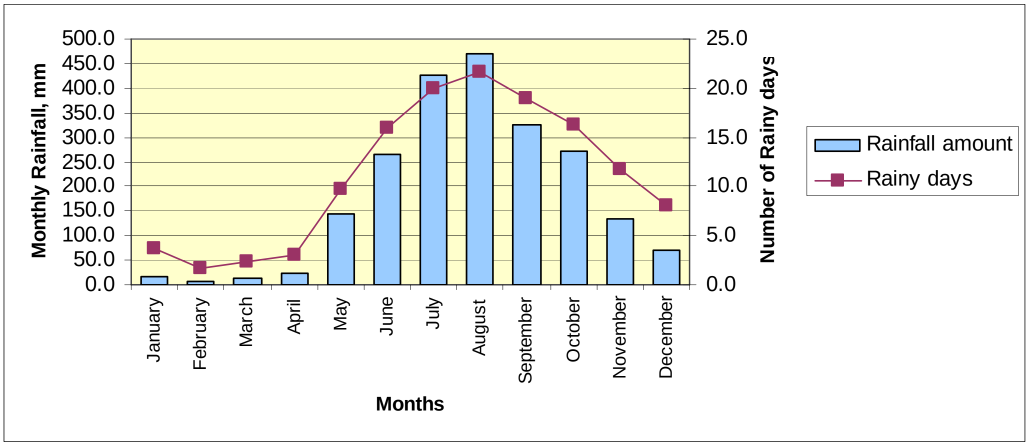

Figure 2.2 Monthly Average Rainfalls and Number of Rainy Days in Metro Manila

Temperature

The overall monthly temperature is about 27.7 ºC. Warmest days occur during the summer months of April and May with an average high temperature of 29.6ºC while the coolest month is January with low average temperature of 25.9 ºC.[2] Figure **2.3** presents the monthly average temperatures in Metro Manila.

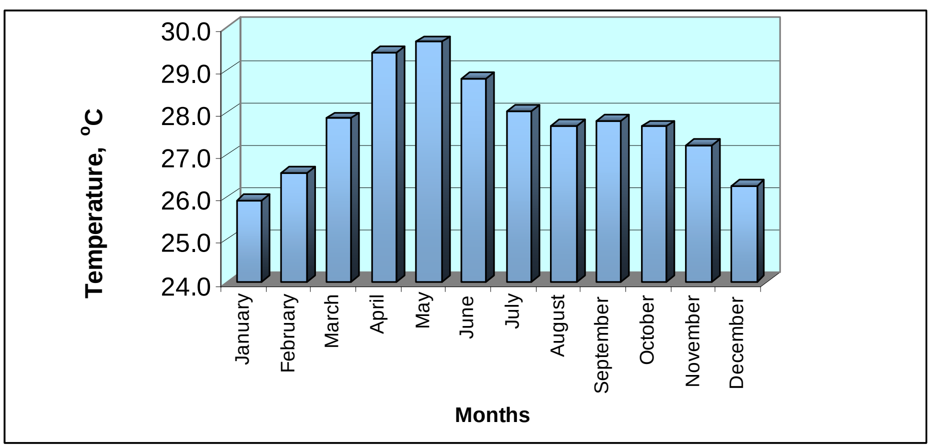

Figure 2.3 Monthly Average Temperature in Metro Manila

The average relative humidity is lowest in April (69 %) and highest in September (84 %).

[2] Derived by averaging the mean monthly temperatures recorded in three PAGASA weather stations: Port Area, Manila, Science Garden, Quezon City, and NAIA, Pasay City.

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2.4 Drainage Basins

The MWSS service area, that is covered by the sewerage component of the Master Plan, was divided into nine major drainage basins. The major basins are Meycauayan, Tullahan, North Manila, San Juan, Marikina/Antipolo, South Manila, Taguig, Parañaque and Pasong Diablo/Magdaong/Sucat. The drainage basins are shown in **Figure 2.4** which includes their drainage areas. These major basins were further subdivided into sub-catchments for the development of the sewerage master plan. The proposed sewerage systems for each catchment are discussed in detail in Chapter 10.

2.5 History

The early development of Manila following the Spanish conquest largely comprised the walled city of Intramuros.

By 1875 the City had a population of 150,000 and had spread beyond Intramuros to what were then described as the ‘suburbs’ of Quiapo, San Miguel and Binondo and the ‘villages’ of Ermita, Sampaloc and Paco. A water system was constructed in 1882 and delivered water to the City from El Deposito, the reservoir near San Juan, through a 21-inch iron pipe.

During the American occupation (1898-1941) the population of the City increased from 160,000 to 700,000 and the urbanized area spread accordingly. In 1904 -1909 the initial sewerage system was constructed in Manila, serving practically all the urbanized area at that time. The port was expanded and Quezon Boulevard, Roxas Boulevard, Taft Avenue and other arteries were constructed and led to the rapidly growing suburbs. By the beginning of 1941, although the city had greatly expanded, its character and organization had not essentially changed. For example, the port still dominated the commercial activities and offices and markets were still located in Quiapo and Binondo, as they had been in 1900; industries were still located along the Pasig River; and the surrounding suburbs were still more or less separate entities.

The demolition of the city during the Battle of Manila in 1945 and the subsequent rebuilding resulted in the clustering of suburbs to form a metropolis. Suburban commercial centers were built during the 1950’s and 1960’s and that trend continues today with the growth of major commercial and residential centers in Makati, Ortigas and Quezon City. Many industries have moved out of the City and the suburbs have been enveloped by the City. It is no longer possible to speak of Manila without considering the entire Metropolitan Area.

In 1975, then President Marcos created an administrative region of Metro Manila to bring four cities and thirteen municipalities of the capital region under a single umbrella. Much of these were carved out from the provinces of Rizal and Bulacan. Metro Manila is an example of what geographers call the Southeast Asian primate city, a single very large city that is the center of industry, government, education, culture, trade, the media, and finance. Continued rapid population growth meant that the boundaries of Metro Manila were expected to expand in the 1990s. In March 1995, Republic Act 7924 was enacted creating the Metro Manila Development Authority (MMDA). The scope of MMDA services is defined under Sec. 3 of R.A. 7924 which says: “metro-wide services under the jurisdiction of the MMDA are those services which have metro-wide impact and transcend local political boundaries or entail huge expenditures such that it would not be viable for said services to be provided by the individual local government units (LGUs) comprising Metropolitan Manila."

Metro Manila is now one of the largest cities in the Asia-Pacific region and also one of the most crowded with a density of about 16,600 persons per sq. km, some three times that of the national average.

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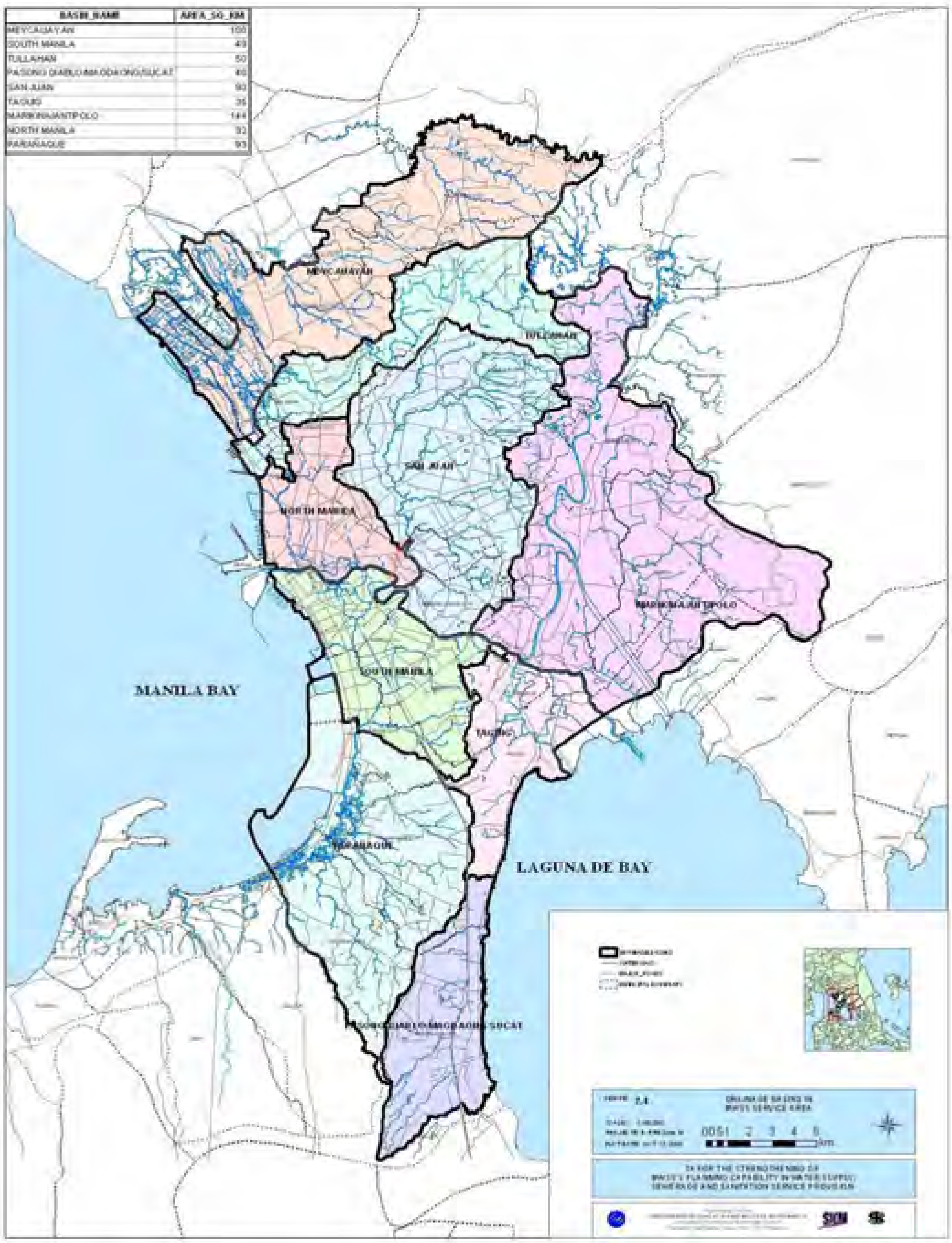

Figure 2.4 Major Drainage Catchments of MWSS Service Area

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2.6 National Economy

The Philippines has a diversified economy, with contributions of the key sectors to GDP in 2003 being: services 53%, industry 32% (of which manufacturing is 23%) and agriculture, forestry and fishing 15%. Real GDP growth has strengthened over the past three years from 1.8% in 2001 to 4.3% in 2003 and about 6% in 2004. Agricultural growth in recent years has averaged 3 – 5%, but is significantly affected by year-to-year weather changes. Inflation in the past appeared to have been under control from mid-2001 until the end of 2003, when it averaged 2.5% p.a. But in 2004, it increased sharply to a within-year rate of about 8%. It is thought that it could be a 'blip' in response to high world energy costs, and that it will decline to about 5% in the medium term.

A key issue in the Philippine economy is the level of unemployment, which is high and has been rising. In the second quarter of 2004, it was recorded at 13.7% as compared to 12.2% for the same quarter in 2003. Government, which is very much aware of this issue, is concerned and is giving high priority to the need to combat unemployment through the creation of new jobs.

A second problem in the economy is the fiscal deficit. This is running at 4-5% of GDP, and is an important reason for the relatively high interest rates in the Philippines. It has resulted largely from difficulties in raising the amount of tax collected, both with respect to enacting appropriate legislation and collection of actual taxes due. An important result of the chronic fiscal deficit has been the escalation of Public Sector Debt, which at the end of 2003 was estimated at 137% of GDP.

Table 2.1 below gives an overview of the main economic indicators for 2003-2004 and projections for 2005-2006.

Table 2.1 - Major Economic Indicators 2003-2006

Description	In Percentage Terms			
	Actual		Projected	
	2003	2004	2005	2006
Real Gross Domestic Product Growth	4.7	5.6	4.6	4.2
Gross Agricultural Production Growth	3.8	5.5	3.7	3.6
Unemployment – Average	11.4	11.6	11.0	10.6
Inflation rate	2.9	5.6	5.3	5.2
91 day Treasury Bill rate	5.9	7.3	8.0	8.5
Fiscal Balance (% of GDP)	-4.6	-4.3	-3.8	-3.2
Current Account Balance (%GDP)	4.2	3.4	2.8	1.7

Source: EIU October 2004

2.7 Poverty Situation

The 2003 Human Development Report ranks Philippines 85th out of 175 countries considered. In that report, the Human Development Index has shown improvement over the past seven years from 0.735 in 1995 to 0.753 in 2002. There has also been progress in reducing the overall level of poverty in the Philippines, poverty incidence having declined from 44.2% in 1985 to 28.4% in 2000.

The country's annual per capita poverty threshold in 2000 was PhP 13, 913, an increase of 22.9% over the PhP 11,319 estimate in 1997. The National Capital Region (NCR) posted the highest poverty threshold at PhP18,001 per person or an increase of 25.9% over the 1997 estimate of PhP 14,299. There are other 8 regions with large increases in poverty lines between 1997 and 2000 including Region IV (22.9%).

Based on the preliminary results of the 2000 Family Income and Expenditure Survey (FIES), the number of families below the poverty line of PhP 13,913 increased from 31.8% or an increase of 2.4%. Urban-rural differential in poverty incidence is also notable with urban areas having lower incidence than rural areas.

Overall, the number of poor families reached 5.2 million up by 707,000 families or 16% higher than in 1997. In the urban areas, the number of families increased by 26.9%, while in the rural areas, the number of families increased by 11.6% over the 1997 estimate. The country's income gap was estimated at 32.1% in 2000, higher by 0.5% over the 1997 estimate. This means that the income of those below the poverty threshold have to be raised by 32.1% to surpass the poverty threshold. NCR consistently had the lowest income gap among all the regions in the country, but it increased to 22.4% in 2000 from 18.9% in 1997.

Because of the large disparity of poverty between rural and urban areas, many people from the rural areas migrate to urban areas, with the largest magnitude coming to Metro Manila. It is estimated that 36 % of Metro Manila's population are informal settlers. This is about 432,450 families as of 1996 (NHA-NCR), distributed as shown in **Table 2.2**. Informal settler families are distributed in about 276 major slum areas in Metro Manila.

Table 2.2 - Magnitude of Informal Settler Households in Metro Manila

Area/Location	Estimate No. of Squatter Households
North:	
Caloocan	83,638
Navotas	18,483
Valenzuela	16,551
Malabon	22,094
East:	
Quezon City	19,849
Pasig	15,978
Marikina	2,044
West:	
Manila	91,356
Mandaluyong	19,460
San Juan	1,343
Makati	15,905
South:	
Pasay	21,915
Parañaque	23,666
Muntinlupa	35,132
Las Pinas	17,527
Pateros	2,100
Taguig	25,408
Grand Total	**432,450**

Source: NHA-NCR

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2.8 Sanitation, Public Health and Disease

The sewerage system in Metro Manila currently covers only about 12% of the population. The remaining population is served by on-site sanitation, primarily septic tanks or pit latrines or not at all. The willingness-to-pay survey conducted as part of this study provided the following breakdown of sewerage and sanitation facilities at the household level.

Connected directly to sewerage system	5%
Septic tank connected to sewerage system	6%
Septic tank discharging directly to drain	60%
Toilet discharging directly to drain/canal/creek	8%
Pit latrines	15%
No toilet	5%

There an estimated 2.2 million septic tanks in Metro Manila, most of which do not have appropriate leaching fields, are irregularly (if ever) desludged and many of which are inappropriately designed. The result is that the septic tanks provide minimal treatment and that most of the open drains and esteros effectively operate as open sewers with a consequent risk to public health. The drains and esteros drain in the major rivers and water bodies such as Pasig River, Marikina River, San Juan River, Manila Bay and Laguna de Bay with the result that these water bodies are unable to achieve water quality standards appropriate for their proposed use for aquatic and recreational purposes. The Pasig River Rehabilitation Program has the objective of improving the quality of water in Pasig River to Class C standard by the year 2014. However, without significant improvement in the domestic wastewater situation, this target is unlikely to be achieved. From data obtained by DENR, an increasing proportion of the pollution loading on Pasig River can be attributed to domestic wastewater (up from 45% in 1991 to 60% in 1998) whereas the proportion attributable to commercial and industrial wastes has reduced from 45% to 35% during the 1991-1998 period. Efforts have been made to control industrial discharges through the development of environmental user fee systems for industrial waste discharges and there has been some movement of industries outside Metro Manila, but little, if any, progress has been made with regard to domestic wastes.

Health statistics on morbidity and mortality were obtained from the Department of Health and from previous master plan documents and are shown in **Tables 2.3, 2.4 and 2.5**. **Table 2.3** shows that diarrhea has been the leading cause of morbidity for the past 10-15 years, albeit at a declining rate. **Table 2.4** indicates the leading causes of mortality for the entire population and is interesting in that it shows the change in diseases causing mortality over the past 70 years with an increasing emphasis on lifestyle diseases such as heart disease and vascular system disorder. However, the impact of poor sanitation is shown in **Table 2.5** where diarrhea/gastroenteritis is shown as a major cause of child mortality in the 1-4 and 5-9 age brackets. While this data is for the entire country, it can be reasonably assumed that Metro Manila with its acute sanitation problem would be represented by these trends.

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Table 2.3 - Leading Causes of Morbidity in the Philippines

Disease	1974		1990		2000		2001		2002	
	Rank	Rate	Rank	Rate	Rank	Rate	Rank	Rate	Rank	Rate
Diarrhea	2	650	1	1,520	1	1135	1	1085	2	900
Bronchitis	-	-	2	1,215	2	917	2	892	3	780
Pneumonia	4	224	4	N.A	3	829	3	837	1	905
Influenza	1	N.A	716	N.A	4	659	4	642	4	600
Hypertension	-	-	N.A	N.A	5	367	5	408	5	370
TB/Respiratory	3	343	N.A	N.A	6	162	6	147	6	120
Heart Disease	-	-	N.A	N.A	7	69	7	60	7	60
Malaria	5	66	5	69.2	8	67	8	52	8	50
Measles	6	56	N.A	N.A	9	46	9	31	10	20
Chickenpox	-	-	N.A	N.A	10	31	10	31	9	25

1. Rate is No. of cases/100,000 of population
2. N.A – Not Available
3. 1974 data is from 1979 Sewerage Master Plan (JMMontgomery)
4. 1990 data is from 1996 Sewerage Master Plan (JICA)
5. 2000-2002 data is from Department of Health

Table 2.4 - Leading Causes of Mortality in the Philippines

Disease	1935	1955	1965	1999		2000	
	Rank	Rank	Rank	Rank	Rate/100,000	Rank	Rate/100,000
Heart Disease	9	6	5	1	78.4	1	79.1
Diseases of the Vascular System	-	-	7	2	58.4	2	63.2
Malignant Neoplasm	-	10	9	3	45.8	3	42.7
Pneumonia	2	1	1	4	44.0	4	42.7
Accidents	-	8	8	5	40.2	5	42.4
Respiratory TB	1	2	2	6	38.7	6	36.1
Pulmonary Disease	-	-	-	7	20.3	7	20.8
Perinatal	-	-	-	8	17.1	8	19.8
Diabetes	-	-	-	9	13.0	9	14.1
Nephritis	-	-	10	10	10.1	10	10.4

1. Data for 1935, 1955 and 1965 from 1969 Sewerage Master Plan (Black and Veatch). Data for 1999 and 2000 is from Department of Health
2. Mortality rates cover population under 59 years
3. Adult mortality (probability of dying between 15 and 59) is 271/100,000 for males and 149/100,000 for females.

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Table 2.5 - Leading Causes of Child Mortality in the Philippines (Year 2002)

Disease	Ages 1-4		Ages 5-9		Ages 10-14	
	Rank	Rate/100,000	Rank	Rate/100,000	Rank	Rate/100,000
Pneumonia	1	37.76	2	7.03	4	4.14
Accidents	2	17.63	1	17.82	1	15.88
Diarrhea/Gastroenteritis	3	16.14	5	2.19		
Measles	4	11.50				
Congenital Anomalies	5	9.01	4	2.85	5	2.09
Malignant Neoplasm	6	4.88	3	3.97	2	4.58
Meningitis	7	4.67	7	2.14	8	1.92
Septicemia	8	4.54	10	1.41	10	1.28
Pulmonary Disease	9	4.43				
Protein/Calorie Malnutrition	10	4.30				
Nervous System			6	2.15	7	1.92
Heart Disease			8	1.87	3	4.33
Respiratory TB			9	1.41	6	2.01
Nephritis					9	1.59

1. Data from Department of Health
2. Child Mortality defined as the probability of dying within the defined age group
3. Overall Child Mortality (probability of dying under the age of 5) is 39/100,000 for males and 33/100,000 for females

The causal link between good sanitation (and hygiene) and public health has been the subject of discussion over a long period and numerous studies have been undertaken to quantify this linkage. However, it is now accepted and promoted by organizations such as the World Health Organization (WHO) whose Director-General, Dr Lee Jong-wook recently stated;

"Water and Sanitation is one of the priority drivers of public health. I often refer to it as 'Health 101' which means that once we secure access to clean health and to adequate sanitation facilities for all people, irrespective of the difference in living conditions, a huge battle against all kinds of diseases will be won."

The following statistics are also provided by WHO on a world wide basis.

- 1.8 million people die every year from diarrhea diseases (including cholera); 90% are children under 5, mostly in developing countries.
- 88% of diarrhea disease is attributable to unsafe water supply, inadequate sanitation and hygiene.
- Improved water supply reduces diarrhea by between 6% and 25%, if serious outcomes are included.
- Improved sanitation (or sewerage) reduces diarrhea by 32%.
- Hygiene interactions including hygiene education and promotion of hand washing can lead to a reduction in diarrhea cases by up to 45%.

- Improvement in drinking water quality through household water treatment, such a chlorination at the point of use, can lead to a reduction of diarrhea episodes by between 35% and 39%.

The willingness-to-pay survey conducted under this study obtained the following information related to health and hygiene issues:

- Respondents on average spent PhP 3,180 per month on medical care which was the second highest individual expense after food and represented about 15% of the average income.
- Only 5% of respondents did not have a toilet in their house, but almost 80% of these expressed a wish to have their own toilet facility and 60% were willing to pay for this.
- Over 90% of respondents placed a significant value on toilets for their health.
- About 90% of respondents were aware that if their wastewater is not disposed of properly, it may be responsible for various diseases in the community and contribute to the pollution of river systems, groundwater and waterways.
- About 87% of respondents indicated the need to improve the wastewater disposal system in the community.
- Most respondents identified the need to improve and maintain drainage systems and prevent waste from entering the drains as the highest priority for improving the waste disposal system.
- Although 70% of respondents were not familiar with the concept of wastewater treatment, 90% would like to see a wastewater treatment facility established to serve their community.
- About 70% of respondents were willing to pay on average 20% of their water bill for improvement in their wastewater disposal systems.

These responses in general indicate that the Metro Manila populace of all income levels are concerned about the current sewage management and understand the implications of inadequate sanitation and are willing to contribute to an improvement in the system.

3. Legal & Legislative

3.1 Key Agencies and Institutions Involved in Sewerage and Sanitation

3.1.1 Department of Health

The Department of Health (DOH) is the principal government organization responsible for planning, implementation, and coordination of the policies and programs for public health protection and sanitation. DOH is mandated to ensure access to basic health services to all Filipinos through the provision of quality health care services. Its mission is to guarantee equitable, sustainable, and quality health for all Filipinos, especially the poor and to lead the quest for excellence in health.

The DOH is mandated to implement Presidential Decree 856 or the Sanitation Code of the Philippines which includes regulations that impact on residential, commercial, institutional, and industrial wastewater discharges to the environment.

3.1.2 Department of Environment and Natural Resources

The DENR is the primary government agency responsible for the promulgation of rules and regulations for the control of water, air, and land pollution in the Philippines. The DENR was created through Executive Order 192, which reorganized and merged the then National Pollution Control Commission (NPCC) and the National Environmental Protection Council (NEPC). All functions of NEPC and NPCC are now being implemented by the DENR through the Environmental Management Bureau (EMB) and its regional offices.

The DENR has five (5) staff bureaus, namely: (1) Environmental Management Bureau (EMB), (2) Forest Management Bureau (FMB), (3) Land Management Bureau (LMB), (4) Ecosystems Research and Development Bureau (ERDB), and (5) Parks and Wildlife Bureau (PAWB).

EMB is a line bureau of DENR and is mandated to formulate policies on environment and implement environmental laws such as the Clean Water Act (RA 9275), Clean Air Act (RA 8749), Solid Waste Management Act (RA 9003), Environmental Impact Statement System (PD No. 1586), Toxic and Hazardous Waste Act (RA 6969), and other mandates originally assigned to NEPC and NPCC. The DENR, EMB and its regional offices have the most important regulations with respect to pollution control. The classification of water bodies and the task of water quality monitoring are being undertaken by the EMB.

3.1.3 Laguna Lake Development Authority (LLDA)

The LLDA is a quasi-government agency organized in 1966 by virtue of Republic Act 4850. The LLDA is empowered to provide regulatory and proprietary functions. The LLDA is mandated to lead, promote and accelerate the development and balanced growth of the Laguna de Bay Region within the context of national and regional plans and policies.

LLDA reports directly through its Board of Management to the Secretary of DENR. However, unlike the DENR, the rules and regulations adopted by LLDA allow the agency to levy and retain any charges, other than fines and permit fees, for environmental protection programs.

LLDA operates an Environmental User's Fee (EUF) system in the cities and towns in its jurisdiction. In terms of environmental standards and regulations for wastewater discharges, the LLDA follows the water quality criteria and effluent standards imposed by DENR, that is, DENR Administrative Order Nos. 34 and 35, respectively.

3.1.4 Department of Public Works and Highways

The Department of Public Works and Highways (DPWH) is the government agency that is in-charge of infrastructure construction. The agency is responsible for the planning, design, construction and maintenance of infrastructure facilities, particularly national highways and water resources development systems, and other national development objectives. DPWH's responsibility extends to the major areas of infrastructure development and construction such as highways, ports, flood control, water supply, school buildings, and urban community infrastructures.

Under the Clean Water Act (CWA), the DPWH is given the lead role with regards to the preparation of the national program on sewerage and septage management.

3.1.5 Metropolitan Waterworks and Sewerage System

The Metropolitan Waterworks and Sewerage System (MWSS) was created in 1971 by virtue of Republic Act No. 6234. MWSS is responsible for domestic sewage collection, disposal, and treatment in Metro Manila and the surrounding municipalities. The agency is also responsible for septic tank desludging. MWSS is an attached agency to the DPWH.

The privatization program of the MWSS which was implemented on August 1, 1997, divided the MWSS service area into the East and West zones. The operations of the facilities of MWSS were turned over to the two private operators, namely, the Maynilad Water Services, Inc. (MWSI) for the West zone and the Manila Water Company, Inc. (MWCI) for the East zone. The operators have a 25-year concession period and have divided the overall MWSS service area.

3.1.6 Pasig River Rehabilitation Commission

The PRRC was created by virtue of Executive Order No. 54, series of 1999, as amended by Executive Order No. 65, series 1999. PRCC is mandated to ensure that the Pasig River is rehabilitated to its historically pristine condition conducive to transportation, recreation, and tourism.

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PRRC is tasked to coordinate, plan, implement, supervise, monitor and/or evaluate programs, projects and activities, enforce laws, rules and regulations, where appropriate, and perform such other functions as are necessary to ensure the rehabilitation of the Pasig River system. Its plans and programs include sanitation improvement components especially within the easement areas along Pasig River presently occupied by informal settlers.

The PRRC is chaired by the Secretary of the Department of Budget and Management (DBM) and co-chaired by the chairman of the Metro Manila Development Authority (MMDA). The PRRC operates under the Office of the President. Its organizational structure is composed of other government agencies such as the DBM, MMDA, DENR, MWSS, DPWH, DOH, LLDA, and HLURB, among others. The primary structure for environmental matters is defined as the Environmental Management Committee (EMC) of PRRC that is chaired by the DENR.

3.1.7 Housing and Land Use Regulatory Board

The Housing and Land Use Regulatory Board (HLURB) is the government's regulatory body responsible for land use and housing. Its role is defined in specific legislation and directives: Letter of Instruction (LOI) 729, series of 1978, PD 933, EO 648, series of 1981 as amended by EO 90, series of 1986, PD No. 1396, RA No. 7160, EO 72, series of 1993 and RA No. 7279.

The HLURB's functions are comprehensive and include:

- prescribing the standards and guidelines governing the preparation of land use plans;
- extending technical and related forms of planning assistance to the local government units (LGUs) including programs on sanitation and sewerage;
- reviewing and approving the comprehensive land use plans of highly urbanized cities, independent component cities, provinces, and the cities and municipalities of Metro Manila;
- monitoring the implementation of such plans; and
- adjudicating and settling disputes over these plans.

These functions are complementary with the mandate of all LGUs under RA 7160, the Local Government Code, to prepare their land use plans. These plans are enacted through zoning ordinances and stand as the primary and dominant bases for the use of land resources in their respective localities.

3.1.8 Local Government Units

Through the Local Government Code of 1991 (RA 7160), the Philippines has implemented a decentralized form of government. As such, there are two main levels of government: central or national government and local government units. The policy described in the Local Government Code is to devolve authority to LGUs who will operate autonomously under the regulatory supervision of the National Government.

LGUs are responsible for the provision of basic services, such as water supply systems, sewerage, and sanitation, either directly or through contracts with the private sector. They are also empowered to collect taxes and fees necessary for providing these services.

3.1.9 Department of Agriculture

The Department of Agriculture (DA) was created by virtue of Presidential Decree No. 461 which reorganized the then Department of Agriculture and Natural Resources (DANR) into two separate departments, namely, the Department of Agriculture, and the Department of Environment and Natural Resources.

DA is principally tasked to promote the country's agricultural growth and development, including the sustainability of resource productivity over the long term and the enhancement of life of small farmers and fishermen in support of the Comprehensive Agrarian Reform Program (CARP).

The Fertilizer and Pesticides Authority (FPA), an attached agency of the DA regulates the manufacture, use and application of agricultural products such as fertilizers and pesticides. It also has regulatory function over the importation of such products to protect domestic agricultural producers from unfair competition of imports made cheap through subsidies by exporting countries. Currently, the MWSS concessionaires have licenses as fertilizer manufacturers for their domestic liquid wastes and sludges.

Under the Clean Water Act (CWA), the DA is tasked to coordinate with DENR in the formulation of guidelines for the reuse of wastewater for irrigation and other agricultural purposes and for the prevention, control, and abatement of pollution from agricultural and aquaculture activities. The DA is also tasked to review and propose guidelines for domestic sludge and septage management particularly on land application of bio-solids.

3.2 Applicable Legislation

3.2.1 Summary

Strategic Action Paper (SAP) 7 reviewed important regulations governing sewerage and sanitation programs in the Philippines. It also enumerated pertinent provisions of recently passed laws and administrative orders that may have impacts on the design and implementation of existing and future sanitation and sewerage projects of the Metropolitan Waterworks and Sewerage System (MWSS) and its concessionaires.

There are a number of government agencies, whose programs and activities have direct impacts on sanitation and sewerage in the Philippines. These agencies, their mandates and the pertinent regulatory provisions are discussed in SAP 7.

The national legislative framework governing sanitation and sewerage in the Philippines is principally governed by four (4) main laws, namely: (1) PD 856 or the Code on Sanitation of the Philippines, (2) PD 984 or the Pollution Control Law, (3) PD 1151 or the Philippine Environmental Policy, and (4) RA 9275 or the Clean Water Act (CWA).

These main laws are further supported by a number of presidential decrees, republic acts, and administrative orders. Such support regulations include: the National Building Code, National Plumbing Code, the Local Government Code, and DENR Administrative Orders 34 and 35, among others. Enforcement of these laws rests with government agencies such as the Environmental Management Bureau of the Department of Environment and Natural Resources, Department of Health, Department of Public Works and Highways and the various local government units (LGUs).

These environmental regulations and their pertinent provisions that may have impacts on the implementation of sanitation and sewerage services have been summarized for consideration in the development of the MWSS Sewerage and Sanitation Master Plans.

Critical reviews and issues on the recently passed CWA and its possible impacts on the on-going and future undertakings of MWSS and its concessionaires were conducted. The draft implementing rules and regulation of CWA, which was updated in April 2005, was also reviewed. This IRR was signed by the DENR Secretary on May 16, 2005.

In summary, the salient environmental rules that provide impact on the provision of sanitation and sewerage services are the following:

3.2.2 PD 856, 1995 IRR and 2004 Supplemental IRR (Code on Sanitation)

The Code of Sanitation (PD 856) was promulgated in December 23, 1975 by then President Ferdinand E. Marcos. Since its promulgation, it has been the basis of rules and regulations imposed for health and sanitation. Chapter XVII of the Code of Sanitation particularly contained provisions on the collection, handling, transport, treatment and disposal of sewage, domestic sludge and septage.

In 1995, the DOH issued the Implementing Rules and Regulations (IRR) of Chapter XVII of the Code. The IRR prescribed guidelines on proper handling, treatment and disposal of sewage. Specifically, the IRR contains the following:

- Approved individual excreta and sewage disposal systems
- Proposed design and construction of septic tanks, leaching tile field and house sewers
- Requirements on public sewerage systems

With the continuous degradation of the river systems due to indiscriminate dumping of septage collected from individual septic tanks and the results of pollution surveys indicating that up to 70% of pollution loading comes from domestic sources, the DOH in 2004 issued a supplemental IRR to cover stricter guidelines on collection, handling, transport, treatment and disposal of domestic sludge and septage.

The IRR and the supplemental apply to all individuals, firms, public and private operators, owners and administrators engaged in the collection, handling and transport, treatment, and disposal of excreta and sewage and domestic sludge from cesspools, communal septic tanks, Imhoff tanks, domestic sewage treatment plants/facilities and septage from household septic tanks.

Figures 3.1 and **3.2** describe the scope of the IRRs.

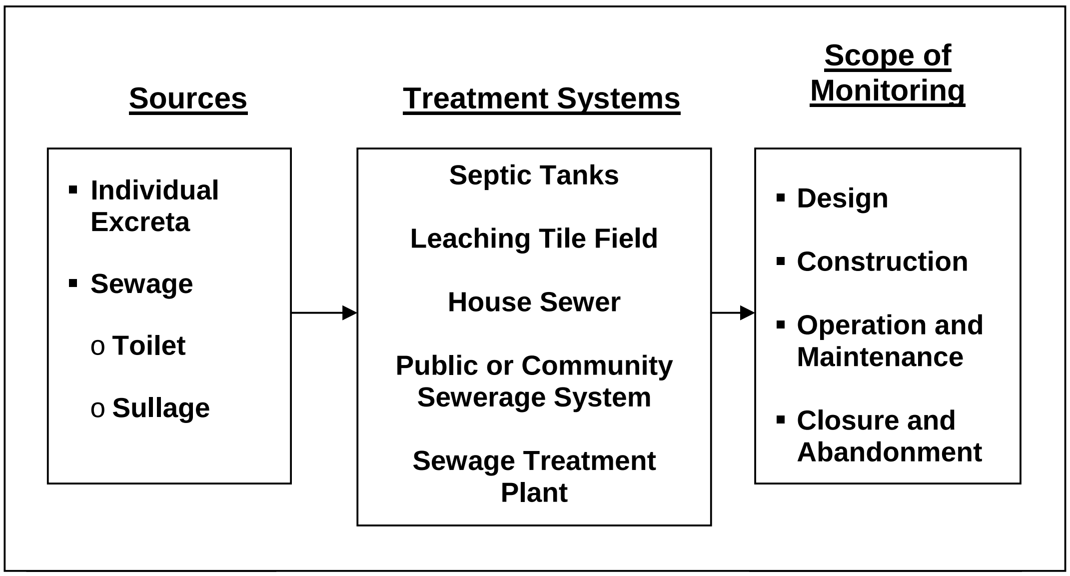

Figure 3.1 Scope of Application of the IRR of the Code of Sanitation to be Implemented by DOH

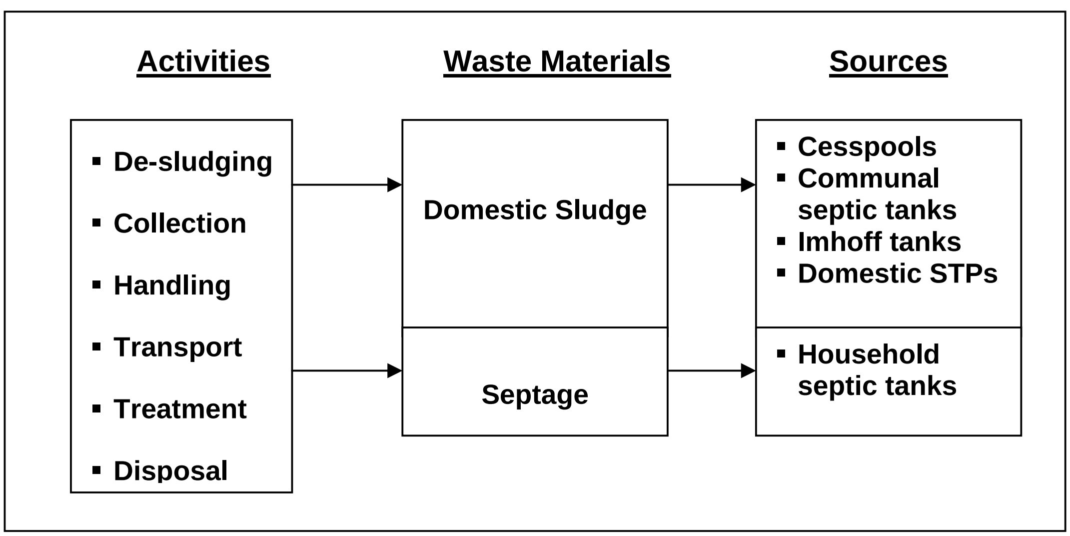

Figure 3.2 Scope of the Supplemental IRR Stipulating Provisions on Sludge and Septage Handling, Transport, Treatment and Disposal

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Some of the key provisions of the Code and the 1995 IRR of Chapter XVII on sewage and sewerage systems include:

- Sewage disposal shall be by means of a municipal or city sewerage system whenever available.
- Where a public sewerage system is not available, sewer outfalls from residences, schools, and other buildings shall be discharged into a septic tank.
- The effluent from septic tanks shall be discharged into a sub-surface soil, absorption field where applicable or shall be treated with some type of purification device. The treated effluent may be discharged into a stream or body of water if it conforms to the prescribed quality standards (now prescribed by DAO 35 series of 1990).
- Properly designed grease traps shall be provided for sewers from restaurants or other establishments where the sewage carries a large amount of grease.
- Septic tanks in new subdivisions are prohibited unless the site is considered to be impractical and inadvisable to install a public sewage collection system with the required treatment.
- Septic tanks shall be cleaned before excessive sludge or scum is allowed to accumulate and seriously reduce settling efficiency. Septic tanks shall be inspected at least once per year and be cleaned when the bottom of the scum mat is within 7.5 cm of the bottom of the outlet device or the sludge and scum has reduced the liquid capacity by 50%.
- Stormwater shall be discharged to a storm sewer, sanitary sewage shall be discharged to a sewerage system carrying sanitary sewage only; but this should not prevent the installation of a combined system.
- Section 3 specifies that any individual, firm or operator, government or private, who are engaged or will be engaged in the collection/desludging, handling, transport, treatment and disposal of sludge and septage is required to secure Environmental Sanitation Clearance (ESC) prior to operation. The ESC shall be issued by the Secretary of Health or the Director of the concerned Center for Health Development (CHD) as his duly authorized representative.
- The ESC application will require the operator's submission of project description (including handling, transport, storage, treatment and disposal operations) and some environmental baseline information of the project site such as topography, geologic condition and hydrology.
- Proper septage and domestic sludge collection and transport system, including vehicle registrations and specifications i.e., vehicle must be enclosed with leak proof body and lock.

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- Mandatory septage and domestic sludge processing and treatment are required prior to disposal.

3.2.3 Presidential Decree 984 (Pollution Control Law)

PD 984 or 'The Pollution Control Law' sets up the administrative and regulatory mechanisms for pollution control and establishes air and water quality standards that define maximum allowable limits of emissions and effluents from domestic, commercial and industrial activities.

The law specifically states that:

"No person shall throw, run, drain, or otherwise dispose into any of the water, air, and/or land resources of the Philippines any organic or inorganic matter that may cause pollution."

PD 984 created the National Pollution Control Commission (NPCC) and gave them the powers with respect to control of air, water and land pollution from point sources. The function of NPCC was subsequently passed on to the DENR by virtue of the department reorganization as per Executive Order 192. P.D. 984 requires the issuance of permits for wastewater treatment facilities.

In 1967, the first set of water quality criteria and effluent standards were promulgated by the NAWAPCO. The 1978 rules and regulations of PD 984 included provisions on air, water, land, noise, and odor pollution, including the ambient water quality criteria. The Effluent Standards was developed in 1982.

After the DENR reorganization in 1987, a review/revision of the standards was again undertaken, hence, developing what we now have as the Revised Water Quality Criteria of 1990 (DENR Administrative Order No. 34) and the revised Effluent Standards (DENR Administrative Order No. 35).

3.2.4 Presidential Decree 1151 (Philippine Environment Policy)

PD 1151 or the Philippine Environment Policy defines the general state policy on the pursuit of a better quality of life without degrading the environment. One of the most important provisions of PD 1151 was the requirement for all agencies and corporations to prepare an Environmental Impact Statement (EIS) for every project or undertaking which significantly affects the quality of the environment.

PD 1151 also created the NEPC and recognized the strength on environmental protection and requirements of environmental impact assessment and environmental monitoring activities. The above functions were later transferred to the DENR as per Executive Order 192.

The law was subsequently strengthened by PD 1586 or the Environmental Impact Statement System which requires projects with potential adverse effects on the environment to obtain an Environmental Compliance Certificate (ECC) as a prerequisite for implementation.

3.2.5 Republic Act 9275 (Clean Water Act)

General

RA 9275, otherwise known as the Philippine Clean Water Act was enacted into law in March 22, 2004. The act provides a comprehensive national water quality program to protect, preserve, and revive the quality of the country's fresh, brackish, and marine waters. The act primarily addresses the abatement and control of pollution from land-based sources and covers all water bodies (natural and man-made), bodies of fresh, brackish, and saline waters, and includes but not limited to aquifers, groundwater, springs, creeks, streams, rivers, ponds, lagoons, water reservoirs, lakes, bays, estuarine, coastal and marine waters.

Provisions of PD 984 relative to wastewater discharges were subsumed by CWA. Under the CWA, development projects including subdivisions, commercial establishments and manufacturing plants which generate and discharge wastewater into the environment are required to secure from the DENR the Discharge Permit and pay the corresponding load based fees to DENR.

The computation of the discharge fee in the IRR of the CWA is based on a net waste load which considers the situation that water to be used by a facility already contains certain pollutants and therefore the discharge fee will be based on the net wastewater load to be discharged.

The CWA integrates the management and control of wastewater and water quality policies that were previously issued through various laws and are currently being implemented among various agencies. The CWA enables the creation and delegation of new regulatory, planning and infrastructure development functions to agencies and subsidiary multi-sectoral bodies and on streamlining inter-agency coordination.

Impacts on Domestic and Commercial Effluents

The following are the major provisions in the CWA-IRR that would have an impact on domestic and commercial effluents:

- Mandatory connection of establishments to existing sewerage systems which reiterates the provisions of the Sanitation Code. If establishments are tapped into the sewer lines of MWSI/MWCI, the concessionaires need to observe the provisions of the Effluent Standards of the DENR in the treatment of effluent prior to disposal into any body of water.

- For MWSS/MWSI/MWCI treatment facilities, a Discharge Permit needs to be secured from DENR or LLDA.

- Domestic and commercial establishments are required to connect sewage lines to existing sewerage systems. Although MWSS does not have the authority to sanction establishments that refuse to connect, the CWA now allows the DENR to initiate actions against these establishments in coordination with the LGUs and DOH. Regulatory actions may include the withholding of permits or denial of issuance of ECC.

- Domestic and commercial establishments that are not connected to existing sewerage systems of MWCI/MWSI should treat their own effluents and comply with the Effluent Standards outlined in DENR Administrative Order No. 35.
- Disposal of septage or domestic sludge should comply with the standards and guidelines issued by the DOH.
- Disposal of sludge through land application should comply with the standards of the DA.
- Use of low-cost sanitation options to augment the sewerage program is promoted in the CWA.

Impacts on Industrial Effluent

The provisions that would have impacts on industrial effluent are the following:

- Mandatory connection of sewage lines to existing sewer lines
- Pre-treatment standards for industrial sources that would discharge into the sewerage system needs to be developed by MWSS (See Section 5.6)

Mandatory Connection to Sewer Lines

Under the CWA, the MWSS through its concessionaires should provide the sewerage and sanitation facilities and enforce the mandatory connection of sewage lines from domestic, commercial or industrial establishments to available sewerage system. In doing so, the accountability in terms of compliance with the effluent standards and the payment of wastewater discharge fee will rest with the MWCI/MWSI as operator of the sewerage system.

In the case of commercial and industrial companies, the MWSS needs to develop discharge standards to sewers to account for the pre-treatment of wastes.

Sanctions for Refusal to Connect to Existing Sewer Lines

The provision on mandatory connection in the CWA basically supplements the Sanitation Code. Despite the presence of this provision in the Sanitation Code, there is resistance to connect due to the following:

1. MWSS has a policy that the house owner shall pay for the implementation of the connection even in the street area with surface restoration.
2. The sanitary surcharge of 50% on the water bill is only imposed if the houses are physically connected.

In implementing the mandatory connection to existing sewerage system based on the CWA, the MWSS and concessionaires should clearly identify commercial and industrial establishments and households connected to existing sewerage systems.

MWSS is not mandated to take any action against establishments refusing to connect into the system under the CWA-IRR. Meanwhile, the DENR can initiate sanctions against an establishment that would fail to connect to available MWCI/MWSI sewer lines in coordination with LGUs and DOH. Sanctions would include the following; (i) DENR can withhold permits or deny the issuance of an ECC; (ii) DENR can request LGUs and other agencies in writing about the sanctions for the establishment based on applicable laws; and (iii) DOH can refuse the issuance of the Environmental Sanitation Clearance.

The sanctions that would be initiated by DENR are relatively considered as low-impact actions in terms of implementing the mandatory connection of establishments. Given the constraints and resistance to connect, this particular provision of the law may face difficulties in implementing. Development of guidelines for the implementation of this particular provision is necessary to strengthen the enforcement and define the roles that other government agencies may render.

Pre-treatment Standards

Under the CWA, pre-treatment standards can be recommended by MWSS and the water concessionaires to DENR to manage effluents (i.e., industrial effluents) that are channeled into sewerage systems. In the absence of pre-treatment standards, the MWSS and the concessionaires can impose pre-treatment standards to establishments tapped into the system through contract with the particular establishment.

Since commercial and industrial wastes vary from domestic sewage, MWSS/MWCI/MWSI may need to consider whether their system can accommodate these sources of pollution. In this case, the design of the sewage treatment facilities should take into consideration pre-treatment standards and appropriate surcharges for non-compliance with the pre-treatment standards.

A fee system should be designed and set-up by MWSS to regulate quality from commercial and industrial sources that would be channeled into the sewerage system.

Compliance with Effluent Standards

The sewage treatment facilities of MWCI/MWSI are required to comply with the guidelines on sanitation of the DOH and the Effluent Standards of DENR. The same standards apply for domestic, commercial or industrial effluents.

In the interim, DENR Administrative Order No. 35 applies as the Effluent Standards while DENR Administrative Order No. 34 will serve as guideline for the water usage and classification and water quality criteria.

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Conflict with LGUs in Imposing Fees

The CWA underscores the role of the LGU in presenting priorities for sewerage and septage management. In the IRR, LGUs are mandated to maintain and shoulder the maintenance of sewerage facilities which overlaps with the mandates of the service providers. It is further stated that LGUs may enact ordinances to impose service fee system. The CWA creates mechanisms for funding through a fee system – property taxes and sewerage system. However, this duplicates the fee being charged by MWCI/MWSI, hence, this may need further review/study.

The fact that the CWA gives the LGUs the responsibility for the provision of rights-of-way and road access, the importance of local political support should likewise be emphasized. However, the imposition of fees to locators should be clearly defined with the LGUs.

While the MWSS can insist on implementing the right to eminent domain as embodied in its Charter, the important role of the LGUs in the implementation of sewerage projects should be taken into account.

Although Metro Manila LGUs have already a long history of good cooperation with MWSS, a pass-on fee to LGUs may be discussed to resolve any potential conflict that may occur with LGUs due to this particular provision of the CWA.

Incentives to Connect to Existing Sewer Lines

While the CWA reinforces the provision on mandatory connection of the Sanitation Code, the sanctions designed in the CWA-IRR are considered as low-impact and may once again face the usual resistance from consumers of MWSI/MWCI. The MWSS needs to discuss with the DENR and DOH stringent sanctions and more importantly attractive incentives to consumers to connect to the sewerage system.

Water Supply Disconnection

Rule 27.6 of the CWA-IRR stipulates that the DENR Secretary may issue an order to the Local Water Districts or to private water supplier such as MWCI or MWSI to disconnect the water service of a violator of any provisions of the CWA. This particular rule may need further legal analysis by MWSS and the issuance of appropriate guidelines by the DENR.

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4. Study Area Status

4.1 Land Use and Urban Development

4.1.1 Existing Land Uses

A large portion of the MWSS service area is composed mainly of built-up areas, specifically in the central and southern service area and some areas in the north. The built-up areas that include residential, commercial, industrial, institutional and related infrastructure make up about 40% of the MWSS service area. The rest, which lies mostly in the northeastern portion of Rizal, is made up of agriculture, forest, open grassland and some mining/quarrying activities.

National Capital Region (NCR)

The land use trend in the NCR has largely been a response to socio-economic demands of a growing population and not necessarily according to plan. Four trends have been identified to characterize land use in the region:

- Increased density and size of informal settlements in city centers;
- Development of medium-scale residential subdivisions for the upper and upper-middle income markets up to the peripheries of the inner and intermediate cores, while low-cost housing has moved to the outer core in the provinces of Rizal, Bulacan, Cavite and Laguna;
- The growth of big commercial centers along EDSA and other major thoroughfares; and
- Infilling of the urban area with high-density housing.

Figure 4.1 shows the summary of existing land uses in the NCR.

Cavite Service Areas

The Cavite Service Areas have become highly urbanized in the past 20 years because of their proximity to Metro Manila. The largely agro-fishery base of the area was lost to residential, commercial, industrial and institutional uses. The rapid urbanization was also due to the resettlement of informal settlers in Metro Manila by the National Housing Authority in Cavite in the late 1980s. Among the Cavite Service Areas, Imus – the provincial capital has the biggest land area, followed by Bacoor and then Rosario. The smallest is Noveleta. These are all along the coast of Manila Bay.

The residential area has increased over the years, due to the conversion of agricultural lands into residential uses, resulting from increased demand for urban land brought about by high population growth. Most subdivisions in the northern portions of Bacoor are now being developed for high- and medium-cost housing, while those located on the southern portion are mostly for medium- and low-cost housing. The residential area covers an area of about 6,326 ha or about 30 % of the total land area of the six LGUs.

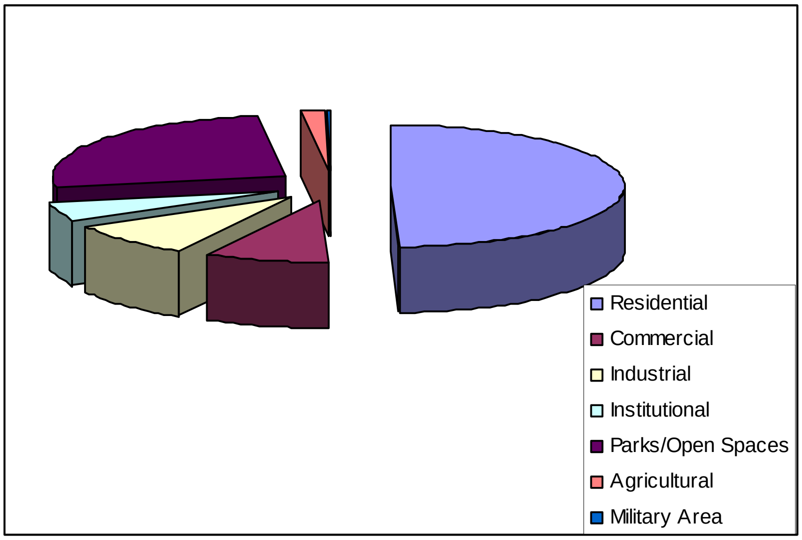

Figure 4.1 Existing Land Uses, NCR

Commercial establishments intersperse the residential areas scattered in all the municipalities, the largest being concentrated in Bacoor and Imus towns. Commercial activities within the Service Area cover an area of 319 ha (1.5% of total area).

Industrial activities cover an area of 2,200 ha (10%). Existing industrial warehouses are scattered within the Service Area particularly along the highways. The industrial activities are concentrated in Imus and Rosario.

Rizal Province

The province of Rizal has the largest land area in all the three provinces within the service area. However, most is dominated by grass and shrub lands covering at least 53% of the provincial land area. Other dominant uses were agriculture (14%), forest (14%), built-up areas (12%) and some 2% were still unclassified.

About 163 ha is devoted to built-up areas composed of urbanizing suburbs, spilling over from the Metro Manila area; flatlands bordering the Laguna Lake are intensively farmed, predominantly for rice and sugarcane production; mountainous areas where bananas and coconuts are grown; and where timber is harvested and a large patch of hilly scrub and grassland.

Rizal province contains a very important watershed providing irrigation, industrial and domestic water supply to numerous population of its surrounding communities including the NCR. The Reserve provides an important catchment area for Laguna de Bay.

The proximity of Rizal province to Metro Manila has greatly influenced its rapid urbanization. This high rate of urbanization is concentrated mostly in the municipalities near Metro Manila. The municipalities of Antipolo, Cainta, Taytay and Tanay are considered the urban centers of the province where most of the economic activities are located. Other minor urban areas are also concentrated along the coastal municipalities of Angono, Binangonan, Cardona, Baras, Pililla, Jala-jala and along the town centers of San Mateo, Rodriguez, Taytay and Teresa.

Industrial establishments are concentrated in Cainta and Taytay because of the extension of Ortigas Avenue in Pasig City, Metro Manila. Some industries may also be found in the towns of Antipolo and Binangonan. The other municipalities have very few industries.
The province is also a favorite local tourism destination with its old churches, several water falls (Daranak, Batlag and Hinulugang Taktak), resorts and a couple of golf clubs – all of which require adequate water supply and sewerage systems.

The forested areas are found in the northern part of Rodriguez and Antipolo as well as the northeastern part of Tanay and Pililla. However, of the total 686 sq. km. of forest lands, only 25% remain covered with trees while the rest are already denuded or sparsely covered by second and third growth forest vegetation. If the trend is not abated, the sparsely covered forestlands will be rendered as grasslands and will later succumb to development.

4.1.2 Proposed Land Use

National Capital Region

Historically, the strongest directions of growth have been towards the northeast, or Quezon City and the south, or Muntinlupa. These growth directions, moreover, appear to be canceling each other out, thereby leaving what planners call a “net eastward” movement in the center of the metropolitan population.

Physical development will encroach and intensify potentially in the watershed areas in Quezon City and Marikina Valley, towards Rizal. Rizal province has been experiencing approximately 10 % growth rate over the last decade and densities, particularly in the municipalities of Cainta and Taytay, are increasing.

People form an important link between the national capital region and the adjoining provinces of Rizal and Cavite, more so as the trend to relocate residences to areas outside Metro Manila continues. The people who live in these areas form a “transient” link between their place of work and the urban core. This arrangement also works the other way around. As industries relocate away from the urban core, the population becomes more transitory, traveling back and forth from their residences to their workplace, particularly since mass transport systems are being developed to further increase the link in these areas.

It is anticipated that the transient character of the workforce in both provinces and Metro Manila would subsequently be absorbed by both areas as expansion of human settlements and industries occur on the plane of reciprocity and integration.

Available data on Metro Manila shows that in view of limited urban land resources, the trend for land development – particularly for human settlements – is to move outwards beyond the region's boundaries.

According to the most recent MMDA study, there are four emerging development trends within the NCR:

- There are built-up areas within the NCR wherein the uses of certain physical infrastructures could not be maximized and are thus, suitable for redevelopment and alternative land use activities;
- There are areas in Metro Manila where physical development vis-à-vis population density has reached a level wherein additional land using activity will result in negative or adverse effects. Here, further development has to be deferred to deter additional pressure on existing amenities and infrastructure support facilities;
- There are ecologically-sensitive areas in the region which require special types of development that would ensure sustainability and prevent unnecessary loss of life and property due to disasters and adverse effects of pollution; and
- In view of expansion of land development towards Metro Manila's outer core, there is the need to plan and regulate such development to ensure that the carrying capacities of resources therein are respected.

For informal colonies, the immediate option is resettlement in suburban resettlement areas or sites outside the metropolis. The municipality of San Juan is already undertaking a Resettlement Program in Taytay, Rizal and the Pasig River Project will be relocating squatters along Pasig River in Montalban, Rizal. Other informal settlement areas, particularly those that will be affected by major infrastructure projects such as the Northrail and McArthur Highway expansion projects, will also be relocated within the region, in Bulacan or Rizal.

The differences between the existing and proposed land uses in Metro Manila as reflected in the Comprehensive Land Use Plans (CLUPs) of the LGUs is shown in **Figure 4.2**.

Cavite Service Areas

The CLUPs of the Cavite Service Areas are proposing further expansion of the built-up areas except for Kawit, Rosario and Noveleta, which up to the writing of this report have not yet prepared their CLUPs. However, based on the increasing trend of population in these areas and their adjoining LGUs, it is projected that their built up areas will likewise increase.

Proposed total residential area in the Cavite Service area is estimated to be more than 70 sq.km. or about 40% of the service area's total area – an increase of about 15 % from the existing area devoted to residential. Commercial land uses will be doubled within the Service Area with the highest commercial land area located in Bacoor.

Most of the municipalities within the Service Area are reducing their industrial land area allocation except for Cavite City which is planning to allocate 98 ha or an increase of 270 percent from the present area allocated for industrial uses. This results in a net increase of industrial areas within the Service Area.

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Rizal Province

Rizal Province is also anticipating continued development of its areas particularly the service centers of Antipolo, Cainta and Taytay.

Growth corridors are being planned in various strategic locations around the province. The Rodriguez-San Mateo-Antipolo growth corridor, which includes the proposal for the establishment of San Mateo Industrial Estate, will link it with Quezon City and the northeastern part of Metro Manila. A planned Antipolo-Sampaloc, Tanay growth area, on the other hand, will focus on the development of a grand industrial estate project that is expected to hasten the eastern province's industrialization.

To support these growth plans, Rizal is planning to increase its built-up area by about 60 %, half of which are found within Antipolo City, Cainta, Taytay and San Mateo – the most rapidly urbanizing LGUs within Rizal. Most of this area will be taken from the open/grassland area.

In general, Rizal is intending to increase its forested area by about 12 % with corresponding protection strategies for forestlands. Agriculture will also allocate a slight increase in the area while the Mining/Quarrying areas will remain the same.

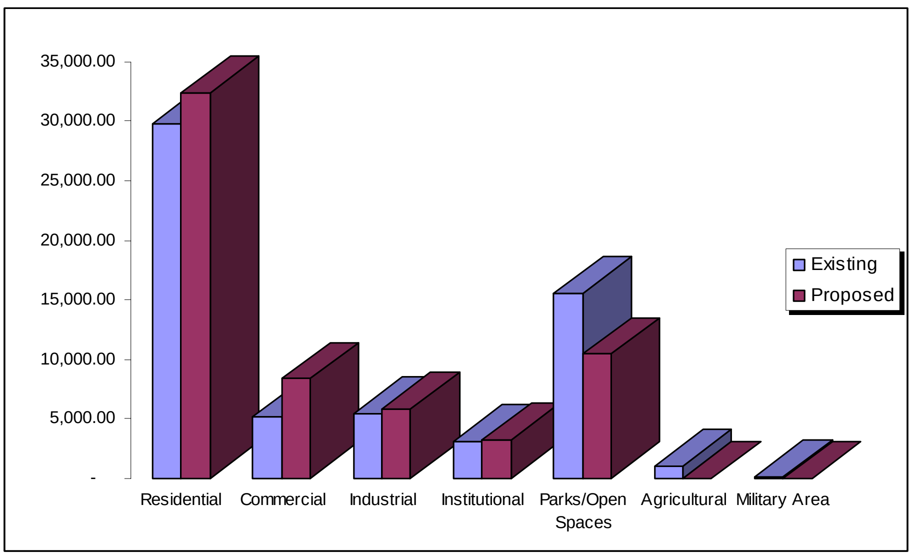

Figure 4.2 Difference between Existing and Proposed Land Uses, NCR

4.1.3 Urban Development Trends and Availability of Vacant Lands

Emerging Trends

The approved/proposed land uses within the service area are developing towards increased residential, commercial and industrial activities with corresponding increases in land allocation. The NCR is going towards mixed use high residential/commercial developments to cater to its increasing population and higher level of commercial activities in the future.

The MMDA physical framework plan intends to decongest Metro Manila and re-distribute and link growth with the suburban centers of neighboring regions and provinces such as Rizal, Cavite, Laguna and Bulacan. This is supported by specific policy areas and applicable strategies such as permitted developments and transport systems. Activities will be encouraged to reflect the corresponding zonal policies.

One of the policies is the relocation of informal settlers in suburban resettlement areas or sites outside the region specially those living in environmentally constrained areas. This supports the continued growth of population in Rizal discussed in Section 4.2.3 of this report.

There are also plans for the development of transport exchange centers where people living outside the NCR can be dropped off and commute from there to their place of work or destination in the region. This is reinforced by the promotion of mass transit systems, including other transport modes such as skyways, subterranean, railways or roads.

For land use and development, the emerging trend is that land value within the NCR, particularly in the regeneration and urban control policy areas, is rapidly rising thereby leading to changes in land using activities in order to meet demand for specific purposes, be they residential or service-oriented commercial uses. In other words, manufacturing entities will find it more practical and less costly to relocate to areas outside the inner and intermediate cores of Metro Manila. Add to this the fact that installation of anti-pollution treatment facilities will add to operating costs of industries who may opt to transfer to industrial enclaves already equipped with such facilities.

The provinces of Rizal and Cavite have assumed a suburban character due to the spillover of housing demand and supply in Metro Manila. A vast number of residents in these areas actually work in the inner and intermediate core of the metropolis.

Availability of Open Spaces/Vacant Lands

In the proposed/approved land use plans in NCR, there are about 10,700 ha of open spaces available which are mostly concentrated in Quezon City and Manila. These are planned for various uses. Most of the cities/municipalities within the region are also planning to enforce the buffer/easement along the river ways and railways, which can be developed for public utilities such as treatment plants. Moreover, derelict or abandoned industrial areas scattered around the region can be recovered for other uses such as sewage treatment plants (STPs). The PRRC plans for the development of linear parks along 10-m easements along Pasig and Marikina River are supported by the concerned LGUs (e.g. Pasig, Makati, Mandaluyong, Marikina), which have enacted new land use/zoning plans and ordinances allocating space for such easements. These easements can be considered for the installation of interceptors/trunk sewers, and even small STPs, if these are included in the strategy evaluated to be most viable.

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4.1.4 Implications for Sewerage and Sanitation Planning

The approved/proposed land uses within the MWSS service area provides for a general increase in residential, commercial and industrial area with the residential area increasing with a higher rate than the two other uses. This implies increased water needs and sewage production in all three major activities. It is estimated that domestic water supply will have a higher proportion than industrial water supply requirements not only because of the high growth rate in residential areas but also because most LGUs in NCR are also limiting their industrial development to light industries with limited water consumption. In certain areas of the NCR, particularly the cities of Manila, Quezon, Makati, Pasig, Mandaluyong and Las Pinas as well as the municipality of San Juan, industrial activities will be reduced to pave way for the creation of new residential/commercial developments. These new developments will require new infrastructure systems.

New infrastructure systems may be easier installed in Rizal than in the NCR and Cavite province because the density and intensity of development there are still lower. For the latter areas, several issues such as higher costs, traffic congestion, informal settler relocation and a host of other issues may confront development/installation of new systems particularly sewerage. Further, the Manila Third Sewerage Project (MTSP) report correctly observes that there may be a resistance to putting in new sewerage systems, particularly STPs in these new residential/commercial areas. In general, industrial zones are considered to be more “compatible” with STP operations.

4.2 Demography, Population Growth and Distribution to 2025

The national and regional population and growth trends are important in this study as they are the basis for predicting the behavior or their component cities/municipalities. The population of the country in 2000 was about 76.5 Million, with an average growth rate of about 2.2 %. The ratio of NCR and Region IV with respect to the total population of the country is about 13 and 15 %, respectively. The ratios of the Province of Cavite and Rizal are 17 and 14 % respectively, out of the 10 provinces within Region IV.

The MWSS Service Area accounts for 16.2 % of the country’s total population in 2000 estimated at 12.4 Million, with an average annual growth rate of 1.5 % in 2000.

The proportionate current (Yr 2000) distribution of population is approximately 60% West Service Area and 40% East Service Area. The National Capital Region comprises about 80% of the total population in the service area; the municipalities covered in Cavite comprise 6% and Rizal Province 14%.

In the 2000 NSO Census, the biggest cities were the cities of Manila, Quezon, and Caloocan, the combined population of which is 40% of the total population in NCR and already one-third of the entire service area population. Meanwhile, the towns with the smallest population are Baras, Jala-jala and Teresa in Rizal Province where the combined population is less than 100,000 or 4.5% of the total population in Rizal or less than 1% of the total population in the service area.

The average density within the service area is about 6,000 people or about 1,300 households per square kilometer. The City of Manila registered the highest population density at about 39,000 people per square kilometer, followed by Caloocan City. The least dense municipality is Tanay, Rizal with only about 234 people or inhabited only by about 47 families per square kilometer.

It is estimated that 28% of the households in the service area are informal settlers, which is approximately 814,000 families. Informal settlement families are distributed to about 600[1] major slum areas in the service area.

Figure 4.3 indicates the population densities in the service area at the time of the 2000 census.

[1] Based on NHA reports

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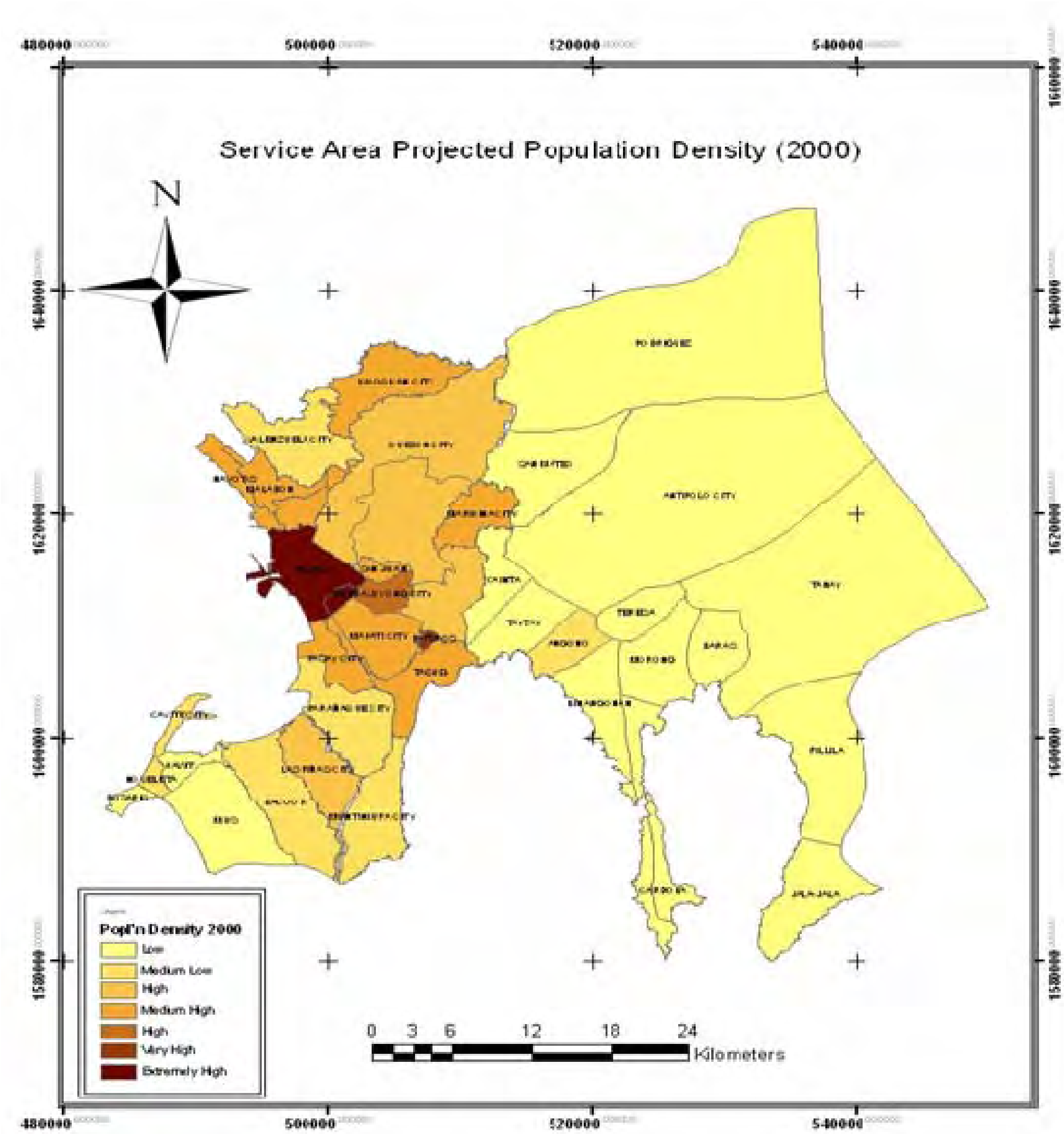

Figure 4.3 Population Densities, MWSS Service Area, 2000

4.2.1 Previous Studies and Reports

Previous Master Plans, Studies and Reports containing data and projections for the MWSS Service Area were reviewed. They were compared for methodology, proximity of projections to actual census (particularly for the earlier Master Plans), and consistency with this Study's predictions.

The ratio method has been commonly used by previous Master Plans for projecting the sub-national level populations. This is also the most widely used method in many countries because of the lack of appropriate methods yet available to project smaller areas. The ratio method simply means that the sum of the component areas cannot be more than the larger area (i.e. national), which makes use of more accurate estimates such as the rate of birth, death and migration.

It can also be observed, that the projections of the earlier years or the ones closest to the next census of the base year are very close to the actual census of that year and the variance becomes wider as the projections become longer. Hence, this Study's projections were made with precautions that the latter year projections might actually be higher than the actual population for those years. A careful study of other parameters such as land use trends and densities was made to compensate for the limitations of the methodology used for predicting future populations of smaller areas.

4.2.2 Population Projection for the Cities/Municipalities of the MWSS Service Areas

The future population in the Service Area was projected for the planning period (2005 to 2025), using the NSO population census of 2000 as base data. The projection aimed at providing data for the estimate of future water demand at city/municipal level.

The ratio method rather than the cohort component method was utilized to project populations of cities and municipalities in the coverage area because of the unavailability of data on fertility, mortality and migration at the city/municipal level. The ratio method of estimating the future population of the MWSS service areas makes use of the levels and trends in the ratios of the population of cities and municipalities to the population of their respective provinces observed in previous censuses. These ratios are then projected on the assumption that after some time stability will be attained.

4.2.3 Population Projections for Provinces (NCR, Cavite and Rizal)

The NSO has prepared a population projection for the Philippines (national level) from 2000 to 2040 using the 1995 Census. This was used as a basis for projecting the population of NCR and the provinces of Cavite and Rizal (based on their ratio with Region IV).

By the year 2025, the projected population within the MWSS service area will be 19.4 million. This is an increase of about 57% or 7 Million persons from the NSO Census of

2000. The highest growth will be experienced by Rizal, which will more than triple by 2025. Cavite will increase by 68 % and NCR by 25%. (**Figures 4.4 to 4.7**)

The projected growth and distribution in Rizal is strongly influenced by the proximity of Metro Manila. The more densely populated municipalities are located within or close to Manila. The high population growth rate is largely attributed to immigration from the other regions of the country, which results mainly from the perceived economic opportunities in Metro Manila.

Because NCR and Cavite Service Areas are highly urbanized, population growth has more or less stabilized and their development strategies focus now on mixed use and high-density residential development.

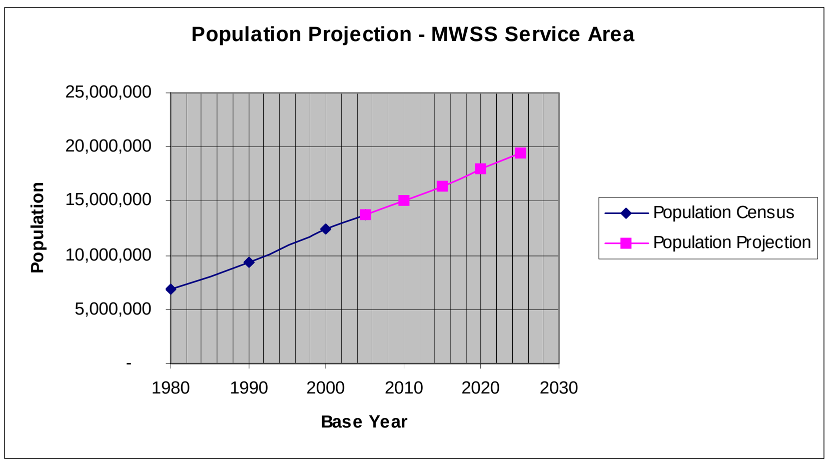

Figure 4.4 Population Projection, MWSS Service Area

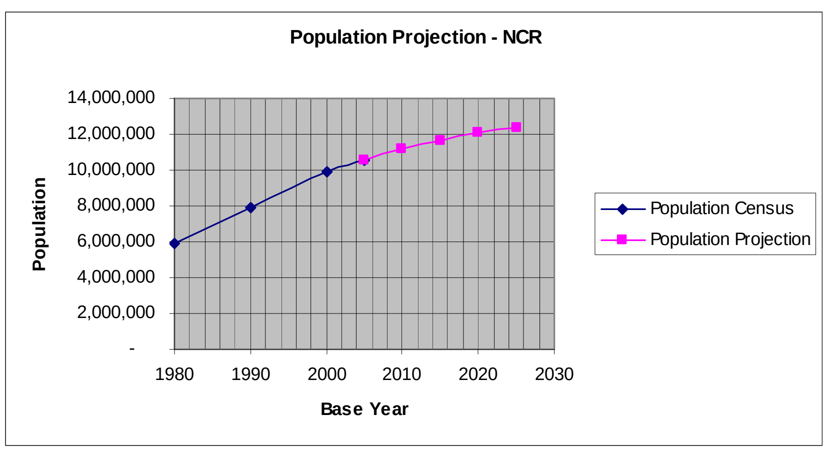

Figure 4.5 Population Projection, NCR

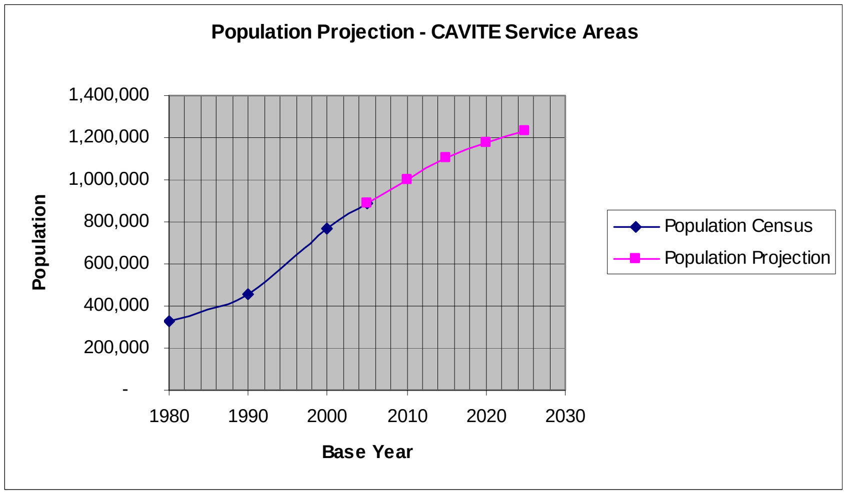

Figure 4.6 Population Projection, Cavite Service Areas

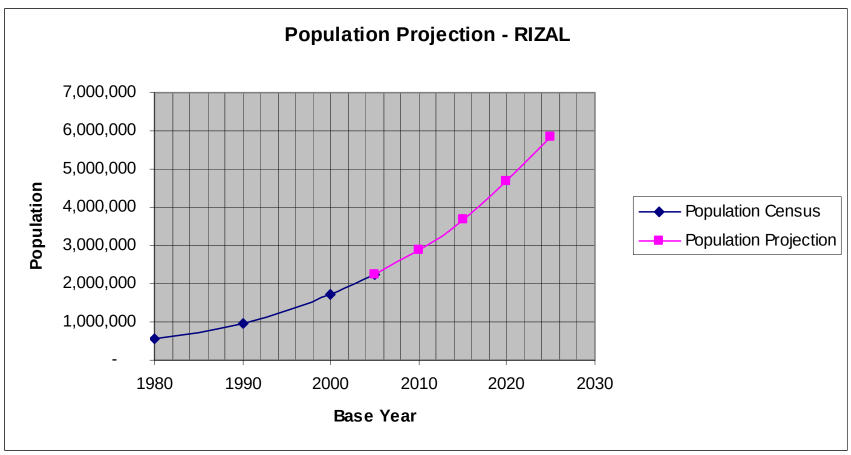

Figure 4.7 Population Projection, Rizal Province

By 2025, the approximate distribution between the East and West Service Areas is projected to be almost 50-50 % because of the high growth rates in the East Service Area.

Some projected population adjustments were made in several LGU projections because of the following reasons:

- Extraordinarily low projections for Manila and San Juan. These two LGUs continue to exhibit negative growth rates using NSO projection method, but their trend shows stabilization in the size of the population. This observation was also expressed in the development plans of Manila. Hence, the ratio base growth rate was adjusted to 0% for both cities. This resulted in a continuing but a slower rate of decline during the study period.

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- Extraordinarily high projections for Antipolo, Cainta and Taytay. These three adjacent LGUs exhibited extraordinarily high growth rates during the study period, which was thought not to be matched by their government's capability to deliver basic services. Moreover, the previous high growth rates in these areas were caused by the exodus of migrants from the provinces and government's resettlement projects, which may slow down in the coming years as development plans of inner and intermediate core cities of Metro Manila are including medium and high density developments for on-site relocation of their population. Hence, in order to avoid extraordinary projection under the NSO projection method, the base rate was assumed as half the recent 5-year ratio growth rate for all three LGUs based on classification IV computation under the ratio method.

The aforementioned adjustments to the population projections naturally affected the ratio and number of population of the other cities/municipalities within the region/province as the ratio method redistributed the adjustments within the area. The observed overall effect still provided the expected general trend based on future densities and land use changes.

The projected population in each of the LGUs in the service area for the years 2000, 2005, 2010, 2015, 2020 and 2025 is shown in **Table 4.1**. The growth rate trends are shown in **Figure 4.8**.

4.2.4 Population Density Projection

The average density of population within the MWSS Service Area by 2025 is about 10,216, an increase of 30 % from the 2000 density. The highest densities will still be found within NCR with the cities of Taguig, Manila and Caloocan achieving densities over 30,000 persons per sq. km. Taguig will become densely populated because of loss of some of its lands to Makati City, particularly the Fort Bonifacio development. The least dense will be Tanay in Rizal province with about 560 persons or about 112 families per square kilometer.

Figure 4.9 presents the density projection within the service area. The growth trend continues to draw eastward with the core of Manila extending to the peripheries of Rizal and Cavite.

Although Manila has shown signs of stabilizing in the last ten years, the local government there would like to manage growth below 1 % to enable it to plan for the basic services it needs to provide and maintain for its population. Furthermore, it wants to manage migration to and from Manila and prioritizing in-city relocation and on-site development as much as possible and the promotion of medium rise building projects for on-site relocation, hence, the continuing high density.

Makati, on the other hand, would like to maintain its competitiveness with the other cities and has applied density limits to existing and proposed developments to preserve the market advantage of these areas relative to other parts of the metropolis.

Table 4.1 - Projected Population and Growth Rates, MWSS Service Area, 2005-2025

	City/Municipality	Population Projection					Projected Growth Rates (%)				
		2005	2010	2015	2020	2025	'00-'05	'05-'10	'10-'15	'15-'20	'20-'25
	NCR	**10,575,188**	**11,137,443**	**11,649,493**	**12,077,301**	**12,402,857**	1.26	1.04	0.90	0.72	0.53
1	Manila	1,572,788	1,542,856	1,498,306	1,437,495	1,361,717	(0.11)	(0.38)	(0.58)	(0.83)	(1.08)
2	Pasay	355,122	350,412	342,295	330,334	314,760	0.01	(0.27)	(0.47)	(0.71)	(0.96)
3	Quezon	2,288,816	2,376,485	2,442,754	2,480,588	2,487,164	1.04	0.75	0.55	0.31	0.05
4	Caloocan	1,305,994	1,428,308	1,546,404	1,654,073	1,746,872	2.09	1.81	1.60	1.36	1.10
5	Mandaluyong	296,293	310,882	322,918	331,374	335,752	1.25	0.97	0.76	0.52	0.26
6	Las Pinas	559,481	652,906	754,286	860,899	970,158	3.42	3.14	2.93	2.68	2.42
7	Makati	461,480	444,207	423,290	398,494	370,408	(0.48)	(0.76)	(0.96)	(1.20)	(1.45)
8	Malabon	330,538	317,956	302,785	284,860	264,608	(0.50)	(0.77)	(0.97)	(1.21)	(1.46)
9	Marikina	412,731	429,446	442,354	450,155	452,302	1.08	0.80	0.59	0.35	0.10
10	Muntinlupa	415,098	447,968	478,589	505,137	526,418	1.82	1.54	1.33	1.09	0.83
11	Navotas	245,524	258,011	268,413	275,867	279,944	1.28	1.00	0.79	0.55	0.29
12	Paranaque	498,242	544,239	588,518	628,723	663,185	2.07	1.78	1.58	1.33	1.07
13	Pasig	576,228	648,316	722,104	794,589	863,297	2.67	2.39	2.18	1.93	1.67
14	Pateros	57,438	56,673	55,357	53,419	50,897	0.01	(0.27)	(0.47)	(0.71)	(0.96)
15	San Juan	119,133	118,932	117,541	114,765	110,638	0.25	(0.03)	(0.24)	(0.48)	(0.73)
16	Taguig	551,941	642,775	741,048	844,040	949,194	3.38	3.09	2.89	2.64	2.38
17	Valenzuela	528,340	567,069	602,531	632,489	655,543	1.71	1.42	1.22	0.98	0.72
	Cavite	**889,204**	**1,001,005**	**1,100,829**	**1,179,874**	**1,231,998**	2.95	2.40	1.92	1.40	0.87
18	Cavite City	103,976	105,650	104,612	100,701	94,199	0.91	0.32	(0.20)	(0.76)	(1.33)
19	Bacoor	352,753	395,270	431,607	458,171	472,635	2.90	2.30	1.77	1.20	0.62
20	Imus	226,717	255,332	280,220	298,977	309,981	3.01	2.41	1.88	1.30	0.73
21	Kawit	72,750	81,901	89,850	95,828	99,318	3.00	2.40	1.87	1.30	0.72
22	Noveleta	38,068	44,032	49,631	54,385	57,911	3.56	2.95	2.42	1.85	1.26
23	Rosario	94,941	118,820	144,910	171,812	197,955	5.21	4.59	4.05	3.46	2.87
	Rizal	**2,230,624**	**2,878,932**	**3,686,046**	**4,672,308**	**5,859,922**	5.49	5.24	5.07	4.86	4.63
24	Angono	100,496	133,373	175,297	227,726	292,250	6.12	5.82	5.62	5.37	5.12
25	Antipolo City	639,804	857,242	1,137,491	1,491,840	1,932,861	6.32	6.03	5.82	5.57	5.32
26	Baras	31,018	38,701	47,820	58,403	70,463	4.82	4.53	4.32	4.08	3.83
27	Binangonan	237,025	295,155	363,995	443,681	534,256	4.78	4.48	4.28	4.04	3.79
28	Cainta	308,654	387,364	481,453	591,452	717,776	4.94	4.65	4.44	4.20	3.95
29	Cardona	45,233	51,727	58,582	65,576	72,515	3.01	2.72	2.52	2.28	2.03
30	Jala-jala	28,724	34,948	42,110	50,151	59,003	4.29	4.00	3.80	3.56	3.30
31	Morong	50,832	59,966	70,059	80,900	92,286	3.65	3.36	3.16	2.92	2.67
32	Pillila	56,027	68,367	82,620	98,685	116,446	4.35	4.06	3.86	3.62	3.37
33	Rodriguez	149,087	190,309	240,584	300,610	371,061	5.30	5.00	4.80	4.56	4.30
34	San Mateo	183,874	245,853	325,552	426,083	550,900	6.28	5.98	5.78	5.53	5.27
35	Tanay	95,441	114,826	136,816	161,125	187,452	4.06	3.77	3.57	3.32	3.07
36	Taytay	267,047	354,825	466,906	607,260	780,232	6.15	5.85	5.64	5.40	5.14
37	Teresa	37,362	46,275	56,761	68,816	82,420	4.67	4.37	4.17	3.93	3.67
	Grand Total	**13,695,016**	**15,017,380**	**16,436,369**	**17,929,483**	**19,494,777**		1.86	1.82	1.75	1.69

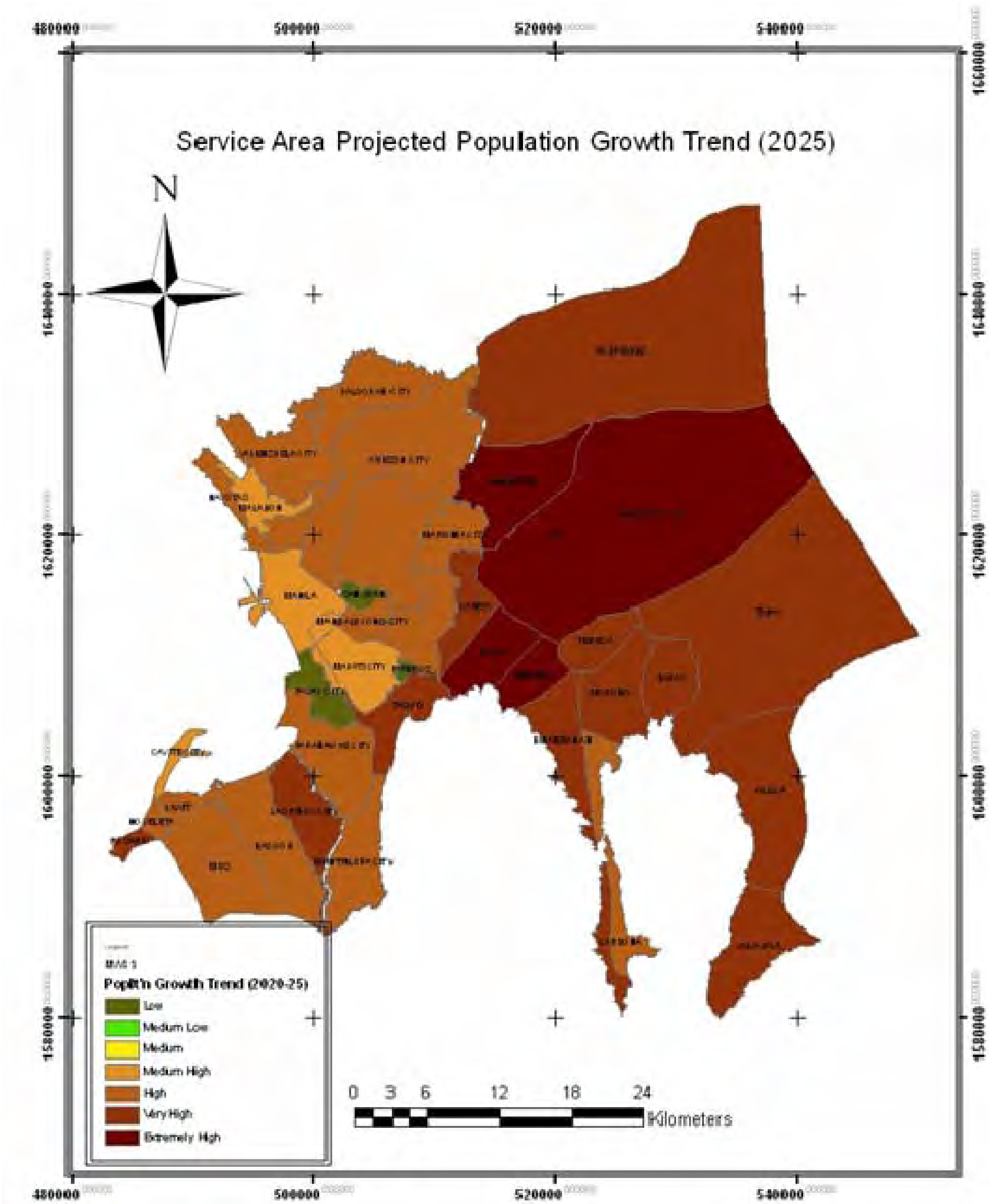

Figure 4.8 Projected Growth Trends, 2025

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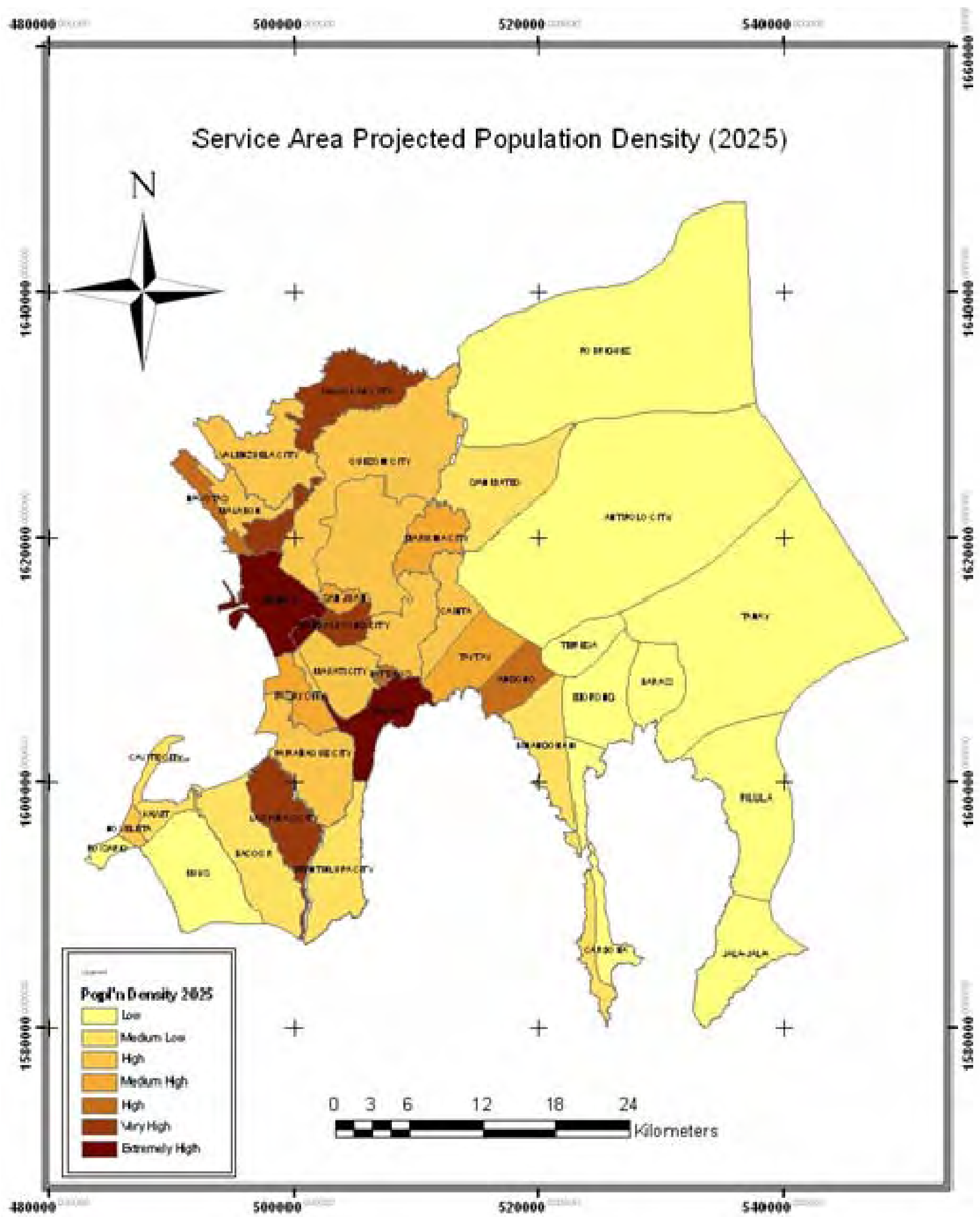

Figure 4.9 Projected Population Density in 2025, MWSS Service Area

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4.2.5 Summary of Opportunities for Sewerage and Sanitation Sector Development

Approximately 19.4 Million people or approximately 4.3 Million families will need potable water supply and sewerage services within the MWSS Service Area by 2025. At present, the level of population served by water is about 7.3 Million[2] with total service connections of about 780,000. Only about 15% of these water connections are sewered.

The projected population will be housed in existing residential areas and in newly developed development of new high-density residential/commercial use spaces. Most of the LGUs are planning for medium-density socialized housing for low-income groups that will decide to stay within the region.

There will also be a general increase in commercial and industrial uses that will require new water supply and sewerage systems. Industrial activities within the NCR will likely be of the small and light industries; large, heavy industries will be relocating outside the region, most likely towards Rizal, Cavite and the adjoining provinces.

Transport projects that will link NCR with Cavite and Rizal are already underway. This will increase the movement and flow of people and goods within the Service Area and will likely promote more development within the planning period.
The new infrastructure systems required for these anticipated developments may be developed on land that is still available if the government is able to secure them as soon as possible. At least 27 % of the total area in Metro Manila is proposed as open space in the individual CLUPs of the different LGUs. These maybe recovered from lands that will be vacated by resettled families, enforcement of easements along rivers and opening up of abandoned and derelict industrial areas.

4.2.6 Summary of Issues and Constraints for Sewerage and Sanitation Sector Development

In terms of land use and development, the NCR and Cavite Service Areas will have a short supply of available land for its increasing population and economic activities. Hence, development will likely be vertical rather than horizontal. The existing systems should be assessed if they can still accommodate the additional load coming from these developments.

Rizal, on the other hand, has a large expanse of open space/grasslands but they are constrained by the availability of water in the area. With the projected growth rate and development trends leading towards this area, new water sources should be given priority for development.

In terms of developing new waste management systems, there are several factors to be considered relative to the projected land uses within the service area.

[2] Based on 2003 MWSS Regulatory Office Annual Report

It is likely that developments will be scattered all over the region and will not likely be developing in scheduled phases as it is mostly private sector led. Hence, careful consideration should be given to designing system requirements for specific sector areas.

The changing advocacies and short term tenures of Chief Executives affect the ability of LGUs to implement their CLUPs and enforce their zoning ordinances within the plan period. Consequently, it also affects the ability of LGUs to undertake the recovery of open spaces, particularly relocation of informal settlers to set the buffer easements along the rivers/creeks. Hence, in the design of new waste management systems, approved/projected land uses should be treated only as indication. It is not likely that these areas will be transformed within the time frame prescribed by the plans.

There are also external and macro-economic factors affecting the rate of development in the NCR and the rest of the country. Historically, the NCR consistently produced the highest output in the country. Cavite and Rizal are closely following the trends of NCR because they are recipient of spill over from the region.

4.3 Water Supply

4.3.1 Present Water Supply Sources

Water supply to the current MWSS service area is sourced from the Angat-Umiray-Ipo system and local groundwater. The total capacity of the existing water source infrastructure is estimated at **4,090 MLD**, of which approximately 98% (4,000 MLD) of the daily supply comes from the Angat-Umiray-Ipo source.

Angat-Umiray-Ipo Sources

The main water supply source for MWSS is the Angat-Umiray-Ipo River System, as shown in **Figure 4.10.**

The system originates in the Angat River basin with a transbasin tunnel, adding yield from the Umiray River basin. Inflow is impounded at the Angat Dam. Discharge from the dam flows down to Ipo Dam. From Ipo Dam, raw water is conveyed thru three tunnels to the Bicti interconnection structure, thence thru five raw water aqueducts to La Mesa. The conveyance from Ipo Dam to La Mesa involves some 20km of tunnel/conveyance pipes. At La Mesa, part of the raw water feeds directly to the La Mesa Treatment Plants and the rest goes to Balara or to the La Mesa Reservoir. The La Mesa Reservoir also receives inflow from Alat Dam and its own catchment.

Groundwater Sources

Sourcing of groundwater from deep wells to either fully meet local demands or augment supply capacity is widespread across Metro Manila, with significant competition existing for use of this resource.

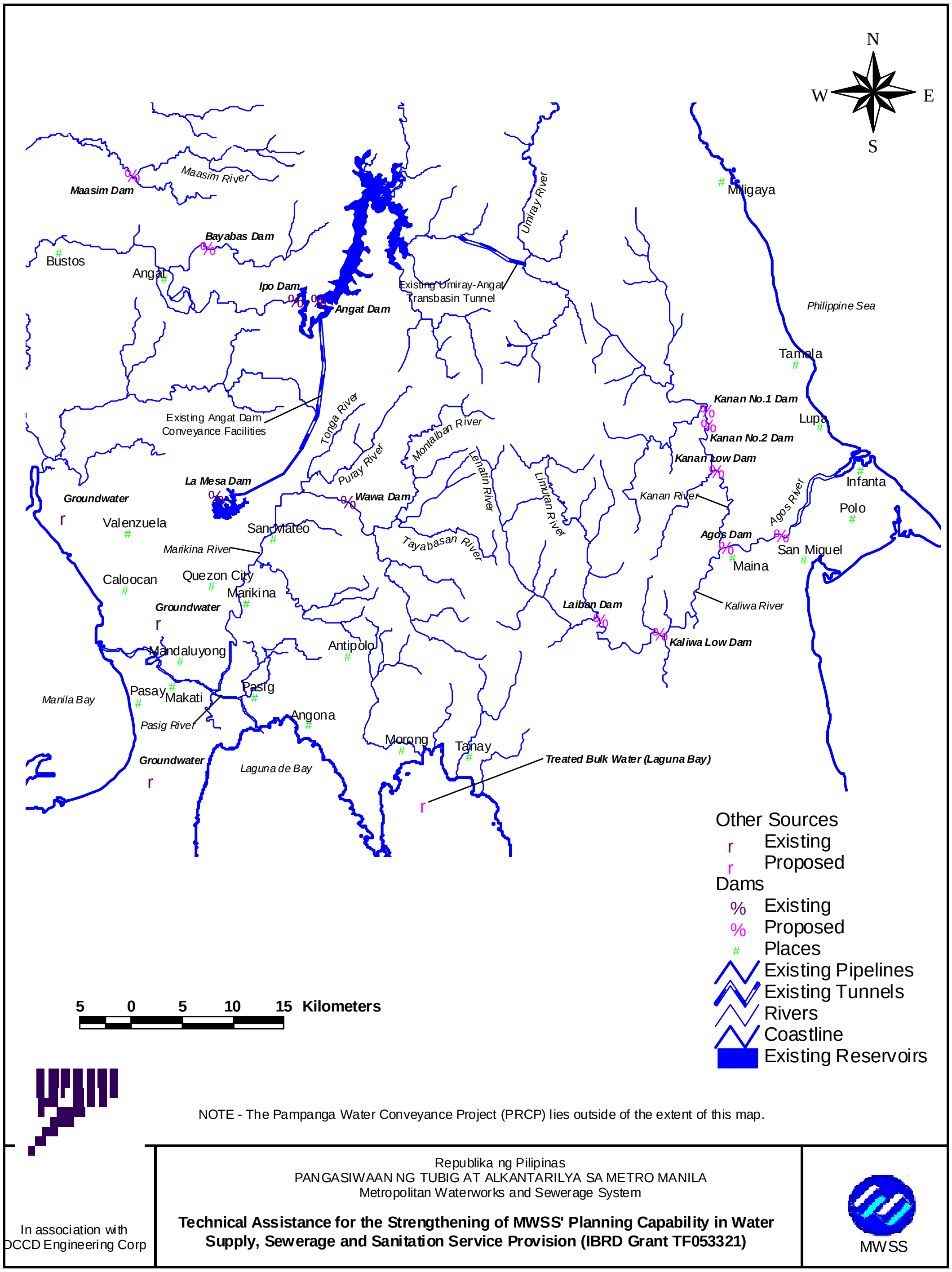

Figure 4.10 Angat-Umiray-Ipo River

In the concession areas, MWSI reportedly has 81 wells operating mainly in Parañaque, Las Piñas, Muntinlupa, Imus, Bacoor, Noveleta, and Cavite City with a total production of 57 MLD. The MWCI has some 50 wells operating in Cainta, Antipolo, Taytay, San Mateo, Rodriguez, Quezon City and Taguig, with a total production in the order of 35 MLD.

The total production capacity of 90 MLD from deep wells operated by the concessionaires represents about 70% of the installed capacity. The reduced level of production is due primarily to declines in aquifer levels and water quality resulting from over-abstraction of this resource. It is expected that these issues will continue to place increasing pressure on the use of groundwater as a resource for municipal water supply in the future.

4.3.2 Primary Distribution System

The MWSS water distribution network had its beginning in 1882 under the old Manila Water District. It has since undergone a series of expansion and upgrading through:

- The Interim Projects in the 1960's:
- The Manila Water Supply Project 2 (MWSP2);
- The Metro Manila Water Distribution Project (MMWDP);
- Angat Water Optimization Project (AWSOP); and more recently,
- The Manila South Water Distribution Project (MSWDP).

The West Zone distribution system was separated from the old MWSS system and it generally covers the influence area of La Mesa Treatment Plants 1 and 2. The pipe network has a total length of about 2,500 km, with sizes ranging from 3200 mm diameter to 50 mm. The primary distribution system (PDS), consisting of pipes 350 mm diameter and above is about 220 km.

Treated water from the La Mesa treatment plants is conveyed through a 3200 mm diameter line to the 200-ML Bagbag treated water reservoir. From the Bagbag Reservoir, the water is directed south through a 3000 mm pipe up to the vicinity of A. Bonifacio Street (Balintawak Cloverleaf area), where the pipe size is reduced to 2800 mm. The size of the pipeline is further reduced to 2200 mm in Moriones, Tondo and continues up to just upstream of the Pasay Reservoir and Pumping Station.

Through the La Mesa Pumping Station, about 24 MLD is sent to Upper Caloocan and 117 MLD is pumped to the Valenzuela area.

The distribution network of the East Zone is generally the part of the MWSS network supplied by the Balara Water Treatment Plants 1 and 2. Total length of the pipes in the system is around 2600 km. About 83.5 km of these have diameters 750 mm and larger. It is estimated that 40% of the distribution system is served by gravity flow while the remaining 60% requires pumping.

The Marikina Gravity Line, a 2200 mm steel pipe, flows by gravity from the Balara Treatment Plant Complex to Marikina, Pasig, Pateros, Makati. It feeds the Pasig, Fort Bonifacio and Makati Reservoirs and Pumping Stations.

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The three Balara-San Juan Aqueducts feed the Balara and San Juan Reservoirs and Pumping Stations, as well as the Cubao Booster Pumping Station. AQ1 feeds the Balara Pumping Station, which discharges through the 1200 mm Katipunan line and the 1050 mm Tandang Sora line. AQ3 serves the San Juan Reservoirs and pumping stations, while AQ2 is currently not in use.

The 1200 mm Tanong line flows by gravity and serves parts of Cainta through the Masinag Booster pumping station.

4.3.3 Water Usage

4.3.3.1 General

Current and future water demand has been analyzed in detail in Volume 2 of this Master Plan – *Partial Update of the MWSS Water Supply Master Plan.* In that study, water demand is broken down into domestic, commercial and industrial demands.

Future water demand estimates are mainly dependent on past consumption trends and other factors such as water tariff and the socio-economic condition of the community. In the present case complete reliance on past consumption trends is inappropriate as these are affected by:

- low pressures
- supply interruptions (intermittent water availability)
- metering errors
- unauthorized connections
- use of sources other than from MWSI or MWCI (private wells)
- tariff increases

The factors enumerated above will result in the underestimation of future demand.

4.3.3.2 Domestic Water Demand and Per Capita Use

A reasonably accurate correlation between per capita consumption and per capita income or family income can be established from past consumption trends in an unconstrained supply setting. In view of the constrained supply situation and the factors enumerated in the preceding paragraph, which affected the normal growth of domestic water demand, it is likely that demand will remain constrained until a major new water source is brought on-stream and/or until non-revenue water (especially in the West Zone) is significantly reduced. Either is unlikely to occur until after 2010.

In estimating future domestic water demands, basic assumptions were made related to service coverage, household income levels and number of households per connection.

With regard to **service coverage**, the coverage targets are taken from the Rate Rebasing Submission of the two concessionaires as shown in **Table 4.2** below.

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Table 4.2 - Coverage Targets

Service Area	2005	2010	2015	2020	2025
West	90%	97%	98%	98%	99%
East	67%	73%	81%	92%	98%
Total	**81%**	**87%**	**90%**	**95%**	**98%**

It is also assumed that water demand is related to **household income**. The total number of families in each city/municipality can be categorized into three income groups: high, middle, and low, using the 2000 Family Income and Expenditures Survey by the National Statistics Office (NSO). Different per capita water demands have been set and applied to each household group. In the absence of a similar detailed survey for the cities/municipalities of the provinces of Rizal and Cavite, the provincial household income percent distribution was adopted commonly for each city/municipality.

The third assumption used in the estimation of water demands is the **number of individuals per connection**. For this study the results indicated in the Consumer Survey prepared by the Public Assessment of Water Services (PAWS) were adopted i.e. 8.1 persons per connection served by MWCI and 7.26 persons per connection for MWSI. These figures were used in computing the historical domestic per capita billed volume.

Domestic per Capita Demand for Years 2005 and 2010

Taking into account the current limitation on water supply, the following consumption rates or per capita demand (constrained) were used: 180 lpcd for the high income group, 170 lpcd for middle, and 140 lpcd for low.

A lower set of per capita demands were adopted for selected and less urbanized towns in Rizal and Cavite, i.e. 160 lpcd for high, 150 for middle and 140 for the low income group.

Using the household distribution by income level and the per capita demand above, the weighted average per capita demand were obtained per city/ municipality. The domestic demand projection for year 2005 was obtained by applying these average per capita demands to the population served resulting in a system-wide average per capita demand of about 160 lpcd.

Domestic per Capita Demand for Year 2015

As a result of the current and planned NRW reduction programs of the concessionaires and the expected recovery of physical losses as well as the availability of a new water source, more water will be available. Hence, the following per capita demands were used: 220 lpcd for the high-income group, 200 lpcd for middle, and 160 lpcd for low income.

Similar to year 2005, a lower set of per capita demands were adopted for selected and less urbanized towns in Rizal and Cavite: 180 lpcd for high, 160 for middle, and 140 for the low income group. From this new set of per capita demands by income level, the domestic demand projection for year 2010 was obtained resulting in a system-wide average per capita demand of about 180 lpcd.

The per capita demand from 2010 to 2015 was assumed to increase linearly from a system-wide average of 160 lpcd in 2010 to 180 lpcd in 2015.

Domestic per Capita Demand from 2015 to 2025

The domestic per capita water demand for each city/municipality in year 2015 was projected to remain at the same level up to 2025. The increase in per capita water consumption during this period from improved economic conditions is expected to be neutralized by price elasticity. There are indications that price elasticity may have been the reason for the decline in billed volumes in both concessions from 2001 to 2004, when water rates were raised.

The computed average per capita demand from 2015 to 2025 is approximately 180 lpcd. This level of consumption correlates well with the present level of consumption, specifically, in some areas in the east zone where there is 24-hour supply and adequate pressures.

Domestic Water Demand from 2005 to 2025

The projected domestic water demand is summarized in **Table 4.3** below. It was projected that the total domestic water demand will increase from 1,767 MLD in 2005 to 3,465 MLD in 2025.

Table 4.3 - Projected Domestic Water Demand (MLD)

Service Area	2005	2010	2015	2020	2025
East	599	734	1,071	1,372	1,653
West	1,168	1,344	1,665	1,747	1,812
Total	1,767	2,078	2,736	3,119	3,465

4.3.3.3 Commercial and Industrial Water Demand

The methodology used for projecting commercial and industrial water demand was based on establishing a relationship between Gross Regional Domestic Product (GRDP) and commercial and industrial water consumption. This methodology relies on the past consumption trends to project future consumption, assuming normal consumption growth is reflected therein. However, when the past consumption rates are affected by supply constraints like low pressures and water supply interruptions, the resulting demand projection may not reflect the true demand growth rate.

To mitigate the effects of constrained supply, this study examined billed volume records in the East Zone, where some areas have uninterrupted supply and relatively good water pressures as compared to the West Zone. The average historical commercial and industrial per capita-billed volume of the East Zone was used in computing future commercial and industrial billed volumes for both concessions. The projected commercial and industrial billed volumes were then used to obtain the non-domestic water demand by applying a correction for commercial losses, which was estimated at 15% of NRW.

This resulted in commercial and industrial water demand projections as shown in **Table 4.4**.

Table 4.4 - Projected Commercial and Industrial Water Demand

Year	Projected Commercial Water Demand (MLD)	Projected Industrial Water Demand (MLD)
2005	636	121
2010	889	172
2015	1,048	204
2020	1,244	242
2025	1,438	281

4.3.3.4 Non-Revenue Water

Non-revenue water levels have historically been high in the MWSS system and have been a major constraint to the achieving an efficient water supply system with adequate pressures and service coverage. This has affected the financial viability of the sector in Metro Manila, with a consequent impact on the ability of the utility to provide suitable sewerage and sanitation services.

Table 4.5 shows Non-Revenue Water (NRW) levels from 1975 to 1996. There was a dramatic increase in NRW starting in 1982, when system pressures increased after the commissioning of La Mesa Plant I (LMTP I), sending an additional 1000 to 1500 MLD into the distribution network. **Table 4.6** shows NRW levels that have been achieved since privatization between 1997 and 2004 and indicates that, while there has been some improvement in the East Zone, there was little overall improvement in that period with total system NRW level still at about 60%.

Table 4.5 - MWSS NRW Historical Level (1975-1996)

YEAR	NRW%	YEAR	NRW%
1975	49.7	1986	66.4
1976	50.3	1987	59.7
1977	48.1	1988	57.7
1978	45.9	1989	57.7
1979	46.8	1990	57.7
1980	47.1	1991	57.1
1981	48.9	1992	55.0
1982	52.3	1993	57.4
1983	54.0	1994	59.0
1984	56.6	1995	55.5
1985	60.6	1996	60.0

Table 4.6 – NRW Levels since Privatization (1997-2004)

YEAR	NRW% (MWCI)	NRW% (MWSI)	Overall NRW%
1997	58.9	66.2	63.4
1998	49.1	64.0	58.1
1999	51.1	69.2	62.4
2000	51.4	66.7	60.8
2001	53.2	67.0	61.6
2002	53.8	68.6	62.6
2003	52.1	69.0	62.1
2004	47.5	69.0	60.4

With the existing and planned non-revenue water (NRW) reduction programs by the East and West Concessionaires, it is projected in this study that the NRW ratios will be decreased from 62%[3] in 2005 to as low as 30% in 2025.

The projected NRW levels and physical losses are presented in the **Table 4.7** below. NRW is divided into two components: non-physical losses or commercial losses and physical losses. Non-physical losses or commercial losses, which are about 15% of the total NRW, are directly applied to the billed volumes to obtain the total water demand. On the other hand, physical losses (estimated to be 85% of the total NRW) are applied to the total water demand to derive the system demand.

Table 4.7 - Projected NRW Levels and Physical Losses

	2005	2010	2015	2020	2025
NRW Ratio (%)	62%	45%	34%	31%	30%
NRW Level (MLD)	3,258	2,292	1,920	1,928	2,088
Physical Losses Ratio (%)	52%	38%	29%	26%	26%
Physical Losses (MLD)	2,769	1,948	1,632	1,639	1,774

4.3.3.5 System Average Day Demand

Table 4.8 below shows the system average day demand, which was obtained by applying the correction due to physical losses to the total water demand.

[3] NRW ratio of 62% will occur if projected system demand is applied. If supply is limited to the existing system capacity, NRW ratio is 57%.

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Table 4.8 – Average Day Demand (ADD) Forecast

Area / Demand	2005	2010	2015	2020	2025
East – MWCI					
Domestic demand (MLD)	599	734	1071	1372	1653
Commercial demand (MLD)	274	396	483	592	707
Industrial demand (MLD)	51	75	93	115	138
Total East demand (MLD)	924	1,206	1,647	2,079	2,498
West – MWSI					
Domestic demand (MLD)	1,168	1,344	1,665	1,747	1,372
Commercial demand (MLD)	363	493	565	652	592
Industrial demand (MLD)	70	97	111	128	115
Total West demand (MLD)	1,601	1,934	2,341	2,526	2,686
Total					
Base demand (MLD)	2,525	3,139	3,988	4,605	5,184
Physical Losses (MLD)	2,769	1,948	1,632	1,639	1,774
Total system demand (MLD)	**5,294**	**5,088**	**5,619**	**6,244**	**6,958**

4.3.4 Future Water Sources

Based on the projected water demands outlined in Section 4.3.3 and considering the current water sources and the projected reduction in non-revenue water, without the development of new water sources, there will continue to be a shortfall in water supply as shown in **Table 4.9**.

Table 4.9 - Water Production Forecast

Year	2005	2010	2015	2020	2025
Average Demand (MLD)	5,294	5,088	5,619	6,244	6,958
Maximum Demand (MLD)	6,617	6,360	7,024	7,805	8,698
Existing Capacity (MLD)	4,090	4,090	4,090	4,090	4,090
Shortfall (MLD)	1,204	998	1,529	2,154	2,868
New source capacity required (MLD)	-	598	1,129	1,754	2,468

The values shown in **Table 4.7** projected a reduction in non-revenue water to 26% from physical losses in both concessions by the year 2025. Demands will continue to be constrained until a major new source comes on stream after 2010. The development of a major water source is a long-term undertaking and is unlikely to be available until at least 2013. Several options are available for interim sources including:

- The currently proposed Wawa Dam development that will produce an additional 50 MLD;
- The Angat Water Utilities & Aqueduct Improvement Project that focuses on construction of AQ-6. Initially, it was assumed that this option could produce up to 750 MLD, but this would depend upon negotiation with NWRB and NIA in allocations from Angat Dam; and,
- Implementation of a proposed BOT scheme to provide 300 MLD of water, possibly from Laguna Lake.

At this stage it has been assumed that a total of 400 MLD may be provided from these interim sources.

In order to satisfy the long-term water demand, however, major development of the Agos River basin will be required. The update of the Water Supply Master Plan (2005) has proposed the development of Laiban Dam as a first stage (1,830 MLD) followed in the future by Kanan No.2 Dam and transfer scheme (3,290 MLD).

Details of the proposed Laiban and Kanan developments are shown in **Figure 4.11.**

In parallel, a program of works focusing on reduction of NRW must also form a key component of the water sourcing strategy to achieve a higher degree of sustainability.

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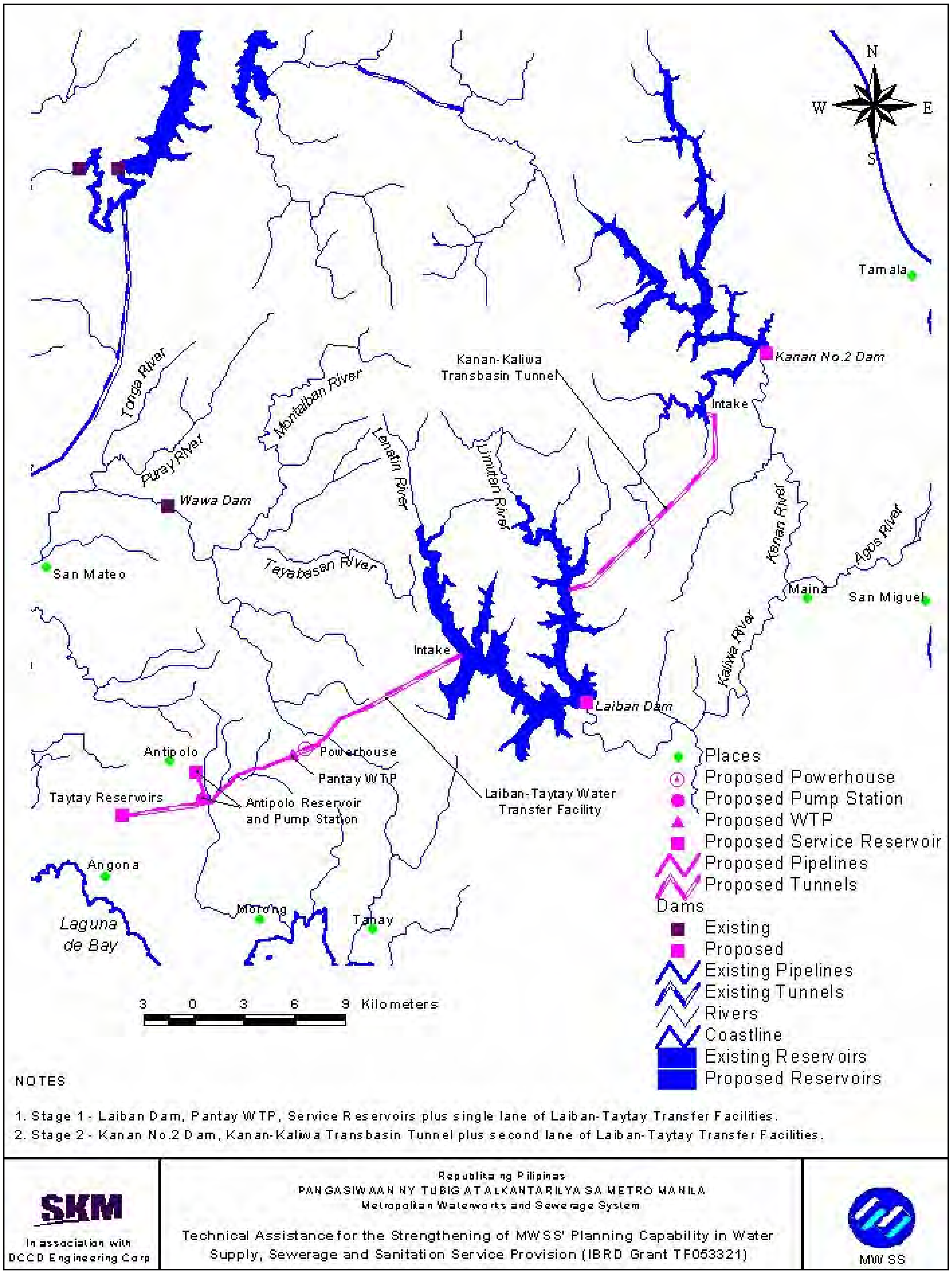

Figure 4.11 Laiban + Kanan No. 2 Dam

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Staging of Water Source Development

The Laiban Dam/Kanan No. 2 Dam development can be staged to some degree in accordance with demand growth. This staging and the corresponding water demand curve is shown in **Figure 4.12** that indicates that the development could be made in two main stages with five sub-stages between 2015 and 2036.

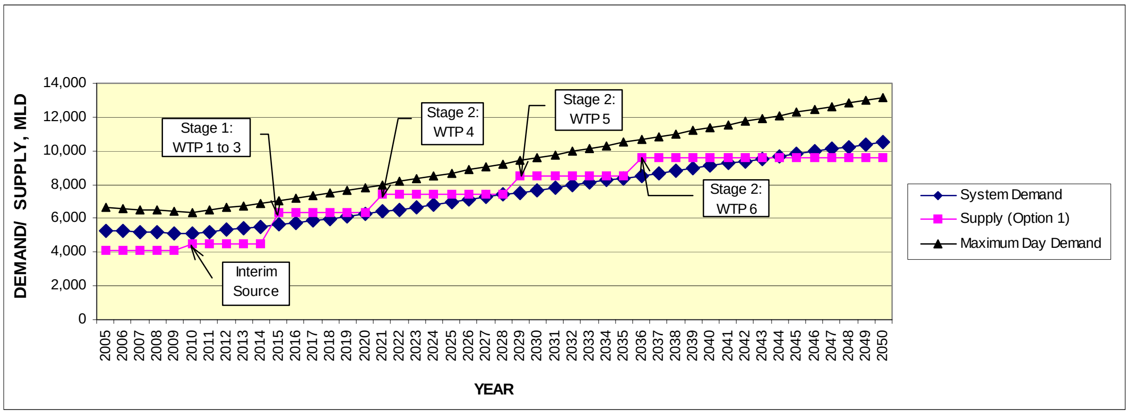

Figure 4.12 Demand and Supply Curve for Laiban Dam/Kanan No 2 Dam Development

The implication of this staging in water source development is that demand within the currently underserved parts of the service area is to likely remain constrained until about 2015 when water from Laiban Dam becomes available. This means that sewerage systems are unlikely to be established in many areas, especially in Rizal and Cavite, until sufficient water is available after 2015. This should be reflected in the sewerage targets and investment programs developed.

4.4 Drainage

4.4.1 Drainage and Public Health

The topography of much of the Metro Manila area is generally flat and stormwater drains slowly during rainfall. Stormwater finds its way into rivers and esteros. The esteros resemble open canals with variable cross-sections, frequently clogged with silt, sediments, solid waste and water hyacinths. In many instances, informal settlers build houses on stilts over many of these waterways and the esteros become effectively open sewers. Stagnant water and garbage in the esteros serve as ideal breeding grounds for flies and mosquitoes.

Most of the waste disposal systems (septic tanks) overflow to local drains or storm drains and canals. These drains discharge to rivers and esteros and add to the pollution along with the open dumping of solid waste. The water in the esteros during the dry season is generally septic. Water pollution of the water bodies in Metro Manila is discussed in more detail in Section 4.7.

Local flooding of polluted water bodies is a public health risk and flood control programs being implemented by the LGUs, MMDA and DPWH must be coordinated with the sewerage and sanitation programs to maximize the positive impact on public health. Road construction has in places intensified flooding problems on a local scale due to the practice of elevating streets above stormwater levels. In many instances, inadequate or clogged drainage facilities aggravate the flooding problems in the low-lying areas, especially in the low income/blighted areas. In the willingness-to-pay survey conducted under this study, the major sanitation improvement desired by most of the respondents was to improve the condition of the local drains.

As will be discussed later in this study, local drains are likely to form an important element of the sewerage/sanitation strategy at least for a significant period of the master plan study. Improving the condition of the drainage network to prevent flooding is a key strategy to enable improvements in public health.

If local drains are to be used as combined drainage to also carry sewage in some areas, it is important to prioritize drainage improvements in the currently flood-prone areas or provide separate sewerage systems in these areas to ensure sewage is not discharged into the streets during the rainy season. MMDA and DPWH have implemented major drainage projects in the past such as the Mangahan floodway and the Napindan hydraulic control structure that has mitigated the flooding problem in the metropolis. In 1998, the Special Assistance for Project Formation on the Pasig-Marikina River Improvement Project funded by OECF was undertaken for DPWH. In 2001, a hydraulic study was made for finalizing the design of the Marikina Control Gate Structure which is integral part of the flood control project (Mangahan floodway and Napindan hydraulic control structure are major components of this flood control project) of Metro Manila.

4.4.2 Drainage Catchments

In the 1996 NJS Master Plan, the MWSS service area in Metro Manila was initially subdivided into 27 catchments or systems, which also served for the 1979 JMM Master Plan. Further, the catchment areas as delineated in the East Concession Area Master Plan Update 2005 were considered since numerous sewerage projects serving small communities are already in the pipeline under the MTSP. The catchment areas in the Philaqua Master Plan (unofficial) also provided a basis in the delineation of the catchment areas for the West Zone. More details on the catchment areas are provided in Chapter 10.

The following considerations were used in the delineation of the catchment areas:

1. The MWSS service area was analyzed as a whole and the boundary between the West and East Zones was not considered as a constraint.
2. The existing sewered areas and the proposed sewered areas under MTSP including privately owned systems were identified and their coverage areas delineated. It was assumed that the MSSP and MTSP projects will be implemented and will become an integral part of the overall master plan.
3. The catchments were delineated based on topography and general drainage patterns.

4. Thirty-one catchments were delineated and grouped into five large clusters, namely, the northern area (Navotas, Malabon, Tullahan, Valenzuela and North Quezon City), Central Manila (Dagat-Dagatan, Caloocan, Balut, Sampaloc, Central North, Central Manila and Pandacan), south area (South Manila, NAIA, Pasay, Las Pinas, Parañaque, Muntinlupa), central area (Cubao, San Juan, Mandaluyong, Guadalupe and Ayala) and east area (San Mateo, Baho-Buli, Ortigas, West Mangahan, Bonifacio and Taguig). The 31 catchments are as shown in **Table 4.10** below:

Table 4.10 - Sub-catchment Areas

Catchment	Location	Catchment	Location
W – 1	Muntinlupa	W – 17	Valenzuela
W – 2	Las Pinas	W – 18	Caloocan B
W – 3	Parañaque	W - 19	Malabon-Tullahan
W – 4	NAIA	EW – 1	Quezon Central
W – 5	South Manila	EW – 2	Quezon North
W – 6	Pandacan	EW – 3	Quezon East
W – 7	Central Manila	E – 1	Taguig
W – 8	Central North	E – 2	Makati
W – 9	Sampaloc	E – 3	Pateros
W – 10	Balut	E – 4	Bonifacio
W – 11	Dagat-Dagatan	E – 5	Pasig
W – 12	Caloocan	E – 6	Mandaluyong-San Juan
W – 13	Malabon-Tullahan	E – 7	Taytay
W – 14	Malabon-Tullahan	E – 8	Quezon South
W – 15	Quezon West	E – 9	Cainta-Marikina
W – 16	Navotas		

5. The eastern municipalities of Rizal and the municipalities of Cavite under the MWSS service area will continue to use septic tanks in areas where there are no sewerage systems and the catchments were not delineated.

4.5 Sanitation

The three main river systems in Metro Manila, namely: (1) Pasig River with Marikina and San Juan Rivers as tributaries; (2) Navotas, Malabon,Tullahan-Tenejeros River Systems; and, (3) Parañaque-Zapote River Systems are currently heavily polluted (DENR 1991).

The Pasig River, once known for its pristine waters and aquatic resources, is now one of the world's most polluted river systems with dissolved oxygen levels dropping to zero for the most part of the year. Total coliform levels exceed standards of the Department of Environment and Natural Resources (DENR) by several log values.

4.5.1 Sanitation Facilities in Metro Manila

According to the NSO 2000 Census of Population and Housing, about 84 % of the households in Metro Manila have septic tanks but maintenance is poor. For both Rizal and Cavite provinces, about 72 % have septic tanks. The use of septic tanks is specified in the National Plumbing Code for those not connected to a sewerage system. **Table 4.11** below shows that the estimated number of households in the MWSS service area was about 2.17 million in the year 2000.

In Metro Manila, the use of septic tanks will most likely to continue, particularly in those areas not covered by a sewerage system. Even with an existing sewerage system, customers are reluctant to connect to the sewers because of the additional 50 % surcharge that is imposed on water bills for connected properties. Under existing conditions, the storm drainage system directly receives overflow of the septic tanks due to poor or non-existent absorption fields as shown in **Figure 4.13**. This is exacerbated by the design of some septic tanks that allows seepage from the bottom. The existing drainage system most often functions as a “combined sewerage system.” **Figure 4.13** also indicates the typical characteristics of sullage and septage. For those tanks not cleaned regularly, high strength septage may be discharged into the storm drains, instead of the sullage overflow from a correctly functioning septic tank.

It was estimated that 26 % of the existing septic tanks in Metro Manila (James Montgomery 1991) are inaccessible for desludging, primarily for the following reasons:

- Poor building practice (beneath other structures);
- Absence of manholes; and
- Access roads to the houses are too narrow.

In the willingness-to-pay survey conducted as part of this study, only 32% of respondents could recall having had their septic tank emptied. When asked whether their septic tank had a manhole for pumping out sludge, many appeared unaware, although 90% of those who answered the question, believed a manhole was available.

A number of master plans have been prepared since 1969 in order to address the sewerage and sanitation requirements of Metro Manila. However, none of these master plans was fully implemented due mostly to financial, social and institutional constraints. The delay in sewerage and sanitation development contributed to the rapid deterioration of the natural water systems in the region.

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Table 4.11 - Population and No. of Households with Septic Tanks (NSO 2000)

City/ Province/ Municipality	Population	Number of Household	Household with septic tanks	Average Household	% Household with septic tank
National Capital Region	9,862,978	2,132,989	1,798,672	4.6	84
Manila	1,568,092	333,547	294,902	4.7	88
Caloocan	1,174,673	249,567	212,939	4.71	85
Las Pinas	470,154	97,962	74,769	4.8	76
Makati	442,144	103,981	95,267	4.5	92
Mandaluyong	275,106	59,628	52,284	4.61	88
Marikina	389,763	80,160	70,111	4.86	87
Muntinlupa	370,333	78,016	55,910	4.75	72
Parañaque	446,766	94,109	76,840	4.75	82
Pasay	353,798	78,180	70,692	4.53	90
Pasig	503,013	107,835	93,541	4.66	87
Quezon	2,158,367	480,624	408,548	4.49	85
Valenzuela	481,047	106,382	88,350	4.52	83
Malabon	336,516	74,137	63,726	4.54	86
Navotas	229,717	49,450	36,746	4.65	74
Pateros	57,172	12,029	10,921	4.75	91
San Mateo	117,398	24,605	22,887	4.77	93
Taguig	462,591	102,723	70,239	4.5	68
Cavite	768,923	163,865	117,902	4.7	72
Bacoor	305,699	64,067	47,897	4.8	75
Cavite City	99,367	21,342	15,324	4.7	72
Imus	195,428	42,232	31,095	4.6	74
Kawit	62,751	13,510	10,759	4.6	80
Noveleta	31,959	6,934	4,208	4.6	61
Rosario	73,665	15,780	8,619	4.7	55
Rizal	1,702,110	356,578	255,776	4.7	72
Antipolo	468,123	97,415	72,087	4.8	74
Cainta	242,137	51,863	41,490	4.7	80
Rodriguez	114,859	24,524	17,167	4.7	70
San Mateo	135,357	28,162	20,277	4.8	72
Taytay	197,279	42,620	30,690	4.6	72
Angono	74,538	15,740	11,018	4.7	70
Binangonan	187,639	38,488	25,017	4.9	65
Cardona	38,994	7,953	5,170	4.9	65
Baras	24,476	4,971	3,056	4.9	61
Jala-jala	23,276	4,759	2,744	4.9	58
Morong	42,453	8,988	6,494	4.7	72
Pililla	45,254	9,001	5,978	5	66
Tanay	78,065	15,720	10,099	5	65
Teresa	29,660	5,374	4,489	4.7	70

** Based on 2000 Census of Housing and Population, 84% of the Households in the National Capital Region has individual septic tanks.

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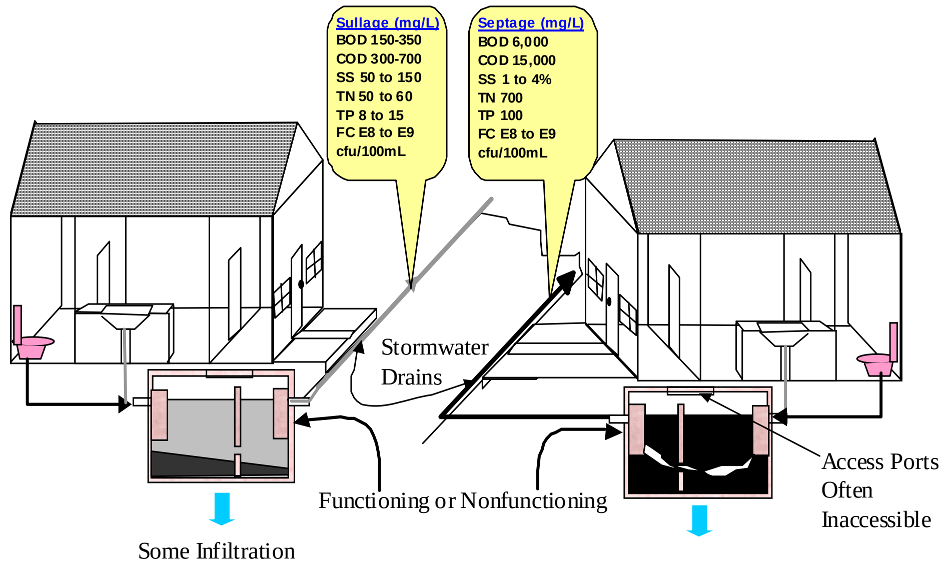

Figure 4.13 Septic Tanks in an Urban Environment

When the MWCI and MWSI Concessionaires took over the MWSS operations in August 1997, the sanitation programs of MWSS were not very well developed. At that time, the areas with sewerage service represented less than 10 % of the total MWSS service area. The sewered areas were the Manila Central System, the Dagat-Dagatan System, the Magallanes System, and isolated systems in Quezon City. Most of the MWSS service area was and is still served by individual septic tanks (see **Table 4.12**).

Table 4.12 - Major Sanitation Facilities in the MWSS Service Area

System Name	Area Served	Sewer Length (km)	Characteristics	MWSS Service	Operator
Quezon City separate systems (see Table 4.13)	Proj. 7 & 8, Quezon City	123.7	Communal septic tanks-Imhoff tanks	O&M, desludging	MWCI
Individual septic tanks	MWSS Service Area	None	Private septic tanks- estimated 2.0 million	Desludging (for water customers)	MWSI and MWCI
NHA Systems (for Zonal Improvement Projects – see Table 4.14)	MWSS Service Area 1,000 Ha.	Not specified	Communal septic tanks	None	MWSI and MWCI

Table 4.13 presents the existing communal septic tanks (CST) of MWCI and their capacities. Septage from the CSTs is collected by MWCI and conveyed to the septage holding facility in Philam Life in West Ave., Q.C. Ten of the CSTs were programmed for conversion to wastewater treatment plants. **Table 4.14** presents the NHA and the private sanitation systems (CSTs) in Metro Manila.

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Table 4.13 - Existing Communal Septic Tanks of MWCI

No.	Location	Tank Capacity (m^3)
1	Violeta St., Roxas District, Q.C.	113
2	Umbel St., Roxas District, Q.C.	53
3	Gumamela St., Roxas District, Q.C.	114
4	Gumamela St., Roxas District, Q.C.	121
5	Waling Waling St., Roxas District, Q.C.	192
6	Waling Waling St., Roxas District, Q.C.	153
7	Everlasting St., Roxas District, Q.C.	230
8	Azucena St., Roxas District, Q.C.	191
9	Azucena St., Roxas District, Q.C.	90
10	Azucena St., Roxas District, Q.C.	70
11	Champaca St., Roxas District, Q.C.	143
12	Camia St., Roxas District, Q.C.	84
13	Everlasting St., Roxas District, Q.C.	79
14	Alley nr. Rimas St., Project 2, Q.C.	338
15	J. Zobel St., Project 4, Q.C.	252
16	Near Sianghio St., Kamuning, Q.C.	410
17	Matiwasay St., U.P. Village, Q.C.	829
18	Mapagmahal St., U.P. Village, Q.C.	432

Table 4.14 - NHA Systems in Metro Manila and Private Systems

System/Location	Owner	Year Built	Service Area	Communal Septic Tank
West Zone				
1. Tangos System, Daang Hari, Tangos, Navotas	NHA	1980s		Septic Tank
2. Capri System, Novaliches, Quezon City	NHA	1980s		Septic Tank
3. Maricaban System,Maricaban,Pasay City	NHA	1980s		Septic Tank
4. Leveriza System, Malate, Manila	NHA	Now connected to Manila Central system		
5. Juan Luna System, Tondo, Manila	NHA	Now connected to Manila Central system		
6. Bangkal System, Bangkal, Pasay City	NHA	MWSS PROGRESS pilot project		
7. Quezon Institute, E.Rodriguez Ave, QC	Quezon Institute			Septic Tank
8. Veterans Memorial Hospital, QC	Veterans Memorial	1953-55	55 ha,200-600 mm dia & 2,581 length	Septic Tank
9. Philam Life, Las Pinas	Private			Imhoff Tank
East Zone				
10. Martin de Porres System, Cubao, QC	NHA			Septic Tank
11. Bagong Nayon System, Antipolo City	NHA	1977		Septic Tank
12. Camp Aguinaldo System, Camp Aguinaldo, QC	DND			Septic Tank
13. Kamuning District, QC	QC govt			Septic Tank: 5.8mx19.0mx3.4m
14. Parks & Wildlife, Quezon Ave., QC	Bureau of Forest Dev			Septic Tank: 8.0mx22.6mx5.0m

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In terms of sanitation service, MWSS provided limited desludging services while the private contractors provided the bulk of the desludging services. The main constraints in the desludging program were the inaccessibility of many septic tanks, unavailability of vacuum tankers and identifying sludge disposal sites acceptable to the DENR. Since September 1995, the only inland disposal site previously used by MWSS (near Marilao, Bulacan) became unavailable and the desludging work ceased. The MWSS equipment had also exceeded their useful life with the desludging units becoming only partly operational. The Dagat-Dagatan lagoons were used for disposal of septage before it was rehabilitated in 2003 and a septage treatment plant installed.

4.5.2 Current Concessionaire Sanitation Programs

MWCI Programs

MWCI schedules the desludging services on an area basis. Provision of such services is coordinated with the barangay wherein the proposed schedule of desludging is disseminated to the households. Under the East Concession, Master Plan Update (2005) the households were asked whether they wish to avail of the services. Only around 80 % of the households in areas visited indicated their desire to avail of the desludging services. However as shown by the willingness-to-pay survey conducted under this study, most respondents appeared unaware of the schedules and 66% employed private contractors to pump out their tanks rather than avail of the services of the MWSS or the concessionaires.

The septage collected by MWCI is transported and discharged to an Imhoff tank located in Phil-Am Village, Quezon City. The Imhoff tank serves as a temporary storage for septage, with private hauling contractors of MWCI coming to collect the septage, and transporting it to lahar areas in Pampanga and Tarlac. The targeted septage collection of 200 m^3/day is unrealized. As of July 2005, the septage collection ranged from 80 m^3/day to 150 m^3/day.

The septage is spread over lahar areas, which are later planted with sugarcane. A research study by the Sugar Regulatory Administration (E.B. Estanislao et. al, 2002) indicated an increased tonnage in the range of 46-74 % as a result of septage application ranging from 40-120 tons per hectare. MWCI intends to continue the septage application until the Antipolo septage treatment plant becomes operational after which, MWCI will focus on soil application of dry biosolids produced by the various sewage and septage facilities.

MWSI Programs

MWSI is responsible for operating the Central Sewerage System, the Dagat-Dagatan System and a portion of the Quezon City system. The Quezon City System consists of several communal septic tanks serving residential developments.

Prior to the completion of the septage treatment plant at Dagat-Dagatan, MWSI continued its collection, treatment, and disposal of septage using the Mobile Dewatering Units (MDU). Private contractors transported the dry sludge to lahar areas in Pampanga and Tarlac. Starting May 2005, the septage treatment plant in Dagat-Dagatan became

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operational and can treat up to 400 m^3/day of septage on a 16-hour day basis. Seven MDUs and 25 vacuum tankers will be fully utilized for desludging activities.

As of July 2005, MWSI was in the final stage of Fertilizer and Pesticide Authority (FPA) registration. A pilot study is now on-going in Floridablanca in coordination with Luzon Agricultural Research Center (LAREC). MWSI intends to secure a permanent license as manufacturer-distributor similar to MWCI.

4.6 Sewerage

4.6.1 Existing Sewerage Systems

Upon privatization of the operations of the MWSS, various sewerage systems were turned over to concessionaires as shown in **Table 4.15**.

For the East Zone concession area, MWCI assumed operation of one sewerage system (Ayala Makati), one (1) bio-module STP in Cainta, one (1) Imhoff Tank in Phil-Am Village, and 33 communal septic / Imhoff tank systems in Quezon City and Antipolo with a total service area coverage of 1,280 ha and a total treatment capacity of 71 MLD.

For the West Zone, the MWSI took over the operations of two sewerage systems (Central Sewerage System and Dagat-Dagatan) and five separate systems in Quezon City, with a total service area coverage of 3,270 ha. For the Central Sewerage System, the sewage is disposed through the Manila Bay outfall. For Dagat-dagatan, the treatment capacity was 52 MLD and the Quezon City systems were served by CSTs.

At the time of privatization, the existing sewerage systems consisted of only the four shown in **Table 4.15**.

Table 4.15 - Existing Sewerage Systems in Metro Manila

System	City/Municipality	Service Area (ha)	Remarks
Central System	Manila City	2,620	No treatment. Outfall to Manila Bay
Ayala System	Makati City	600	
Dagat-Dagatan System	Caloocan, Malabon, Navotas Manila	333	Only STP is turned over to MWSS
Separate Systems	Quezon City	1000	
Total		4,553	

A brief description of the three major systems follows.

Manila Central Sewerage System

Built in 1902, the Manila Central Sewerage System (**Figure 4.14**) consists of two collection networks, one north and one south of Pasig River. It has about 305 km of sewers, ranging in size from 125 mm to 1425 mm and seven lift stations, i.e. Legarda, Luneta, Malate, Paco, Port Area, Sta. Ana and Sta. Cruz.

Both networks end at the Tondo pumping station, that pumps the sewage through a 1800 mm outfall into Manila Bay. Screened raw wastewater is discharged through this outfall via a 300 mm diffuser section at a depth of about 11 m. The design flow capacities of the Tondo Pumping Station are 5.0 m^3/s at peak flow and 3.3 m^3/s at average flow. Average flow equals 280 ML/s as designed.

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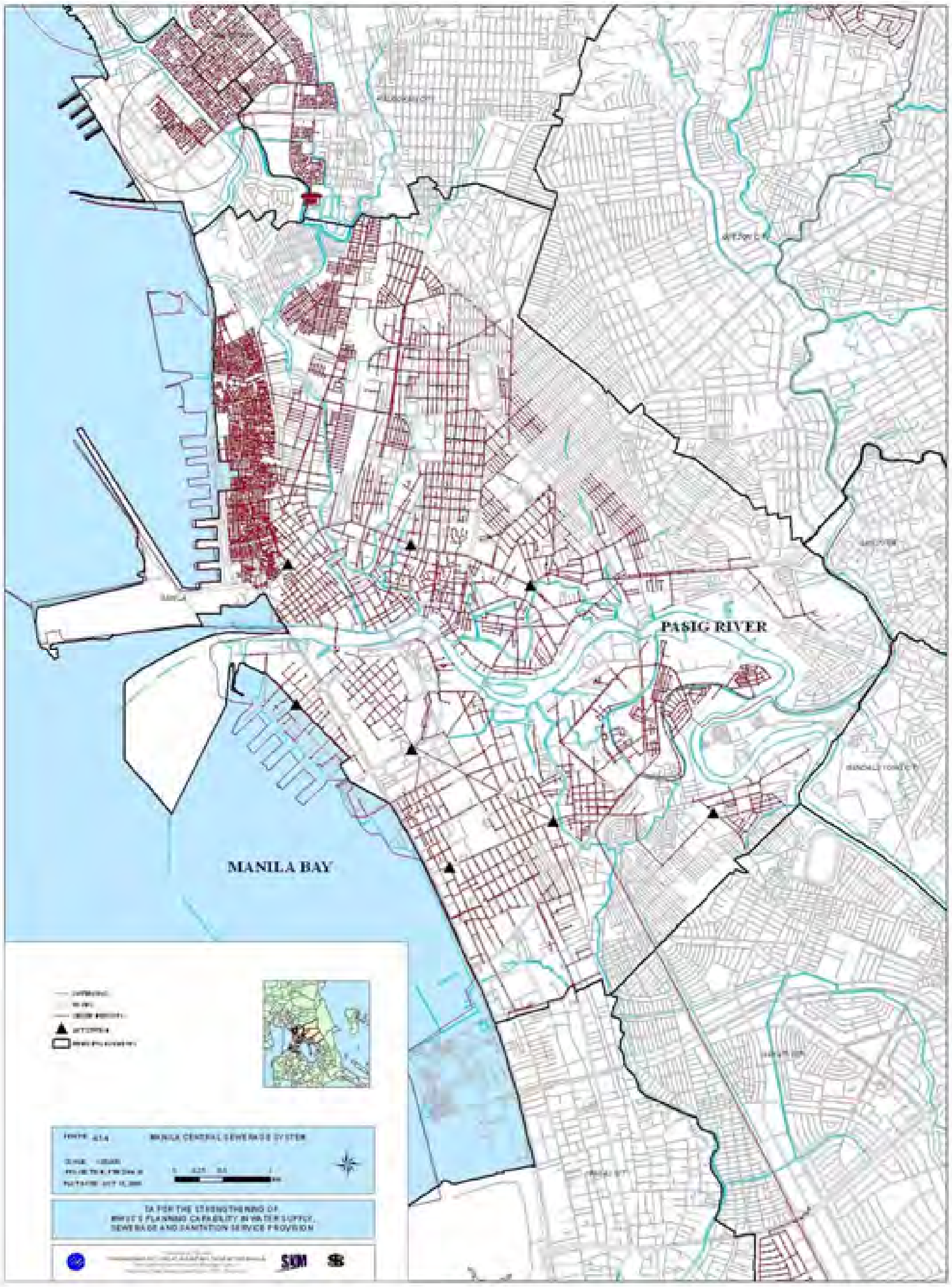

Figure 4.14 Manila Central Sewerage System

The system has undergone three major rehabilitations. The last one was carried out in 2004 under the MSSP 4 and was funded by the World Bank. The works being implemented under the MSSP rehabilitation included (i) Improvement of the Tondo Pumping Station; (ii) Rehabilitation of all 7 Lift Stations; (iii) Sewer lines improvement consisting of cleaning and CCTV inspection and repair of sewer lines and raising of buried manholes; and (iv) Installation of 10,000 service connections. Notable in this program has been the difficulty in securing the new connections, with only 730 out of the proposed 10,000 having been installed as of September 2005.

Dagat-Dagatan Sewerage System

The Dagat-Dagatan Wastewater Treatment Plant (WWTP) was originally developed by the National Housing Authority (NHA) from 1979 to 1986 and features lagoons lined with the natural clay on-site. It has a 332 ha service area on a reclaimed land. It comprises 67 km of sanitary sewers, with diameters ranging from 200 to 750 mm; a pumping station equipped with four pumps; and WWT ponds that occupy approximately 5 ha. Only two of the three planned modules of the treatment ponds were constructed. Each module consists of one aerated lagoon, one facultative lagoon, and a polishing pond. Since construction, only module 1 and the aerated lagoon of module 2 were commissioned. The design flow for the two modules is 26 MLD, with peak flow of 52 MLD. The detention time of sewage is 44 days.

Under MSSP, rehabilitation work was carried out on the Dagat-Dagatan sewerage system which included the following:

- Dewatering of and sludge removal from the four lagoons, replacement of riprap embankment and construction of baffled walls, and installation of a total of eight floating mechanical aerators on the two aerated lagoons (with an OTR of 50 kg/hr).
- Removal and replacement of four major pumps and associated piping, complete replacement of all mechanical and electrical systems, and a wide variety of general site improvements.
- Construction of a 200 m3/day Septage Treatment Plant

Sewage flow was yet to be restored (Nov. 2005) to the plant due to problems with the supply line.

Ayala Sewerage System

The Makati collection system consists of a network of local and trunk sewers ranging from 200 to 1500 mm. in diameter and a by-pass pumping station. The treatment plant is situated at the southwestern most tip of Magallanes Village, the lowest point in the service area and the effluent discharges into Dilain Creek, which runs along the southern boundary of the plant site. A trickling filter was first constructed in 1966, and operated for five years thereafter. During much of that time, the plant did not function effectively and was replaced by a 22.7 MLD activated sludge plant in June 1971. The plant was further expanded to a nominal capacity of 40MLD in 1979 to provide for a service area population of about 120,000 people. Improvements included new sludge drying beds, provision for froth spray nozzles in the effluent launder channels of the sedimentation tanks, and replacement of the propeller-type return activated sludge meters with venture or insert flow meters.

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Under the Manila Second Sewerage Project (MSSP), upgrading of the Ayala sewerage system was implemented, including rehabilitation of the pumping station and sedimentation tanks to provide mechanical treatment of sewage and septage, and repair of pipes, equipment and other works.

Other Sewerage Systems

As indicated in **Table 4.16** there are now also various sewerage systems serving a mix of residential and commercial developments including new systems serving new real estate property development by private developers. Shopping malls and commercial centers located in non-sewered areas have built individual wastewater treatment plants. Examples are SM Megamall at Mandaluyong City and Greenhills Shopping Center at San Juan.

There are also various communal systems with sewer networks (**Table 4.14**) built by the National Housing Authority (NHA) which were not all turned over to MWSS (and eventually to MWCI / MWSI) for various reasons. Their conditions are not known.

The location plan of these sewerage systems is presented in **Figure 4.15.**

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Table 4.16 - Summary of Existing Sewerage Systems in Metro Manila

	Sewerage System Name	Service Coverage				Sewerage System						Wastewater Quality (mg/l)					
						Collection			Treatment Plant			BOD		SS		COD	
		Area (ha)	Service Area Land use	Equiv. Pop or Est. Population (2005)	Barangay / City	No. of Lift Stations	Sewer Pipe Length	Pipe Diameter (mm)	Design Capacity (cumd)	Present Inflow (Mld)	Process Type	Influent	Effluent	Influent	Effluent	Influent	Effluent
	I - West Zone - MWSI																
1	Manila Central system	2,617	residential / commercial	1,200,000	North & South of Pasig River; Approx 67% Manila area	7 + 1 main pump station	305 km			206,016 (Yr 1994 ave.)	None - Manila Bay outfall	100	-	88	-	300	-
2	Dagat-dagatan system	333	residential	104,000	NHA Dagat-dagatan housing development, Manila-Navotas	1				No sewage inflow due to rising main leaks	Aerated lagoons system	62	9	78	19	217	109
3	Q.C. CST-Imhoff Tank systems (presently operational)		residential		Project 7 & 8, Quezon City	-											
	Sub total	2,950															
4	Private Systems																
4a	Ayala-Alabang system	350	residential / part commercial		Brgy Ayala-Alabang, Muntinlupa City	1 (commercial area)											
4b	Filinvest Alabang system	375	residential / commercial		Filinvest Alabang, Muntinlupa City	-											
4c	Smokey Mountain system (MRH)	100	residential	15,000	Brgy Isla Balot, Tondo, Manila	1 LS per STP			2 Mld per STP	start operation in May 2005	Attached growth biological treatment	300 (design)	< 50 (Class C water body)	300 (design)	< 70 (Class C water body)	600 (design)	< 100 (Class C water body)
	Sub total	825															
5	Old NHA systems (not turned over to MWSS / MWSI)					-											
	Total																
	II - East Zone - MWCI																
1	Makati Ayala system (Magallanes STP)	600	residential / commercial	109,000	Ayala central business district & surrounding villages		73 km		40 Mld	37 Mld	Activated sludge						
2	New small systems (MCSP)																
2a	Quezon City (10 sites)	603.9	residential	73,578					609 - 7,027		Bio-contact						
2b	Karangalan Village - Pasig (3 sites)	25.6	residential	12,000					764-1,193		Anaerobic						
2c	Karangalan Village - Cainta (6 sites)	51.2	residential	24,000	Karangalan Village, Cainta & Pasig City, Rizal	Gravity sewer network with Lift station at Plant			404-1,265		Anaerobic						
2d	Mandaluyong (1 site)	2.8	residential	1,080					287		Bio-contact						
2e	Makati City (1 site)	8.7	residential	4,560					851		Bio-contact						
2d	Taguig (5 sites)	25.5	residential / commercial	26,226					4,761		Activated sludge						
	Sub total	717.6		141,444.0													
3	Private systems																
3a	Global City (Bonifacio Water Corp)	440	residential / commercial	17,500	Fort Bonifacio, Makati & Taguig cities	2	16 km	300 - 1000	5.3 Mld	1.9 Mld	Activated sludge						
4	CSTs & Imhoff Tanks (proposed for renovation / STP upgrading) - 34 NHA-built	2,176	residential	155,701	Various NHA project areas in Quezon City in 1940s-50s	all gravity systems	107 km					Effluent quality do not pass DENR standards (MWCI 2002)					
	Total	3,934		423,645													

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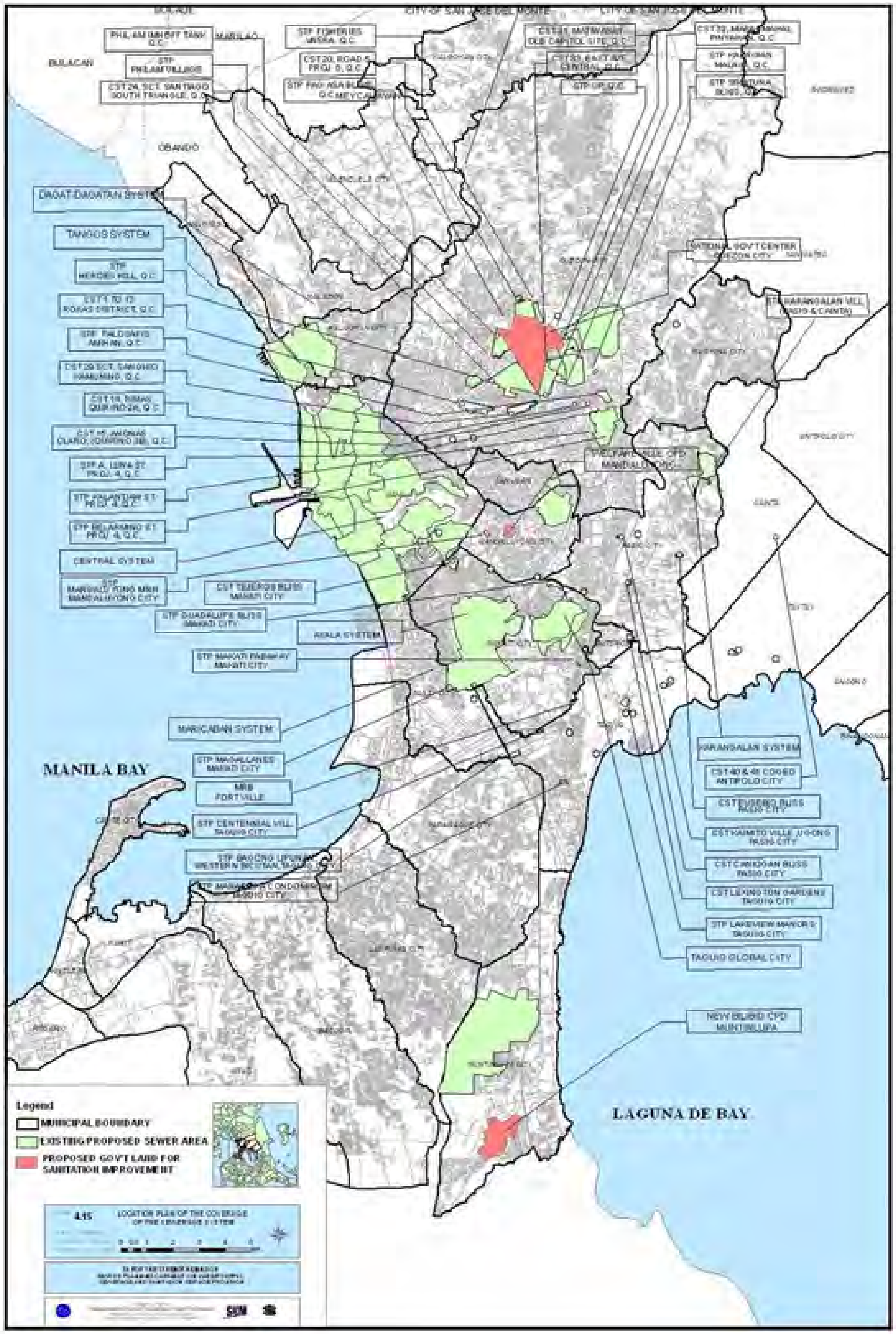

Figure 4.15 Location Plan of the Coverages of the Sewerage Systems

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4.7 Water Quality of Receiving Waters in Metro Manila

The study areas' primary receiving waters include:

- Esteros
- Rivers
- Laguna de Bay
- Manila Bay

The major rivers that form the catchments in the MWSS service area are shown in **Figure 2.4** and include**:**

- Tullahan-Tenejeros River
- Marikina River
- San Juan River
- Pasig-Napindan Rivers
- Parañaque River
- Zapote River
- Imus River

Figure 2.4 also shows some of the numerous esteros in Metro Manila. The great majority of these esteros act primarily as trunk storm drains that carry stormwater from urbanized areas to the rivers or to Manila Bay. During the dry season, they have little or no fresh water. Instead their content is mostly wastewater, septic tank effluent and industrial wastes.

The Tullahan-Tenejeros River that drains the Malabon Basin is one of the more polluted river systems in Metro Manila. This river intercepts wastewater from domestic and industrial concentrations in Tenejeros, Malabon, Navotas and also from Bulacan. The river is not suitable for municipal water supply, fishing wildlife or recreation, and the only possible non-navigational use is the cultivation of fish in fishponds on the coastal plain near the river mouth.

Major portions of the Marikina River serve mostly as a wastewater conduit. Because of the relatively flat valley and easy accessibility, several large industrial establishments are still located there. Only in the upper reaches beyond Montalban is the water still relatively uncontaminated.

The Pasig River cuts across the heart of Metro Manila. It is a major recipient of domestic and industrial wastewater. With the existing degree of pollution, the Pasig River's primary use is to serve shipping and navigation in the transport of products for industries located along the river, although this industrial concentration is now declining. Major initiatives, such as the Pasig River Rehabilitation Project have been initiated to promote water quality improvements in Pasig River.

San Juan River discharges into the Pasig River and drains areas of Quezon City, San Juan and Manila with a high concentration of residential and industrial development. The river is highly polluted.

The Parañaque, Zapote and Imus Rivers drain the southern basins of the study area. These are the least polluted of the rivers within Metro Manila. Thus, their beneficial uses are not restricted to industry related activities. Fishing is a source of livelihood at the mouth of the Parañaque River. In the Zapote and Imus Rivers, shellfish cultivation and fishponds abound near the coastal plain.

Laguna de Bay is a receiving water for portions of Metro Manila and Rizal. However, the construction of the Napindan hydraulic control structure minimizes the use of Laguna de Bay as a receiving water. The Laguna Lake Development Authority has the overall responsibility for the lake and the drainage areas discharging into it and controls industrial pollution through an Environmental User Fee System (EUFS) on industries within LGUs under its jurisdiction.

Manila Bay is the final receiving water for the wastewater generated in the study area. This wastewater is either directly discharged into the Bay through existing sewer or storm drain outfalls or indirectly reaches the Bay by means of rivers in the study area. The earlier 1969 Sewerage Master Plan (Black and Veatch) conducted significant data collection and undertook analyses to ascertain the assimilation capacity of Manila Bay for untreated wastewater or wastewater with primary treatment. The subsequent 1979 Sewerage Master Plan (James M Montgomery) substantially used the earlier 1969 data together with additional data from the National Pollution Control Commission (NPCC) to make an assessment. The 1979 Master Plan concluded that wastewater discharges into Manila Bay would continue to be possible within the time frame of the Master Plan without serious or irreversible water quality degradation provided a properly designed outfall and diffuser system was constructed.

This study does not have the mandate or the resources to undertake a detailed water quality study of Manila Bay and the strategies developed in the short to medium term rely on decentralized inland treatment plants that will not significantly impact on the quality of water in Manila Bay. However, the current Manila Central Sewerage System outfall has been controversial, although the cost to provide either enhanced primary or, especially full secondary treatment upstream of the outfall is very expensive. The long-term sewerage strategy is likely to be to incrementally centralize the sewerage system such that sewage drains to Manila Bay either through several outfalls as proposed in the 1969 and 1979 Master Plan or to either enhanced primary or full secondary treatment plants located at the coast, probably on reclaimed land.

The cost of providing treatment prior to discharging into Manila Bay through an outfall will be significant and will require decisions to be made on the basis of reliable information on the assimilation capacity of Manila Bay. It is therefore essential that an intensive program of water quality monitoring be conducted in Manila Bay to enable studies to be conducted by the time decisions need to be taken regarding the need for either enhanced primary of secondary treatment of wastewater prior to discharge into Manila Bay.

The water quality assessment of various wastewater systems in Metro Manila for the past five years were reviewed and presented in the succeeding sub-sections:

Pasig River and its Tributaries

The Pasig River runs through the highly urbanized and densely populated parts of Metro Manila and is the main waterway that connects Laguna Lake to Manila Bay. The Pasig River system is comprised of the rivers of Pasig, Marikina, and San Juan and other smaller streams (esteros) and drainage canals. Pasig River has played a significant role in the metropolitan history and commerce. Through the years, it has received wastes from various sources resulting to its present foul state. Arduous efforts have been made to revive the river through projects like the Pasig River Rehabilitation Program. Despite these efforts, there has been little improvement on the water quality due to inadequate sewerage system, and the perennial problem of indiscriminate solid waste dumping.

Figures 4.16 and **4.17** present the mean dissolved oxygen and biochemical oxygen demand concentrations, respectively, at different sampling stations along the Pasig River as compiled by EMB from 1999 to 2004 (reported in the 2004 WB report). As a Class C river system, Pasig River should maintain minimum dissolved oxygen of 5 mg/l and BOD range of 7 to 10 mg/l.

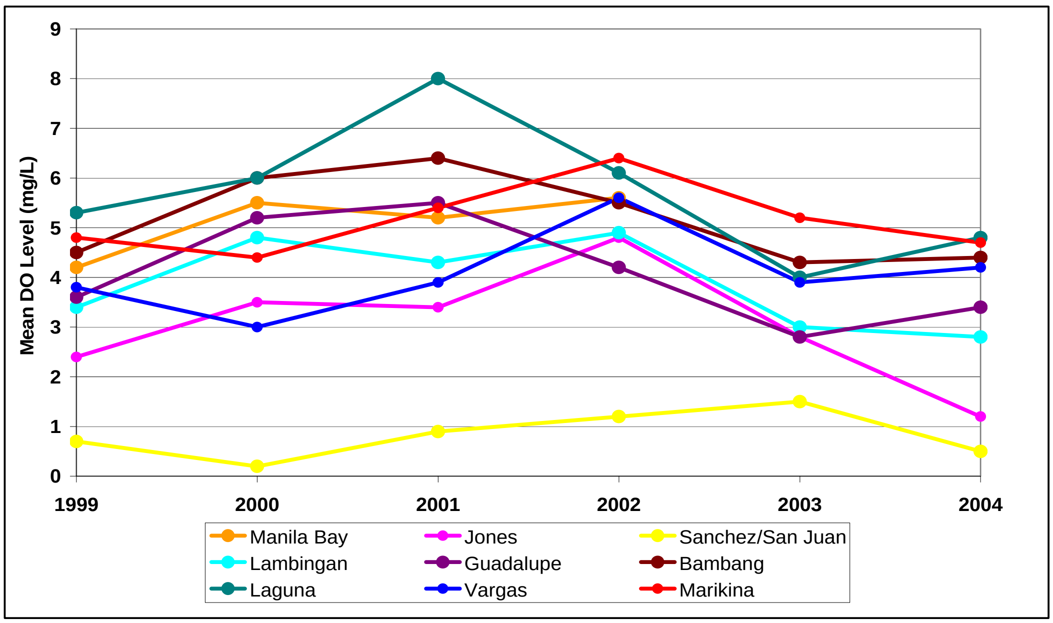

Figure 4.16 Mean Dissolved Oxygen Levels at Various Sampling Points in the Pasig River System (1999-2004) [Philippine Environment Monitor 2004, WB]

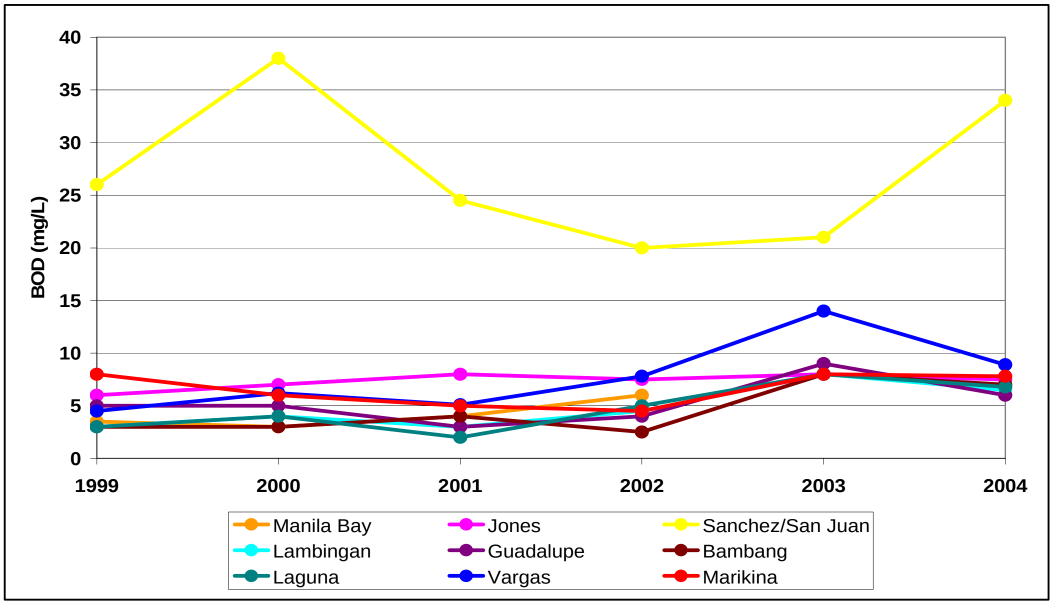

Figure 4.17 Mean Biochemical Oxygen Demand at Various Sampling Points in the Pasig River System (1999-2004) [Philippine Environment Monitor 2004, WB]

The World Bank Environmental Monitor 2003 indicated a marked improvement of water quality in terms of BOD concentrations from 1998 to 2001 in most of the sampling stations. But from its updated report in 2004 which included water quality data of 2002 to 2004, the BOD in most stations has increased from 2001 to 2004 as shown in **Figure 4.17**. BOD concentrations in most stations were even higher than those values reported in 1999.

The updated report may imply that the continuous discharge of untreated domestic wastewater is still putting pressure on the assimilative capacity of the Pasig River. As it continues to receive direct domestic discharges from Metro Manila residents, the river could not naturally cleanse itself to maintain acceptable BOD level.

It is also important to note that the very poor water quality condition of San Juan River, a major tributary of Pasig River has been a major factor affecting pollution load of Pasig River. San Juan River receives most domestic, commercial and industrial wastewater flow from San Juan and most of Quezon City, which are still largely not sewered.

Malabon-Navotas, Tullahan and Tenejeros River System

Malabon-Navotas, Tullahan and Tenejeros (MNTT) River System has consistently failed the water quality standards for Class C waters. The river system catches the drainage of northern Metro Manila including Caloocan, Malabon, Navotas and northern parts of Quezon City. The water quality along its length deteriorates from its headwater in the La Mesa Water reservoir to its downstream station near Manila Bay.

Except for some sewered areas in the northern part of Quezon City, most of the areas in its catchment are still not sewered. The EMB reported below 4 mg/l dissolved oxygen and BOD above 20 mg/l in all of the sampling periods from 2001 to 2004.

Parañaque River System

The Parañaque River System also has consistently failed water quality standards for Class C waters. The river receives the drainage of south Metro Manila particularly Parañaque and a portion of Las Piñas.

As in the case of most rivers, majority of the sampling in Parañaque River yielded BOD values way above the 10 mg/l maximum limit for Class C water.

Figures **4.18** and **4.19** indicate the average water quality of major rivers in Metro Manila as reported by EMB from 2000 to 2004.

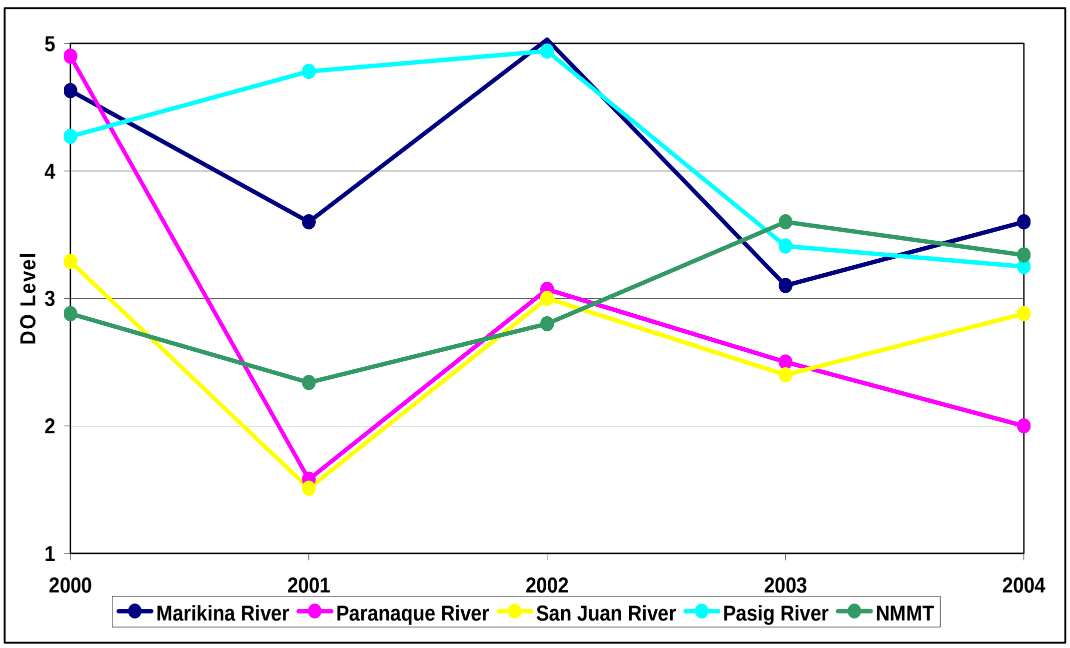

Figure 4.18 Mean Dissolved Oxygen Levels of Various Metro Manila Rivers (2000-2004) [Monitored and Compiled by EMB, WQS 2005]

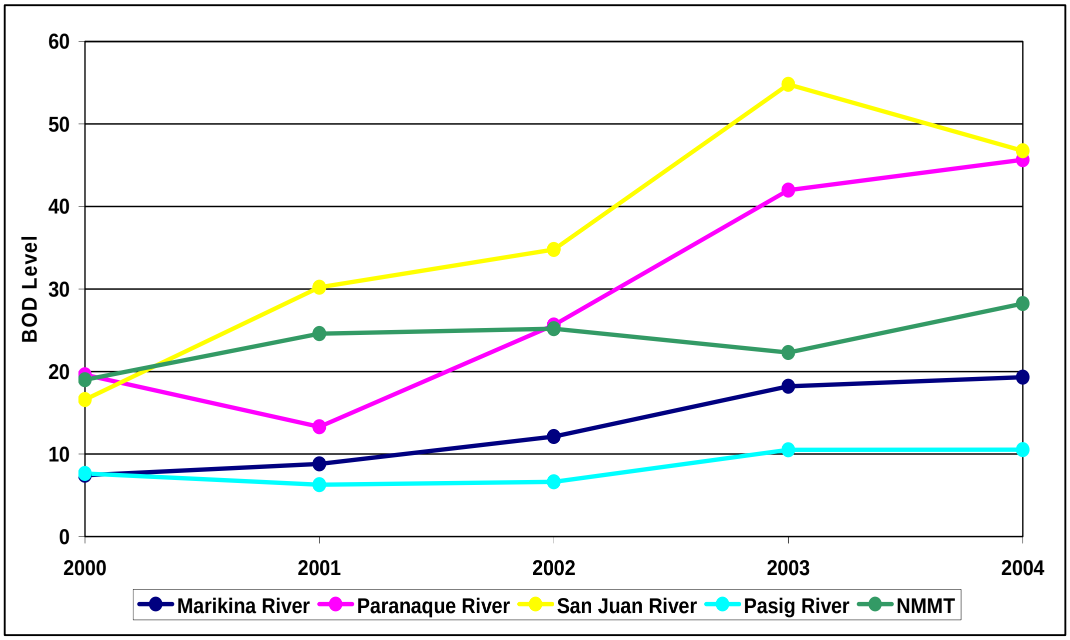

Figure 4.19 Mean Biochemical Oxygen Demand of Various Metro Manila Rivers (2000-2004) [Monitored and Complied by EMB, WQS 2005]

Manila Bay

Manila Bay is roughly 1,800 sq. km. in area, with a coastline of about 190 km and with the bottom gradually deepening at the rate of 0.1 %. As the ultimate receiving water body, it receives waste and wastewater from the Metro Manila Region and from about 17,000 sq. km. of watershed drained by 26 principal rivers. It plays a significant socio-economic role for Metro Manila and the surrounding provinces sharing its coastline. It is the center of the Metro Manila's international and domestic shipping operations; and is a major recreation and tourist area. The present state of environmental infrastructure and the conditions of the water quality of the rivers draining into Manila Bay have been the major cause of the deteriorating condition of this vital water resource.

At present, pollution loads from domestic, commercial, industrial and even agricultural sources significantly affect the water quality of the bay. In general, water quality for most of the principal rivers draining into Manila Bay is poorest during the dry season. The quality improves toward the end of the rainy season, as drainage basins are flushed, although pollution due to stormwater is still considered significant.

The eastern shore of Manila Bay adjacent to Metro Manila shows signs of significant pollution especially in the vicinity of the mouths of rivers and the openings of major storm drains. However, water quality improves rapidly in relation with the distance between the sampling and the discharge points.

One major source of pollution to the bay is the outfall diffuser from the Manila Central Sewerage System. Wastewater from major drainage areas of Manila including Balut, Pandacan, Sampaloc, Sta. Ana and Tondo are received by the bay almost untreated. The outfall with engineered diffusers terminating in the open bay water may not significantly reduce the pollution load due to lower assimilative capacity of the bay compared to its condition 20 years ago.

Manila Bay has its own water quality monitoring program under the Manila Bay Improvement Project of the EMB. Critical factors that are monitored regularly include BOD and coliform counts. BOD represents the amount of organic wastes introduced to the bay. Coliform, measured in terms of most probable number / 100 ml sample indicates the relative safeness of the bay water for primary contact recreation activities (such as swimming and diving).

Figures 4.20 and **4.21** present the fecal and total coliform count in some of the beach areas of Manila Bay. The prescribed limit for Class SC water is 5,000 MPN/100 ml. Most data show higher values than the prescribed limit. **Figure 4.22** shows the BOD level in three monitoring stations in Manila Bay. Class SC limit for BOD is 7 mg/l.

The reduction of pollutants discharged to rivers and esteros due to treatment, source control, or diversion of the wastewater will have a positive effect on water quality of the bay. Noticeable improvements on water quality will be obtained only through coordinated programs of collection, treatment and disposal of wastewater and the collection and disposal of solid waste.

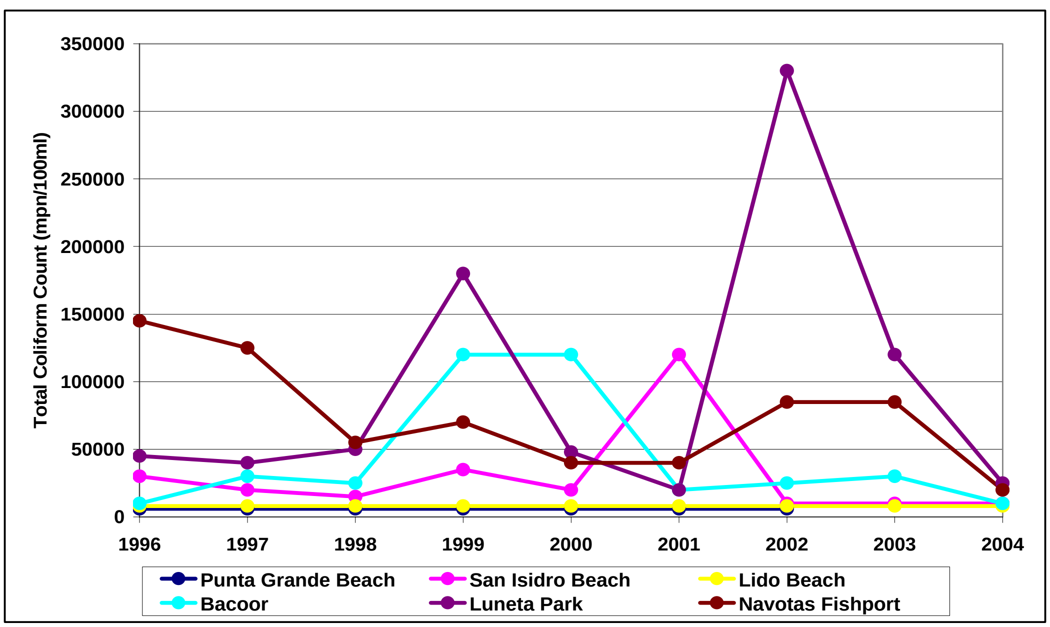

Figure 4.20 Total Coliform Count of Bathing Beaches in Manila Bay, 1996-2002 [Source: Philippines Environment Monitor 2003]

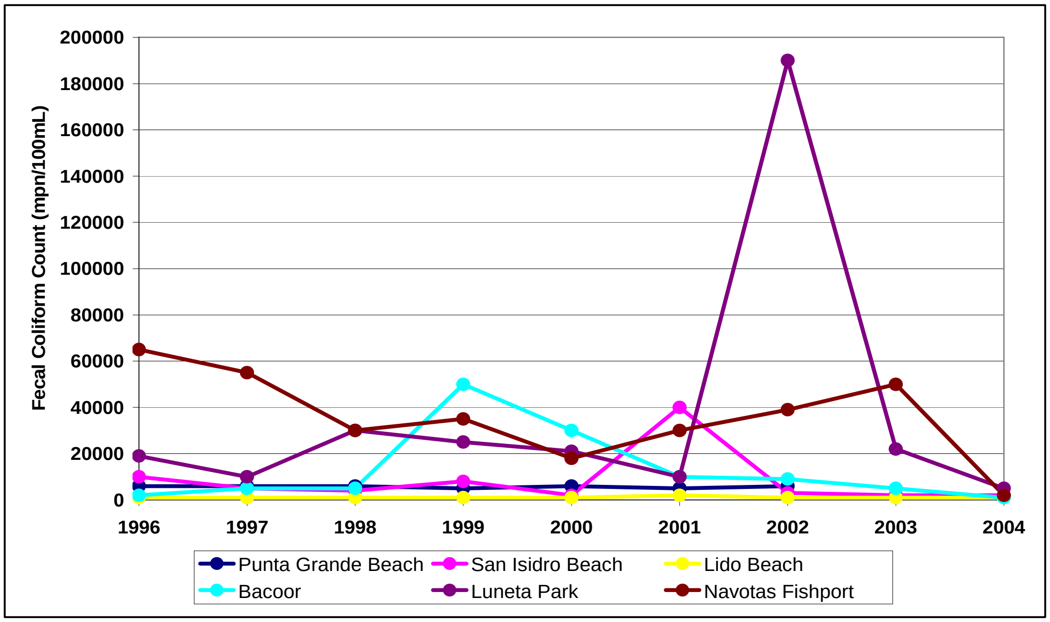

Figure 4.21 Fecal Coliform Count of Bathing Beaches in Manila Bay, 1996-2002 [Source: Philippines Environment Monitor 2003]

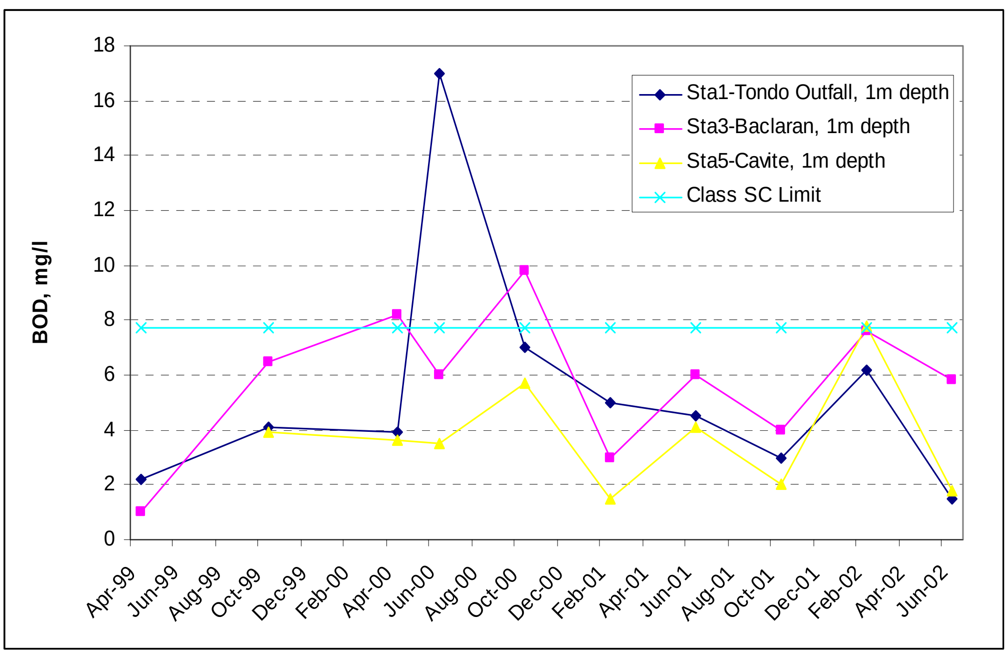

Figure 4.22 Biochemical Oxygen Demand Levels in Selected Stations in Manila Bay, 1999-2002 [Source: Philippines Environment Monitor 2003]

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Laguna Lake

Laguna Lake is estimated to have a total volume of 3.2 billion cubic meters of water with an average depth of 2.8 meters. The lake receives flow from 21 rivers that meanders from five provinces.

Only few companies use the lake's water for its industrial process, but majority of the industries in its vicinity refer to the lake as its wastewater's receiving body of water. Five major industry classifications were identified as main contributors to pollution loading in the lake namely, food processing, hog raisers, slaughterhouses, beverage firms, and textile industries. In 1994, less than 70% of the industries in the Laguna Lake area have wastewater treatment facilities. These figures may have changed significantly in the present. **Figure 4.23** and **Figure 4.24** present water quality data from Laguna Lake and its tributaries as reported from 1996 to 1999 by LLDA.

Industries are not the only cause of pollution problems at Laguna de Bay. In fact, it is estimated that industrial pollution accounts for only about 30% of the deterioration in the water quality of the lake. This figure is less than the contribution of agricultural activities (40%) but as much pollution from domestic sources which is also estimated at 30%.

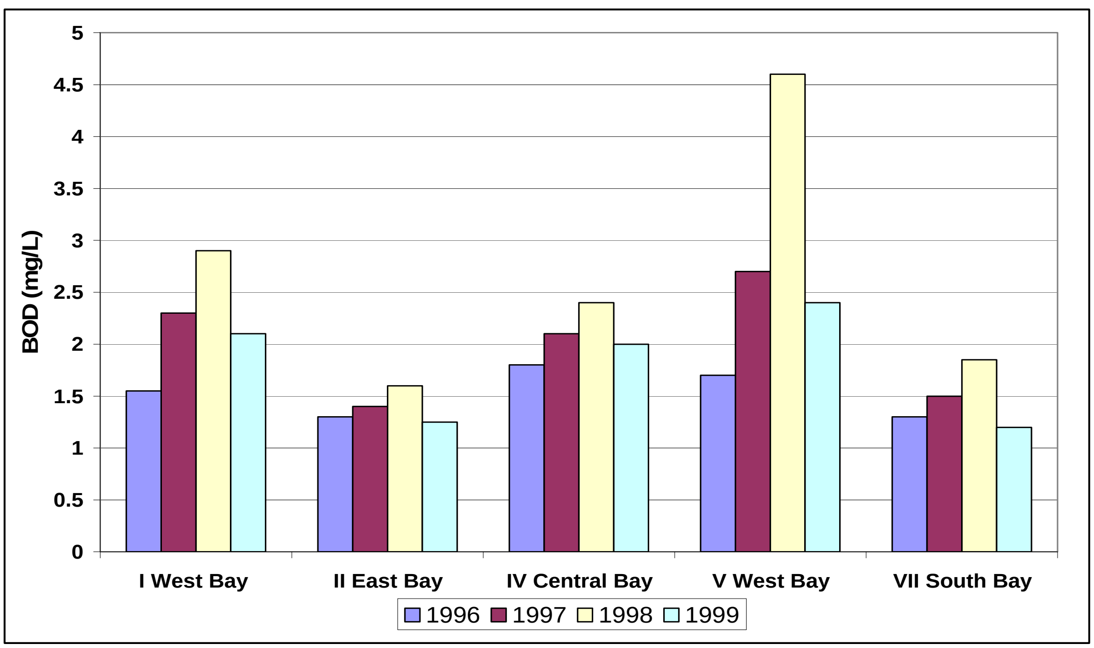

Figure 4.23 Annual Average BOD of Laguna de Bay, 1996-1999. [Philippine Environment Monitor 2003]

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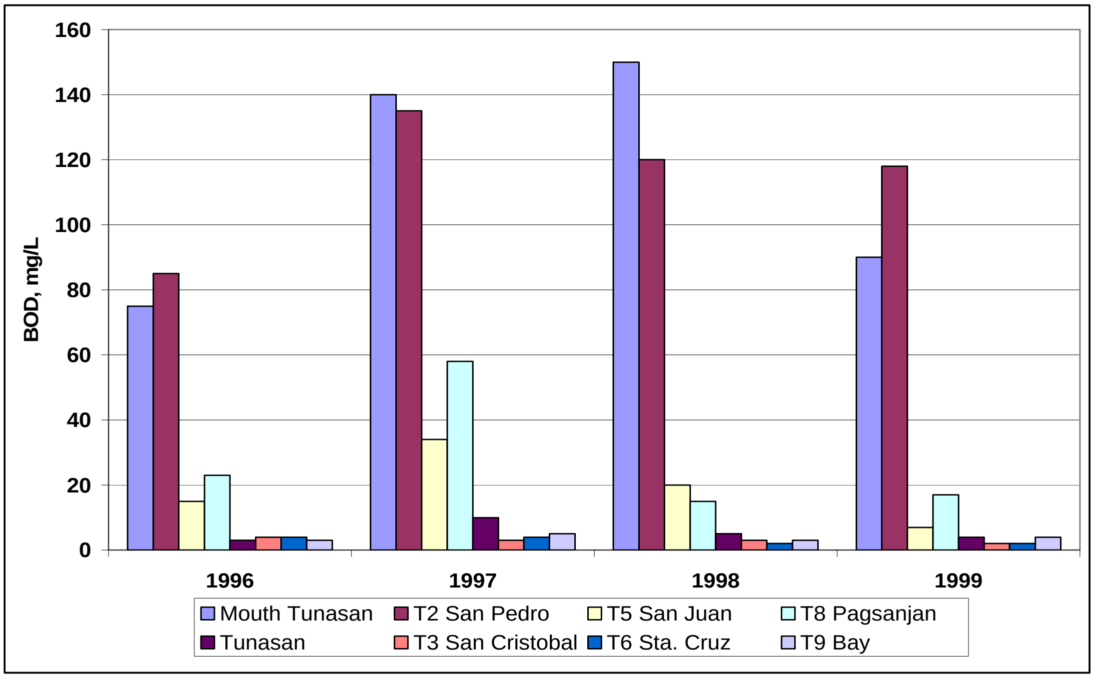

Figure 4.24 Annual Average BOD of Tributary Rivers in Laguna Lake, 1996-1999. [Philippine Environment Monitor 2003]

5. Relevant Past Studies

5.1 Earlier Master Plans and Programs

5.1.1 1969: Sewerage Master Plan for a Sewerage System for the Manila Metropolitan Area

This Master Plan was prepared by Black and Veatch during 1968-69. A diverse centralized concept for a separate sewerage system for Metro Manila was envisioned and proposed. Consideration was given to a combined sewerage system but was not recommended due to the extent of the existing sewerage system, the high intensity rainfall in Manila and the consequent increased cost of a combined system. Collection of wastewater was to be centralized at three disposal points in Manila Bay. Inland treatment was not considered due to the negligible assimilative capacity of the streams.

Major interceptor sewers were proposed adjacent to drainage paths to transport sewage to the disposal points. A significant feature of the plan was construction of a major sewer which would run along the bed of the Pasig River and intercept dry weather flows from the stormwater system. By the year 2000 it was felt that the assimilative capacity of Manila Bay would have been reached and treatment would be necessary.

It was proposed to implement the Master Plan in three stages – Phase 1 was to be the Central Sewerage System upgrade and the North and South Manila Basins, Phase 2, the lower San Juan Basin and portions of the Parañaque Basin and Phase 3, the major sewerage construction in the remainder of the Study area.

Sanitation was not considered in this Master Plan.

The Master Plan was never implemented and was superseded by a further Master Plan prepared in 1979.

5.1.2 1979: Sewerage and Sanitation Master Plan for Metro Manila

The next Master Plan was prepared by James Montgomery/Kampsax Kruger/DCCD in 1979. This plan discarded the previous plan on the basis of inadequate costing. They went on to recommend a plan based on:

- A sewerage expansion program involving rehabilitation of existing facilities and a monitoring system called METROSS. (Metro Manila Sewerage and Sanitation);
- Use of combined sewers;
- Secondary treatment of sewage with four outfalls into Manila Bay; and
- A sanitation programme comprising minor drainage projects for the depressed areas (PROGRESS) and a septic tank desludging programme (STAMP). Part of PROGRESS and STAMP were implemented as a component of METROSS – 1.

Only METROSS – 1 was implemented, although rehabilitation of the Central Sewerage System remained uncompleted.

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5.1.3 1994: Manila Second Sewerage Project

The Manila Second Sewerage Project (MSSP) was envisaged to begin addressing the increasing water pollution in Metro Manila. MWSS proceeded with the implementation of the MSSP in 1994 with World Bank assistance. Although based on the 1991 Second Manila Sewerage Feasibility Study, changes in the proposed project components were made due to the high cost of implementation.

MSSP sought to provide specific measures for the following objectives:

- Improve the quality of sanitation services;
- Reduce environmental pollution; and
- Minimize the health hazards from wastewater.

In order to achieve these goals, the project was developed into four components. These were as follows (i) Septage Management Plan, (ii) Ayala Sewage Treatment and Sewerage System Rehabilitation, (iii) Manila Central Sewerage System Rehabilitation and (iv) Supply of Laboratory Equipment, Vacuum Trucks and Other Vehicles. These components are discussed below.

Septage Management Plan

The Septage Management Plan of the MSSP provided the means for immediate action to be taken with the septage collection and hauling using specific collection vehicles. The collected septage was to be handled through interim and permanent solutions by means of open sea disposal and establishment of septage treatment plants (SpTP), respectively.

Barge loading of the collected septage for sea disposal was to be done through the use of loading stations to be constructed at Napindan and Estero de Vitas. The typical capacity of each loading station was to accommodate 760 m^3/day of septage. The sea disposal of septage was proposed to continue until 2004, when the construction and rehabilitation of proposed SpTPs were to come on-line.

The rehabilitation and upgrade of the Dagat-Dagatan Lagoons to include a SpTP was planned to ultimately have a 900 m^3/d septage treatment capacity in addition to its current 52 MLD sewage treatment capacity. Septage treatment would involve dewatering and aerated lagoons for biological treatment processes. It was projected that the Dagat-Dagatan, along with two other SpTPs, would have combined capacities of 1,700 m^3/d by 2004 when the open sea dumping operations would cease.

Ayala Sewage Treatment and Sewerage System Rehabilitation

The Ayala Sewage Treatment Plant (STP) was in need of major rehabilitation with most of the structures and equipment already past the end of their design lives. Although the plant generally met effluent standards, it was found to be overloaded especially during periods of rainfall.

The construction of a grit chamber and concrete sludge thickener tank were to comprise two phases of the plant rehabilitation. A separate structure was also included in the second phase of construction to provide dewatering of the sludge produced during treatment. Service lines such as the Amorsolo Inverted Siphon, Edsa Trunk Line Alternate Route and Valero-de la Costa Sewer Connection were also in need of proper maintenance.

These maintenance works coupled by improvements in sewer manholes, cleaning of sewer lines, and repair or replacement of damaged lines, were deemed to be adequate to enable the sewers to accommodate both dry and wet weather flows.

Manila Central Sewerage System Rehabilitation
Expansion works proposed for the existing Manila Central Sewerage System included the extension of catchments in Pasig and the retrofitting of the Manila Bay outfall to the Tondo Pumping Station. The sewer lines, equipment and pumps were assessed to be in more deteriorated states than what was observed during the inspection for the 1991 feasibility study. Other problems involved the observed backflow during high tides due to damaged flap gates and the clogged Pasig River Inverted Siphon.

Rehabilitation recommendations included for the Manila Central Sewerage System were as follows:

- Automatic gate opener to replace manual inlet and outlet gates ;
- Gate boxes to be provided for bypass for grit chamber;
- An aeration grit chamber before the main pump to be installed;
- A ventilation system for the pump pit room to be installed;
- Main pumps to be repaired and spare parts for impellers procured;
- Flow meters to be repaired;
- Installation of odor control systems; and
- Back-up electrical power to be provided.

Supply of Laboratory Equipment, Vacuum Trucks and Other Vehicles
More effective monitoring of the wastewater, from collection to final discharge, through laboratory analyses was deemed to be needed to establish proper treatment processes. Although MWSS utilized the Central laboratory, which began operations in 1983, added samples from the proposed numerous sewage and septage treatment plants was considered likely to render the laboratory overloaded.

In order to facilitate continuous effluent monitoring of the proposed treatment plants, establishment of adequate on-site laboratories for every plant was deemed to be required. The laboratories were to be outfitted with adequate testing facilities and mobile testing units. This equipment would enable testing of effluent quality from the treatment plants and would also enable samples to be tested on-site from septic tanks and sea septage dumping. In conjunction with the laboratories and other testing equipment, the addition of laboratory staff and proper training also were also proposed.

5.1.4 1996 Study on Water Supply and Sewerage Master Plan of Metro Manila

The projected rise in the population of Metro Manila in the last decade of the millennium prompted the need for an increase in water supply. This projected increase in water consumption would result in an increase in generated sewage from the service area. Despite the rehabilitation and development being implemented under MSSP, the sewerage and sanitation programs for Metro Manila were still insufficient in terms of the increased environmental load. This 1996 Study on Water Supply and Sewerage Master Plan of Metro Manila by Nippon Jogesuido Sekkei (NJS) addressed the pressing issues on both water supply and sewage generation.

The options between separate and combined sewer systems were evaluated. Other concerns were drainage system improvement and expansion, septage management, maintenance of overflow chambers and household service connections.

Proposals for systems comprising smaller service areas were introduced to enable more immediate implementation of the plans. The proposed smaller-scale treatment plants were to be eventually integrated thereby to form a centralized system.

Sewage Treatment Development
Sewage treatment methods were narrowed to the following processes:

- Stabilization Pond (SP);
- Aerated Lagoon (AL);
- Oxidation Ditch (OD); and
- Conventional Activated Sludge (AS).

The trade-off in the selection of the above alternatives was between high capital cost for the construction, operation and maintenance for the more mechanized alternatives such as activated sludge, against the increase in required land area for treatment methods such as stabilization ponds.

Inland treatment systems as well as ocean outfall systems were also compared. Alternatives for inland treatment were based on the size of catchments for small, medium or large-scale treatment systems. Improved ocean outfall systems were studied but proved to be unacceptable in terms of environmental impacts and implementation. The Medium Scale Inland Treatment System (MSITS) was found to be more advantageous than the other options. Optimization plans for the MSITS were further explored.

Sewerage Systems
Considerations in some of the catchments were made in accordance with the improvements being done in MSSP. The development of the identified catchments and the recommended individual treatment methods were based on key priority factors such as development of the area cost per capita, cost-recovery, and environmental impact. The priority sewerage areas were individually discussed as follows (i) Ayala System, (ii) North Manila System, (iii) Central Manila System, (iv) South Manila System and finally, (v) West Mangahan. Recommended sewerage systems for the remaining catchments were

discussed collectively. **Figure 5.1** presents the sewerage catchments, proposed STP locations and the recommended treatment methods.

- **Ayala System**
  Since Makati had an existing sewerage system, which extended to residential and commercial buildings, the benefit cost was low. However, the high-income populace made this a priority area for improvement of the sewerage system.

  The importance of the rehabilitation works of the wastewater treatment plant through MSSP was emphasized. No further rehabilitation works for the treatment plant or the sewerage system were recommended.

- **North Manila System**
  Cost-recovery for improvement of this system was considered low because of the population's low ability to pay. However, the high population density of the area resulted in a lower cost per capita. The environmental impact of the development of the North Manila System was considered to have the potential to bring about an improvement in water quality of the Pasig River, considered to be the most polluted in the Metro Manila region.

  The North Manila System covers the San Juan River Basin. Communal septic tanks scattered within the boundaries of Quezon City were to be connected by an interceptor system to the treatment plant.

  Recommendations for sewage treatment were constrained by the available land area. Aerated lagoons may take up as much as 120 ha of land and so the use of an oxidation ditch was suggested.

- **Central Manila System**
  The service area of the Central Manila System was mostly covered by an established sewerage system. The high population increased the need to expand the service area due to the high environmental impact from unsewered households. Also, the large population translated into a lower cost per capita for the rehabilitation works.

  The developments in the Sampaloc, Balut, Dagat-Dagatan and Caloocan areas could be connected with the Dagat-Dagatan treatment plant, which would be upgraded in the MSSP. The upgrading included more efficient means of treatment such as aerated lagoons and an accompanying increase in treatment capacity. The Tondo Pump Station was proposed to continue its operation.

- **South Manila System**
  The South Manila System was characterized as a highly populated area with an equally high degree of commercial activity. Because of this, cost per capita was the lowest in the considered areas and cost recovery was considered easier. Development of the sewerage system was deemed important due to the high population and commerce that generated a high pollution loading for Manila Bay.

Portions of the Central Manila System were to be transferred to the South Manila System including the Pandacan area. The total area of the STP would cover about 94 ha for an aerated lagoon system while an area of only about 23 ha was specified for an oxidation ditch treatment method. The selected treatment method would depend on the available area.

- **West Mangahan**

  The area of West Mangahan experienced a considerable increase in development, especially in the Ortigas area, which was projected to be sustained in the following years. The cost per capita and the project recovery would largely depend on the high-income capacity of the residents in the Ortigas area.

  As with other developed regions of Metro Manila, sewage from the Ortigas area was proposed to be collected via an interceptor system. Land acquisition for West Mangahan was seen to be less difficult thereby making an aerated lagoon treatment method viable.

- **Remaining Catchments**

  The use of aerated lagoons for sewage treatment of the East Mangahan, Muntinlupa and Parañaque catchments was assessed to be favorable in reducing operation and maintenance costs, due to the availability of the required land area in these catchments. The Marikina basin was proposed to utilise an oxidation ditch to reduce the required area. However, an activated sludge treatment process was proposed for the Bonifacio basin due to the intended high-density development in this area.

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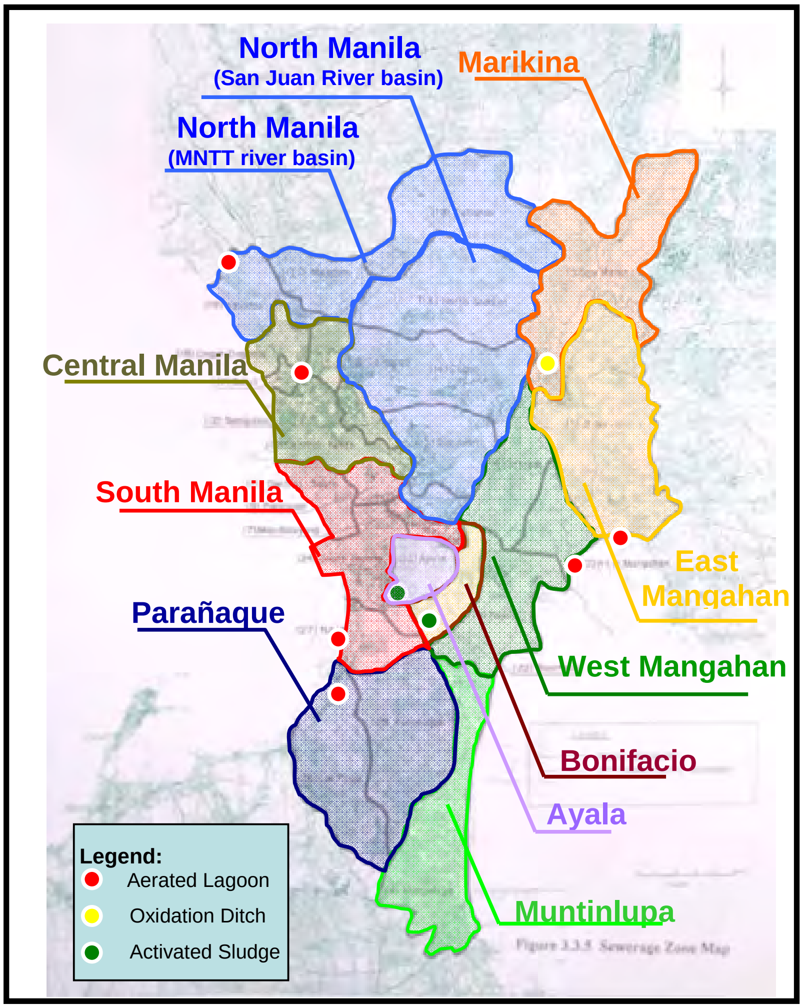

Source:1996 NJS MP

Figure 5.1 - Proposed Catchments, STP Location and Treatment Method

Septage Management Plan

Because sanitation is critical in any wastewater strategy, a sanitation development plan was prepared. Although drainage was considered to be part of the sanitation project, details were omitted from the study. The sanitation development plan was divided into on-site treatment facilities and the septage management plan development stages. Each is discussed accordingly.

i. On-site treatment facilities

A review of existing septic tanks was conducted and recommendations for the design suggested. Communal septic tanks using anaerobic processes were recommended. Other facilities based on different technologies such as the

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Japanese type JOHKASOU bio module, Anaerobic Sludge Blanket Reactor, and the Korean type treatment were suggested for applicability trials.

ii. Septage Management Plan

Four SpTPs dividing the service area of the unsewered locations were considered. These were the Dagat-Dagatan, Quezon City, Taguig, and Las Piñas setpage treatment plants. The septage plan was to be continued even after the 2010 target period for sewerage coverage. The septage management plan involved the septage cycle from collection to treatment through added rehabilitation programs included as part of MSSP.

Implementation of this Master Plan was overtaken by the privatization of the operations of MWSS in 1997. Since this time the concessionaires, while taking into consideration some of the recommendations of the Master Plan especially related to sanitation, have largely pursued their own sewerage and sanitation strategies. The 2003 rate rebasing exercise resulted in a further deviation from the sewerage strategies, which in the case of the East Zone resulted in an emphasis on sanitation rather than sewerage for economic/financial reasons and in the West Zone the deferral of all sewerage targets due to financial constraints.

5.1.5 2005 East Concession Area Master Plan Update

The 2005 East Concession Master Plan Update was based on a study undertaken by NJS. The master plan integrated some of the packages proposed in the Manila Third Sewerage Project (discussed below in 5.3) to form an overall strategy in the implementation of the sewerage and sanitation programs for the service area of MWCI. The proposed sewerage and sanitation development in the East Concession master plan update is discussed briefly below.

Sewerage Development

In the updated master plan, a total of 11 catchments were delineated, based on topography, drainage patterns, and the potential STP sites. Although previous studies provided recommendations for STP locations, most of these sites gave way to other development and become unavailable. Other site locations were considered as replacements for the occupied sites.

Alternatives were chosen to allow a proper assessment of cost, tariff, technical constraints and benefits. Based on the target adjustments given by the 2003 Rate Rebasing, the implementation of an extended implementation schedule was considered. Also, separate and combined sewerage systems were compared. A reduction to seven catchments owing to the union of certain catchments was likewise considered. The sewerage alternatives were presented as:

- Alternative 1 – 1997 CA Target Service Levels and Implementation Schedule with Separate Sewerage System in 11 Catchments;
- Alternative 2 – 1997 CA Target Service Levels with Extended Implementation Schedule with Separate Sewerage System in 11 Catchments;

- Alternative 3 – 1997 CA Target Service Levels with Extended Implementation Schedule with Separate Sewerage System in 7 Catchments;
- Alternative 4 – 1997 CA Target Service Levels with Extended Implementation Schedule with Combined Sewerage System in 11 Catchments;
- Alternative 5 – 1997 CA Target Service Levels with Extended Implementation Schedule with Combined Sewerage System in 7 Catchments.

The outcome of the study evaluated the most feasible stratagem for implementation in terms of technical issues and constraints, relative cost and the benefits was **Alternative 5**. The combined sewerage system required the least capital cost due to the elimination of laterals and house connections. The tariff rate was the lowest for the alternatives considered. Reduction of the catchments also required four less STPs. **Figure 5.2** presents the locations of the STPs and their respective catchments for Alternative 5.

Water quality of the major rivers was projected to improve with the implementation of the combined sewer system in the recommended scheme. Creeks and drains, however, would not benefit from any water quality improvement.

Septage Management and Sanitation Development
Septage management programs considered the 586 m^3/day North and 814 m^3/day South SpTPs proposed in the Manila Third Sewerage Project (MTSP) complemented by a SpTP in Antipolo for the Rizal province service areas. Given that combined sewerage systems were to be implemented, the initially proposed septage capacity of 600 m^3/day for the Antipolo SpTP would eventually become inadequate. To accommodate the lack of a separate sewer system for the Rizal service area, two alternatives were proposed:

- The planned capacity of the proposed Antipolo SpTP should be increased to a total treatment capacity of 1,689 m^3/day by the year 2020.
- Construction of a separate SpTP in Binagonan or Cardona to accommodate the 1,089 m^3/day load from the projected increase in development of the Rizal service areas.

5.2 Manila Second Sewerage System Progress

5.2.1 East Zone (Manila Water Company Inc.)

Continuance of the MSSP was passed on to the concessionaires following privatization in 1997. The major component of the MSSP for the east zone was the rehabilitation of the Ayala STP to facilitate an expansion of sewerage coverage. Other components such as septage management were also to be carried out by MWCl. The following are the components of the MSSP for implementation by MWCI:

- Construction of a barge-loading station at Napindan with a capacity to transfer about 500 m^3/d of septage from collection vehicles to barges;
- Upgrading of the Ayala sewerage system, including rehabilitation of the pumping station and sedimentation tanks to provide mechanical treatment of sewage and septage, and repair of pipes, equipment and other works;

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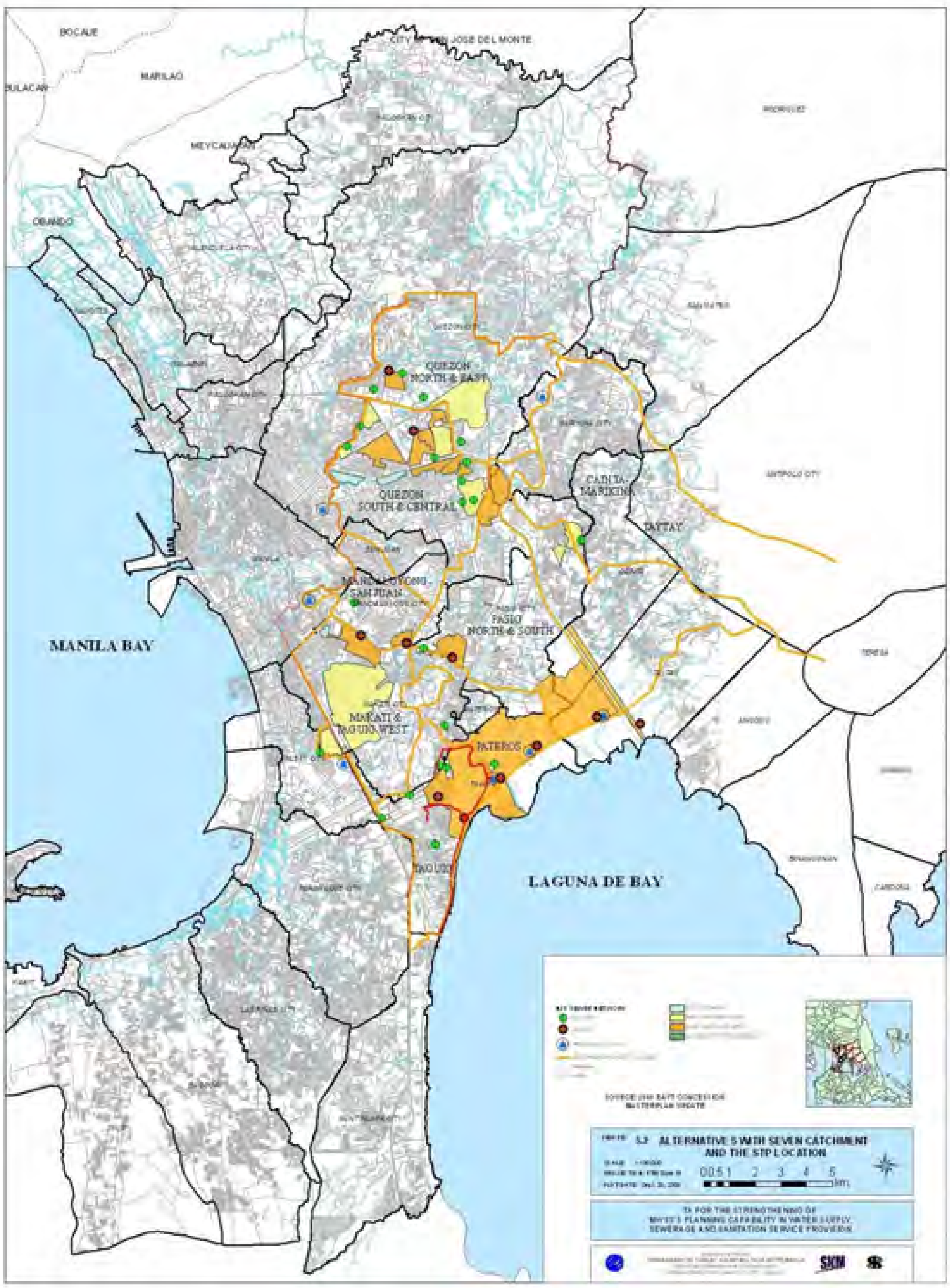

Figure 5.2 Alternative 5 with Seven Catchments and the STP Locations

- Strengthening of MWCI's central laboratory, through the provision of specialized instrument, equipment, furniture and materials;
- Strengthening of the technical capabilities of MWCI to operate and maintain sewerage systems in the East Service Area, through the provision of vehicles, machinery and tools;
- Strengthening of the technical capabilities of MWCI in construction supervision, development of septage treatment experiments, environmental monitoring and preparation of follow-up sewerage projects, through the provision of consultants' services and the provision of software; and
- Planning and implementation of sewerage projects in the East Service Area, including the construction and rehabilitation of Karangalan Lift Station and rehabilitation and expansion of municipal sewerage systems in Taguig.

Open sea disposal of septage had been met with some public resistance. Even with the completion of the barge loading facilities and memorandum of agreements from the different local government units, the sea disposal activities have since ceased. The MSSP also introduced the MSSP Community Sanitation Program (MCSP). The project involved upgrading of the communal septic tanks (CST) into STPs with the expansion of existing coverage areas. Construction of new STPs for coverage areas were also included. **Table 5.1** shows the components of MCSP:

Table 5.1 - MCSP Components

Name of the STP	No. of Connections	Service Area (m^2)	Area of STP (m^2)	Name of the STP
Phil -Am STP	1,847	467,500	400	bio-contact treatment
Kalayaan STP	3,700	784,400	800	bio-contact treatment
Pag-asa BLISS STP	544	219,000	150	bio-contact treatment
Sikatuna BLISS STP	544	228,200	300	bio-contact treatment
Belarmino STP	411	454,000	400	bio-contact treatment
Fisheries STP	679	66,320	145	bio-contact treatment
UP Campus STP	1,673	2,900,000	5,000	bio-contact treatment
A. Luna STP	1,492	587,100	495	bio-contact treatment
Palosapis STP	1,286	127,600	218	bio-contact treatment
Heroes' Hills STP	87	204,400	270	bio-contact treatment
Karangalan Village STP No. 1				anaerobic treatment
STP No. 2				Anaerobic treatment
STP No. 3				Anaerobic treatment
STP No. 4				Anaerobic treatment
STP No. 5	6,000	768,000	500	Anaerobic treatment
STP No. 6				Anaerobic treatment
STP No. 7				Anaerobic treatment
STP No. 8				Anaerobic treatment
STP No. 9				Anaerobic treatment
Mandaluyong MRH STP	180	27,900	75	bio-contact treatment
Guadalupe BLISS STP	760	86,500	350	bio-contact treatment
Lakeview Manors STP	458	72,420	200	Activated sludge
Maharlika MRH STP	420	32,430	150	Activated sludge
Centennial Village STP	1,140	85,920	350	Activated sludge
Fortville STP	1,140	11,100	350	Activated sludge
Bagong Lipunan STP	1,213	53,370	375	Activated sludge

Source: MWCI

The original Implementation schedule of the MSSP was from 1996 to 2000. Target completion date was extended to June 2003 with the execution of the Agreement Amending Loan Agreement (AALA) in 1998. An 18-month extension was granted from June 2003 to December 2004, based on the endorsement of ICC-CC in 2003. In November 2004, a 5-month extension was requested for the MSSP to be completed in May 2005.

Components of the MSSP such as the construction of a septage management plan, upgrading of the Ayala sewer network, rehabilitation of the Ayala Wastewater Treatment Plant, implementation of Community Sanitation Projects (CSP) and strengthening of laboratory and maintenance equipment had already been completed.

Most of the CST upgrade programs of the MCSP in **Table 5.1** were likewise completed with only A. Luna, Palosapis, and Hero's Hills STP replacement projects still on-going. Construction of the UP Campus STP was completed in 2004. Belarmino and Fisheries STPs' construction are also on-going.

5.2.2 West Zone (Maynilad Water Services Inc.)

The majority of the components of the MSSP were implemented in the West Concession area. These tasks were originally targeted to be completed in 2001. However, some were completed just recently and others are still under construction.

The major tasks specified in the project included the following:

- *MSSP 1- Construction of barge-loading stations at Estero de Vitas (760 m^3/day) and Parañaque*

The barge loading station in Estero de Vitas was completed in 2002. The planned construction of the Parañaque barge station was aborted because the identified site was no longer available.

- *MSSP 2-Construction of a 200 m^3/day Pilot Septage Treatment Plant in Dagat-Dagatan*

This project had been completed and the facility became fully operational by April 2005. Running with two, eight hour shifts, the capacity has been doubled.

- *MSSP 3-Strengthening of the central laboratory through acquisition of specialized equipment and materials*

All the laboratory equipment, vehicles, and sewer maintenance equipment for both MWSI and MWCI have been delivered.

- Strengthening of the technical capabilities in the operation of sewerage systems and in the construction and supervision of a pilot septage management program.

- *MSSP 4-Upgrade of the Central Sewerage System*

Repair and construction works are currently on going.

- *MSSP 4-Construction of 10,000 new sewer connections in Metro Manil*a

This program had only minor success with very few connecting due to the 50% tariff in the water bill.

- MSSP 7 & 8- *Construction of pilot vermiculture and aerated composting facilities.*

In 2001, an invitation for a pre-qualifying bid for the vermiculture project was posted by MWSI. GHD completed the design and bid documents for this project. None of those who responded to the invitation qualified for the requirements set by the MWSI. This project has since been aborted. The composting project was aborted due to the failure in acquiring the lot intended for the facility.

The remainder of the project had been completed and the facility was fully operational by April 2005. As such, the scope of work in the West Zone as defined in the MSSP components are heavily concentrated in the Central and Dagat-Dagatan Sewerage Systems. The status of the project implementation is discussed below.

Manila Central Sewerage System

The scope of work identified in the rehabilitation of the Manila Central sewerage System under MSSP was:

- Improvement of the Tondo Pumping Station covering (i) construction of a new grit chamber, odor control facility, supply/install a stand-by generating set including a generator house, and associated mechanical and electrical works, (ii) repair of existing facilities like screen gates, pumps, flow meter and instrumentation controls, and (iii) general refurbishment of the station building;
- Rehabilitation of all seven Lift Stations consisting of: (i) replacement of pumps and associated electrical / instrumentation controls, (ii) installation of new odor control facilities, and (iii) refurbishment of station house;
- Sewer lines improvement consisting of: (i) cleaning and CCTV inspection of sewer lines including the Pasig River siphon and Bay outfall, (ii) repair of sewer lines and raising of buried manholes, and (iii) supply / install flap gates.
- Installation of 10,000 service connections including acquisition of excavation permits from concerned government agencies;
- Various additional works identified during the project construction.

As of closure of the World Bank loan on 30 June 2005, the rehabilitation works by the Contractor were substantially complete. The Contractor started work on 5 October 2001 for a contract duration of 540 days, but this was extended five times, to end similarly with the loan closure. Remaining minor works are assumed by the MWSI.

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Dagat-Dagatan Sewerage System

The system upgrade and rehabilitation of the Dagat-Dagatan wastewater treatment plant, the upgrade of the pumping system, and the construction of the Septage Treatment Plant were under the project entitled "Construction of Septage Treatment Plant and Rehabilitation/Upgrading of Existing Sewage Treatment Plant at Dagat-Dagatan". The funding for the project was part of an MWSS loan from the IBRD (Loan no. 4019 PH). Consultancy services were provided by SKM, in association with TCGI Engineers. The construction contract was awarded to the JVACC-JEMCO Joint Venture.

Rehabilitation work included the following:

- Dewatering of and sludge removal from the four lagoons, replacement of riprap embankment and construction of baffled walls, and installation of a total of eight floating mechanical aerators on the two aerated lagoons (with an OTR of 50 kg/hr);
- Removal and replacement of four major pumps and associated piping, complete replacement of all mechanical and electrical systems, and a wide variety of general site improvements; and
- Construction of the Septage Treatment Plant.

Over 20,000 m^3 of sludge was removed from the lagoons. Desludging operations were contracted to MV Vidal Co., who hauled the sludge to Batangas for application to agricultural land. Sludge removed from the lagoons in excess of the 20,000 m^3 contracted volume is currently stockpiled within the WWTP site. Only the aerated lagoon of module 1 remains undesludged. Desludging operation is expected to be completed by the end of April 2005.

The four old pumps in the pumping station were removed and replaced with four new pumps equipped with an emergency power generator. The pumping station features two rising mains: two pumps are normally allocated to the 500 mm diameter main, and the other two to the 700 mm diameter main. The normal operation of the pumps will provide alternate use of the two rising mains, with the 500 mm main directed to module 1 and the 700 mm main directed to module 2. A reconstructed inter-connecting valve array at the downstream end of the rising mains just prior to the lagoons at the WWTP allows this selection to be varied. The mains have since proven defective and MWSI has engaged a contractor for their rehabilitation.

The SpTP occupies approximately 1.2 ha within the vicinity of the WWTP. It has a design capacity to dewater approximately 200 kL of sludge in an ordinary working day (1 8-hr shift). Over a year, it can treat septage from 10,000 septic tanks. The SpTP was commissioned in 17 January 2005 and operated 5 days each week. This was part of the 3-week commissioning period, which ended in February 4, 2005. Currently four operators operate the plant on each of the (2) 8-hour shifts. The SpTP became fully operational on 1 April 2005. In all, 32 vehicles are available: 7 dewatering units, (19) 10m^3 vacuum trucks, and (6) 4m^3 vacuum trucks. Typically, a 4m^3 truck can accommodate septage from 2-3 households. The current fleet has 14 new vehicles, of which, only 5 were used during the commissioning period.

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5.3 Manila Third Sewerage Project (MTSP)

In order to improve and expand the sewerage and sanitation projects developed in MSSP, the Manila Third Sewerage Project (MTSP) was conceptualized by both MWSS and MWCI for the East Zone concession area. The objectives of the MTSP included the reduction of pollution of waterways within Metro Manila and Manila Bay, reduction of the health hazards from sewage exposure, and the gradual improvement in the sewerage services through expansion of the septage management program.

In order to achieve such goals, specific components were introduced for implementation. These are (i) Taguig Sewerage System, (ii) Riverbanks Sewerage Treatment Plans, (iii) Septage Treatment Plants, (iv) Sanitation of Low-income Communities, (v) Quezon City-Marikina Sewerage, (vi) Upgrade of Existing Sanitation Systems and (vii) Technical Assistance.

i. Taguig Sewerage System

Works for this component will involve the four flood control retention ponds near the Laguna Lake, which are being constructed by the Department of Public Works and Highways (DPWH). These retention ponds are proposed to be converted into STPs to allow proper treatment during the dry season before discharge to Laguna Lake under the MTSP.

Another component of the Taguig Sewerage System is the upgrading and rehabilitation of the drainage system. This is to facilitate the use of a combined sewerage system in this area. Interceptor sewers are to be installed for affected communities.

ii. Riverbanks Sewerage Treatment Plans

This project involves three underground treatment plants located along the banks of Pasig River. Specific locations are narrowed down to Barangay Poblacion in Makati, Barangay Ilaya in Mandaluyong and Barangay Capitolyo in Pasig.

Interceptors shall provide for collection of wastewater from drainage lines to be treated before being discharged to the Pasig River. As such, improvement of the drainage outfalls and lines may be included in the component.

iii. Septage Treatment Plants

In line with the new targets for sanitation, construction of two SpTPs is proposed to service the North and South zones of the concession area. The North SpTP is to be located in San Mateo, with a capacity of 586 m^3/d to serve Quezon City, Marikina and San Juan. Southwards, a SpTP at FTI, Taguig City with a capacity of 815 m^3/d will serve the areas of Mandaluyong, Pasig, Makati, Pateros, Taguig, as well as some of the towns in Rizal province. . An added feature of the Treatment Plant is the capability to treat 2 MLD of sewage flows from the FTI complex.

Collection of septage from the individual septic tanks in the service area is to be facilitated by the acquisition of 70 truck-mounted vacuum tankers.

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iv. Sanitation of Low-income Communities

This originally involved the construction of CSTs or STPs, as appropriate, and shallow, small bore sewer lines to serve some low-income communities in the East Zone that have inadequate sanitation facilities.

This has now been reduced to two communities (Pinagsama, Taguig and East Bank, Taytay) in lieu of issues on willingness and capacity to pay for water and sewer charges. STPs will be constructed for these communities using combined systems with drainage upgrading. The feasibility of separate systems was also considered and found to be impractical and expensive.

v. Quezon City-Marikina Sewerage

A proposed STP along the Marikina River in front of Sitio Orlandes Resettlement Site is to be constructed under the MTSP. The location is to utilise portions of the legal easements established for the Marikina River Main drainage collector pipes. The main drainage collector pipes, which collect combined sewage and drainage from communities in Quezon City and Marikina, will be connected to the STP to treat the dry weather drainage/sewage flow. The treatment plant is to reduce the sewage load discharging to the Marikina River.

A low-lift station is to be constructed to carry flows from the Sitio Orlandes to the proposed STP. In order to fully utilise the combined sewerage system for the service area of the treatment plant, an upgrade of the drainage system for the Camp Atienza, Sitio Orlandes, Industrial Valley, Cinco Hermanos and Blue Ridge basins is proposed.

- **Upgrade of Existing Sanitation Systems**

Upgrades of CST sanitation systems into STPs for the East Zone are proposed, specifically those located in East Avenue, Road 5 and Matiwasay St. A separate sewer system in East and West Kamias is to be laid for the conveyance of the sewer flows to the East Avenue Regional STP.

The project also aims to transfer CST flows to nearby STPs for full treatment. Flows from Mapagmahal and Anonas CST are to be transferred to East Avenue STP, Matiwasay CST flows to UP STP and Scout Santiago to Heroes Hill STP.

- **Technical Assistance**

The components include an information campaign on proper liquid waste disposal and environmental protection and other follow-up programs on sewerage and sanitation. Low cost sanitation methodologies are still recommended.

The package components of the MTSP are to be implemented within a five year duration period. Timetable of the individual components are shown in **Table 5.2**.

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Table 5.2 - MTSP Component Timetable

Component/Packages	Project Start	Target Completion
(i) Taguig Sewerage System	May 2006	April 2010
(ii) Riverbanks Sewage Treatment Plants	August 2006	January 2008
(iii) Septage Treatment Plants	June 2005	July 2007
(iv) Sanitation for Low-Income Communities	May 2007	November 2008
(v) Quezon City-Marikina Sewerage System	June 2006	February 2008
(vi) Upgrade of Existing Sanitation Systems	September 2006	March 2008
(vii) Technical Assistance	2007	2008

Source: MWCI

Due to the fact that MTSP is still in the infancy stage, no significant progress review can be made in terms of physical accomplishments. The proposed SpTPs for MTSP located North (San Mateo) and South (FTI, Taguig City) are currently near the stage of award.

5.4 2000 West Zone Sewerage Master Plan

A draft sewerage master plan (SMP) for MWSI was prepared by PhilAqua Consultants Inc. in 2000. Due to a misunderstanding between the concessionaire and the consulting firm, the draft proposal was not recognized by MWSI as an official document.

The items presented below are parts of the draft SMP. The draft report recommended the use of centralized sewerage systems in the West Zone until 2011. After this period, a decision was to be made on whether centralized or decentralized systems would be more advantageous. A comparison between sewerage and sanitation (septic tanks) was also presented as a special topic.

Sewage Management

i. Identification of New Catchments
The West Zone was delineated into relatively small catchments in parts where sewerage coverage was specified in the Concession Agreement. A total of 150 new catchments were identified based on the following guidelines:

- the catchment should each have a resident population of about 50,000;
- the sewer lay-outs identified in previous master plans are to be followed where appropriate; and
- trunk sewers or interceptors were expected to follow natural waterways in order to avoid the need for small pumping stations.

ii. Construction of Sewage Treatment Plants
The draft SMP recommended the construction of sewage treatment plants (STPs) for treatment of sewage collected from the various identified catchments. Many combinations of alternative sites and processes were reviewed.

Under the proposed plan, the existing Dagat-Dagatan STP would continue to operate until 2016. The Dagat-Dagatan site was found to be too small for a regional STP. It was also deemed inappropriate, the site being residential with constrained access. In the medium term, a new Central STP would have to be constructed. In the absence of available land with sufficient area, reclaimed land in Manila Bay would be utilized for the development of this Central STP. Alternative decentralized fallback options in the North and South were also proposed.

From a roster of twenty choices, five short-listed alternatives were compared. No specific cost advantage was identified for any of the options. All ranked similarly with the Net Present Value analysis based on the 2000 cost data. For the medium term, the North and South STP option was identified to be most expensive.

The proposed sewage treatment process was to include primary & secondary treatment and disinfection. The identified primary treatment consisted of screening, de-gritting, oil/grease removal, and primary settling. Secondary treatment could either be using activated sludge, trickling filters, or bio-aerated filters. Enhanced Primary Treatment, the addition of a chemical flocculants, was proposed for STPs that would discharge into Manila Bay. Secondary Treatment would be required for STPs that would discharge to inland bodies.

Treatment alternatives for the bio-solids accumulated from the sewage treatment process were: gravity thickening, stabilization, and dewatering. Some combinations of processes were proposed for both on-site and off-site sludge treatment facilities.

The draft SMP recommended that sludge from primary treatment processes be thickened prior to its transfer to an off-site treatment facility. The off-site treatment facility should be located where transport costs could be minimized and where market for the treated bio-solids could be optimized.

It was also recommended that MWSI should plan to accept industrial wastewater as the sewers are extended to areas where these industries are located provided that the industries treat their effluent to strengths equivalent to those found in typical domestic sewage.

Septage Management Program

The septage management program adopted by MWSI was part of the implementation of the MSSP components. Throughout the concession period, septage removed from the septic tanks in the concession area would be treated at the recently completed Dagat-Dagatan Septage Treatment Plant (SpTP). Except for this facility, no other SpTP was proposed for construction.

In the draft SMP, two septic tank gravity system (STGS) alternatives were presented and compared with conventional sewerage, viz. STGS requiring construction of new septic tanks and STGS requiring new interceptors but utilising the existing septic tanks. Cost comparison of the three alternatives revealed there was no clear leader in terms of required financing. Other criteria for comparison were risks involved and technical & operational requirements. Both STGS options were not recommended because of the need for a septage desludging program, which would be required even after the laying out of the sewers.

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5.5 Existing Infrastructure Condition Report

5.5.1 Inspection of Systems and Facilities

Various sewerage and treatment systems and sanitation facilities operated by MWCI, MWSI, NHA and private firms were visited in April 2005 by the Study Team. For the sewerage systems, the wastewater treatment plants visited included the following:

1) East Zone Systems of MWCI consisting of Magallanes Wastewater Treatment Plant and several STPs built under the MSSP such as Karangalan Village STP#1, Guadalupe Bliss, Sikatuna Village, Phil-Am Village and UP Campus.
2) West Zone systems of MWSI consisting of Manila Central Sewerage System and Communal Septic / Imhoff Tanks in Project 7 & 8, Quezon City.
3) Private and NHA systems that included the sewage treatment plants at Ayala Alabang Village, Filinvest Alabang and Smokey Mountain Housing Development of NHA.

For the sanitation facilities, the rehabilitated Dagat-Dagatan Septage Treatment Plant that commenced operation in March 2005 was visited.

Details of the evaluation of the existing systems resulting from the field inspections is shown separately in SAP 8-Sewerage Strategies.

5.5.2 Evaluation of the Systems and Facilities

The site visits indicated that expansion of existing sewerage systems by increasing the capacity of treatment plants and service areas appeared viable. Expansion of the private sewerage systems is feasible due to high affordability of the served population. The served population for large public systems such as the Manila Central Sewerage System can be substantially increased by infilling service connections, i.e. requiring all households and establishments in an existing sewer line to be connected to the system.

Conditions of these existing systems were as follows:

(a) Although the residents of the prime Magallanes Village oppose the expansion of the Magallanes WWTP, there is ample space in the 3.4-hectare site for plant expansion and enhancing the existing high fence and tree-lined buffer from adjoining residential houses for improved odour mitigation. Considering the difficulty in finding suitable large land areas as well as the high cost of acquisition, the expansion of the Magallanes WWTP is a viable option. The continuing build-up of the Makati Business District by mixed-use high-rise buildings and the need to provide sewerage services to several villages (e.g. San Lorenzo, part Bel-Air) in its catchment area make the option to expand the plant capacity a viable alternative.

    The system covers 600 ha of the 1000-ha Ayala subdivision development area, comprising 370 ha residential, 300 ha commercial/institutional and 30 ha open spaces. The other 400 ha remains unsewered due to geographic and/or economical reasons.

(b) The 10 MLD Ayala Alabang WWTP site of 2 ha has adequate space for plant expansion. Such a plant expansion could service adjoining residential villages and the additional wastewater flows from further development of the Ayala Alabang Town Center;

(c) Under the MSSP, plans were developed for the Manila Central Sewerage System (MCSS) to increase the service coverage by infilling, i.e. install laterals and service connections to households and establishments. Under the MSSP4 project component, some 10,000 service connections were to be installed by the Contractor, but actual connections were less than 10%, due mostly to the cost those that connected to the sewer would incur.

It is estimated that about 20,000 households within the service area are not connected to the system.

(d) With roughly 25% occupancy of the 440-hectare Global City since it was developed in the late 1990s, the present wastewater generated is about 1.9 MLD for the 3.5 MLD WWTP. There is sufficient space in the 2.0 ha treatment plant site for plant capacity expansion.

Strategies to significantly expand sewerage coverage should consider the following:

a) The existing sewerage systems should be the nuclei of the proposed centralized systems within defined catchment areas. Current projects such as MSSP and MTSP should be considered in the development of the Sewerage Master Plan.

b) Acquire private sewerage systems for eventual integration to the central system.

It has been part of MWCI's sewerage strategy to acquire the operation and maintenance of private systems, particularly those built by the NHA in its housing developments. Existing communal septic tanks and Imhoff tanks are upgraded to STPs, sewers cleaned and repaired, and additional service connections installed.

A similar upgrading of small sewerage systems currently operated by MWSI in the West Zone could be undertaken.

Large real estate development for prime residential, commercial and mixed-use development and industrial parks have sewerage systems built and operated by the private developer. From diligent system evaluation and discussions with the developer, mutually beneficial arrangements can be made to integrate the private system into the central system, which is considered to be more efficient.

Sewerage systems built by the NHA which were not turned over to MWSS (and eventually to MWCI & MWSI) should be inspected / assessed for improvement / rehabilitation potential. Rehabilitation of an existing system will be less expensive as the plant sites could be utilised (less expensive than new land acquisition) and the sewer network could be cleaned and repaired.

c) Build small systems in the short-term for centralization in the long-term. Small parcels are land likely to be more available and since the concessionaires have to buy the land; this could emphasize the de-centralized approach that MWCI is now pursuing.

The approach to sewerage for Metro Manila in the short-term has to fit with a longer-term plan, past the Concession period to the year 2025. This may mean that smaller decentralized systems in the short term should be able to accommodate (or be converted to) a centralized system in the future.

d) All wastewater treatment systems should be upgradeable in the future to cope with possibly tighter environmental restrictions. In dense housing developments, communal septic tanks or other low-cost sanitation systems could be installed (instead of individual septic tanks). Integration of such CSTs in a central system will be more convenient in the future.

e) Application of the appropriate treatment technologies should be systemic and standardized to allow ease of understanding and maintenance.

f) Provisions of the Clean Water Act 2004 (IRR promulgation in early 2005), Presidential Decree No. 856 – Sanitation Code of the Philippines Sec. 74, Revised National Plumbing Code of the Philippines, 30 Sept 99, PD 856, DOH and DENR requirements for Class C discharges (e.g. maximums of BOD of 50 mg/L, TSS of 70 mg/L, oil & grease of 5 mg/L, total coliforms of 10^5 MPN/100mL) should be followed.

All relevant CLUPs will have to be considered in any sewerage plan. The general trend is an increase in residential and commercial areas and a decrease in industrial areas. This provides opportunity for new sewerage systems that can be integrated into a central system in the future.

5.6 Provision of Sewerage and Sanitation Facilities for the Urban Poor

5.6.1 Responsibility for Services to the Urban Poor

It is currently estimated that over 20% of the population of Metro Manila, i.e. over 2 million people, live either below or near the poverty line and 35% of the population resides in informal slum settlements, many of which are gateways for a continuous influx of poor rural migrants. The growth of these settlements and the demand for services have overwhelmed the capacity of the government and NGOs to respond effectively.

Resettlement programs that have relocated the urban poor to remote sites away from established sources of livelihood have generally failed. Many of the 2 million residents in the blighted areas live in dense and abject conditions, with poor quality housing. Drainage is generally poor and the areas are subject to severe flooding during rains.

In order to address the results of this rapid unplanned urbanization, in particular in Metro Manila, HUDCC and the LGUs have developed a 15-year slum eradication policy to provide a renewed commitment to the urban asset reform. This includes on-site urban upgrading and integrated urban development approaches to address urban poverty and improve access to basic services, while avoiding complicated off-site resettlement schemes that are prone to failure. While the available land under the control of the LGUs in Metro Manila is in short supply, national government land parcels have been identified for privatization.

The development of new sewerage and sanitation programs for the urban poor communities will by necessity relate to the housing improvements. Urban upgrading projects will incorporate infrastructure improvements, including sewerage and sanitation. The Medium Term Development Plan 2004-2010 (MTDP) estimates a new housing need of almost 500,000 households in NCR during the Plan period and targets a housing provision of socialised and low cost housing of 1.15 million Philippine wide and about 150,000 in NCR. Priority relocation programs for the North Rail, South Rail, Pasig River Rehabilitation and the *Esteros* Program would account for a total of about 70,000 families.

There are various programs from a range of government and non-government agencies that address the housing and infrastructure needs of the urban poor in Metro Manila. The MTDP develops a strategic framework anchored on multi-stakeholder, market based, private sector and LGU led reforms and approaches to meet the goals of improving the living conditions of the urban poor. The strategies include:

- Expand private sector participation in socialised housing finance and construction;
- Continue to address the housing requirements of the formal and informal sectors, particularly the socialized and low cost housing categories;
- Strengthen the institutional capacity of the housing agencies; and
- Enhance the capacity of the LGUs.

The principal agencies involved in providing services to the urban poor are described below.

Housing and Urban Development Coordinating Council (HUDCC)

HUDCC, created through E.O 90, is the highest policy making and coordinating office in the housing sector. It is an umbrella organization under the Office of the President that consists of:

- The heads of four housing agencies; National Housing Authority (NHA), Home Guaranty Corporation (HGC), National Home Mortgage Finance Corporation (NHMFC) and the Housing and Land Use Regulatory Board (HLURB);
- The heads of three funding agencies; SSS, GSIS and HDMF;

- The heads of several government agencies; PMS, DOF, DBM, NEDA, DBP, MMDA; and
- Two private sector organizations – an NGO and a private developer.

HUDCC is in the business of coordinating the formulation and application of a national urban policy framework and enabling the delivery mechanisms/markets of affordable and accessible housing with special concern for urban households qualified for social housing, namely informal settlers, homeless and the urban poor.

National Housing Authority (NHA)
NHA is an agency with nationwide responsibility for improving housing for the people of the Philippines. The national housing policies recognize slum improvement as an approach to deal with squatter areas and blighted communities in urban areas. Slum improvement includes upgrading or introducing roads, footpaths, drainage, sewerage, water and power systems, and other community service. In the context of slum upgrading, NHA is involved in resettlement programs, sites and services development, medium rise housing and community based housing programs.

Local Government Units (LGUs)
Through the Local Government Code of 1991 (RA 7160), LGUs are responsible for the provision of basic services, such as water supply systems, sewerage, and sanitation, either directly or through contracts with the private sector. They are also empowered to collect taxes and fees necessary for providing these services. In addition to the sewerage and sanitation services provided through MWSS and the concessionaires, LGUs develop in coordination with NHA and other national government agencies as well as through their own initiative, slum upgrading and housing for the urban poor including sewerage and sanitation infrastructure.

LGUs also provide for development of sanitation for communal facilities such as public markets, bus terminals and the like. The current program to provide sewerage and treatment facilities for Muntinlupa Public Market is an example. The existing public toilets are also under the jurisdiction of the LGUs. In the City of Manila, however, the policy is to remove public toilets when they are no longer considered necessary.

Other Agencies
A range of other government and non-government agencies are responsible for slum upgrading programs, usually in coordination with NHA and the LGUs, and often through development assistance programs from multi-lateral and bilateral agencies or the private sector. Examples are the Pasig River Rehabilitation Commission through its urban renewal program in MACDA (Guadalupe, Makati), BASECO and Parola, the relocation of informal settlers from the banks of the Pasig River and tributaries, and NGOs such as Gawad Kalinga and Habitat for Humanity.

5.6.2 Strategies for Improving Sewerage and Sanitation for the Urban Poor

Existing Slum Communities

The current housing condition in the slum communities makes it difficult to address sanitation improvements through the provision of sewerage systems. On-site 'drop and store' sanitation is most appropriate in these areas where sufficient space is available. Flush and discharge sanitation, such as the use of the traditional septic tank is generally not appropriate for these communities due to insufficient space to construct the septic tank and lack of access for desludging. Communal septic tanks may be appropriate, but this requires pipes to be laid in the narrow alleys to collect sewage from individual households. Except possibly for the maintenance of communal septic tanks, sanitation in the current urban poor communities is best left as a responsibility of the LGUs at the barangay level. Installation and operation of public toilets and of drop and store sanitation facilities could be funded through the barangay and remain outside the jurisdiction of the MWSS and the concessionaires.

Public Toilets

An inspection of a sample of public toilets in the City of Manila was conducted by the 1979 Master Plan study team. In 1970 about 70% of the public toilets located in the MWSS service area were located in the City of Manila. During the period 1957 to 1979, the number of public toilets in Metro Manila had dropped from 172 to 54 and no public toilets have been constructed since 1962. Between 1970 and the present, the percentage of households without toilet facilities has dropped from 11.2% to 5%.

In the 1979 survey, an inspection was made of seven public toilet facilities in the Tondo area. While only two of the facilities were in a relatively clean condition, most received an extremely high degree of use, up to 20 times the design capacity. It was recommended in the Master Plan that consideration should be given to rehabilitating the relatively large number of existing public toilets in the depressed areas that are still in relatively good structural condition. It was also recommended that the public acceptance be assessed of the usefulness of public toilets that are maintained in a clean and serviceable condition.

In October 2005, the Manila City Hall provided a list of their public toilets within the city. **Table 5.3** shows the locations of the public toilets with their corresponding sanitary conditions. Out of the 43 public toilets, 29 are operating and are rated from poor to very satisfactory conditions, 12 are closed and two are under construction. Twenty-two (22) or 51 % were assessed to be satisfactory to very satisfactory.

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Table 5.3 - Public Toilets in the City of Manila

District I	Location	Sanitary Condition
1	Llallana St. nr. F. Varona St., Tondo (Bgy 95, Zone 3)	No longer exists
2	Llallana St. nr. Velasquez St., Tondo (Bgy 95, Zone 8)	No longer exists
3	Tayuman St. nr. Rizal Elementary School (Bgy 95,Zone 4)	No longer exists
4	Dagupan St. nr. Gabriela St., Tondo (Bgy 50, Zone 4)	No longer exists
5	Near T. Paez Elementary School (Bgy 139, Zone 11)	No longer exists
District II		
1	J. Planas St. back of Gagalangin Fire Station (Bgy 163,Zone 14)	Poor
2	Ma. Guizon St. corner Perfecto St. (Bgy 152, Zone 14)	Satisfactory
3	Old Antipolo St. nr Narra St. (Bgy 217, Zone 20)	Poor
District III		
1	605 T. Alonzo St., Binondo (Bgy 300)	Satisfactory
2	Del Pan St. nr Delpan Sports Complex (Bgy 272)	Satisfactory
3	Del Pan Island (Bgy 286)	Satisfactory
4	Lacson Underpass, Quiapo	Satisfactory
5	New Antipolo, Talipapa, Sta. Cruz (Bgy 365)	Satisfactory
6	1224 Anacleto St., Sta. Cruz (Bgy 332)	Satisfactory
7	Reina Regente St., Binondo (Bgy 293)	Poor
8	Kusang Loob St., Sta Cruz (Bgy 353)	Poor
9	Pista St. corner Becena St., Sta. Cruz (Bgy 351)	Poor
10	258 Isla de Romero St., Quiapo	Closed/for demolition
11	P. Ducos St. nr. Quinta Market, Quiapo	Closed/for demolition
12	1806 New Antipolo St., Sta. Cruz (Bgy 369)	Closed/for demolition
13	1863 Leonor Rivera St., Sta. Cruz (Bgy 370)	Under construction
District IV		
1	R. Papa St. nr. Morayta St. (Bgy 464, Zone 46)	Permanently closed
2	Ma. Clara St. (Bgy 485, Zone 48)	Under construction
3	Espana Blvd. (Bgy 472, Zone 47)	Satisfactory
4	Palawan St. (Bgy 453, Zone 56)	Satisfactory
5	Lavanderos St. (Bgy 410, Zone 42)	Satisfactory
6	190 Loreto St. (Bgy 417, Zone 43)	Satisfactory
7	1447 San Diego St. (Bgy 499, Zone 49)	Satisfactory
8	Algeciras St. (Bgy 484, Zone 48)	Permanently closed
9	Sta. Teresita St. (Bgy 409, Zone 42)	Permanently closed
District V		
1	1922 Taft Ave., Malate (Bgy 692, Zone 75)	Satisfactory
2	Taft Ave. in front of Phil. Christian University	Satisfactory
3	Plaza Lawton in front of Metropolitan Theater	Satisfactory
4	Sta. Monica St. corner Guevarra St. (Bgy 668, Zone 72)	Satisfactory
5	Baywalk, Roxas Blvd., Ermita (Bgy 701, Zone 77)	Very satisfactory
6	Roxas Blvd. nr. US Embassy (Bgy 666, Zone 72)	Very satisfactory
7	Padre Faura St. nr Supreme Court (Bgy 670, Zone 72)	Satisfactory
8	1949 F. Munoz St., Paco (Bgy 735, Zone 80)	Satisfactory
9	1207 Interior Anakbayan St., Paco (Bgy 740, Zone 80)	Permanently closed
10	PNR Compound, Paco (Bgy 825, Zone 89)	Poor
11	1475 Fabie St. (Bgy 815, Zone 88)	Poor
District VI		
1	Sikat St., San Miguel (Bgy 645, Zone 67)	Satisfactory
2	Lamayan St., nr. Old Panaderos St., Santa Ana (Bgy 891,Zone 98)	Satisfactory

Note: Remarks on the sanitary condition of each public toilet were based on the Assessment Report of each District Sanitation Officer to the City Sanitation Officer.

Although the percentage of households without toilet facilities has continued to decrease and is now down to 5%, this still represents a substantial number of households. The willingness-to-pay survey indicated that over 60% of households without toilets would like access to a public toilet and that about 70% of these were willing to pay an average of P3 per visit. Most respondents believed bathing facilities could also be incorporated in the public toilets.

A program of rehabilitation of existing public toilets on the basis of that recommended in the 1979 Master Plan is therefore considered warranted, together with construction of new public toilets in existing slum areas where access to toilet facilities is limited. It is considered that the installation and operation of public toilets should be the responsibility of the LGU/barangay but that they may be connected to a MWSS sewerage system where available.

Urban Upgrading Projects
As discussed above, urban upgrading projects are implemented through a number of agencies, but most will include improved sewerage or sanitation infrastructure including provision of sewage treatment facilities. Although funding is from various sources, the projects are generally coordinated with HUDCC/NHA and/or the LGUs. Infrastructure from these projects is best absorbed into the MWSS system and operated by the concessionaires.

(a) NHA Housing Projects

As indicated in **Chapter 4** and **Table 4.14**, there are a large number of NHA urban upgrading projects that have been implemented that incorporate sewerage and sewage treatment systems, only some of which are now currently operated by MWSS/Concessionaires. Many of these are projects from the Metro Manila Zonal Improvement Program (ZIP) that had been implemented by NHA since the late 1970s. It is recommended that an inventory and condition survey be conducted of those systems that have not been turned over and negotiations be conducted with NHA or the owners associations as appropriate regarding the conditions for turn over for eventual operation by MWSS/concessionaires.

Advice from NHA is that the single dwelling style programs such as ZIP are not now being implemented and the current emphasis is on medium rise buildings (MRBs) that it could be expected would be provided with a common sewage treatment facility. It is recommended that, when operational, these facilities be also turned over to MWSS/concessionaires and could eventually be incorporated into a sewerage system once it is available in the locality. There is probably a need for closer cooperation between NHA/MWSS/concessionaires during the development stage of urban upgrading projects to ensure appropriate and compatible sewerage and treatment facilities are provided that can be effectively operated and maintained in the future by the water utility.

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(b) Pasig River Rehabilitation Program

The Pasig River Rehabilitation Project includes two types of urban upgrading programs as follows:

- Resettlement of an estimated 10,000 families from the banks of Pasig River and tributaries to new sites located in Montalban and Cavite; and
- Urban renewal projects adjacent to the Pasig River focussed on improvement of low-income housing.

The Pasig River resettlement areas in Cavite are located outside the MWSS service area and are not relevant to this study. The resettlement area in Montalban is within the service area, but there are no sewerage targets for Montalban within the concession period. While sanitation facilities within the Montalban resettlement area will be serviced by MWCI, sewerage facilities are likely to remain the responsibility of the owners association during the master plan period.

Several plans have been prepared for various urban renewal areas to be funded through the ADB Sector Development Plan loan. These include MACDA in Guadalupe, Makati, BASECO, Parola and Punta in Manila, Pineda in Pasig and Joriz in Mandaluyong. None of these have yet been developed, but all are within areas where sewerage systems may be available during the master plan period and the Pasig River Rehabilitation Commission (PRRC) should liaise closely with MWSS and the concessionaires regarding the opportunity for sewage from these developed being incorporated into existing and planned sewerage systems.

(c) Metro Manila Urban Services for the Poor Project

This is a proposed ADB funded project, not yet approved by ADB or the Philippine Government, for which the project preparation study has only now commenced. If approved, it would commence in 2006 and would provide assistance to HUDCC in their strategy for slum eradication. It would be a major project to support and initiate a phased slum eradication project in support of decentralization and devolution whereby local governments and the private sector will assume responsibility for urban upgrading, renewal and regeneration.

The thrust of the project will be to emphasize on-site urban upgrading and improvement of basic services, while avoiding complicated and unpopular resettlement schemes that have been prone to failure largely due to livelihood issues. Lack of available land under the control of the LGUs in Metro Manila has been a constraint in the past for on-site slum upgrading, but there are national government lands available that have been identified for privatization, which are currently occupied by squatters. LGUs have expressed interest in on-site upgrading of these land parcels or in using them as in-city relocation sites for their squatter populations.

National government land slated for privatization includes the 76-hectare Welfareville property in Mandaluyong, the 450-hectare New Bilibid Prison property in Muntinlupa, and the National Government Center in Quezon City, among others. The location of these sites is shown in **Figure 4.15**. An important aspect of the slum upgrading will be the provision of services including sewerage and sanitation. The Master Plan will consider the incorporation of these projects in the strategy and it is important that MWSS and the concessionaires are part of the multi-stakeholder effort required should these projects be implemented.

(d) Manila Third Sewerage Project (MTSP)

One component of MTSP is the provision of sanitation for low-income communities. This originally involved the construction of CSTs or STPs, as appropriate, and shallow, small diameter sewer lines to serve some low-income communities in the East Zone that have inadequate sanitation facilities.

This has now been reduced to two communities (Pinagsama, Taguig and East Bank, Taytay) in lieu of issues on willingness and capacity to pay for water and sewer charges. STPs will be constructed for these communities using combined systems with drainage upgrading. The feasibility of separate systems was also considered and found to be impractical and expensive.

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6. Sanitation & Sewerage System Constraints

At a global level, it has been reported (DFID 2005) that the major constraint for general sanitation is by lack of political will: “activities that fail to establish sustainable and hygienic facilities and behaviour, a high rate of abandonment of existing infrastructure, and clear linkages with illness rates.”

All previous Metro Manila Master Plans have recognized that a centralized sewerage system would eventually solve most of the environmental degradation and health issues caused by polluted waters. Some also recognized some of the limitations or constraints for implementation of such a system within Metro Manila.

A review of previous sewerage and sanitation master plans, of past and current projects of MWSS, MWCI and MWSI and from site visits have identified issues which have constrained or are constraining the development of the sewerage and sanitation infrastructure in Metro Manila. Earlier master plans have only been partially implemented at best. Physical, fiscal and cultural limitations all ultimately determine and direct the implementation of an environmental agenda in the Philippines in general but particularly in Metro Manila.

6.1 Lessons Learned from On-going Sewerage and Sanitation Projects

Close coordination with LGUs, housing agencies and the beneficiary communities impact positively on project implementation. Intensive and regular consultations with affected communities are necessary to ensure cooperation during project implementation as well for liaison with homeowners regarding any fees associated with the management of dirty water, e.g. sewer connection fees. However, proper consultation does not ensure a willingness to pay as evidenced by the following case studies.

Case 1 MSSP Community Sanitation Project (MCSP)

The MCSP involved the construction of 26 on-site STPs. The rationale was that existing facilities in the target communities were unable to meet the DENR effluent standards and directly contributed to the pollution of inland rivers and waterways.

During the project conceptualization, the communities were consulted and provided with project details. Memoranda of Agreement (MOA) were executed for easements on the lots for the STPs as well as for sewer charging. However, even with due consultation, six out of 26 projects were cancelled. At the time when construction was about to commence, the communities reneged on the MOA due to the issue of sewer charging.

Case 2 MSSP-4

One of MWSI’s MSSP commitments was the installation of about 10,000 new sewer service connections, the cost of which shall be chargeable to a World Bank loan. Within the period of October 5, 2001 to September 2005, MWSI was able to connect only 730 households. Again, sewer charges (water bills would be increased by 50%) coupled with absence of direct recognizable benefits were the people’s main contention for not connecting.

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Case 3 Pateros Sewer System

As part of the original Concession Agreement sewer targets, MWCI was supposed to install a separate sewer system for Pateros and portions of Taguig. The Pateros LGU, having communities belonging to the low-middle income class, out rightly rejected the proposal due to unavailability of land, potential traffic disruptions and issues on ability of residents to pay. The LGU suggested that improvements and low-cost sanitation services be provided for pocket areas where there is little or no access to sanitation facilities.

Case 4 Septage Sea Disposal Trial (2001-2002)

In the absence of proper septage disposal facilities, the MSSP also included a septage sea disposal trial. However, full operation of the septage sea disposal component did not eventuate due to social pressure from the LGUs and an NGO. They expressed unwillingness to allow the dumping of septage into Manila Bay. MWSS had to immediately cease the septage sea disposal operations, which were originally planned up to 2015. The issue even merited the World Bank's Inspection Panel, which recommended action plans on septage management. The action plans, included a septage management program with focus on the provision of sanitation services and construction of septage treatment plants.

On June 16, 2003, MWCI formally wrote to MWSS regarding its position to cease all sea dumping operations. MWCI completed a one-year septage trial from April 2001 to June 2002 and dumped a total volume of 26,000 cubic meters of septage. MWCI submitted all monitoring data to DENR-EMB and the PCG.

From July 2002 up to present, MWCI hauls collected septage to lahar areas in Tarlac and Pampanga for use as soil conditioner in enhancing the growth of sugarcane. Previous to these lahar operations, MWCI had been conducting experiments for using dried and liquid sludge as soil conditioner and composting material. As of end-September 2003, MWCI had hauled about 25,000 cubic meters of septage, which was applied in 282 ha of lahar land. The experiments are monitored by the Sugar Regulatory Administration (SRA). The lahar operations have been televised on national television and have been witnessed by MWSS and the WB.

In September 2003, MWSI formally wrote MWSS regarding its position not to pursue the septage sea dumping operations. MWSI completed the Estero de Vitas barge loading station in September 2002 but was not able to sail any barge. MWSI was dumping collected septage in the Dagat-Dagatan lagoon in Navotas prior to its renovation as a SpTP.

6.2 Disease Prevention

Sewerage and Sanitation

The chief purpose of sanitation, sewerage and treatment is to prevent the spread of human diseases from the discharge of their waste, particularly from dense concentrations of human habitation.

Poor water supply and sanitation-related diarrhea cause the deaths of 3,900 children globally every day (UNICEF-WHO JMP 2004). Areas, where negative pressures within the water supply system occur are most susceptible to drinking water contamination by sewage infiltration.

The spread of water-borne diseases is brought about by human contact with sewage or dirty water. Diarrhea was the 2nd and 3rd cause of morbidity in Metro Manila for the 5-year average period of 1996-2000 and in 2001, respectively (DOH 2005). According to a World Bank publication (Philippines Environment Monitor 2003), 31% (5.2 M cases) of illnesses for the five-year period from 1996 to 2000 were related to water. Avoidable health costs were estimated at PhP 3.3B per annum.

Better sanitation/sewerage translates into benefits for the community which result in real economic return such as (DFID 2005):

- Reduced health sector costs;
- Reduced patient expenses;
- Increased time savings;
- Productive days gained;
- Days of school attendance gained;
- Child days gained; and
- Deaths avoided.

The lack of maintenance of septic tanks all over Metro Manila inadvertently releases relatively raw sewage into the drainage system. Drains are in practice combined sewers. In the low-lying areas of Manila, where the onset of flooding is experienced during the rainy seasons, there is a high probability of human contact with raw sewage. The floodwater carries with it not only sewage but also solids from submerged septic tanks. Raw sewage and septic tank wastes are highly pathogenic and can transmit a variety of human diseases.

6.3 Protection of the Environment

Sewerage and Sanitation

The quality of the environment and the state of the human condition, both health wise and the quality of life, have always been directly related.

The adverse environmental effects of the discharge of sewage, either directly to the creeks, esteros and rivers or through the approximately 2.17 million septic tanks significantly contributes to the degradation of the water systems in Metro Manila. According to the Philippine Environmental Monitor 2003 (World Bank), the Class C water quality parameters for the river systems within Metro Manila are not met and the Philippine economy loses PhP 17B annually due to the degradation of the marine environment.

The failure to desludge the septic tanks is tantamount to not having them and simply discharging untreated sewage into the drainage system. Although proper maintenance (i.e. regular desludging) would reduce this problem, an overall septage management plan is needed. With the continued use of existing drainage systems for the collection of sewage, pollution levels will not be lowered in the esteros, creeks and rivers until entire drainage flows are intercepted and treated. Odor emissions from these combined sewers are also deleterious to residents and should also be considered.

In general, the lack of an overall sanitation management plan in combination with the use of drains as combined sewers with no treatment are the major sources of environmental degradation to inland water systems and major water bodies within and around Metro Manila.

6.4 Land Availability

Sewerage and Sanitation

Land availability for sewerage and septage treatment plants is a major consideration in implementation of sewerage and sanitation programs. Most free areas in Metro Manila are already heavily inhabited by formal and/or informal settlers and large open areas are scarce. If ever there are available spaces, these parcels of land would be costly and would be reserved for profit-oriented type of development.

There is an obvious need for management of dirty water but only minimal land areas are available for the required larger treatment systems. Lands identified as available in previous master plans as sites for treatment plants have mostly been developed for other purposes. Manila is developing too quickly for vacant areas over 0.5 ha to remain available for any length of time.

Ideally, the site for a treatment plant should preferably have some isolation from residential communities to avoid nuisance from odor, noise and truck traffic. Also, the site should ideally be near main waterways, receiving bodies of water or areas where recycling is possible and be at a low elevation. These requirements would further limit the ideal parcels of land available for this purpose.

6.5 Traffic Disruption

Sewerage

The works required in installing a centralized sewerage network would involve excavation of major and minor thoroughfares. Many of the Metro Manila roads are narrow or heavily congested. If conventional methods of construction will be used, the time to complete the project would take years, depending on the extent and the location of the network. In areas where the water table is high, sheet piling and dewatering would be required. With narrow streets, there would be a need to support the structures along the streets to prevent settlement and damage to property. This would result in great public inconvenience.

Any kind of excavation in roadways or footpaths (sidewalks) will be disruptive to the area's normal flow of human and vehicular traffic. In areas with a high population density (e.g. most of the NCR, Bacoor, and Cainta, some with greater than 20,000 persons/km^2), this disruption can degrade to simple chaos. The excavation of certain roads is banned in some cities/municipalities, so special methods like tunneling would be required. The construction schedule includes processing of permits which may also be difficult and time consuming to obtain. Manila City for example issues excavation permits good for only for two weeks. Every time they expire, they have to be renewed.

Presence of Utilities in Roads

In the planning of a centralized sewerage system, a major constraint would be the existence of utility infrastructure for water supply, storm drainage and outfalls, electricity distribution, gas, and telecommunications. The sewer pipes are installed deeper than the other utilities, but they may intercept these utilities. Also, for the old and narrow streets of Metro Manila, the utilities may not easily be located. Close coordination with the various utility owners is necessary to obtain the as-built plans. However, the as-built plans are not always available.

During the construction of other infrastructure facilities, existing sewer lines can be accidentally damaged by other contractors, even if the sewer pipes are buried deep in the ground. During the implementation of MSSP4, damages to sewer pipes were confirmed. One was along Taft Ave., which was damaged when the LRT was being constructed. The other was along Onyx St. which was hit during pile driving for the slope protection works at Estero Tripa de Gallina (field visit to MSSP4 project office on March 17, 2005).

6.6 Cultural Preferences

Sewerage and Sanitation

A project may be technically and financially feasible, but if the project is not socially acceptable, it will not be implemented. Sewerage and sanitation projects cannot be "socially" acceptable because of their cost. Customers do not receive direct benefits by connecting to the sewerage system and paying the corresponding sewer charges. There are also social stigmas and preferences that identify technologies or approaches, which are more acceptable than others.

6.7 Inaccessibility of Septic Tank Systems

Sanitation

In many instances, the septic tanks cannot be accessed because they are built under structures or have illegal structures built over the septic tanks. There are many cases wherein the septic tanks cannot be desludged for the alleys leading to the houses are too narrow and cannot be accessed by the vacuum tankers.

The Second Manila Sewerage Project Feasibility Report (JMM 1991) cited a 1980 survey, which estimated that about 50% of the septic tanks within four cities (Manila, Quezon City, Caloocan and Pasay) and about 80% of the septic tanks in the remaining municipalities are fully accessible. Due to the increased population and a general policy that each new residence shall be served with an individual septic tank, the report assumed increased rates of 60% for the four cities and 90 % for the municipalities. For the same study, around 74% of the septic tanks were assumed accessible for the whole of MWSS service area.

6.8 Septic Tank Design

Sanitation

In 1980 (JMM 1991), a survey of 20 septic tanks in the MWSS service area recorded gross volumes from 1.2 m^3 to 6.04 m^3 with persons served ranging from four to 16 persons per septic tank. The water consumption for each tank ranged from 20 lpcd to 260 lpcd. The survey showed no correlation among the septic tank volumes, number of persons in the household and the unit water consumptions. The Implementing Rules and Regulations of the Code on Sanitation of the Philippines specify the design of septic tanks. Even then, over the years, there were household septic tanks that had most likely been under-designed. In certain areas, one septic tank may serve multiple households. On the average, the gross septic tank volume (including the leaching pit) had been estimated to be 6 m^3 and the effective septage storage capacity is 1.8 m^3.

Other common design deficiencies of septic tanks are:

a) No access manholes; and
b) Unlined bottom which allows percolation into the ground.

6.9 Transport System

Sewerage

Metro Manila utilizes a system of roads, railways and navigable waterways. A major consideration in sewerage planning is the main roads which are heavily traveled. These roads are also likely the sewer trunk routes.

Sanitation

The distance of the septage treatment plant and the disposal/reuse site are factors to consider. The distance would impact fuel and lubrication costs. Increased fuel and lubrication costs of the tankers would also be incurred due to the relatively heavy traffic situation within Metro Manila itself.

6.10 Affordability: Financial Constraints

6.10.1 Lack of National Government Financial Support

The National Government of the Philippines does not provide significant grants for sewerage systems. It cannot afford to pay for the major cost of such projects because of the huge capital investment. Annual investment in sewerage on a national level is a very small percentage of the total investment in water supply and sanitation. Since 1970, for every PhP 97 spent on water, only PhP 3 has been spent on sanitation and sewerage.

6.10.2 Willingness-to-Pay for Sanitation and Sewerage Services

6.10.2.1 Background

A Willingness-to-Pay (WTP) survey was conducted during April 2005. The survey covered a total of 2000 respondents across the MWSS service area and included 1200 respondents within the West Zone and 800 respondents within the East Zone. Respondents were asked if they would be willing to contribute to the costs of three alternatives to improve the environmental effects of sewage discharges. The three alternatives for respondents with toilets (95% of respondents) were:

1. Improve and expand the existing separate sewerage system that discharges into a sewage treatment plant – this would require households with septic tanks to connect their wastewater facilities to the MWSS sewerage system.
2. Improve the combined sewerage system – this would maintain the current situation whereby household septic tanks discharge to a storm drain, but in this option the storm drain would discharge to a treatment plant prior to entering a major water body.
3. Improve the effectiveness of septic tank cleaning by strengthening the periodical cleaning program – this would require regular pumping out of the septic tank.

In addition to the survey, twelve Focus Group Discussions (FGD) were conducted with representatives from various groups such as the LGUs, barangay officials, Sangguniang Kabataan, women and people's organizations, at the following locations:

- Barangay Wawa, Taguig
- East Kamias, Cainta
- Maggahan, Taytay
- Karangalan Annex, Cainta
- Pulo, Valenzuela City
- Pasolo, Valenzuela
- Barangay NBBS, Malabon
- Barangay 705, Malate, Manila
- Barangay Sn Rafael 4, Noveleta
- Centennial Village, Taguig City
- Maharlika Village, Taguig City
- Barangay 123, Moriones, Tondo, Manila

The groupings of the FGDs were based on the type of water service delivery, sanitation conditions and sewerage coverage within the sampling areas. These FGDs were used to deepen the consideration of the sewerage and sanitation options. They enhanced the understanding of the benefits and advantages of each service option including costs or service fees. The FGDs also provided significant feedback on the current situation of the sewerage and sanitation systems and the consumers' concerns and issues.

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6.10.2.2 Survey Participant Characteristics

The selected sample sites for the survey comprised the service delivery area of MWSI and MWCI. A total of 67 sample sites were covered in the survey, specifically 40 sites for MWSI and 27 sites for MWCI. Each sample site had a minimum of 30 respondents. The sample sites are the proposed areas where improvement of the sanitation and sewerage systems under MSSP and MTSP will be undertaken. A map showing the location of the sample sites is shown in **Figure 6.1**.

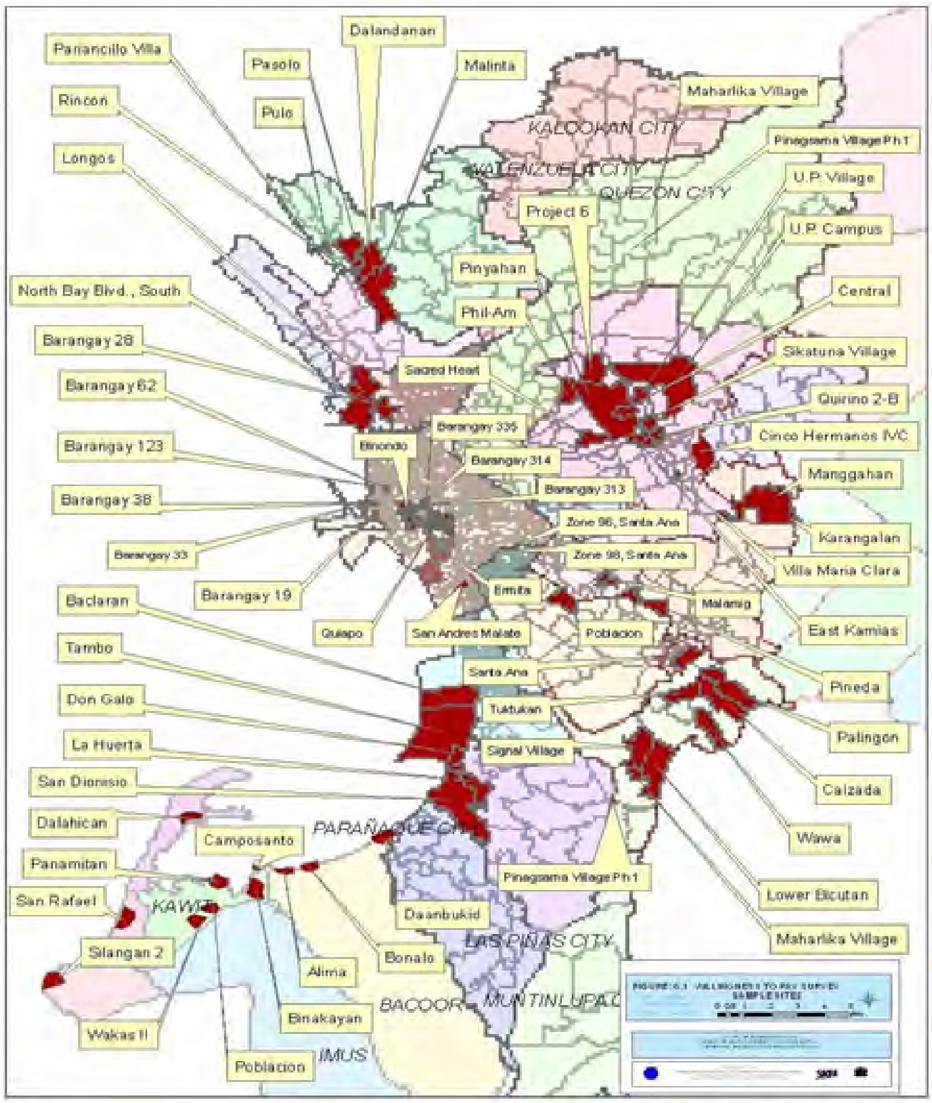

Figure 6.1 Willingness-to-Pay Survey Sample Sites

The respondents were placed in three categories based on the location and standard of housing.

Blighted/Low Income Area – temporary structures, squatter's area and similar (50% of respondents)

Middle Income – semi-permanent/permanent structures/low cost housing, renting apartments/small houses/cheap cars (30% of respondents)

Upper Income – living in better/classy subdivisions, big houses, high fences and have more than one car (20% of respondents)

The actual selection of respondents on site was randomized, either by block or by streets.

The majority of respondents were female (66%) and above 35 years of age (78%) with 40% having either graduated or spent some years in college and another 40% having some secondary education. There was a wide range of occupations of household heads, but overall 70% were self-employed, and 15% were employed. The majority of the respondents owned their houses (70%)

A summary of the household income and expenditure for the three household groups is shown in **Table 6.1**.

Table 6.1 – Total Income, Total Expense and Net Income in PhP (Monthly)

HH Type		Total Income	Total Expenses	Net Income
Blighted/Low Income	No. of Respondents Mean	954 10,007	954 7,566	931 2,470
Middle Income	No. of Respondents Mean	568 20,613	606 13,015	560 7,690
Upper Income	No. of Respondents Mean	343 51,429	386 21,054	338 31,148
Total	**No. of Respondents** **Mean**	**1865** **20,855**	**1971** **11,883**	**1829** **9,368**

During the interview, respondents were presented with three sewerage/sanitation options as follows:

Option 1: Toilet connected with sewerage system discharging to a wastewater treatment plant (separate system).

Option 2: Toilet connected to septic tank discharging effluent to a storm drain leading into a wastewater treatment plant (combined system utilizing existing drains).

Option 3: Toilet discharging to septic tank that is cleaned out frequently as required, but no piped sewerage system (sanitation only).

The respondents' choice was:

Option 1 – 54%
Option 2 – 29%
Option 3 – 16%

Respondents without toilets were also given the option of choosing to use a public toilet. Fifty-seven per cent (57%) of respondents without toilets chose to use a public toilet, while 33% opted for a separate sewerage system. The breakdown of respondents selecting each option and their respective willingness-to-pay is shown in **Figures 6.2** and **6.3**.

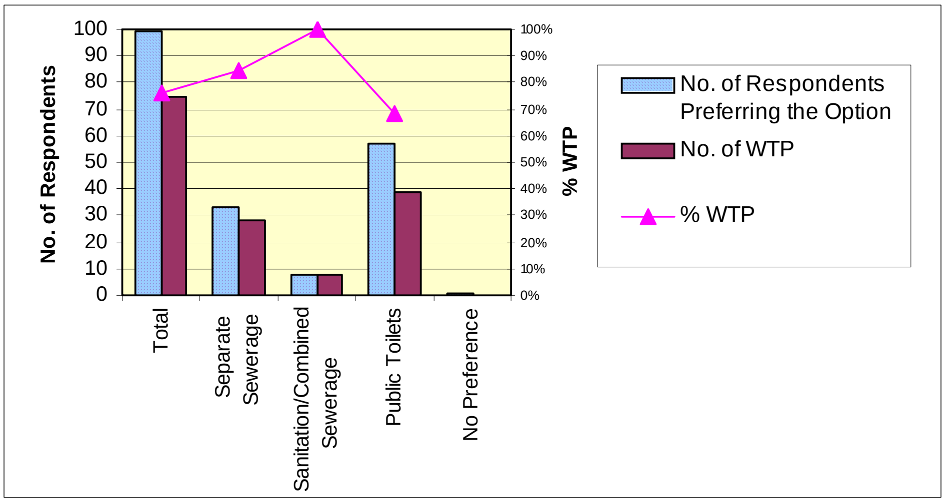

Figure 6.2 Preferred Service-HH without Toilets

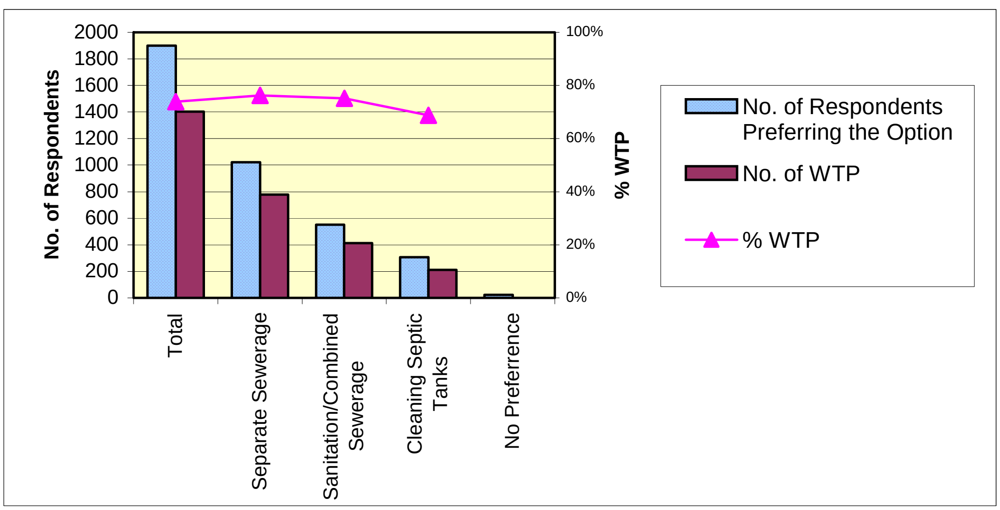

Figure 6.3 Preferred Service-HH with Toilets

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6.10.2.3 Sewerage (Separate System)

A total of 215 respondents reported that they were currently connected to a sewerage system.

More than 50% of respondents preferred a separate sewerage system where waste from toilets is to be discharged directly to a sewer that is separate from the stormwater and to be treated prior to discharge to the major rivers, streams or Manila Bay.

Seventy-six percent (76%) of those who chose separate sewerage system were willing to pay for services associated with this option (see **Figure 6.3**). Sixty eight percent (68%) of those willing to pay were prepared to pay 20-40% of their water bill for the service, with most willing to pay around 20%. Most of those unwilling to pay believed that MWSS should bear the entire cost, others believed the cost was too high or they did not believe MWSS can make any improvements.

Of those willing to pay, 40% would pay whatever charge is imposed for a sewer connections, 18 % did not know while most of the remainder were willing to pay up to P500 for connection. Sixty percent (60%) of respondents wanted payments for connections to be incorporated into their water bill.

6.10.2.4 Sanitation

Current Situation

Ninety-five percent (95%) of the respondents have toilets of their own, while the remaining either use communal toilets or share with others. Fifty-three percent (53%) of those who have toilets have the flush type connected to a septic tank while 34% of households use a pour flush toilet. While 80% of the upper income group has flush toilets connected to a septic tank, only 38% of the low-income groups have this facility; the majority uses the pour flush latrine. The type of toilets owned and used is highly dependent upon income groups as shown in **Chapter 7**, **Figure 7.2**.

Of the five percent (5%) of households that do not own a toilet, 60% claim to have no space for installation. Those without a toilet usually go to a public toilet (27%) use the neighbor or landlord's toilet (29%) or wrap and throw (27%). Only 6% of those without toilets pay for the use of public toilet facilities. Seventy-nine percent (79%) of those who do not have toilets expressed a desire to own a toilet and 60% expressed a willingness to spend for a private toilet.

Ninety-two percent (92%) of respondents place a very significant value on toilets for their health. Eighty six percent (86%) were aware where their waste/toilet water goes with 52% saying it goes from the septic tank to the drains and 10% saying it goes into a sewerage system either directly or via a septic tank. Eight percent (8%) believed it went directly to an open canal/creek/river and 11% were unsure to where the septic tank was connected.

Of those using septic tanks, 62% reported that these had never been emptied and 56% stated that their septic tank has a manhole for pumping sludge. The most common

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practice of emptying septic tanks is once every five years, although some were more frequent.

Willingness to Pay for Connecting Septic Tanks to the existing drainage system with treatment prior to entering major water courses (Combined System)

Of the 29 % of respondents who preferred to connect their septic tanks to the existing drainage system with provision for treatment prior to entering the major water courses (Option 2), 75% were willing to pay the costs incurred (see **Figure 6.3**). There was no significant difference in the response of the various household types. Eighty-eight percent (88%) of the respondents were willing to pay in the range of 20-40% of their water bill for the services, although most responses were close to 20%. The majority of respondents from all geographical locations, except Malabon and Navotas, registered a positive response regarding payment. Those unwilling to pay believed that MWSS should bear the entire cost, some stated they could not afford to pay and some believed that MWSS could not make the necessary improvements.

Willingness to Pay for Frequent Emptying of Septic Tanks

Frequent emptying of septic tanks (Option 3) was the choice of 16 % of the respondents with toilet facilities. It was presented to respondents as the least costly among the three options. Respondents were not aware that the environmental fee that they are paying monthly entitles them to a septic tank cleaning service; rather they are aware of a fee of P800 being charged for this service. Concessionaire schedules for desludging of septic tanks, which is covered by the environmental fee, were unknown to the respondents.

Sixty-nine percent (69%) of the respondents who chose this option were willing to pay for regular septic tank emptying (see **Figure 6.3**) and 85% of these are willing to pay between 20% and 40% of their water bill for such a service (although most of these were willing to pay close to 20%). Respondents in Sta. Ana, Caloocan, Malabon and Tondo were the most likely to be unwilling to pay (although the sample was small). Reasons for unwillingness to pay were that MWSS should bear the entire cost, they cannot afford to pay and they have a lack of belief that MWSS could improve the system.

6.10.2.5 Public Toilets

Sixty-eight percent (68%) of respondents without toilets who preferred to use a public toilet were willing to pay for the use of such a facility. The amount that respondents are willing to pay ranged between PhP 1-20 per visit. Thirty-five percent (35%) expressed the view that PhP 2.00 would be appropriate, while 14% would pay PhP 1.00 or less. Concerns about the use of a public toilet related to hygiene and sanitation as well as privacy and convenience. Most respondents experienced the need to clean and maintain public toilets and made suggestions such as the need to clean every day, prepare a schedule for cleaning, develop joint responsibilities for cleaning, providing a payment for a cleaner, the need to have water for the operation of the toilets and the need for users to contribute for the cleaning of toilets.

Fifty-seven percent (57%) of respondents suggested that the LGUs should be responsible for installing the public toilets, 15% suggested a role for the community, while some respondents considered private contractors could be used. Sixty-one percent (61%) of respondents considered that the government should shoulder the expenses related to the construction of the public toilets. Eighty-two percent (82%) of respondents indicated their willingness to cooperate in the conduct of a fund raising activity to finance the construction of a public toilet and 75% believed that the public toilet should include amenities for washing and bathing activities.

6.10.2.6 Environmental Awareness

A total of 215 of the 2000 respondents were connected to a sewerage system. However, almost of the 2000 respondents made an assessment of their perceived system of wastewater disposal. Opinions ranged from poor to very poor (35%); average (35%) and good to very good (29%). A large majority indicated the need to improve their wastewater disposal system, specifically the need to construct and expand canals and drains and clean clogged drains/pipes.

While most of the respondents (71%) were not familiar with the concept of a wastewater treatment plant, after explanation of the concept, 91% favored such an installation in their area. The remaining 9% believed that there were already suitable facilities that just needed improved operation and maintenance, that it was not affordable or that the government cannot satisfactorily operate such a facility. Most respondents (69%) believed that the government should shoulder the expenses for improvements in the sewerage system. Only 5% believed consumers should pay for improvement of services. However, 91% of respondents expressed willingness to cooperate if their barangay sponsors activities that will raise funds for system improvements. The local government was identified by 65% of the respondents as the most suitable organization to be responsible for O&M of a wastewater treatment facility. Only 2% saw this as a responsibility of NGOs or the private sector.

6.10.2.7 Implications of Findings of Willingness-to-Pay survey

A significant number of respondents (74% of 2000) were willing to pay for different options of sewerage and sanitation services as shown in **Table 6.2**.

Table 6.2 – Willingness-to-Pay for Preferred Service

Service	HH With Toilets	HH Without Toilets	Total
Separate sewerage system with treatment	779	28	807 (40.4%)
Septic tanks discharging to drains with treatment	414	8	422 (21.1%)
Frequent cleaning of septic tanks	211	N.A	211 (10.6%)
Public Toilets	N.A	39	39 (2.0%)
Total Willing to Pay	1,404	75	1,479 (74.1%)
Unwilling to Pay	497	24	521 (25.9%)
Total	1901	99	2,000

This situation may be attributed to the following key factors:

- The significant value accorded by respondents on the importance of sewerage and sanitation for them to sustain health and cleanliness; and
- The respondents' recognition of the need to improve the sanitation and sewerage systems for them to sustain health and cleanliness.

The respondents, however, while being willing to pay for the service, consider that the improvement costs should be shouldered by the government as part of its responsibility. Very few saw a role for the private sector in the delivery of sewerage and sanitation services.

Respondents who were willing to pay considered that a payment equivalent to 20% of their water bill was reasonable for the provision of sewerage and sanitation services. This value was constant across all income classes. Based on the 75% of respondent who was willing to pay 20% of their water tariff for sewerage/sanitation, it can be projected that all respondents would pay an average of 15% of the water bill.

Table 6.3 shows the percentage of income that each of the income categories is willing to pay for water and sewerage, based on the stated mean incomes and current water bills. This shows that the low income groups willingness to pay is very close to the accepted value of 5% of income, whereas the upper and to a lesser extent, the middle income have a greater capacity to pay than their stated willingness.

Table 6.3 – Capacity to Pay for Income Groups

	Low Income	Middle Income	Upper Income
Mean Monthly Income	PhP 10,007	PhP 20,613	PhP 51,429
Av. Monthly Water Bill	PhP 423	PhP 723	PhP 1,031
Willing to Pay for Sewerage/Sanitation	15% of water bill (PhP 63)	15% of water bill (P108)	15% of water bill (PhP 154)
Total Monthly Water Bill	PhP 486	PhP 818	PhP 1,185
% of Income	4.8	4.0	2.3

As a lesson learned from the implementation of the past MWSS/MWSI/MWCI sewerage projects, it is difficult to convince people to connect and pay for the corresponding additional sewer charges. The 50 % increase in water tariff upon connecting to the sewer is a definite disincentive. The advantages and benefits of the sewerage and sanitation projects are not immediately felt and seen.

6.10.3 Affordability of Sewerage and Sanitation

Cost of Sewerage System

The capital cost of a conventional gravity sewerage system and treatment is substantial as has been shown by previous master plans. The cost includes the trunk mains and the sewerage reticulation, lift stations, sewage treatment plants, land acquisition and land development costs and house connections. It is therefore important to identify more affordable approaches.

The early stage of the system as conceptualized by MTSP is a combination of separate sewer systems and combined drainage with interceptors. Essentially, the combined drainage includes interceptors, pump station(s), sewage/ septage treatment plant(s), and land. The sanitation system would retain the individual or community septic tanks to serve as the primary treatment and would use the existing storm drainage pipes to convey the wastewater to the interceptors. The reduction of the capital investment is the non-installation of the laterals and the house connections. However, there may be a need for street drainage improvements.

Cost of Sanitation

The cost of sludge management and disposal will require initial capital investment for fleets of vacuum tankers to collect septage from septic tanks and waste sludge from small STPs. Trucks would also be needed to haul the final product to the final reuse/disposal site(s).

The estimated costs of the vacuum tankers (NJS 2005) are:

Capacity (m^3)	PhP Million
3	4.0
5	5.28
10	6.6

The cost of hauling dewatered sludge to lahar areas in Pampanga is placed at PhP 123 per m^3 (NJS 2005).

There are many alternatives for sludge reuse/disposal. It may be reasonable to first establish the final reuse/disposal options before considering the treatment processes needed. Costs would vary depending on the final disposal option chosen and the method of treatment selected, if any. The septage may be treated in septage treatment plants using the stages of preliminary processing, thickening, blending-storage, stabilization, dewatering-drying and disposal. Depending on the method of disposal, land may be an additional investment cost if the sludge will be disposed in landfill sites. The more economical and sustainable use of sludge is to reuse it for application to agricultural areas or to lahar areas.

Cost of Sewage Treatment

The operation and maintenance of central sewage treatment plants is substantial. Costs include power, chemicals, maintenance of trucks and equipment, fuel, waste solids management, and personnel. The cost of power, oil and lubrication, and chemicals are also sensitive to foreign exchange fluctuations. The more mechanized the technology, the higher would the operation and maintenance cost.

With decentralized STPs, the most suitable STP technology can be selected for each of the catchments considering constraints on land availability and local conditions. For catchments where land is available and inexpensive, the less or non-mechanized options maybe selected, such as waste stabilization ponds, which would reduce the operation and maintenance cost.

In general, the long-term cost of repair, maintenance and operation of many STPs is likely more expensive than one centralized STP. In addition, each STP would have to be managed and operated by a manager and support staff.

6.11 Technology Constraints

6.11.1 Inadequacy of Existing Facilities

As of 1996, about 12% (in terms of land area) of Metro Manila was sewered (SKM 2003). This includes the Manila Central Sewerage System wherein the raw sewage is discharged into Manila Bay through an outfall. The other systems are treated by the Ayala Wastewater Treatment Plant at Magallanes, Dagat-Dagatan treatment plant and by communal septic tanks-Imhoff tanks in Quezon City. Since 1996, privately owned separate sewerage systems have been developed in Global City (Ft. Bonifacio) in Taguig, Filinvest Corporate City in Alabang, Smokey Mountain in Tondo, and in the various malls all over Metro Manila. By now, an estimated 15% of the land area of Metro Manila is sewered.

According to the NSO 2000 Census of Population and Housing, about 85% of the households have septic tanks but maintenance is inadequate. For Rizal and Cavite provinces, about 79% and 84%, respectively, have water-sealed sanitary toilets. In most cases, the septic tank effluent is discharged directly into the storm drainage system or even to open canals and creeks. Most, if not all, of the depressed and low income areas do not have access to basic sanitation facilities.

Presently, there is only one septage treatment plant (SpTP) in Metro Manila, a new one in Dagat-Dagatan located on the West Zone, which became operational in March 2005. It has a design capacity to dewater approximately 200 kL of sludge in an ordinary working day (one 8-hr shift, double for a 16-hr shift). The plant is scheduled to treat septage from 10,000 septic tanks over the course of a year.

There are three SpTPs being tendered in year 2005 for the East Zone. In addition, there are new sewage treatment plants (STPs) that were constructed for subdivisions in Cainta, Pasig and Quezon City and for communities like the Guadalupe Bliss Housing on the East Zone.

The sanitation component of the Pasig River Rehabilitation Project (PRRP), which will be implemented by MWSS and MWCI, will involve provision of septic tank maintenance services through the procurement of 36 vacuum tankers and the construction of a 600 m^3/day septage treatment plant in Antipolo. With this project, approximately 37,000 septic tanks will be emptied annually.

The current fleet of vacuum tankers is inadequate for pumping out substantial number of septic tanks. Presently, MWCI is providing sanitation services by desludging septic tanks

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in the East Concession Area, complementing a number of private desludging companies. MWCI has a fleet of one 5 m^3 and fourteen 10 m^3 vacuum trucks. One-half was delivered in 2001 and the other half in 2004. Through an ADB loan, MWCI is increasing its fleet by six 5-m^3 and thirty 10-m^3 trucks that will be delivered in years 2006 and 2007. Also under a WB Loan, additional 70 units of vacuum tankers will be procured and expected to be delivered in 2008.

For MWSI, there are 32 vehicles available with breakdown as follows: 7 dewatering units, 19 No.10-m^3 vacuum trucks, and 6 No. 4-m^3 vacuum trucks.

6.11.2 Limited Information

The LGUs have limited information on available low cost sewerage and sanitation technologies (CDM 1994). There is a need to disseminate information on the applicability of and proper design criteria of low cost technologies.

6.12 Management of Flow / Pollution Load

Focus on stormwater infiltration is one of the primary concerns for a separate sewerage system. In combined drainage, the stormwater and sewage flow mixes in a single conduit like a storm drain or pipe. This can lead to the overloading of the transport conduit as well as hydraulic difficulties at any intercepting facility like an STP. Flow oscillations occur seasonally and can dictate the use of equalization facilities to even out flows. The use of designed bypasses and overflows can eliminate the need for equalization but increases environmental pollution as well as the risk of greater contact with the diluted sewage.

6.13 Management / Recycle / Disposal of Residuals

Management of residual is currently not much of a problem as there are few biological solid residuals (sludges) generated by the present treatment plants. However, as the number of SpTPs and STPs increase in the future, management and reuse of biological solids will become an important issue.

In 2004, the consultant GHD prepared a Bio-solids Management Strategy Study for MWCI. Disposal of septage and sludge via application (septage of 80 to 120 m^3/ha/yr) to the lahar (volcanic ash and soil) areas in parts of Pampanga and Tarlac in Central Luzon has been shown to be beneficial (National Engineering Centre, 1998). Application of septage and sludge to lahar areas is unique and new to the Philippines and guidelines are required to regulate their application.

The removal of the sludges can be either by truck or by barge, depending on where the STPs are to be located. When evacuated by trucks, there are constraints on land transport within Metro Manila.

The bio-solids can be handled by thickening, dewatering and stabilization. Generally, the management of the sludges and bio-solids will require sizeable land areas, which is a major constraint in Metro Manila. For example, the proposed Eastern Concession 600

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m^3/d SpTP in Antipolo is expected to generate about 38 m^3/d to 90 m^3/d of sludge depending on the type of solids stabilization used (SKM 2003). Preferably, the location should be far from any human settlement. Other environmental issues have to be addressed like preventing groundwater pollution and soil contamination. If mechanical methods are to be employed, there would be more expensive capital investment and a corresponding increase in power consumption.

6.14 Planning Constraints

6.14.1 Low Priority Given to Sewerage

The National Government has high interest in protecting urban health and the environment. However, due to the magnitude of the capital investment for sewerage projects, it cannot afford to pay for any major part of the cost for such projects on a wide-ranging basis. More so for the LGUs, who do not have the financial resources to build a sewerage system. Basically, for this reason, the sewerage projects are given low priority.

MWSS implemented the first Rate Rebasing under the Concession Agreement in 2003. In the Rate Rebasing, MWCI reduced its sewerage targets and increased its sanitation targets. MWSS agreed that the combined sewers can be utilized as a means of achieving the sewerage targets, whereas prior to 2003, only separate sewers with direct connections were allowed. MWSI, on the other hand, deferred sewerage investment due to their financial difficulties.

6.14.2 Need to Optimize Funds

There may be cities or municipalities that have some interest and some capability to participate in sewerage and sanitation programs. If funds are available from the National Government, the local government can pool its resources with the National Government and identify priority areas within its jurisdiction in order to pursue such projects.

6.14.3 Lack of Public Awareness for Sewerage/Sanitation Facilities

There is a lack of public awareness of the need for sanitation facilities. Thus, the general public may not be conscious of its importance to public health and environmental well being (CDM 1994).

6.15 Concessionaire Planning

The MSSP was passed on to the concessionaires after privatization. MWCI and MWSI have completed and also have on-going projects under the MSSP as discussed in **Chapter 5**. In order to improve and expand the sewerage and sanitation projects developed in MSSP, the Manila Third Sewerage Project (MTSP) was conceptualized by both MWSS and MWCI for the East Zone concession area. The current MTSP was developed to comply with the 2003 Rate Rebasing targets for sewerage and sanitation, in particular with the service targets of 2010 of MWCI.

Since there are two independent concessionaires, there was a need to develop an overall strategy for the whole MWSS service area. Some of the catchments are currently divided between the East and West Zones. Also, some municipalities/cities have areas both in the East and West Zones. With the different plans of the East and West Zones, there is a need to consider and incorporate these plans in order to develop a sanitation and sewerage master plan for the whole MWSS service area. However, the plans of the Concessionaires impose their own constraints for master planning as detailed below.

The 2003 Rate Rebasing converted many of the sewerage targets for MWCI into increased sanitation targets. MWSI sewerage targets remained as per the 1997 Concession Agreement but were moved forward by five years, starting in 2006. No change was made to the MWSI sanitation targets to compensate for the delays in sewerage coverage.

MWCI

The meeting by MWCI of their 2003 Rate Rebasing targets for sanitation and sewerage is mostly tied to implementation of the MTSP. Achieving contractual targets does not necessary promote those design options that provide the lowest cost sewerage per unit area. Lower costs are often achieved by approaching the design from a wider drainage catchment perspective. Drainage catchments often cross municipal boundaries and can also cross concession zones.

The below excerpt from *Strategic Action Paper 11* of this study illustrates that small STPs and catchments are only implemented at considerably higher per capita costs, particularly if little or no space is available (see the underground Riverbank STPs - Poblacion STPs with a catchment of 30 ha; Ilaya STP with a catchment of 49 ha; Capitolyo STP with a catchment of 100 ha).

The Riverbank STPs may meet 2003 Rate Rebasing contractual targets, but in a short time (i.e. fifteen years or just beyond the concession period) these plants will be beyond their economic service life. The STPs will have to be decommissioned in favor of an interceptor leading to a larger STP. Sites for this larger STP will likely be more scarce than present due to increasing population pressures.

Much of the analyses in this 2005 Master Plan concurred with what was done in the 2004 NJS Master Plan for the East Concession. Combined drainage was selected as the least cost / preferred option in both studies. This study proposes to use combined drainage (i.e. the use of the storm drains) where it is appropriate but proposes to decommission those systems on a “greatest human risk” basis when the financial ability is available to do so.

SKM

Table 6.4 – Comparison of Dirty Water Treatment Technologies[1]

Dirty Water Treatment System	Dirty Water Flow Range	Dirty Water Flow BOD	Estimated Const.Cost[1] per kg BOD Rem. per Year		Estimated Annual O&M Cost[1] per kg BOD Rem	
	(MLD)	(kg/d)	($US)	(PhP)	($US)	(PhP)
Sequencing Batch Reactors						
Foess (2003)	0.4	102	$18.71	P1,029	$3.23	177.65
MTSP: Poblacion Riverbank STP[2]	1.5	142	$14.01	P771	$1.06	58.46
MTSP: Ilaya Riverbank STP[2]	2.3	266	$7.10	P391	$0.87	47.84
MTSP: Capitolyo Riverbank STP[2]	3.9	693	$3.17	P175	$0.56	30.67
MTSP: Taguig Low Income Scheme[2]	6.1	1,775	$2.81	P155	$0.36	19.55
Cost Estimate 2005 MP Study	10.0	3,000	$6.82	P375	$0.56	30.93
MTSP: Quezon City – Marikina sewerage system[2]	10.4	3,120	$5.73	P174	$0.29	15.97
Bradford, California[3]	27.0	3,436	$5.73	P267	$1.03	56.65
MTSP: Alternative Option of Stand-along SBRs for Treating Pollution from Hagonoy, Taguig, Labasan and Tapayan Rivers into Laguna Lake (alternative to conjunctive use of flood ponds); for 2025 flows[4]	151.9	34,411	$2.56	P141	$0.38	21.12

The use of the low-cost methodologies for sewerage adopted in this study (i.e. combined drainage and STED systems) requires a strong sanitation program to keep the existing septic tanks in working order. New septage treatment plants and truck fleets are proposed to meet this demand. Moreover, new sewage treatment facilities should be capable of treating not only sewage but also septage. There are too many septic tanks to decommission in favor of pure gravity sewerage. The approach is pragmatic and economically sound.

MWSI

The effect of moving sewerage targets five years forward without moving sanitation done in (2003 Rate Rebasing) will adversely affect the management of pollution as illustrated by the examples in **Figures 6.4**, **6.5,** and **6.6** for the municipalities of Pasay, Quezon and Caloocan, respectively.

The total sanitation and sewerage coverage for Caloocan City in the original concession agreement by 2021 was 100%. The 2003 Rate Rebasing reduced this 2021 total to 53% or a decrease of 47% (**Figure 6.4**).

[1] 1 All costs have been escalated to 2005.
2 NJS et al (2004)
3 http://www.town.bradfordwestgwillimbury.on.ca/articles/MasterServicingStudy
4 MTSP Feasibility Study by NJS et al (2004); flow represents a population of 732,411; assumes 80% H20 use, 7.3 m3/ha/d infiltration, 47g BOD/p/d by 2025.

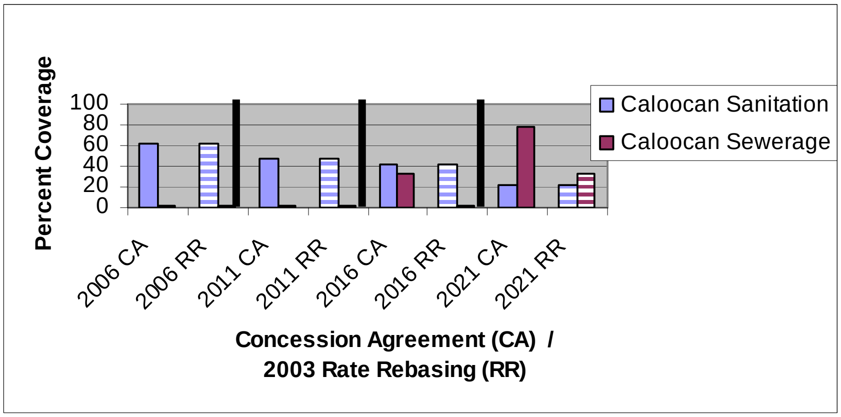


Figure 6.4 Sewerage and Sanitation Targets for Caloocan

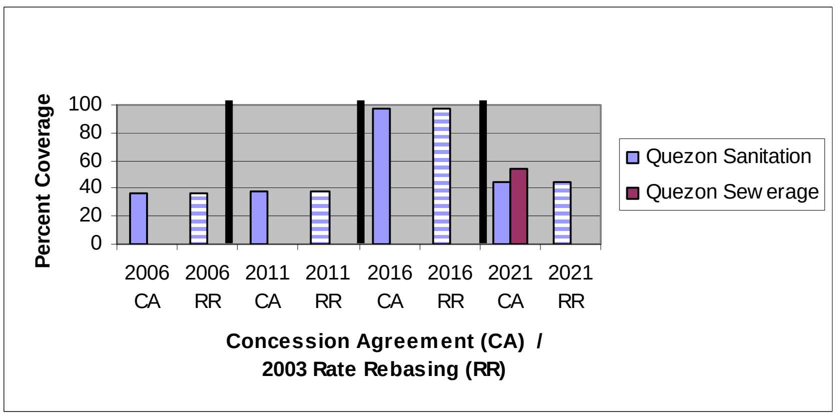


Figure 6.5 Sewerage and Sanitation Targets for Quezon

This coverage is worse for that portion of Quezon City in the West. The total sanitation and sewerage coverage in the original concession agreement by 2021 was 99%. The 2003 Rate Rebasing reduced the 2021 total to 45%. By 2021 there will be no sewerage coverage, yet reduced sanitation coverage from 2016 to 2021 of 54% (**Figure 6.5**).

Another example is the case of Pasay City. The total sanitation and sewerage coverage in the original concession agreement by 2021 was 95% sewerage. The 2003 Rate Rebasing reduced this by 2021 to 16% sewerage; at the same time, sanitation coverage disappears entirely from 2016 to 2021 (**Figure 6.6**).

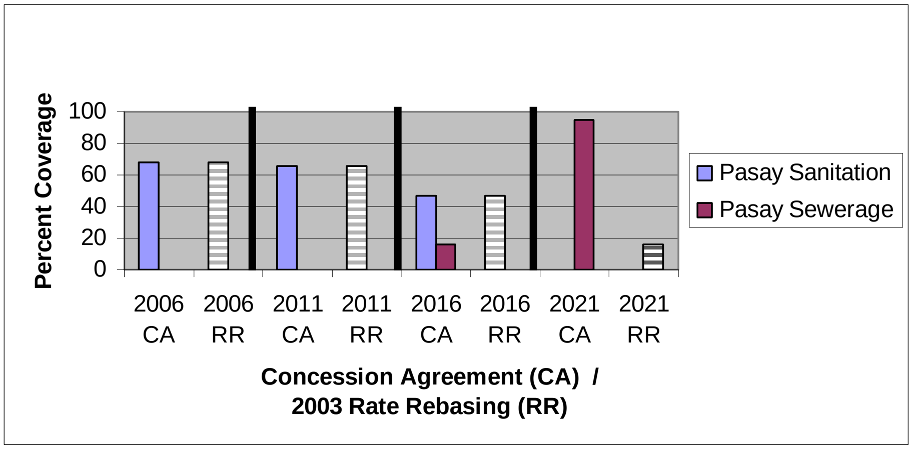


Figure 6.6 Sewerage and Sanitation Targets for Pasay

Sanitation and sewerage were taken as inseparable in the original 1997 CA but considered separately in the 2003 Rate Rebasing. As a result some areas were greatly disadvantaged.

SKM

7. Review of Relevant Technical Options

7.1 Dirty Water Characteristics

Over the course of a year, each person can produce some 400 to 500 litres of urine (containing 4 kg of N and 0.9 of P and 0.4 kg K (Jönsson 1997) and 50 litres of faeces. If waste management is via the common flush toilet, 15,000 litres of potable water is used per person each year for conveyance of this waste. Greywater or sullage, the aqueous discharge from the bath, kitchen and laundry, accounts for another 15,000 to 30,000 litres for each person every year (Esrey et al. 1998). Stormwater and industrial discharges also add to this volume of dirty water. Urine is usually sterile and contains from 50 to 90% of the nitrogen, phosphorus and potassium of human waste (Ciba Giegy 1977).

7.1.1 Sewage

The recent Master Plan Update for the East Zone used the BOD per capita load presented in Chapter 8, **Table 8.6** BOD loads and sewage volume calculations are also presented in Chapter 8.

For the sake of this analysis for evaluating and comparing dirty water treatment technologies, the characteristics below were assumed for domestic dirty water:

- $BOD_{influent}$ = 300 mg/L
- $BOD_{influent}$/EP = 40 g/EP/d
- Flow Peaking Factor = 1.5
- $(COD/BOD)_{influent}$ = 1.8
- Total Solids $(TS)_{influent}$ = 300 mg/L
- Effluent Standard = DENR Class C

7.1.2 Septage

Septage is that wastewater and solids that results when conventional septic tanks are de-sludged and cleaned. Septage contains grit, plastics, rags, hair, grease, scum and other solid wastes. It is highly malodorous due to the anaerobic conditions and the presence of hydrogen sulfide.

Septage may contain over thirty (30) times the BOD concentration of domestic wastewater, 70 times the amount of solids and 80 times the amount of grease. The COD to BOD ratio in domestic wastewater typically ranges from about 1.8 to 2.2. Septage has a COD to BOD ratio of 4 to 9, indicating the presence of a significant non-biodegradable/inorganic component (SKM, 2003).

Mean concentrations values were reported in the 2003 Feasibility Study for the Antipolo Septage Treatment Plant and are in **Table 7.1**. Additional data reported for Metro Manila septage characterisation can be seen in **Tables 7.2 to 7.4**.

SKM

Table 7.1 - Average Chemical and Physical Properties of Septage (SKM, 2003)

Parameter	USEPA Mean	MM 1994 Data*	USEPA Design Concentration	Parameter	USEPA Mean	MM 1994 Data*	USEPA Design Concentration
(mg/L)				(wt %)			
BOD5	5,000	4,338	7,000	**pH**	6.9 units		6.0
COD	42,850	23,250	15,000	**LAS**	157 mg/L		150
TKN	677		700	**TS**	3.9		4.0
NH3-N	157		150	**TVS**	2.5		2.5
TP	253		250	**TSS**	1.3	5.3	1.5
Grease	9,090		8,000	**TVSS**	0.9		1.0
				TVS/TSS	0.65	0.56 to 0.60	0.63

*Data taken from Design Report of Dagat-Dagatan Septage Treatment Plan, Dec 1994. (as reported by SKM in 2003)

Table 7.2 - Additional Data on Metro Manila Septage (as reported in SKM, 2003)

		No Tests	Low	Mean	High	No Tests	Low	Mean	High
pH	units	13	6.9	7.0	7.5	12	6.7	7.0	7.8
BOD	mg/L	13	198	5,532	22,000				
COD	mg/L	13	845	12,807	55,200				
TS	mg/L	6	1,165	31,376	152,828	13	1,512	37,419	312,747
TVS	mg/L	5	764	19,245	82,742	13	860	24,608	210,166
			0.66	0.61	0.54				
TSS	mg/L	13	328	26,517	112,000				
TVSS	mg/L	13	98	11,965	54,328				
TDS	mg/L	12	188	7,030	72,288				
Settleable Matter	mL/L	1	750	750	750				
NH3-N	mg/L	14	44	209	725	1	134	134	134
TP	mg/L	14	4.3	12.8	29.5	1	4.6	4.6	4.6
S(2-)	mg/L	12	4.0	29.8	80.1				
O&G	mg/L	9	200	1,493	5,640				
Fe	mg/L	2	1,130	1,160	1,190				
Cu	mg/L	2	13	29	45				
Zn	mg/L	2	196	218	240				
Ni	mg/L	2	2.2	3.1	3.9				
Mn	mg/L	2	10	15	20				
Cd	mg/L	9	0.002	0.257	0.851				
Ag	mg/L	2	0.080	0.100	0.120				
Hg	mg/L	9	0.000	0.004	0.028				
Pb	mg/L	7	0.014	1.988	8.777				

SKM

Table 7.3 Results of Sampling Septage in Metro Manila (SKM, 2003)

Parameter	Units	No Samples	Montgomery (1991) MEANS from Individual Septic Ranks in Manila	No Samples	PIA (2001) MEANS from Vacuum Trucks in Manila	No Samples	PIA Tests, MINIMUM % Removal, upon 30 min Septage Settling	USEPA Design Values for Septage	PIA (2001) Suggested Design Values for Manila Septage
pH	units	13	7.0	7	7.5		n/a	6	7.5
BOD	mg/L	13	5,532	7	4,641	8	50%	7,000	6,000
COD	mg/L	13	12,807	7	16,005	8	48%	15,000	15,000
COD/BOD	mg/L		2.3	7	2.6		n/a	2.1	2.5
TS	mg/L	6	31,376	7	19,541	1	95%	40,000	40,000
TVS	mg/L	5	19,245	7	11,133	1	91%	25,000	25,000
TVS/TS	mg/L		0.61	7	0.54		n/a	0.63	0.63
TSS	mg/L	13	26,517	7	16,775	2	76%	15,000	20,000
TVSS	mg/L	13	11,965	7	5,301		n/a	10,000	10,000
NH3-N	mg/L	14	209	7	115	7	70%	150	150
TKN	mg/L	n/a	n/a	7	678	7	26%	700	700
TP	mg/L	14	12.8	7	74	7	41%	250	100
O&G	mg/L	9	1,493	7	215	8	57%	9,100	1,500
Settleable Matter	mL/L	1	750	1	800		n/a	n/a	n/a

n/a: not analyzed or not applicable

The SKM 2003 report indicated that septage varies in strength considerably from various septic tank sources. It was also noted from the septage analyses that lower volatile ratio indicates the solids are older in the septic tanks in Metro Manila than what the USEPA had measured as an average. It was also reported that septage from Metro Manila did not contain significant levels of heavy metals that would end up in the dewatered solids **(Table 7.4).**

Table 7.4 - Heavy Metals in Metro Manila Septage (SKM, 2003)

Parameters		Sample	Sample 1 Split	Sample 2	Sample 3	Sample 4	Sample 4 Split	Sample 5	Sample 6	Average
S^2	mg/L									
SO_4^{2-}	mg/L	858	284	900	153	69	21.3	483		395
MBAS	mg/L		36				0.4	7.09		14.6
WholeFe	mg/L							278.25	9.8	278
Cd	mg/L	0.090	0.000	0.090	0.007	0.015	0.000			0.034
Hg	mg/L	0.0350	0.01800	0.0360	0.0050	0.0040	0.0002			0.0164
Pb	mg/L	4.08	0.0008	4.08	0.30	0.70	0.02			1.53
Cr^{6+}	mg/L	0.010	0.000	0.010	0.010	0.010	0.000			0.007
Sn	mg/L	0.500	0.033	0.500	0.500	0.500	0.231			0.377

SKM

7.2 Sanitation

7.2.1 Definitions

Sanitation Facilities are those facilities utilized for the purpose of receiving and disposing of human excreta and urine, located "on-site" within the household and/or residential plot. Examples are pit latrines, pour flush toilets, septic tanks, soakage pits and field absorption systems or leaching fields. Sullage water (kitchen, laundry and bathing wastewater) is sometimes directed to the septic tank with eventual disposal in soakage pits or field absorption systems but in MM mostly in the storm drains. Communal sanitation facilities include public toilets or latrines.

Septage refers to the mixture of scum, sludge (solids) and liquid removed from a domestic septic tank. Septage is characterized by a high BOD_5 and total solids content and has little volatile organic matter compared to sewage sludge.

7.2.2 Types of Sanitation Facilities

Sanitation practices promoted today fall into one of two broad types:

- "Flush-and-discharge" (for example the flush toilet), and
- "Drop-and-store" (for example the pit toilet).

Since the last century, the flush-and-discharge method has been regarded as the ideal management approach, particularly for urban areas. As with other developing countries, the Philippines has endeavoured to emulate this model despite scarce capital, often sourced from development loans. The two concessionaires for Manila have also indirectly tapped development loans to provide sanitation services.

The provision of water to greater numbers of people in Manila, in combination with the preferred use of flush-and-discharge methods of waste disposal, has accelerated environmental degradation and increased the health risk to certain population sectors, mostly those economically disadvantaged.

Globally, some 80 countries, representing 40% of the world's population, are already suffering from water shortages at some time during the year (Union of Concerned Sci, 1992; UNCHA, 1996; UNDP, 1996). This pending water scarcity / shortage will inevitably encourage [where possible] the use of drop-and-store sanitation methods.

Drop and store sanitation
This is the least expensive and simplest type of sanitation and involves sitting and excreting the waste. There are various methods of receiving and storing the waste products. Examples include:

- Dehydration Toilets
- Ventilated Improved Pit Latrine
- Composting Toilet

- Sanitation Privy
- Aqua Privy
- Pail System/Vault Toilet

Flush and discharge sanitation
This sanitation method is the most common in Metro Manila and includes:

- Traditional Septic Tank;
- Septic Tank/Anaerobic Filter; and
- Multi-baffled Septic Tank.

7.2.3 Evaluation of Sanitation Options

An evaluation of the various types of sanitation facilities was undertaken by using a multi-criteria analysis (MCA). In the MCA approach, relevant constraints were "*weighted*" to reflect their importance when considering a particular group of options. Weightings changed from one group of options to another, depending on their perceived importance. The total weighting for any group would sum to 100%.

Each option within a group was then judged against its rivals, and a "*judgment ranking*" (on a scale of 0 to 10) assigned. Judgment rankings multiplied by the weightings for each constraint resulted in a score for each option within a group. The highest score identified the preferred option(s) within a particular group. Changing the weightings has the greatest effect on the MCA outcome. The preferred option in any one group may not be universally applicable around all of MM. In this case, the top two (2) or three (3) options were taken as "preferred".

The MCA for sanitation, both Drop-and-Store and Flush-and-Discharge methods described above are shown in **Tables 7.5** and **Table 7.6**, respectively. A more thorough description of the weightings and judgement criteria selected can be found in *Strategic Action Paper 11 – Least Cost Technical Options for Sewerage and Sanitation Approaches*).

SKM

Table 7.5 - Multi-criteria Analysis of Drop-and-Store Sanitation

SANTIATION: DROP & STORE		Selected Weighting	Judgement Ranking					
No.	Multi-criteria Analysis of Constraints	(x / 100)	Dehydration Toilets (1 to 10)	Ventilated Pit Latrine (1 to 10)	Composting Toilet (1 to 10)	Pit Privy (1 to 10)	Aqua Privy (1 to 10)	Pail System/Vault Toilet (1 to 10)
1	Cultural Acceptability in MM	10	2	2	2	2	8	1
2	Affordability (Capital Requirement)	10	2.4	5	1.1	4	3.3	10
3	Disease Prevention	15	9	6	8	6	4	3
4	Protection of the Environment	10	9	5	8	5	5	3
5	Consistency with MWCI and/or MWSI Plans	10	5	4	5	4	10	10
6	Land Availability	10	9	9	9	9	9	10
7	Traffic Disruption	10	10	10	10	10	10	10
8	System Design & Complexity	10	5	7	5	8	6	10
9	Operations & Maintenance	10	7	9	6	4	9	2
10	Management/Recycle of Residuals	5	10	4	10	4	6	2
	TOTAL WEIGHTING (should be 100):	**100**						
	INDIVIDUAL SCORES (x / 1000 max):		**679**	**620**	**631**	**570**	**693**	**615**
	HIGHEST SCORE:		**Aqua Privy**					

Table 7.6 - Multi-criteria Analysis of Flush and Discharge Sanitation

SANTIATION: FLUSH AND DISCHARGE		Selected Weighting	Judgement Ranking		
No.	Multi-criteria Analysis of Constraints	(x / 100)	Traditional Septic Tank (1 to 10)	Septic Tank / Anaerobic Filter (1 to 10)	Multi-Baffled Septic Tank (1 to 10)
1	Cultural Acceptability in MM	10	10	10	10
2	Affordability (Capital Requirement)	10	10	4.3	8
3	Disease Prevention	15	5	6	6
4	Protection of the Environment	10	5	7.5	7.5
5	Consistency with MWCI and/or MWSI Plans	10	10	10	10
6	Land Availability	10	7	8	5
7	Traffic Disruption	10	10	10	10
8	System Design & Complexity	10	10	8	8
9	Operations & Maintenance	10	7	8	7
10	Management/Recycle of Residuals	5	6	6	6
	TOTAL WEIGHTING (should be 100):	**100**			
	INDIVIDUAL SCORES (x / 1000 max):		**795**	**778**	**770**
	HIGHEST SCORE: Traditional Septic Tank				

SKM

The MCA yielded the Aqua Privy as the most preferred of the Drop and Store methods considered and Traditional [single baffle] Septic Tank as the most preferred of the Flush-and-Discharge Sanitation methods considered. The lower economic cost of the Traditional Septic Tank greatly favours its use over other technologies, in spite of its higher environmental cost.

Selected Sanitation Approach for Metro Manila

- If Drop & Store is to be utilized, the Aqua Privy was the preferred option. This option would mostly be used for low income / informal settlement areas as appropriate.
- Construct public serviced flush and discharge pay toilets in larger informal settlement areas.
- Where septic tanks are to be used in future developments, they should be mostly of a two (2) chamber design (with collection of their overflow for treatment). Areas were land is greatly restricted, a vertical, anaerobic filter design can be employed.
- All septic tanks should be regularly desludged. A network of Septage Treatment Plants (or sewage/septage treatment plants) and truck fleets should be assigned for specific areas.
- A program should be established to address the estimated 30% of "Inaccessible Septic Tanks", which cannot currently be accessed for sludge removal.

7.2.4 Introducing Sanitation Approaches to the Community

The major aim of a sanitation program should be to improve the health and quality of life of the population as a whole, especially the more vulnerable lower-income families. Proper sanitation must form a barrier against the spread of diseases caused by human pathogens in human excreta.

Flush-and-discharge is not particularly efficient at pathogen destruction by itself. Human waste in water mimics an intestinal environment, i.e., rich in nutrients and organic matter, constant temperature (in the Philippines, nearly human temperature) and the absence of light or UV.

In the Philippines, the type of toilet a family uses is often dependent on their income level (**Figure 7.1).**

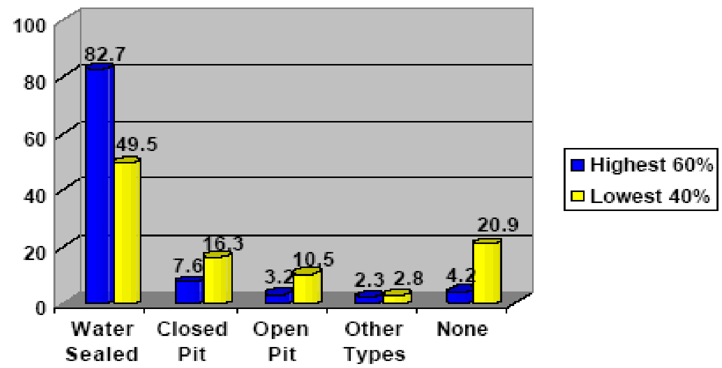


Figure 7.1 Percentages of Philippine Families by Types of Toilets and Income strata in 1998 (Robinson 2003)

The willingness-to-pay survey conducted under this study showed a similar relationship between income and type of facility as shown in **Figure 7.2.** Overall, the survey showed that only 5% do not have toilet facilities, but this corresponds to about 10% of the low income group, an improvement on the 1998 data.

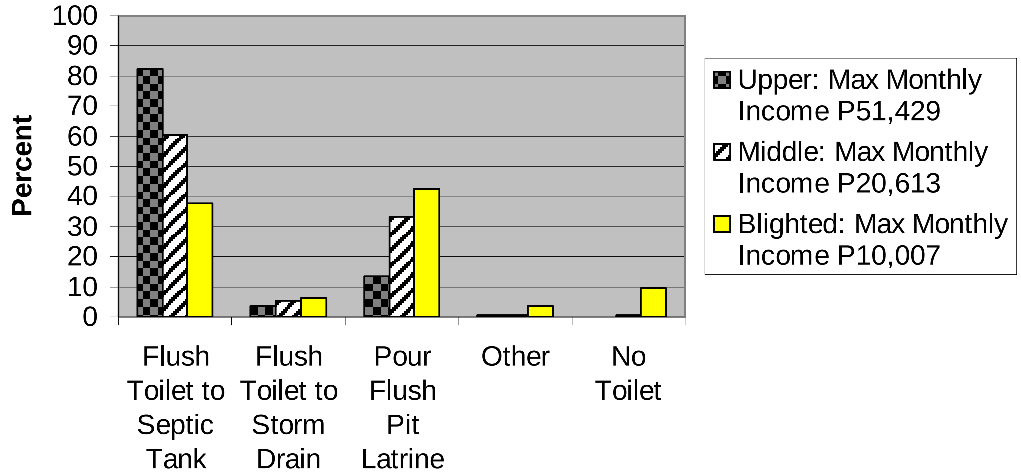


Figure 7.2 Types of Toilets Used in Manila (2005 survey)

Cultural Awareness

Health education activities include person-to-person communication for the purpose of changing individuals' behavior. In conditions where there are no sanitary facilities, door-to-door field work may be required to make people aware of alternatives to the "wrap and throw" practice as well as to introduce possible programs for communal toilets and other sanitation services.

Homeowner's Responsibility

The operations and maintenance requirements for on-site facilities will continue to be the responsibility of the property owners, with additional inspection, regulation, and assistance being provided to improve performance. For latrines and pour flush facilities, owners are currently responsible for cleaning the premises, vector control, periodic redirection of discharge to fresh pits, and removal of cured humus (optional). Owners are also responsible for septic tank maintenance and repair, although they generally need private contractors or public agencies to provide desludging services.

The basic policy of owner responsibility for operations and maintenance of on-site facilities is sound and should be retained by all local government program participants. Operations and maintenance performance can be improved, however, through the use of more aggressive monitoring and control programs. Local governments should be encouraged to employ contract organisations to provide sanitation advisors/inspectors to conduct scheduled periodic inspections, identify needed repairs, assist the owner to determine when to relocate to a new discharge site, and provide advice and assistance to owners on all aspects of operations and maintenance (Philippine Urban Sewerage and Sanitation: National Strategy and Action Plan 1994).

Community Participation and Public Awareness Campaign

Involving consumers in the sanitation program is an essential element of urban sanitation strategy. Community education and participation are intended to counter the perception that the government provides services at no direct expense to the public. This idea has prevailed for many years, and it will require considerable effort to change. One of the best ways to changing public thinking is through community education and participation programs. These are important in informing the public about the benefits of sanitation and are essential to the long term objective of full cost recovery from program beneficiaries.

There is a special need for such coordinated community participation especially in informal settlements. Residents will not use or maintain facilities unless they participate fully in planning and are committed to the program. It is proposed that voluntary organizations sponsor and coordinate the inputs of defined groups of informal settlers for the purpose of developing sanitation services.

7.3 Sewerage

For many centuries sewers have been installed to collect and transfer aqueous human waste away from constant human contact via gravity, either via a pipe or open conduit or drain. Babylonia has been documented by many as one of the first places to mould clay into pipes (via potter's wheel). Tees and angle joints were produced and then baked to make drainage pipes, all as early as 4000 BCE (Schladweiler 2005).

SKM

7.3.1 Gravity Sewerage

The early gravity drainage systems were eventually developed into what today is known as conventional [gravity] sewerage. Large bore pipes are usually buried and the hydraulic design is such that sewage is collected from properties at the their lowest point and conveyed into the main conduit. Intermittent pump stations are used to prevent extreme excavation depths. At each change of direction and at a maximum typical 90 metre spacing, manholes are located to provide access points for maintenance such as for unblocking obstructions and removing tree root intrusions. Property owners have to connect their properties to a junction (boundary riser) and have no responsibility other than to flush dirty water into the sewer and avoid dumping toxic or harmful pollutants.

Sewers can either be devoted to conveying only sewage (a “separate” system) or also include stormwater (a “combined” system). The latter use would require larger pipe diameters and complicated hydraulics at the end of the system. Combined sewerage conveys water from stormwater runoff from house roofs, parking lots, and streets in addition to household dirty water to eventual treatment and/or disposal. Storm drains in MM are used as combined drains. During severe storms, there may be more rainfall than the sewers can handle. Management of combined sewers is via emergency overflows to allow excess water to be discharged into a nearby watercourse.

Traffic disruption and the depth some sewers have to be laid to maintain the correct hydraulic gradients are among the chief disadvantages of a separate gravity sewerage system. Combined sewers, particularly those that employ stormwater drains, also suffer from human health issue disadvantages. The chief advantages for separate sewers are that they are well known and understood and can be long lived if well maintained. The chief advantage of combined sewers is their low cost.

7.3.2 Vacuum Sewerage Systems

Vacuum sewerage does not rely on gravity to transport liquid wastes. In regions difficult to sewer by gravity, the vacuum system has proven a useful alternative. A vacuum sewerage transport system has vacuum valves at each household, a single plant room that supplies vacuum to a central collection tank, and a pumpout system that discharge to the sewer mains or a treatment plant. A valve monitoring system within the plant room monitors the activity of all valves within the vacuum sewerage network.

There are three basic components to any Vacuum Collection System: the valve pit, the vacuum lines, and vacuum collection station.

The sewage enters the lower part of the valve pit fed by gravity from a number of homes, typically 4 to 15. At a pre-determined level, the pneumatic valve in the pit, via a controller, opens for several seconds and its dirty water is sucked into the pipeline or vacuum transport conduit. The vacuum transport conduit is laid in narrow trenches in a series of high and low points and the profile is likened to a saw tooth shape. The saw-tooth profile is designed to ensure that any waste liquid in the pipe will not block the pipe at low flow periods when the liquid may be at rest.

Sewage is moved through the vacuum conduits by these same valve cycles until it reaches the vacuum collection tank, which is maintained under vacuum by a vacuum pump(s). Each vacuum pump typically runs 2 to 3 hours per day (4 to 6 hours total). The pumps do not run continuously since the vacuum interface valves are normally closed and the vacuum gradually decreases from -70 kPa to -50 kPa. The vacuum pumps are sized to increase the system vacuum from 50 - 70 kPa in 3 minutes or less. Typical vacuum pump sizes are 7.5, 12 and 15 kW.

As potential vacuum loss is associated with every lift, the length of each vacuum conduit is often limited to about 3 to 5 km. The laying of lines can include detours to avoid obstacles such as around buildings, trees or rocks. Elevation changes can extend or reduce this range.

When the collection tank is full, a sensor activates a sewage pump. The waste is subsequently pumped to its next destination (e.g. a treatment plant or to the conventional gravity system). The collection station equipment is generally housed in a small building, although several systems have been constructed without a building.

The chief advantages of a vacuum sewerage system are substantial cost savings in difficult terrain and the need for only shallow trenching with minimal traffic disruption. The chief disadvantage of a vacuum system is the lack of experience by water authorities and developers and the overall cost of the system.

7.3.3 Pressure Sewerage System

This system operates through the use of a pump. Pumped lines are smaller diameter than gravity lines and create less traffic disruption when laid in streets or walkways. Two pressure sewer systems that do not require modification to plumbing inside the house include:

- The septic tank effluent pump (STEP) system; and
- The grinder pump (GP).

In STEP systems, dirty water flows into a conventional septic tank to capture solids and the liquid overflow is directed a holding tank, containing a pump and control devices. The effluent is subsequently pumped to another location for treatment. The STEP system would be most applicable to MM due to the large number of septic tanks. In a GP system, household sewage flows to a vault (no septic tank) where a grinder pump grinds the solids and discharges the sewage into a pressurized pipe system.

Pressure sewer systems that connect several residences to a “cluster” pump station can be less expensive than conventional gravity systems. On-property facilities represent a major portion of the capital cost of the entire system and are shared in a cluster arrangement. This can be an economic advantage since on-property components are not required until a house is constructed and are borne by the homeowner.

Pressure sewerage systems have several advantages, including ability to be independent of gravity that eliminates the strict alignment and slope restrictions for conventional gravity sewers, the use of shallow trenching and the fact that several hundred systems are in use in the US, Australia and elsewhere. The chief disadvantages are the need for greater institutional involvement due to the number of mechanical components, the need for involvement of lot owners (each has to purchase and maintain their own pump) and the overall O & M costs.

7.3.4 Simplified Sewerage

These are low-cost sewerage technologies (SC 2005) that have been used in South American countries and some Asian countries. The size of the sewer pipes is by intent smaller due to the use of other design criteria than what is used for conventional gravity sewerage.

7.3.4.1 Settled or Small-bore Sewerage

Settled sewerage is a means of conveying domestic sewage by gravity that has been settled in a septic tank (Septic Tank Effluent Disposal or STED system). STED was developed in Zambia in 1960 and now is used around the world in over 300 different schemes.

Design criteria for drains included a minimum diameter pipe of 100 mm and a grade of 0.4%. Conventional separate sewerage would require a minimum pipe of 150 mm diameter and a grade of 0.7% (earthenware) and 0.5% (PVC). Manholes are replaced with flushing points for network access. The STED design reflects the advantage of removing gross solids in the septic tanks prior to liquid conveyance.

It has been found in studies (Venhuizen 2005) that when pumping is required, generally the most cost efficient system would route effluent from several septic tanks through STED sewers into a collective STEP tank, an effluent pump station. In a very flat terrain this strategy will be more cost efficient than either conventional sewers with a central lift station or a STEP system with individual pump tanks at each septic tank as shown in **Figure 7.3**.

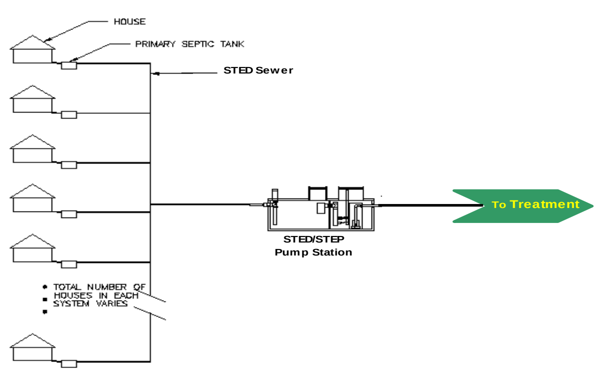


Figure 7.3 A STED/STED System Configuration

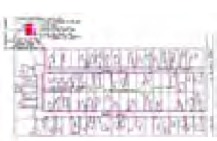
Each pump well in a simplified sewerage scheme collects all settled household dirty waters (toilet wastes and sullage) from the small pump wells in small-diameter pipes (eg 100 mm dia.) laid at fairly flat gradients such as 0.5%. The sewers can be laid like water lines or inside the housing block, or in the front garden or under the pavement (sidewalk), rather than in the centre of the road as with conventional sewerage. There must be an overall fall from the upstream end of the sewer to its downstream end. In sections where there is pressure flow, the hydraulic gradient cannot rise above the level of the invert of any interceptor tank outlet (if it does, then either select the next larger pipe diameter or increase the depth at which the sewer is laid) (SC 2005). It is suitable for existing unplanned low-income areas and new housing estates with a more regular layout.

The sewerage authority in charge, e.g. LGUs or concessionaires, has to ensure that only connections from septic tanks are made to the settled sewer, and it also has to be responsible for desludging the septic tanks regularly. At the start of the scheme the sewerage authority should desludge and, if necessary, renovate the existing septic tanks, and then regularly, as required, arrange for them to be desludged.

7.3.4.2 Condominial Sewerage

Condominial sewerage is basically small-bore conventional gravity sewerage attained via a minimum hydraulic design. sewerage collects all household dirty waters (black and grey waters) to small-diameter pipes laid at fairly flat gradients. A 100 mm diameter sewer for example, laid at a gradient of 1 in 200 (0.5%), will serve around 200 households of 5 people with a dirty water flow of 80 litres per person per day. In northeast Brazil, the earliest 100 mm diameter sewers were laid at 1 to 167 (0.006 m/m). Schemes based on minimum tractive tension, rather than minimum cleaning velocity, are now laid at 1 in 255 or 0.004 m/m (Azevedo Netto 1992).

The sewers are often laid inside the housing block or in the front garden or under the pavement or sidewalk, rather than in the centre of the road as with conventional sewerage. It is suitable for existing unplanned low-income areas and new housing estates with a more regular layout (SC, 2005). CAESB, the water and sewerage company of Brazília and the Federal District, started implementing simplified sewerage in poor areas in 1991 and now considers simplified sewerage as a “standard solution” for rich and poor areas alike. CAESB has the largest example of simplified sewerage in the world (SC, 2005), with over 1,200 km of Condominial sewers in operation.



Example of STED system in Texas (Venhuizen 2005)

Failures have occurred, mainly due to poor construction and/or poor institutional commitment, and especially due to poor maintenance. Laying small diameter (commonly 100 mm diameter) pipes at fairly flat gradients of 0.5% requires careful construction techniques. Plastic pipes are best used as they are easily jointed correctly, and this essentially eliminates dirty water leakage from the sewer and groundwater getting into it. As with the STED there is no need to have manholes of the type used for conventional sewerage but simple brick or plastic junction chambers (SC, 2005).

The biggest advantage of these two simplified sewerage approaches is that in areas with existing septic tanks, the cost reduction over conventional sewerage can be as high as 40 to 70 percent (SC, 2005). STED systems obviously aid solids management at the treatment plant and both STED and condominial systems do not require conventional manholes but merely rodding access. The biggest disadvantage for simplified sewerage is the increased maintenance requirements; blocks do occur and equipment and personnel have to be available for remedy. STED of course depends on functioning septic tanks. Condominial sewerage requires specialized installation contractors to be fully functional. Sound cooperation between the sewerage agency, community leaders, and users is a must for both systems.

A septic tank effluent disposal (STED/STEP) scheme would seem to be the most natural fit in MM (and the least expensive) as there is an estimated 2.17 million septic tanks. The 26% of septic tanks that are inaccessible (JMM 1991) would require replacement or installation of a STEP tank. Moreover, some septic tanks will be unsuitable for STED and will require replacement. All septic tanks would be pumped out for solids on a regular basis and the septage taken to treatment plants. In many drainage catchments, the overflow from septic tanks would be caught by small bore sewerage, other catchments could use the storm drains as a "combined drainage". All of MM could gradually be sewered by a phased approach.

7.3.5 Evaluation of Sewerage Options

Estimated unit costs of the aforementioned sewerage options are given in **Table 7.7**. Simplified and combined sewerage have a big capital cost advantage over conventional gravity sewerage. The annual O&M, however, costs do not reflect the increased institutional requirements of simplified sewerage.

Table 7.7- Estimated 2005 Costs from the Literature of Sewerage Systems

Sewerage System	Estimate Percent Cost of Gravity Sewerage*	Estimated Cost per Household ($US)	Estimated Cost per Household (PhP)	Estimated Annual O & M ($US)	Estimated Annual O & M (PhP)
Escalated 1979 Estimate for Conventional Gravity Sewerage[1]	100%	$3,700	P203,500	$26	P1,430
Combined Gravity Sewerage[2]	32%	$1,184	P65,120	$13	P715
Vacuum Sewerage[3]	116%	$4,300	P236,500	$52	P2,860
Pressure Sewerage: Grinder Pump[4]	88%	$3,256	P179,080	$228	P12,540
Pressure Sewerage: STEP[5]	50%	$1,850	P101,750	$114	P6,270
STED / STEP Sewerage[6,7]	42%	$1,554	P85,470	$14	P784
Condominial Sewerage[8]	62%	$2,294	P126,170	$18	P990

*All costs except vacuum sewerage are proportioned against conventional gravity sewerage

[1] Costs of Montgomery et al (1979) report were escalated via the Philippine Retail Price Index of Selected Materials of Construction in the National Capital Region; NJS et (2004) estimated cost of sewerage for the Riverbanks STPs at $US2,050 / household (61% was for household connections)

[2] NJS et al (2004); operating cost extracted from Taguig Sewerage System and includes treatment via ponds

[3] Based on costs from a development in Sydney (Envr. Tech. Case Studies, 2005)

[4] Based on worst case cost from Australia (Shoalhaven Water 2005); Tedwill (2005) estimated 52% from US development

[5] Bounds (2005)

[6] Venhuizen (2005) costed STED/STEP for Texas area at $US2,500 (42% of conventional sewerage), which included new septic tanks; Palmer et al (2005) estimated $3,225 per household in country Australia but 31% of conventional sewerage

[7] Operating cost from Palmer et al 2005

[8] Azevedo Netto 1992; NJS et (2004) costed a simplified sewerage system at Manggahan (Manila) with smaller diameter sewers under the sidewalks for 80% of the cost of conventional sewerage.

A multi-criteria analysis (MCA) of the various sewerage systems was performed as shown in **Table 7.8**. The MCA yielded that the **Combined**, **Condominial**, and **STED/STEP** methods are the most preferred methodologies for MM of those considered. The MCA scores were heavily weighted towards affordability and were close. Moreover, one system would not be universally applicable to the whole of MM; as such the top three were considered as 'preferred'.

Table 7.8 - Multi-criteria Analysis of Sewerage Alternatives

SEWERAGE for Metro Manila		Selected Weighting	Judgement Rankings						
No.	**Multi-criteria Analysis of Constraints**	(x / 100)	Conventional Sewerage: Separate (1 to 10)	Conventional Sewerage: Combined (1 to 10)	Vacuum Sewerage (1 to 10)	Pressure Sewerage: GP (1 to 10)	Pressure Sewerage: STEP (1 to 10)	Simplified Sewerage: STED / STEP (1 to 10)	Simplified Sewerage: Condominial (1 to 10)
1	Cultural Acceptability in MM	0	10	10	10	10	10	10	10
2	Affordability (Capital Requirement)	25	3.2	10	2.8	3.6	6.4	7.6	5.2
3	Disease Prevention	10	9	6	9	9	9	9	9
4	Protection of the Environment	10	7	5	9	9	8	8	9
5	Consistency with MWCI and/or MWSI Plans	10	5	9	4	4	4	4	9
6	Land Availability	5	6	9	7	7	7	7	7
7	Traffic Disruption	10	3	9	8	8	8	8	8
8	System Design & Complexity	5	7	8	5	6	6	7	7
9	Operations & Maintenance	10	9	9	6	6	6	7	7
10	Management of Flow / Pollution Loads	10	7	5	8	8	9	9	9
11	Management/Recycle of Residuals	5	9	6	9	9	6	6	9
	TOTAL WEIGHTING (should be 100):	**100**							
	INDIVIDUAL SCORES (x / 1000 max):		**590**	**795**	**614**	**641**	**695**	**740**	**754**
	HIGHEST SCORE:		**Conventional Sewerage: Combined**						

7.3.6 The Selected Sewerage Approach for Metro Manila

- A Combined Drainage System (i.e. storm drainage and dirty water) should be mostly employed where possible for conveyance of dirty water to a treatment plant. The combined system should be gradually passed out in favor of a separate system for the protection of human health.
- The separate sewerage system that should be combined sewerage should be small bore and STED / STEP systems.
- The appropriate sewerage design should be suited for each drainage catchment.

7.4 Dirty Water (Sewage) Treatment

The principal objective of dirty water treatment is generally to detoxify/remove human and anthropogenic and industrial effluents impurities to allow their environmental disposal and/or reuse of the water without danger to human health or unacceptable damage to the environment.

The most appropriate [dirty water treatment] process has to be one that produces a final effluent that meets the relevant / appropriate microbiological and chemical quality guidelines, preferably at a low cost and with minimal operational and maintenance requirements.

The history of dirty water treatment has mostly relied on gravity conveyance of sewage, via neighbourhood reticulation systems into larger ring mains, terminating at a centralized treatment plant. Whilst this approach is still mostly preferred, its large initial capital requirements have encouraged consideration of smaller reticulation systems and decentralized treatment plants. This has especially been true in a developing country context.

Decentralized Dirty Water Systems (DEWATS) is one designation for this approach and is defined as the collection, treatment, and disposal / reuse of dirty water from individual homes, clusters of homes, isolated communities, industries, or institutional facilities, as well as from portions of existing community at or near the point of waste generation (Tchobanoglous, 1995). DEWATS can be composed of anaerobic or aerobic treatments, with the objective of removing impurities from the water flow in the most economical and space conscious manner (in addition to addressing other constraints).

7.4.1 Dirty Water Treatment Process Train

7.4.1.1 Preliminary Treatment

Preliminary treatment is the first stage of dirty water treatment for the removal of coarse solids and other large materials often found in untreated dirty water. Pretreatment operations typically include coarse to fine screening, grit removal and, in some cases, comminution of large objects. Grit removal is mostly used for sewage (as opposed to industrial or commercial effluents) and often not included as a preliminary treatment step in many of the "package" or smaller dirty water treatment plants. Comminutors are sometimes adopted to supplement coarse screening and serve to reduce the size of large particles so that they will be removed in the form of sludge in subsequent treatment processes. Flow measurement devices, often standing-wave flumes, are most always included at the preliminary treatment stage.

7.4.1.2 Primary Treatment

Preliminary treatment is followed by Primary treatment. Primary treatment is to remove settleable organic and inorganic solids by sedimentation as well as impurites like oil, grease and scum that float by skimming. Approximately 25 to 40% of the incoming biochemical oxygen demand (BOD_5), 50 to 70% of the total suspended solids (TSS) (Tchobanoglous & Burton, 1991), and 65% of the oil and grease are removed during Primary treatment.

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7.4.1.3 Secondary Treatment

Secondary biological treatment is a biological process and follows the first two physical treatments. It is designed for removing dissolved organics, nitrogen and phosphorous as well as suspended solids. Secondary treatment can involve either anaerobic (without the use of added air) and / or aerobic (use of added air) biological processes. Those biological processes considered as "high-rate" are characterized by relatively small reactor volumes, greater process complexity and high concentrations of microorganisms. Conversely, "low-rate" biological processes employ are less complicated processes, resulting in larger reactor volumes (with larger land takes) and low biomass concentrations.

The growth rate of new organisms is greater in high-rate systems because of the well controlled environment. Common high-rate aerobic processes can include some activated sludge processes (like those using MF membranes), advanced trickling filters or biofilters, oxidation ditches, rotating biological contactors (RBC) and processes using plastic media, either in a static or fluidized configuration. High-rate anaerobic processes include Upflow Anaerobic Sludge Blanket (UASB) reactors, anaerobic filters, stirred tank anaerobic tanks and fluidized [media] anaerobic processes to name the most prevalent.

7.4.1.4 Tertiary Treatment

This process step follows secondary treatment and usually involves final disinfection by chlorine, ultra-violet irradiation, ozone, chlorine dioxide or other oxidant. Tertiary treatment can also include sand filtration to help remove additional suspended solids.

7.4.1.5 Advanced Tertiary Treatment

Advanced Tertiary processes are often the last and most complex processes in the treatment train. These processes are mostly used to give the treated water purity enough for reuse. Processes can include finer pore filtrations like microfiltration (0.2 μm), down to reverse osmosis (0.0001 μm). Also included are those processes for advanced nutrient removal as well as advanced oxidation processes for the removal of more recalcitrant dissolved pollutants such as residual human pharmaceutical products and / or pesticides and herbicides.

7.4.2 Biological Treatment

The greatest costs and largest land takes when upgrading any dirty water for reuse and / or environmental discharge occur for the secondary and advanced tertiary treatment processes. Substantial costs lie with biological treatment. The chief tertiary process of interest for the purposes of the Manila Master Plan would be disinfection and in some instances filtration. Advanced tertiary processes are mostly considered for use under special circumstances, often involving water reuse, salinity issues, or removal of recalcitrant chemicals.

7.4.2.1 Anaerobic Biological Treatment

Anaerobic biological treatment is an energy efficient process for usually the removal of large amounts of carbon as is often found in food processing effluents. The use of anaerobic reactors for domestic sewage dirty water treatment has mostly been restricted to the use of the common [anaerobic] septic tank. However, larger anaerobic reactors have been increasingly used at centralized treatment plants since the 1980s.

Anaerobic reactors may be classified as *suspended growth,* where the active treatment bacteria are suspended in the bulk liquid, or *attached film*, where the active treatment bacteria are attached as dense films to a solid media within the reactor. Advanced designs such as the upflow anaerobic sludge blanket reactor or UASB reactor would be considered a medium to high-rate suspended growth reactor has great potential for treating sewage in developing countries, particularly those with tropical climates.

This technology does not require the input of air as well as producing far less waste biomass that also needs to be environmentally managed. The major differences between an anaerobic and aerobic biological treatment can be seen by their process yields as seen in **Figure 7.4**.

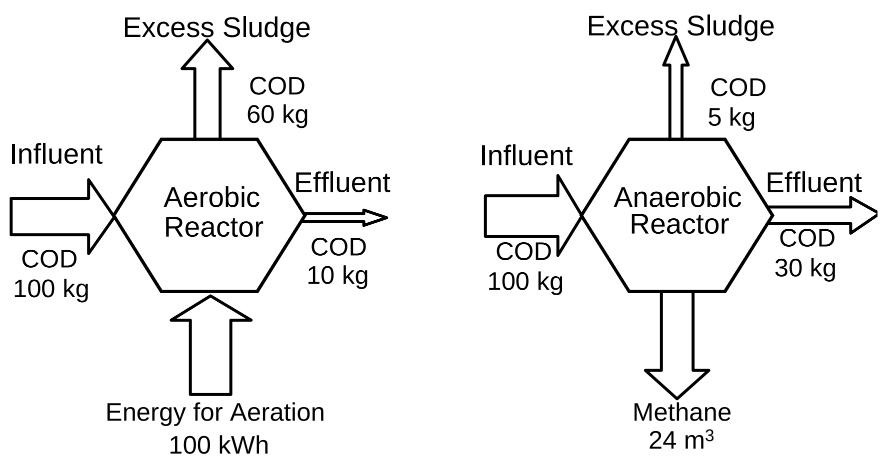
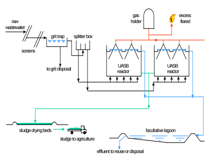


Figure 7.4 Yields from Aerobic and Anaerobic Biological Treatment (Jewell 1994)

Screened and degritted dirty water can be introduced at the bottom of the UASB and distributed evenly across the base of the reactor. "Flocs" of anaerobic bacteria (often as granules) are continually suspended as a blanket by the incoming dirty water flow. Particulate matter is trapped as it passes upward through the sludge blanket, where it is eventually digested. Anaerobic digestion of the retained particulate and soluble organic material generates "biogas" (~65% methane, ~20% carbon dioxide & ~5% other gases) and relatively small amounts of new sludge (<5% of incoming COD to new biomass). The rising gas bubbles are part of a three-phase mixture (gas, liquid and solids or GLS) that is ideally well mixed.

The GLS mixture is separated via a phase separator, consisting of the gas collector dome(s) or hoods and a separate quiescent settling zone. The settling zone is relatively free of the mixing effect of the gas, allowing the solid particles to fall back into the reactor. Some designs employ a settler after the UASB to settle the biomass and return it to the UASB reactor. The clarified effluent overflows into launders at the top of the reactor for removal. The biogas is collected and can be used as a fuel for generating power for the treatment plant or simply flared.



Example of UASB treatment train.

A properly designed UASB reactor eliminates the need for mechanical mixing and has few moving parts. For dirty water with high concentrations of suspended solids, sedimentation of the solids is biggest main concern. The design criteria are largely dictated by the maximum upflow velocity that the solid particles can withstand before being washed out of the reactor, generally between 0.5 and 1.0 m/hour for municipal effluents (Haskoning 1995).

There are several case studies of UASB reactors, or similar anaerobic units, being used for domestic sewage treatment systems as seen in **Table 7.9** (Journey and McNiven, 1996). The UASB reactor units treating sewage are operated at ambient temperature, normally higher than 20°C, at a hydraulic detention time in the range of 6 to 10 hours, and organic loading rates lower than 3.0 kg COD/m^3/d (Foresti 2002). They have presented removal efficiencies in the range of COD: 55% to 75%, BOD 60% to 85% and total solids of 60% to 80%. The main problems have been identified as construction imperfections and some complaints about odours in those cases that did not adequately allow for malodour management.

Table 7.9 - Multi Comparison of Four UASBs Treating Municipal Dirty Water

Parameter		Municipal Dirty Water			Mixed
		Bucaramanga, Colombia	Mirzapur, India	Kanpur, India	Kanpur, India
Design Peak Capacity	(MLD)	42	14	5	36
Operating Capacity	(MLD)	36	10	4.8	21.8
Average organic loading					
COD	(mg/l)	400	360	560	1,183
BOD_5	(mg/l)	150	180	210	484
TSS	(mg/l)	230	360	420	1,000
Average Removal Efficiency					
COD	(%)	65	61	74	57
BOD_5	(%)	75	66	75	63
TSS	(%)	70	70	75	56
Average HRT	(hour)	5	8	6	5.2
Influent temp. Range	(^oC)	23-25	21-30	20-30	22-30
Gas production	(m^3/day)	3,300	500	480	

Cited advantages by many include costs of 3 to 6 times less than aerobic secondary plants (Journey et al, 1996), few moving parts and smaller footprints, production of biogas that can be converted to electricity, and low production of waste solids. The major disadvantages are the need for an aerobic secondary process to meet Class C, longer start up times and less operating experience by water authorities, although substantial use of the technology has occurred in India and South America.

7.4.2.2 Aerobic Biological Treatment

Aerobic biological treatment for removal of dissolved impurities from domestic sewage are also classified as *suspended growth,* where the active treatment bacteria are suspended in the bulk liquid, or *attached film*, where the active treatment bacteria are attached as dense films to solid media within the reactor.

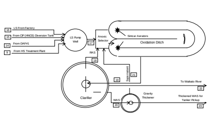
Conventional Activated Sludge (CAS)

The activated sludge process was developed in England during early 1900's. Organic and inorganic waste is introduced into an environment with a culture of aerobic and facultative bacteria, fungi and other species. Carbon and nitrogenous compounds are broken down / oxidized and converted into new bacterial cells, carbon dioxide, and gaseous nitrogen compounds, depending on the redox environment. Bacterial cells will also consume each other under what is termed endogeneous respiration.

After the reactor tank, a clarifier or settler separates the activated-sludge biomass from the treated water. A portion of settled cells from the clarifier is recycled (the return activated sludge or RAS) into the influent for initial absorption of carbon and to maintain the desired concentration of the microorganisms in the reactor. Another portion of the settled cells, termed the waste activated sludge or WAS, is wasted to a digester (for more treatment) or for dewatering.

Activated sludge is well known to most water authorities, recovers quickly from shock loadings, usually not considered malodorous and can biologically remove phosphorus and nitrogen pollutants. The major disadvantages are the high operating cost due to the need for a continuous oxygen supply and the fact that up to 75% of the influent BOD is converted into sludge, which has to be itself managed.

Oxidation Ditch (OD)



Typical oxidation ditch configuration

The oxidation ditch is also activated sludge but with a slightly different design configuration. An oxidation ditch uses a ring- or oval-shaped channel and is equipped with mechanical aeration devices that encourage a linear velocity of about 0.25 to 0.35 m/s (Metcalf and Eddy, 1991) in addition to supplying oxygen. Screened and degritted dirty water enters the ditch where it is aerated. Oxidation ditches typically operate in an extended aeration mode with long hydraulic and solids retention times.

After biological treatment in the oxidation ditch, a clarifier is again used to settle out the biomass and to recycle RAS to the influent stream. Nitrification and denitrification is achieved inside the oxidation ditch due to the aerobic zones near the aerators and anoxic zones away from it.

The oxidation ditch process is flexible and reliable and will also biologically remove nutrients. The mechanical aeration is also quite dependable. The design does require a large land take and there is also the energy requirement because of aeration and the production of a large volume of sludge.

Sequencing Batch Reactor (SBR)

In a sequencing batch reactor configuration, all processes in the activated sludge system take place in a single reactor. Whilst processes for the SBR and AS are identical in principle, the *fill and draw* configuration of the SBR enables the mixed liquor to remain in the reactor during all cycles. This eliminates the need for separate secondary sedimentation tanks.

The 5-phase operation sequence in an SBR (**Figure 7.5**) consists of (1) fill, (2) react (aeration), (3) settle (sedimentation/clarification), (4) draw (decant of supernatant), and (5) idle. During the treatment process, sludge wasting typically occurs during the settle or idle phases, thus eliminating the need for return sludge. Multiple reactors are used to ensure an over-all continuous process.

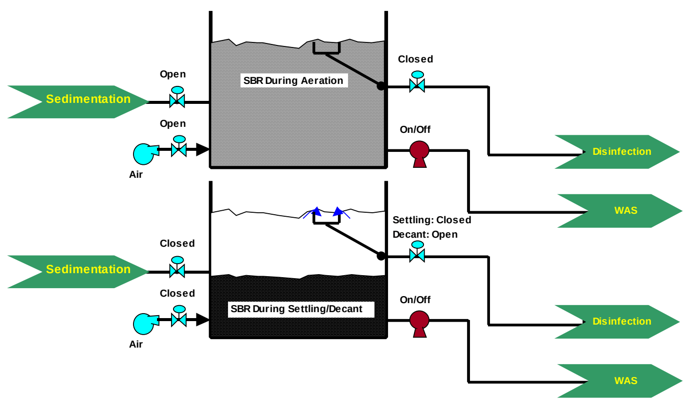


Figure 7.5 Operational Sequence of a Sequencing Batch Reactor

An SBR requires less space than a CAS or OD and is less expensive to build as there is no need for a clarifier. Aerobic to anoxic conditions inside the SBR allow biological nutrient removal and most operators find the process easy to understand and manage. The design is highly dependent on a good settling biomass; the predomination by filamentous bacteria can promote high suspended solids in the effluent. The system is essentially a batch process and effluent quality can be less consistent than a continuous process like CAS or an OD.

Aerobic Lagoons

Aerobic lagoons or ponds are large, shallow earthen basins that are used for the treatment of dirty water by natural and mechanical processes, involving the use of both algae and bacteria. The shallow depth or mechanical mixing ensure aerobic conditions throughout the basin. Except for the inclusion of the algal population, the treatment processes in the aerobic lagoon are very similar to those in an activated-sludge system. Bacteria aerobically degrade/oxidize solid and dissolved organic matter, using dissolved oxygen from algal photosynthesis. Resident nutrients and the carbon dioxide by-product

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of the degradation are subsequently used by the algae. This forms a symbiotic relationship between algae and bacteria.

They are mentioned herein for completeness but are mostly inappropriate for MM because of their large land take. The aerobic lagoons currently at Dagat-Dagatan treatment plant will likely be converted to a more intensive process in the future.

Rotating Biological Contractor (RBC)

The rotating biological contactor is an attached biomass system, consisting of a series of closely spaced, polystyrene or polyvinyl chloride circular disks. The disks are rotated slowly while submerged by about 40%. As a result, sessile biological growth occurs on the disk surfaces, forming a slimy layer over the entire surface area.

The rotating motion of the disks alternates the contact of the biomass with the organic material in the dirty water and with oxygen from the atmosphere. Liquid running through the packing also picks up oxygen. The revolution rate of the disks determines the rate of oxygen transfer and maintains aerobic condition for microbial growth. This motion also removes excess solids from the disks by creating shearing forces. The sloughed solids are conveyed to a clarifier for separation. RBCs can be used for secondary treatment as well as more advanced processes such as biological nitrogen and phosphorus removal as seen in **Figure 7.6**.

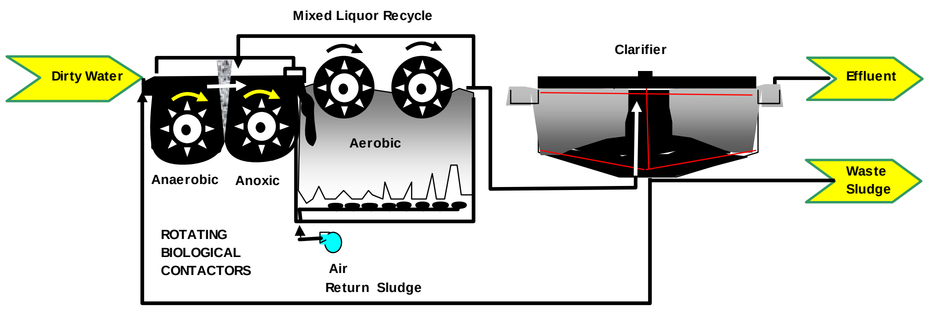

Figure 7.6 An Anaerobic, Anoxic and Aerobic RBC Configuration

The RBC design reduces operating cost and sludge production but the substantial space is required for larger STPs. The design is rarely used for flows over 10 MLD and constant mechanical maintenance is required because of the rotating components.

Trickling Filter (TF)

V-Valley Granular TF, Bangalore, India (May 2001)

Trickling filters (TF) have been in existence for over a century and have been used for carbonaceous BOD (CBOD), COD and NH_3 (ammonia or NBOD).

Granular media ("sand") filters have been known for about 50 years since from studies conducted at the University of Florida. It was found that using larger media and doing more frequent dosing enables sand filters to perform better than what was quoted in the EPA literature. Over 25 years ago, it was shown that employing recirculation enhanced the efficiency of the process. These characteristics have been confirmed in many efforts over the past several years. Recently, alternative types of media-textile and foam have been researched. These media can be loaded much more heavily than a granular media filter, offering the potential for smaller and a more cost efficient biofiltration bed (Venhuizen 2005). Most rock media can provide approximately 149 m^2/m^3 transfer area per unit media volume (USEPA 2000).

Many of the old rock trickling filters are being replaced in the US with plastic media. Plastic cross-flow media type is now commonly used in TFs. Good nitrification requires a second filter after the primary TF or a NTF. Research has shown that cross-flow media may offer better flow distribution than other media, especially at low organic loads (USEPA 2000).

The Philippine National Housing Authority (NHA) opted to utilize trickling filter STPs to service the low-cost medium rise development of Smokey Mountain, a former garbage dumpsite. At the time of the site visit in April 2005, final stages in construction were being completed. The treatment processes consist of two covered trickling filters Figure 7.7 (a), each with a capacity of treating 2 MLD, with a rotary liquid distributer (b), plastic media imported from the US (c and d), and two aerobic sludge digesters.

Figure 7.7 Smokey Mountain Sewage Treatment Plant

The Trickling Filter is a simple, reliable and proven process. A second in-line filter is employed for nitrogen removal and a clarifier is needed post the filters to separate out the sloughed biomass from the filter. Land take can be small if plastic media is employed. Operating costs are lower than AS and sludge production is about one-third that of an AS process (sludge ages of >75 days are common). Modern designs are covered to contain odor and to reduce vector problems. The filters require periodic intensive hydraulic dosing to promote biomass sloughing to prevent the media from clogging and developing anaerobic pockets.

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Fixed Bed

Fixed beds employ a biofilm attached to a plastic carrier (often polyethylene) as a base for sessile (i.e. clinging to the surface) microorganisms. The oxygen supply is provided externally, usually by a fine bubble diffused aeration system that delivers air to the bottom of the bed.

Fixed Bed technology (submerged and aerated fixed bed) has been employed for dirty water treatment since 1989 in Europe. This system combines the best characteristics of trickling filter technology with those of the activated sludge procedure, whilst avoiding many of their disadvantages. Successful applications in the field of decentralized domestic dirty water treatment led to an increasing number of installed units around the world. More than 6,000 plants have been put up in Germany in the last ten years (EGL 2005).

Submerged fixed bed systems can be classified into two basic categories for BOD_5 removal, nitrification, and denitrification (MOP 1992) as follows.

- *Fixed film elements submerged in mixed liquor where there is sludge return from the secondary clarifier*. These elements may be suspended in the mixed liquor (for example, Captor, KMT, and Linpor-C) or fixed (for example, Ringlace, submerged RBCs, Bio 2, and Sludge). The fixed film may or may not play the dominant role in biological treatment.
- *Fixed film elements and attached biomass are the primary mechanisms of the treatment process*. Liquid may be recycled, but clarified sludge is not. These processes may use floating (Biostyr), subsided bed (for example, BioCarbone, Biofor), or fluidized-bed (for example, Oxitron, Biolift) media.

Pure fixed beds can be configured in cylindrical or rectangular vessels. Plastic media is available often in blocks and are easily installed. Surface areas (per unit volume of media) between 100 and 200 m^2/m^3 or greater are available. Floating biofilm chambers can also be employed with specific surface ranges from 200 – 1200 m^2/m^3, depending on the specific model of media (EGL 2005). Dirty water is either introduced to the bed in an upflow (Biofor) or downflow configuration (Biocarbone). A study on twelve plants showed that COD removal was proportional to the hydraulic loading as per COD = - 8.6 (hydraulic loading, $m^3/m^2/h$) + 89.56, regardless of the flow direction (detailed in MOP 1992).

Fixed bed processes are designed similarly to activated sludge principles that allow for simple tank construction. Fixed bed biofilm reactors for the treating of sewage are suitable for most sizes, but are commercially attractive up to 20,000 EP (EGL 2005).

The fixed film process is uncomplicated to operate like the TF. Unlike the TF, however, air is mechanically forced through the filter, thus increasing its operating costs. The system is fully contained, allowing easy management of vector problems and odor. A clarifier is again used for settling out the excess biomass sloughed off of the packing. Designs are mostly proprietary and can be expensive.

Fluidized Bed

Fluidized beds also use attached growth treatment processes. The media on which the bacteria grow can be as traditional as molded [modified] Lessing rings (cylinders with internal divisions) and Pall rings to proprietary designs that are often extruded. Most are made of polypropylene or polyethylene to reduce density. Other carriers such as sand have also been used but require more aeration to maintain fluidisation.

Bacteria attach to the internal structures of the packing (erosion often sloughs sessile growth from the outside surfaces) and the packing is in turn “fluidized” through the force of the incoming air. Treatment intensity is achieved through extreme liquid turbulence in combination with the large surface area of bacteria. Attached sessile bacterial microorganisms are known to be more tolerant than free floating biomass to toxicity changes (e.g. pH, chemicals, temperature, etc) and often produce less than one-half to one-third the amount of waste biomass.

A fluidized, attached biomass system can often be anywhere from 5 to 30 times more intensive than a suspended biomass system such as activated sludge. They are consequently one-fifth to one-thirtieth the volume. Fluidized beds are commonly used as a tertiary treatment for denitrification processes.

Fluidized systems are mostly designed as several in-series reactors, usually a minimum of two. Heavily polluted water (COD in excess of 20,000 mg/L) may require as many as three in-series reactors. This configuration allows for different bacteria populations to exist in each reactor, each interested in a particular fraction of the pollution mixture (e.g. sugars, starches, fats, etc). Instrumentation usually consists of dissolved air meters in each reactor and sometimes thermal couples (high temperatures are often experienced). Air is provided via blowers, usually distributed into the reactor through coarse aeration grids. The presence of fluidized packing also improves the oxygen transfer from the incoming air.

Fluidized systems produce less waste biomass but biomass that can be difficult to settle. The “Kaldness” configuration fluidized bed at the Shoalhaven Paper Mill near Nowra, NSW (Australia) is followed by an activated sludge reactor and a clarifier and subsequently with a dissolved air flotation (DAF) system to ensure removal of the biomass prior to [sensitive] river discharge of the effluent. The “Cranos” configuration, pioneered by ACTEW (now ACTEW-AGL) in Canberra (Australia) employs sand media and operates under pressure (in a pressure vessel). The waste biomass is separated by dropping the pressure (from the system pressure to atmospheric), thus creating a dissolved air flotation (DAF) like environment. To date, this system has been used mostly with municipal dirty waters. In Europe, particularly in colder Scandinavian countries, many STPs have been upgraded via fluidized bed systems.

Fluidized beds are capital intensive but have small land takes and provide good process reliability. There are several Philippine examples, mostly for industrial wastewater treatment.

7.4.3 Evaluation of Dirty Water Treatment Options

The most promising of the aforementioned biological treatment methodologies for Manila were taken and processes designed for 10 MLD treatment plants. The designs were analysed for both capital and operating costs. These costs were put into a ten-year Net Present Value analysis at 6% for comparison. Biogas from the anaerobic-aerobic process was assumed utilized for electrical generation as shown in **Figure 7.8**.

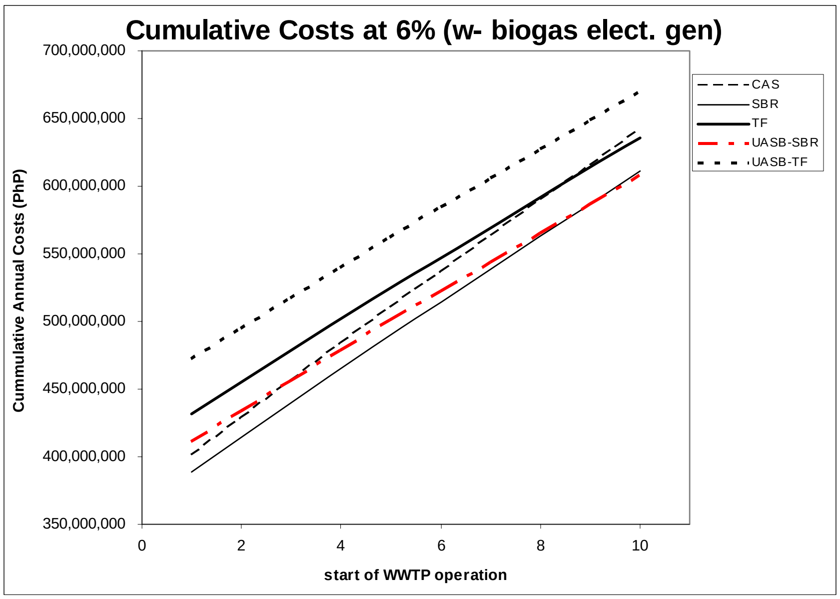

Figure 7.8 NPV analyses for dirty water treatment options

The UASB-SBR combination and the full SBR turned out most economically favourable at the end of 10 year analysis period. The lower operating costs of the UASB eventually overtake its initial higher capital cost. The TF suffered from the expense of its imported [oil-based] plastic packing.

Costs from other references of some of the treatment systems mentioned previously are shown in **Table 7.10**. This also shows the cost benefit of using an anaerobic system and the increased costs associated with nutrient removal.

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Table 7.10 - Comparison of Dirty Water Treatment Technologies

Dirty Water Treatment System	Dirty Dirty Water Flow Range	Dirty Water Flow BOD	Reactor Activity kgBOD /	Reactor Activity kg COD /	Estimated Construction Cost* Capita		Estimated Const.Cost* per kg BOD Rem. per Year		Estimated Annual O&M Cost* per kg BOD Rem	
	(MLD)	(kg/d)	m3 / d	m3 / d	($US)	(PhP)	($US)	(PhP)	($US)	(PhP)
Anaerobic										
UASB[1]: Mirzapur, India (1994), 2 x 2,400 m3 reactors	14.0	2,700	0.42	0.73	$7.85	P432	$1.39	P76	$0.01	0.55
UASB[1]: Kanpur, India (1991), 2 x 5,016 m3 reactors, 9 MLD of tannery effluent	36.0	17,400	1.10	2.44	$10.84	P596	$2.29	P126	$0.34	18.70
UASB[1]: Bucaramanga, Colombia (1991), 3 x 3,350 m3 reactors	42.0	6,300	0.48	1.00	$17.83	P981	$2.32	P128	$0.13	7.15
Continuous Activated Sludge										
Cost Estimate 2005 MP Study	10.0	3,000			$92.02	P5,061	$7.00	P385	$0.60	33.00
Bradford, California[8]	27.0	3,436			$100.53	P5,529	$0.06	P3	$0.92	50.60
Oxidation Ditch Activated Sludge										
MTSP: Manggahan Floodway Scheme (catches Laguna Lake flow)[2]	7.8	2,332			$33.49	P1,842	$2.36	P130	$0.33	18.13
MTSP: Alternative Option of Stand-along ODs for Treating Pollution from Hagonoy, Taguig, Labasan and Tapayan Rivers into Laguna Lake (alternative to conjunctive use of flood ponds); for 2025 flows[3]	151.9	34,411			$34.61	P1,903	$2.02	P111	$0.29	15.85
Thornside STP, QLD, Australia (BNR)[4]	7.5	1,680			$319.00	P17,545	$15.63	P860	$1.17 to $1.56	65 to 86
Coolum STP, QLD, Australia (BNR)[4]	5.0	650			$579.00	P31,845	$36.59	P2,012		
Cleveland STP, QLD, Australia (BNR)[4]	9.5	2,500			$243.00	P13,365	$10.14	P558		
Sequencing Batch Reactor										
Foess (2003)	0.4	102			$177.03	P9,737	$18.71	P1,029	$3.23	177.65
MTSP: Poblacion Riverbank STP[2]	1.5	142			$192.78	P10,603	$14.01	P771	$1.06	58.46
MTSP: Ilaya Riverbank STP[2]	2.3	266			$93.45	P5,140	$7.10	P391	$0.87	47.84
MTSP: Capitolyo Riverbank STP[2]	3.9	693			$46.31	P2,547	$3.17	P175	$0.56	30.67
MTSP: Taguig Low Income Scheme[2]	6.1	1,775			$39.65	P2,181	$2.81	P155	$0.36	19.55
Cost Estimate 2005 MP Study	10.0	3,000			$89.61	P4,928	$6.82	P375	$0.56	30.93
MTSP: Quezon City – Marikina sewerage system[2]	10.4	3,120			$83.30	P4,581	$5.73	P174	$0.29	15.97
Bradford, California[8]	27.0	3,436			$157.22	P8,647	$5.73	P267	$1.03	56.65
MTSP: Alternative Option of Stand-along SBRs for Treating Pollution from Hagonoy, Taguig, Labasan and Tapayan Rivers into Laguna Lake (alternative to conjunctive use of flood ponds); for 2025 flows[3]	151.9	34,411			$43.98	P2,419	$2.56	P141	$0.38	21.12
Rotating Biological Contractors										
Foess (2003)	0.4	102			$200.12	P11,007	$21.15	P1,163	$2.89	158.95
Trickling Filters										
Smokey Mountain (Plastic Media)[5]	4.0	1,200			$117.70	P6,474	$3.10	P171	$0.10	5.61
Cost Estimate 2005 MP Study (Plastic Media)	10.0	3,000			$100.76	P5,542	$7.67	P422	$0.50	27.59
USEPA Fact Sheet (rock media)[6]	3.8	680			$89.69	P4,933	$4.25	P234	$5.89	323.93
USEPA Fact Sheet (rock media)[6]	37.8	6,804			$74.82	P4,115	$3.55	P195	$1.40	77.11
USEPA Fact Sheet (rock media)[6]	189.0	34,020			$59.00	P3,245	$2.80	P154	$1.31	71.97
USEPA Fact Sheet (rock media)[6]	378.0	68,040			$74.82	P4,115	$3.55	P195	$1.22	66.83
Fluidized Beds										
Lakefield, Canada[9] (incl. 134 m3/d septage)	2.4	306			$110.67	P6,087	$3.71	P204	$0.99	54.45
Aerated Lagoon										
Westmorland, California[8]	1.9	305			$114.12	P6,277	$3.76	P207	$1.58	86.90

*All costs have been escalated to 2005
[1] Journey et al. (1996)
[2] NJS et al (2004)
[3] MTSP Feasibility Study by NJS et al (2004); flow represents a population of 732,411; assumes 80% H20 use, 7.3 m3/ha/d infiltration, 47g BOD/p/d by 2025
[4] De Haas (2005); BNR denotes STPs that biologically remove N & P; 1AUD=0.76USD
[5] Smokey Mountain personal communication; data provided by contractor
[6] USEPA Fact Sheet (Martin and Martin 1990), traditional designs. A dirty water strength of 180 mgBOD/L and 321 L/p/d was assumed. Numbers were adjusted using US Consumer Price Index.
[7] Westmorland, California http://www.cocef.org/aproyectos/Westmorland_Stepll_final.pdf
[8] http://www.town.bradfordwestgwillimbury.on.ca/articles/MasterServicingStudy
[9] RAL Engineering LTD. (2004),

The MCA for the treatment technologies in **Figure 7.8** is shown in **Table 7.11**.

Table 7.11 - Multi-criteria Analysis of Dirty Water Treatment Options for MM

	Dirty Water Treatment for Metro Manila	Selected Weighting	Judgement Rankings				
			Continuous Activated Sludge	Sequencing Batch Reactor (SBR)	Trickling Filter w- Plastic Media (TF)	Anaerobic (UASB) - SBR	Anaerobic (UASB) - TF
No.	**Multi-criteria Analysis of Constraints**	(x / 100)	(1 to 10)	(1 to 10)	(1 to 10)	(1 to 10)	(1 to 10)
1	Cultural Acceptability in MM	0					
2	Affordability (NPV @ end of 10yr @ 6%)	25	9.2	9.6	9.3	10.0	9.0
3	Disease Prevention	10	10	10	10	10	10
4	Protection of the Environment	10	8	8	9	9.5	10
5	Consistency with MWCI and/or MWSI Plans	10	10	10	10	9	9
6	Land Take	20	8.5	9.2	7.6	10	7.0
7	Traffic Disruption	0					
8	System Design & Complexity	5	7	7	8	6	6
9	Operations & Maintenance Costs	10	8.1	8.8	9.6	10.0	10.0
10	Management of Flow / Pollution Loads	5	10	10	10	10	10
11	Management/Recycle of Residuals	5	8.5	8.5	9	9.5	10.0
	TOTAL WEIGHTING (should be 100):	**100**					
	INDIVIDUAL SCORES (x / 1000 max):		**888**	**920**	**904**	**963**	**885**
	HIGHEST SCORE:		**Anaerobic (UASB) - SBR**				

The MCA was weighted heavily (25%) toward affordability and yielded that the **UASB-SBR** and **SBR** methods are the most preferred methodologies for dirty water treatment in MM of those five processes considered. The MTSP Master Plan (NJS, 2004) also preferred the use of SBRs and oxidation ditches of the treatment trains they considered. The UASB-SBR also came up with the smallest requirement for land.

7.4.4 The Selected Dirty Water Treatment Approach for Metro Manila

- Generally use an Anaerobic-Aerobic biotreatment (UASB – SBR) for a system of Decentralized Treatment Plants.
- Employ a simple SBR biotreatment where the UASB – SBR combination is inappropriate: example would include dilute sewage feed.
- Eventually convert the smaller Decentralised Treatment Plants into larger Centralised Treatment Plants.

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7.5 Solids Management

7.5.1 Background

In Metro Manila today, there are four sewage treatment plants with total capacity of 67 MLD, serving residential-commercial-institutional and mixed-use development with a total catchment area of 1,765 ha. These operating plants produce digested sewage sludge that is air dried on beds at their respective plant sites. Private entities haul most of the dried sludge to be used for fertilizer mix. Grits, plastics and other debris screened from the influent sewage are collected and co-disposed with other solid wastes.

The large Manila Central Sewerage System disposes sewage via a 2 km outfall pipe offshore into Manila Bay. The Dagat-Dagatan Sewerage System utilises waste stabilization ponds. These two plants essentially generate no sewage sludge for regular disposal, except for the screened debris at the pumping stations and coarse solids at influent grit chamber of the Tondo Pumping Station. Considering the small volumes generated, these wastes are disposed together with garbage.

At present, there is also one Septage Treatment Plant (200 m^3/d capacity for 8 hours or double for 16 hr/day) operating and three proposed plants (total capacity of 2,000 m^3/d) under bidding process and expected to be operational in mid 2007. Treatment of septage is discussed in Chapter 9, but solids generated from septage treatment plants can be considered as sludge/biosolids and are covered in this section.

The rapid urbanisation in Metro Manila and the increasing awareness of degrading environment, make it imperative that sludge production from treatment plants be properly regulated. Rules and regulations (including the recent Clean Water Act) for the environmental discharge of treated effluent are currently covered but it appears not to be the case for the residuals produced from the treatment plant operations.

7.5.2 Definitions

Sludge and Biosolids - The **residuals** of dirty water (sewage) treatment are commonly termed **sludge** or **biosolids**. The Water Environment Federation (WEF) promotes the use of the term biosolids to reflect the fact that wastewater solids are organic products that can be beneficially used. A decision as to when sludge meets beneficial use criteria is determined by compliance with the US EPA 40 CFR Part 503 regulation. The term **sludge** is only used before beneficial use criteria have been achieved, e.g. primary sludge, waste activated sludge, secondary sludge, etc. These sludges are residuals before any stabilization process is made to attain beneficial use criteria. The term **biosolids** is used to describe the residual after beneficial use criteria have been achieved through processes such as stabilization or composting. When it is uncertain whether the beneficial use criteria have been met, the term **solids** is used.

The generation of dirty water treatment **residuals** depends on the treatment process, i.e. the amount and characteristics of solids generated in a treatment plant is affected by how the liquid streams are processed. Biological nutrient removal processes typically produce secondary solids that are harder to dewater. Centrifuge dewatering of anaerobically

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digested sludge produces centrate with a high ammonia concentration that will increase the ammonia loading to a biological nitrogen removal process.

7.5.3 Sludge Production / Treatment / Disposal by Existing Plants

Several sewerage systems in Metro Manila were visited in March – April 2005 to observe the current operation of the treatment plants and facilities, clarify / update information obtained from reports, and inquire on current problems of the systems. The visits included observations on the treatment / disposal of sludge, septage, and effluent water. A detailed report on the plant visits is presented in *Strategic Action Paper No.10 – Sludge Management and Water Recycling for Metro Manila.*

Table 7.12 presents a summary of the treatment processes and theoretical estimates of the generated sludge from the wastewater treatment plants in Metro Manila.

Table 7.12- Estimate of Sludge Output of Existing Treatment Plants

System	Service Area (ha)	Plant Capacity	Treatment Process	Dry Sludge Estimate (tons/day)	Remarks
Sewage Treatment Plants (STP)		MLD			
1. Magallanes WWTP	600	40	Activated sludge	11	At maximum capacity with BOD_{in}=400 mg/L
2. Ayala Alabang STP	350	10	Activated sludge	3	
3. Filinvest Alabang WWTP	375	11.7	Activated Sludge	3	At maximum capacity with BOD_{in}=400 mg/L Plant capacity is for partial development
4. Global City	440	5.3	Activated Sludge	2	At maximum capacity with BOD_{in}=500 mg/L. Present capacity for partial development
Small Community STPs					
5. Quezon City (10 sites)	604	22.2	Activated Sludge	3	At maximum capacity with BOD_{in}=250 mg/L
6. Makati/Mandaluyong (2)	11.5	1.1	Activated Sludge	0.2	
7. Karangalan Village (9) (Cainta & Pasig)		7.5	Activated Sludge	1	
8. Taguig City (5)		4.8	Activated Sludge	1	
9. Smokey Mountain NHA		4	TrickLing filter	1	At maximum capacity with BOD_{in}=300 mg/L
Septage Treatment Plants (SpTPs)					
1. Dagat-Dagatan	MWSI	200 m^3/d	Screening, dewatering, biological	31	Started operating March 2005
2. Antipolo SpTP	MWCI	600	-do-	93	For construction,

System	Service Area (ha)	Plant Capacity	Treatment Process	Dry Sludge Estimate (tons/day)	Remarks
Sewage Treatment Plants (STP)		MLD			
3. South SpTP, Taguig City	MWCI	800 2000 (sewage)	-do- + SBR	124 +0.4	expected to operate mid 2007
4. North SpTP, San Mateo	MWCI	600	-do-	93	

Notes:

(i) Present sewage / septage influent are below plant capacities

(ii) Waste stabilization pond system for Dagat-Dagatan and Bay outfall of Manila Central Sewerage System do not generate sludge for regular disposal.

(iii) Private wastewater treatment plants serving commercial establishments are not included.

(iv) Biosolids production in SpTP is based on the F/S of the 600 kL Antipolo SpTP assuming septage treatment by lime stabilization and dewatering.

7.5.4 Previous Studies on Sludge Management

The most recent relevant studies that address sludge management were the 2000 West Zone Sewerage Master Plan, prepared by PhilAqua and the 2004 MWCI Biosolids Management Strategy prepared by GHD. The outcomes of these two studies are discussed briefly below.

(a) 2000 West Zone Sewerage Master Plan (PhilAqua)

The proposed sewerage master plan for the West concession area comprised sewer networks draining into trunk mains leading to three STPs at the shores of Manila Bay, where enhanced primary treatment of sewage was proposed.

Sludge Disposal - To reduce the amount of land required at the proposed STPs, sludge was to be transported off-site for further treatment at locations where the price of land is lower. Since STPs were to be located along the Bay, barges would be used to transport the thickened liquid sludge to treatment and disposal sites located along Manila Bay north of Manila. Buffer storage tanks should have sufficient capacity to store the thickened sludge for four days. These buffer tanks should normally be kept almost empty so sludge could be transported as soon as possible. Several potential sites had been identified where biosolids maybe developed for reuse.

The sludge was to be pumped from the barges into the deep lagoons where it would be held for a period of up to 12 months, during which time it would be stabilized by the anaerobic digestion process. A small proportion of the stabilised sludge might be re-used in slurry (liquid and solid mix) form for application to agricultural or forestry land. It would also be beneficial if the biosolids were to be marketed in solid or cake form.

Since there might not be a large market for the re-use of all the biosolids produced, the excess could either be disposed in a landfill site or retained for possible future re-use. There is no known opportunity for co-disposal of biosolids with municipal solid waste. Bunded and lined monofill landfill areas could be developed for disposal of surplus de-watered biosolids.

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Sludge quantities generated by the enhanced sewage primary treatment for processing by the Biosolids Treatment Works (TW) were estimated and shown in **Table 7.13** below.

Table 7.13 – Estimated Sludge Generated by West Comcession MP STPs

Period TW Type *Location*	Design Population Equivalent	Tons of Dry Solids per Day	Required Land Area for TW (ha)	Treatment Works (TW) Process
2001 to 2006 Biosolids TW *1 Site*	2,787,000	108	53	BUF – Barge Unloading Facility ADL – Anaerobic Digestion Lagoons BDP – Biosolids Dewatering Plant CTL – Centrate Treatment Lagoons BSA – Biosolids Storage Area
2007 to 2011 Biosolids TW *1 Site*	4,202,000	176	97	Site 1 - Extend: ADL, CTL, BSA
2012 to 2016 Biosolids TW *2 Sites*	6,103,000	281	198	Site 2: New BUF. ADL. BDP, CTL, BSA
2017 to 2021 Biosolids TW *3 Sites*	7,969,000	614	382	Site3: New: BUF, ADL, BDP, CTL, BSA

(b) 2004 MWCI Biosolids Management Strategy: Options Study (GHD Pty Ltd)

The Study commissioned by MWCI aimed to improve and streamline current biosolids management practices in anticipation of the significant increases in the rate of biosolids generation (from 95 m^3/d to around 400 m^3/d of dry solids) from the current and future sewage / septage treatment plants.

The Study had the following conclusions:

- Biosolids produced from the MWCI Plants are unstabilized. The use of biosolids should be restricted and applied to land, adopting international practices;
- Current viable markets (i.e. disposal options) include the rehabilitation of the lahar fields and in extensive agriculture in nearby provinces;
- In the short-term, management of the application of biosolids in these markets needs to be improved for health and safety reasons, and to avoid potential environmental harm in the long-term. This should include reviewing the current practice of distributing dried sludge to third parties;
- The production of higher quality biosolids will create alternative markets, which are likely to be closer to Metro Manila and transportation costs will be lower;
- Having a range of viable markets will reduce risks for MWCI in case the current options are restricted, like potential disruption due to storms and other unforeseen events; and
- A landfill option would play a significant role in contingency planning.

Based on the outcomes of the Study, strategies for a short-term (up to 2005), medium-term (2005-2010) and long-term (beyond 2010) were proposed.

The strategies identified the biosolids markets and the appropriate technologies for sludge stabilization. The biosolids markets include: lahar application, extensive or intensive agriculture, transport/management, and disposal. The identified technology for sludge treatment include stabilization and dewatering. The markets and technologies are developed progressively.

The Study identified the potential biosolids reuse market sectors as follows:

- Extensive agriculture such as livestock and pasture production, broad cropping or plantation forestry;
- Intensive agriculture such as nurseries, fruit and orchard growing, market gardening, turf grass growing, etc;
- Land rehabilitation such as land/mine-site reclamation, landfill, erosion stabilization;
- Landscaping such as domestic horticulture, municipal parks, sports ground, etc;
- Energy recovery such as gasification, pyrolysis, anaerobic digestion, etc; and
- Bioremediation for contaminated soils.

The Study recommended high priority for extensive agriculture and land rehabilitation considering the lower quality sludge for these markets. Low priority is recommended for landscaping and intensive agriculture due to the higher quality sludge required and the demand is not as large as for extensive agriculture and land reclamation.

The estimates of the dry solids by the sewage treatment plants (shown as STPs below) and septage treatment plants (shown as SpTPs below) are given in **Table 7.14** below.

Table 7.14 – Estimate of Dry Solids Generated by MWCI Treatment Facilities

Source	Dry Solids (kg/d)	Transport Volume (m^3 / day)	Type of Biosolids	Remarks
Magallanes STP	1,500 to 2,000	4 to 7	Stabilised and Dried Sludge	Anaerobic Digester and sludge drying beds
Pabahay Village STP	8	1	Liquid Sludge	Sludge holding tanks on-site. To septage tanks
Villa Verde STP	1.5	0.15	Liquid Sludge	Sludge holding tanks on-site. To septage tanks
Karangalan Village STP	7	0.4	Liquid Sludge	Sludge holding tanks on-site. To septage tanks
MSSP STPs	550	2.2	Liquid Sludge	Plate filter pressed on site. No stabilization
MTSP STPs	31,300	125	Liquid Sludge	Plate filter pressed on site. No stabilization
MTSP STPs	794	32	Liquid Sludge	Thickening only
MSSP STPs (JFE)	1,276	160	Liquid Sludge	Holding tanks prior to transport to STP
PRRC SpTP	90,000	90	Stabilised	Screw press and lime stabilization
Payatas SpTP	22,200	74	Wet Septage	Limited to dewatering of septage
Taguid SpTP	31,000	103	Wet Septage	Limited to dewatering of septage

7.5.5 Sludge Treatment and Disposal (Biosolids Management)

7.5.5.1 General

There are various sources of sludge in the sewage treatment process as illustrated in **Figure 7.9**. The grit (sand, broken glass, plastics, etc) collected in the grit chamber is solid materials and are not considered sludge. Raw sludge settled at the bottom of primary clarifiers contains about 3% to 8% solids (approximately 70% organic). It rapidly becomes anaerobic and highly odiferous. This sludge is usually thickened using gravity thickeners. Secondary sludge, or wasted sludge from secondary treatment processes, consists of microorganisms and inert materials that are about 90% organic. In the absence of air, it becomes anaerobic and emits noxious odors. Trickling filter sludge has higher solids content (2 to 5%) than wasted activated sludge (0.5 to 2%). When the aeration tank also serves as a reaction basin for phosphorus removal, the secondary sludge produced contains large amounts of chemical precipitates (Davis and Cornwell 1995).

The characteristics of tertiary sludge vary depending on the tertiary treatment process involved. In the removal of phosphorus, the sludge produced is difficult to handle and treat. In nitrogen removal by denitrification, the resulting biological sludge has properties similar to those of waste activated sludge.

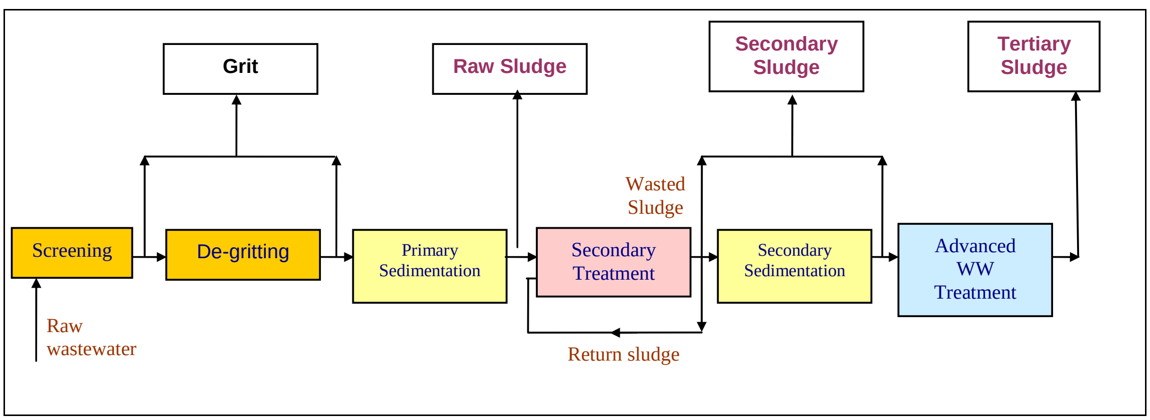

Figure 7.9 - Solids Flow in a Dirty Water Treatment Process

7.5.5.2 Biosolids Handling

The basic treatment processes for sludge/biosolids include the following:

a) Thickening

Sludge thickening is the process of reducing the water content of sludge to about 4% (secondary sludge) or 7% (primary sludge). The primary objective of this process is to remove as much water as possible prior to sludge digestion or final dewatering. This can be achieved using gravity thickeners or flotation units. In gravity thickening, the sludge that settles to the bottom is scraped into a hopper. In the flotation process, pressurized air is injected into the sludge. As the sludge flows into an open tank at atmospheric pressure, solid particles attach to the minute air bubbles coming out of the sludge. This sludge layer can be removed by skimming.

b) Stabilization

Stabilizing the sludge eliminates the unpleasant odors emitted during putrefaction through biochemical breakdown of organics in the sludge. Sludge stabilization techniques include anaerobic/aerobic digestion, lime stabilization, composting, and thermal drying. Currently, there is no requirement to stabilize sludge prior to disposal.

c) Conditioning

Sludge conditioning is the treatment of sludge with chemicals or heat to enhance water separation. In chemical conditioning, the coagulants (such as ferric chloride, lime, cationic/anionic polymers, and ash from incinerators) added to the sludge act to clump the solids together. In sludge conditioning by heat treatment, the sludge is subjected to high temperatures (175 to 230°C) and pressures (1000 to 2000 kPa) thereby releasing the bound liquid in the sludge. Sludge conditioned through this process dewaters better than chemically conditioned sludge. However, the operation and maintenance of thermal conditioning units is more complex.

d) Dewatering

The final separation of water and solids in sludge can be achieved by subjecting the sludge to vacuum, high pressure, or drying. Common equipment include: drying beds, vacuum presses, belt filters, and centrifugal filters.

7.5.5.3 Sludge Production Estimates

Considering the projected population during the planning period years 2005-2025 and the concession area targets, the estimated sludge/biosolids production in the MWSS service area is shown in **Table 7.15.** Sludge/biosolids generation in the sewered areas exhibits an increasing trend but is much smaller compared to that from non-sewered areas, which is relatively constant. These trends are attributed to the increasing sewerage targets and decreasing sanitation targets, as reflected in the concession targets.

Table 7.15 - Estimated sludge/biosolids production

Design year	Served Population	Sludge from sewered area, in metric tons/day	Sludge from non-sewered area (septic tanks), in metric tons/day
2010	**15,017,380**	48.85	1, 473.3
2015	**16,436,369**	88.69	1, 487.9
2020	**17,929,483**	111.8	1, 170.6
2025	**19,494,777**	197.2	1, 304.5

7.5.5.4 Sludge/Biosolids Disposal Alternatives

There are a number of disposal/management options for the residuals in sewage treatment. Some of the important and practical alternatives are discussed below:

a. Disposal to landfill

In landfilling, the sludge is buried in excavated trenches and covered with soil. The sludge can be buried either wet or dewatered. Incinerated sludge can also be disposed to a land fill. In general, the highest disposal costs are associated with the disposal of untreated wet sludge. Disposal costs decline with the reduction of sludge volume.

Septage collected from septic tanks may be co-disposed with solid waste at controlled proportions. This option is limited to areas with precipitation rates of less than 90 cm/year. The disadvantages of this method include: possible vector attraction issues, foul odors, and leachate production and requirement for treatment. Advantages include biological activation of the landfill with increased disposal volume created.

b. Lagooning

When STPs are located in remote areas, untreated or digested sludge can be deposited in lagoons (earthen basins). The solids settle to the bottom of the lagoon. Any excess liquid from the sludge may be returned to the treatment plant. When cleaning is to be done by scraping after lagoon is dried, the lagoon should be shallow, with depths of about 1-1.5 m.

c. Ocean dumping

Sea disposal of sludge is based on the premise that marine water can naturally assimilate and degrade most organic contaminants in sludge. This is practiced by some Asian countries like Japan and Korea. In the Philippines, the permit to dump is issued by the Philippine Coast Guard.

d. Incineration

If sludge as soil conditioner is impractical, or if a site is not suitable for landfill using dewatered sludge, the sludge may be incinerated. To minimise fuel costs, the sludge must be dewatered before it is incinerated.

Sludge may be incinerated when beneficial use is impractical or a landfill site is not suitable for dewatered sludge. Incineration is capital and energy intensive. To reduce fuel costs, it is recommended that sludge be dewatered prior to incineration.

e. Aquaculture Disposal

Sludge is utilized either as a primary or as a secondary food substance for fish stocks in controlled aquaculture programs. When used as a primary substance, sludge becomes a food stock for fish which are harvested for direct human consumption. When used as a secondary substance (frequently to overcome social stigmas) sludge is used as food stock for fish which are harvested and processed into fish meal. The fish meal is then used as a high protein food supply for carnivorous fish.

f. Beneficial Use as Soil Conditioners

Biosolids can be used as soil conditioner. The most important consideration in this method is the cost of hauling the sludge to a suitable site. Within Metro Manila, this cost is expected to be very high as suitable agricultural areas are distant from the cities. The primary concern in applying the biosolids to soil is the possible presence of residual pathogenic organisms, helminth ova and heavy metals.

Depending on its grade (classification), the biosolids can be applied on top soil or at the sub-surface level. High-grade biosolids can usually be applied on top soil with minimal consideration. Lower-grade biosolids need to be applied at the sub-surface to minimize potential foul odor emissions and vector attraction. In the case of septage applied at the sub-surface level, the nitrogen removal rate is significantly reduced because ammonia volatilization is eliminated.

g. Land Spreading

Land spreading is the process of applying residuals to land for the purpose of recovering nutrients and water, and reclaiming despoiled land such as mine spoils.

7.5.6 Relevant Philippine Rules and Regulations on Biosolids Management

7.5.6.1 Code of Sanitation

The Code of Sanitation (PD 856) has been the basis of rules and regulations imposed for sludge/biosolids management. Chapter XVII of the Code particularly contains provisions for management of sewage, domestic sludge and septage.

With the continuous degradation of the river systems due to indiscriminate dumping of septage collected from individual septic tanks, the DOH in 2004 issued supplemental IRR for Chapter XVII to cover stricter guidelines on collection, transport, treatment and disposal of domestic sludge and septage.

Section 6 of the supplemental IRR recommended mandatory septage and domestic sludge processing and treatment prior to disposal. Treated or processed domestic sludge and septage must be properly disposed off via landfill and land application. However, the Code did not specify pertinent standard limits for the characteristics of sludge prior to disposal. The DOH-approved treatment methods include, but are not limited to the following: thickening, stabilization, conditioning, disinfection, and heat drying.

Prior to disposal, the sludge must be analyzed for nitrogen, phosphorus, potassium, pathogens, essential and heavy metals. In the absence of Philippine set of standard limits, the DOH and DA recommend the adoption of US EPA procedures for biosolid processing and disposal.

7.5.6.2 Clean Water Act

The Clean Water Act (CWA) reiterates the requirement of the PD 856 on mandatory connection of domestic wastewater sources to existing sewerage systems. The CWA mandates the Department of Public Works and Highways to prepare the National Sewerage and Septage Management Program. The program shall include guidelines on sludge management for companies engaged in desludging operations, which would fortify existing guidelines prescribed by the supplemental IRR of PD 856.

Section 8 of the CWA also tasked the DOH to develop standards and guidelines for the disposal of septage and domestic sludge. For land application, the DA is tasked to develop necessary standards prior to land application of the biosolids.

The Bureau of Soil and Water Management (BSWM) of the Department of Agriculture has yet to establish allowable and acceptable limits for biosolids characteristics for the purpose of agricultural productivity enhancement. The DOH is also mandated to develop similar limits (both for sludge and biosolids) for protection of public health and the receiving water environment.

7.5.6.3 USEPA Guidelines Recommended by the DA and DOH

The USEPA, in response to the US Clean Water Act Amendments of 1987, adopted "*The Standards for the Use or Disposal of Sewage Sludge (Title 40 of the Code of Federal Regulations [CFR], Part 503"*. It establishes the minimum requirements for biosolids intended for land application. Sludge that exceeds the concentration limits for nine trace elements (listed in **Table 7.16**) may not be directly applied to soil.

Table 7.16 - USEPA Concentration Limits for Trace Elements

Pollutant	CCL [a,b] ppm[f]	PCL [a,c] ppm	CPLR [a,d] lbs/acre
Arsenic	75	41	36
Cadmium	85	39	35
Copper	4600	1500	1340
Lead	840	300	270
Mercury	57	17	16
Molybdenum	75	[e]	[e]
Nickel	420	420	375
Selenium	100	100	89
Zinc	7500	2800	2500

[a] dry weight basis
[b] CCL (Ceiling Concentration limits) = maximum concentration permitted for land application
[c] PCL (Pollutant Concentration Limits) = maximum concentration for biosolids whose trace element pollutant additions do not require tracking (i.e. calculation of the CPLR)
[d] CPLR (Cumulative Pollutant Loading Rate) = total amount of pollutant that can be applied to a site in its lifetime by all bulk solids meeting CCL.
[e] The February 25, 1994 Part 503 Rule amendment deleted molybdenum PCL for sewage sludge applied to agricultural land but retained molybdenum CCL.
[f] ppm = part per million

The Part 503 regulation requires the reduction of pathogens (virus, bacteria, and worms) and vector (rodents, birds and insects) attraction properties of sludge/biosolids. Two types of biosolids, Class A and Class B, are specified based on the levels of pathogen present. Pathogen requirements (**Table 7.17**) for Class A aim to reduce the pathogen levels to below detectable levels. Requirements for Class B are intended to ensure that pathogens have been reduced to levels that are unlikely to cause threat to public health and environment, especially after its disposal. The 503 *Regulations* also enumerate eleven alternatives for vector attraction reduction. These include 38% reduction of volatile biosolids, achievement of oxygen uptake rate of 1.5 mg O_2 per hour per gram dry solids at 20˚C, and alkaline stabilization.

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Table 7.17: US EPA Pathogen Requirements for Biosolids

Class A Pathogen Requirements
• Fecal coliform density of less than 1000 most probable number (MPN)/g total dry solids • A Salmonella sp. Density of less than 4 MPN per 4 g dry solids
Class B Pathogen Requirements
• Treatment by processes to significantly reduce pathogens or equivalent processes • At least seven samples should be collected at the time of use or disposal and analyzed for fecal coliform during the monitoring period. The geometric mean of the densities of these samples will be calculated and should meet the following criteria: less than 2.0×10^6 MPN/g total solids or less than 2.0×10^6 colony forming units (CFU)/g total solids.

The quality of biosolids is classified in terms of the pollutant (trace element) concentrations, pathogen levels, and vector attraction reduction control. The classification determines which land application requirements must be met. Biosolids that meet the Part 503 PCLs, Class A pathogen reduction, and vector attraction reduction option that reduces organic matter are classified as *exceptional quality* or *EQ biosolids*. *Pollutant concentration (PC) biosolids* satisfy the same PCLs as EQ biosolids but it usually meets class B rather than Class A pathogen requirements. *Cumulative Pollutant Loading Rate (CPLR) biosolids* requires tracking of the cumulative metal loadings other than just meeting the PCLs

7.5.6.4 Existing Permitting Procedure in the Philippines for Disposal of Sludge/Biosolids

a) Disposal via Ocean Dumping

The disposal of sludge/biosolids via ocean dumping must secure the following permits shown in **Table 7.18**.

Table 7.18 - Requirements for ocean dumping

Permit	Designated Office	Remarks
Permit to Dump	Philippine Coast Guard	The proponent must submit permit to dump application indicating method of dumping, frequency, volume and the anticipated impacts.
Environmental Compliance Certificate	Environmental Management Bureau	This maybe required by PCG when disposal site is considered environmentally critical.
LGU Endorsement	Affected LGU (provincial offices)	This is part of the ECC documentation but may be required by PCG independent of the ECC.
Certificate of Exemption from RA 6969 (Toxic and Hazardous Waste Act)	National Solid Waste Management Commission	This is required by PCG to certify that wastes being dumped re exempted from RA 6969

b) Disposal via Landfill

Landfilling of sludge is a DOH approved method of disposal. The environmental and technical criteria on the design and operation of such landfill accepting sludge are stipulated in the 2004 supplemental IRR of PD 856.

The disposal of sludge/biosolids via landfill must conform to the following permitting procedures shown in **Table 7.19.**

Table 7.19 - Requirements for Landfilling the Biosolids

Permit	Designated Office	Remarks
ECC	EMB-DENR	The sanitary landfill must have a valid environmental compliance certificate.
Certificate of Exemption from RA 6969 (Toxic and Hazardous Waste Act)	National Solid Waste Management Commission	This maybe required by the LGU or operator of the landfill to certify that wastes being disposed off are exempted from RA 6969. The proponent must prove this by a comprehensive characterization of their sludge and comparison with existing USEPA standards.

c) Disposal via Land Application for Soil Conditioning

Sludge/biosolids may be applied to land both as a soil conditioner or an organic fertilizer. In both cases, the manufacturer of such products must register with the Fertilizer and Pesticide Authority (FPA), an attached agency of the DA, as a fertilizer manufacturer/distributor. Each product must then be submitted for registration with the same office prior to sales and distribution to end users.

The disposal of sludge/biosolids via land application must conform to the following permitting procedures shown in **Table 7.20**:

Table 7.20 - Requirements for Land Application

Permit	Designated Office	Remarks
ECC with Proof of Social Acceptability	EMB-DENR	The ECC will be required and may be applied in the appropriate EMB regional office.
License as Fertilizer Manufacturer	Fertilizer and Pesticide Authority	The proponent must register as both manufacturer and distributor of fertilizer (organic or soil conditioner).
Certificate of Product Registration	Fertilizer and Pesticide Authority	The proponent must register every product manufactured prior to sales and distribution.

At present both MWCI and MWSI are registered with the FPA as fertilizer manufacturers. MWCI has already registered their domestic dried sludge and domestic liquid sludge as soil conditioners for corn and sugarcane, respectively. MWSI is on the process of securing permanent registration of their products.

The registration took MWCI almost three (3) years prior to securing a permanent product registration. The registration involves the following procedure shown in **Table 7.21.**

Table 7.21 - MWCI Registration Procedure for Permit to Dispose Biosolids

Procedure	Activities Involved
Initial Phase – Laboratory	• Sludge/septage and soil characterization • Laboratory scale studies • Comparison with US EPA limits
Temporary Registration	• Pilot application on proposed site • Monitoring of soil characteristics (pre and post amendments) for heavy metals, pathogens and nematodes/helminth eggs • Groundwater and surface water monitoring • Crop/ agricultural productivity evaluation • Comparison with US EPA limits for biosolids and sludge-amended soils
Permanent Registration	• Commercial distribution to end users i.e., farmers • Distribution must be supported by manifest. • Annual monitoring of soil • Regular monitoring of surface and groundwater

7.5.7 The Selected Biosolids Management Approach for Metro Manila

Following the non-renewal of the permit to dump septage at sea, the options for biosolids managements are limited to land spreading, beneficial use (soil conditioner), and landfilling. These disposal options are currently practiced by the MWSS Concessionaires, and the operators of private STPs. In the absence of a septage treatment plant, MWCI mixes and spreads collected septage with lahar at a site in Pampanga. The sludge that accumulated in the aerated lagoons at Dagat-Dagatan over its 20-year operation was applied to a farm site in Batangas. Private-owned and managed STPs at the Global City and at Ayala Alabang dispose digested/dried biosolids by on-site land application.

7.5.7.1 Short term

On-site land application of biosolids produced in sewage treatment is recommended for STPs with sufficient land area. The Ayala Alabang, Global City, and Dagat-Dagatan STPs currently adopt this option. In most of the new small STPs built within the east concession area, land space is limited and sludge disposal should be off-site, either by application to nearby agricultural lands or by landfilling. Similarly, septage collected from septic tanks may be land applied after sufficient treatment (drying, digestion, composting and stabilization) is done.

7.5.7.2 Medium term

With the increasing demand for landfills that will accommodate the solid waste generated in Metro Manila, the management options for biosolids should rely less on landfill disposal. Sludge management options should take advantage of the high organic and nutrient content of the residuals from wastewater and septage treatment processes.

A biosolids grading system should be recommended for residuals intended for land application and landfilling. This grading system should consider the local conditions (soil type, climate, land use) in the Philippines. As an alternative to the USEPA guidelines currently being followed, the DOH may consider the South Australian biosolids classification system that govern the re-use of the biosolids as indicated in **Table 7.22.**

Table 7.22 Australian Biosolids Re-use Classification

Biosolids Classification	Allowable Land Application Use	Minimum Quality Grades	
		Contaminant Grade	Stabilization Grade
Unrestricted Use	Home Lawns and gardens Public contact sites and Urban landscaping Agriculture and Forestry Soils and Site rehabilitation Landfill disposal Surface land disposal[2]	A	A
Restricted Use 1	Public contact sites and Urban landscaping Agriculture and Forestry Soils and Site rehabilitation Landfill disposal Surface land disposal[2]	B	A
Restricted Use 2	Agriculture and Forestry Soils and Site rehabilitation Landfill disposal Surface land disposal[2]	C	B
Restricted Use 3	Forestry Soils and Site rehabilitation Landfill disposal Surface land disposal[2]	D	B
Not Suitable for Use	Landfill disposal Surface land disposal[2]	E[1]	C[1]

[1] biosolids products which are not contaminant or stabilization graded are automatically classified *Not suitable for Use*
[2] to be applied within the boundaries of the sewage treatment plant site

7.5.7.3 Long term

The establishment of a management program and marketing strategies for the biosolids will address the disposal issues in the years to come. These program and strategies should address biosolids regulation issues, land availability, economic factors involved, and promotional/information drives among end-users (farm owners).

7.6 Water Recycling & Reuse

Reclaimed or recycled water is not a new development. Historically, rivers have been used to receive effluents from community, agricultural and industrial activities at an upstream location and be drawn downstream for the same water uses. In this study, recycled water is defined as given by the California Water Code as "water which as a result of treatment of waste, is suitable for direct beneficial use or a controlled use that would not otherwise occur."

The effluent from treatment plants (STP & SpTP) is the main source of water for recycling purposes. The reuse of water from these plants reduces (i.e. replaces) demand of potable water for non-potable means. This ensures that sources are reserved for public drinking which is considered as the highest priority of water use.

7.6.1 Trends and Needs for Water Reuse

Recycled water can replace potable water for a multitude of applications. Applicable treatment for the various water requirements, depending on human contact, for each should be made. The need for recycled water in different sectors is listed below.

(a) Agricultural Irrigation
- Irrigation of food and non-food crops
- Pasture and fodder for gazing animals
- Stock water
- Washdown water for stockyards and non-food contact areas of dairies

(b) Municipal
- Irrigation of public parks and gardens, sports fields, school ovals and median strips
- Irrigation of golf courses including those incorporating residential development
- Ornamental landscapes including decorative ponds
- Dust suppression at construction sites and mines

(c) Residential (Non-Potable)
- Garden watering
- Toilet flushing
- Car washing
- Path/wall washing

(d) Industrial
- Cooling system and make-up water
- Boiler feed water
- Process water
- Washdown water
- Fire protection
- Dust control

The prevalent practice in most of the STPs within the service areas of MWCI and MWSI is direct discharge of the plant's effluent to nearby creeks, streams or rivers. Smaller STPs built by MWCI as part of the MSSP Community Septage Program (MCSP) are using recycled water for the flushing of toilets inside the plants. Water recycling methods were being proposed or practiced by only a number of the STPs visited by the study team. These STPs and their water reuse are as follows:

(a) Ayala Alabang STP

The water effluent of the plant is used for irrigation to sustain a variety of flora within the STP grounds. Water hoses are used for irrigation. Benefits of the use of recycled water for irrigation can be seen in the growth of the plants and trees even during the dry season. Chlorinated effluent water is also used for golf course irrigation.

(b) Fort Bonifacio STP

The development in the Fort Bonifacio included purple water pipes for recycled water, in particular, for irrigational purposes. Previous requirements for the locators included recycled water piping for toilet uses. The main pipe from the STP to Fort Bonifacio has yet to been laid.

(c) Guadalupe Bliss STP

The STP at Guadalupe Bliss has made provisions for the collection of Metro Manila Development Authority (MMDA) water trucks. Water is being use to irrigate plants along and in the road islands.

(d) UP Diliman STP

The newly constructed UP Diliman STP also constructed a truck refilling system to accommodate MMDA trucks. Water from the lagoon surrounding the STP is also pumped back to the UP main campus lagoons for polishing (nutrient removal) which also serves as ornamental ponds.

7.6.2 Quality Standards / Rules and Regulations for Disposal / Constraints

The quality standards for water reuse come from the applicable uses. The minimum treatment is preliminary sedimentation or any equivalent solid removal process followed by stabilization process (i.e. lagoon) or full secondary treatment. The recommended detention period for lagoons after preliminary sedimentation should be a minimum of 25 days. This is to remove Helminth eggs as well as reduce effluent concentrations of 1000 thermotolerant (or E.*coli*) /100 mL. Detention period of 60 days removes intestinal protozoa and viruses (EPA, 1999). The treatment processes involve any of the following: Primary Treatment; Secondary Treatment; Tertiary Treatment; Treatment Lagoons; and Disinfection.

The classification of water reuse shall determine the amount of treatment and the usage. In the Philippines, there is no legislation for treatment and reuse of recycled water. The classification is crucial in the determination of health risks involved in the handling of recycled water.

The main constraints in recycled water stem from public perception of it. Locally, the standards set are those only for the attainment of the quality of the receiving body of water for discharge effluents. Further treatment to attain high recycled water reuse is a matter of economic viability.

7.6.3 Estimates of Effluent Volume and Quality (Present and Design Periods)

The amount of wastewater losses inside STPs is concentrated only in the solids removed through the various treatments such as settling and sludge production. The total volume of the losses is but a small percentage of the volume of the wastewater. For this study, the total capacities of the STPs shall be considered the effluent production. The effluent volume of existing STPs is shown in **Table 7.13.**

The effluent qualities of the STPs mentioned are mostly discharging to creeks and rivers within Metro Manila classified under Department of Environment and Natural Resources (DENR) standards as Class C. The effluent quality of the STPs adheres to the effluent standards set under DENR Administrative Order (DAO) 35 for class C inland waters. It is therefore assumed that the quality of effluent from these STPs meet the requirement.

7.6.4 The Selected Water Reuse Approach for Metro Manila

The development of potable water sources and the means to bring it to Metro Manila significantly lags behind the water needs of the demand centers. Besides water conservation, the re-use of effluent from wastewater treatment plants can narrow the gap of supply and demand for water.

Municipal uses such as irrigation for parks and landscapes should be encouraged. The on-going collection of the recycled water from the STPs should be continued on a larger scale. The use may not be limited to roadway irrigation but for road construction and rehabilitation works. Nearby fire departments may also use recycled water as added reserve for fire trucks.

The potential use of recycled water for processes should also be further investigated. The water demand of applicable non-sensitive processes, i.e. boiler feed and cooling systems, may be satisfied by the use of recycled water. Further enhance treatment such as decrease in the level of microorganisms (pathogens and coliform counts) should occur at high temperatures associated with the said processes. Return system of recycled water for industrial uses may restrict expandability to the vicinity of the STPs.

The largest demand for recycled water in Metro Manila may be for irrigational purposes. Nitrogen, phosphorous and potassium removal is not part of sewage and septage treatment currently, making the effluent from the STPs rich in nutrients. Golf courses and agricultural land can benefit from the added nutrients being supplied by the recycled water. Cost savings from a decrease in required fertilizer is also an advantage of using recycled water. Reuse of effluent water will also prevent the effects of eutrification such as water hyacinth and algal bloom in the receiving bodies of water.

The following strategies for water re-use are proposed in the short, medium and long term.

(a) Short Term

The short term plan for the reuse of water should be concentrated on irrigation and other municipal uses. This produces the most immediate and least-cost alternative to be readily implemented.

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(b) Medium Term

The marketing of recycled water to agriculture and industrial uses may be addressed as the medium term. Establishment of recycled water return systems for toilets and other non-potable domestic uses can expand recycled water demand.

(c) Long Term

The establishment of a recycled water management program can address the need, treatment, and standards required for the safe distribution and use of recycled water. This should encompass the long term viability of the reuse of water.

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VOLUME 4
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8. Dirty Water Management

8.1 Lessons from Past Experience

The fact that most of the earlier sewerage master plans prepared in the past for Metro Manila have only been implemented only partially or not at all is no accident. This has been due to the constraints outlined in Chapter 6, but also due to several factors common in such attempts in many developing countries, whereby the approach has been neither demand driven nor incentive driven. These factors are:

- **Use of a supply-driven approach**
This approach develops demand projections based on demographic and economic progress indicators and prepares programs without taking into account the expressed needs of the users. This approach often results in investments that are unaffordable to all but the high-income neighborhoods that limit the ability to recover investment costs with a consequent impact on the ability to provide effective operation and maintenance services.

- **The large scale of urban sanitation projects**
There has been a tendency in the past to propose ‘macro’ projects for urban sewerage and sanitation. This has resulted in much of the investment being used for expensive trunk sewers or treatment plants, and little to meet the immediate needs of the unserved. To recover these costs, high, unaffordable charges are required that restrict many from connecting to the system. Smaller scale projects based on an overall strategic framework could be considered to bring some benefits to those in greatest need.

- **Poor system performance**
The inadequate level of operation and maintenance of many sewerage and sanitation systems has resulted in unreliable services and therefore poor collection efficiency and a lack of willingness to pay. Local users, having been excluded from the planning process, have no vested interest in looking after the systems. The result is a downward spiral in service quality, cost recovery and attention to maintenance.

- **Unsustainable investments and illusionary benefits**
In many urban sanitation programs the combination of inappropriate designs, neglect of user requirements and inadequate maintenance has resulted in a disillusionment of users when the improvements do not materialize. More successful programs have generally relied on extensive user involvement in planning, choice of service levels, scale of investments, charges and cost recovery structures.

8.2 The Strategic Sanitation Approach

Applying a strategic planning approach to urban sewerage and sanitation should result in choosing the right policy instruments for service provision, and developing strategic investment and cost recovery programs. The question of appropriate service standards is difficult in that ultimately it should be answered by considering user preference and willingness to pay. In a large city such as Metro Manila, with many pockets of poverty, service standards are likely to be spatially differentiated because many households cannot afford conventional sewerage without massive government subsidies. This indicates that a strategic approach should incorporate differential plans matching housing types, income levels and user preference.

A strategic sanitation approach has been developed by the UNDP-WB Water and Sanitation Program. The strategy is meant to be flexible and adaptive so it can incorporate lessons from new experiences and innovations in the sanitation sector worldwide. The approach involves:

- A wider choice of technology options;
- Recognition and analysis of consumers' willingness to pay for perceived benefits;
- Methods of matching service levels to affordability so as to achieve optimum coverage with economic efficiency;
- Innovative financing mechanisms and institutional frameworks, including unbundling of investments into affordable parts; and
- Capacity building initiatives to enable all levels of government and other stakeholders to implement responsive and sustainable programs.

The main goal of the strategic sanitation approach is the sustainable expansion of sewerage and sanitation coverage. The prerequisites for attaining this goal are investment efficiency and operational efficiency. The strategic measures for achieving investment efficiency are:

- Unbundling sanitation investments such as property connections, feeder sewers, trunk sewers and treatment;
- Utilizing a demand orientation based on what users want and the resources they are willing to use to finance and manage installed systems; and
- Designing and installing facilities so that they function according to the designs and cost-sharing arrangements agreed upon with users.

The strategic measures for achieving operational efficiency are:

- Helping to ensure that the installed facilities are used, as they were intended so that beneficiaries gain optimum health and other benefits. This may require awareness raising and hygiene education to modify behaviors and to encourage proper usage; and
- Providing for long-term and effective management of the facilities. This ensures that sufficient resources will be available to cover operations and maintenance during the active life of the physical infrastructure.

8.2.1 Application of the Strategic Sanitation Approach to the Sewerage and Sanitation Master Plan for Metro Manila

Stakeholder Participation

A demand-based approach is responsive rather than prescriptive, whereby the users and the service agency have common goals, developed through a consultative process involving all stakeholders. Stakeholder consultation activities during the Master Plan preparation have included:

- Establishment of Technical Working Groups comprising government agencies and NGOs to discuss concepts developed for the Master Plan;
- Community consultation (comprising primarily LGU representatives) to discuss Master Plan proposals;
- Focus Group Discussions with community representatives to discuss sewerage/sanitation issues and willingness to pay for services;
- Focus Group Discussions with communities affected by proposed sewage treatment plants; and
- Willingness-to-pay survey where various technical options were presented to users for them to establish a value for the benefits provided.

The consultations were those deemed necessary for a broad master planning approach and within the resource constraints of the project. However, individual projects that are developed out of this master plan, especially within the urban poor communities will require a far more detailed consultative approach whereby the users have the opportunity to consider technological options and payment mechanisms and participate in the planning of the projects that will affect their community.

Widening Technological Options

Developing countries and cities are now realizing that poor urban residents cannot afford, nor do they necessarily want or need costly conventional large bore sewerage. A broad range of cost-effective technologies is now available to respect the demands of urban consumers.

The Master Plan study considered a wide range of technological options for sanitation, sewerage and sewage treatment and evaluated them based on a multi-criteria analysis as outlined in Chapter 7. Technologies included standard approaches such as conventional sewerage, innovative technologies such as condominial, simplified and small bore sewerage and low cost on-site systems such as VIP latrines, aqua privies, pour flush latrines and septic tanks. The use of these options may be site specific depending on community acceptance, affordability and willingness to pay.

Wastewater management technologies also have a wide range of costs. Low cost treatment approaches range from natural treatment systems (waste stabilization ponds, constructed wetlands) to decentralized treatment systems to newer treatment systems such as UASB reactor. In Metro Manila, land is a major constraint for the low cost options but many systems were evaluated and the most cost effective selected based on a multi-criteria approach.

Assessing Sewerage and Sanitation Demand

A demand-based approach requires stakeholders to be drawn into all stages of the decision-making process, starting with the assessment of sewerage and sanitation demand. Demand was assessed through the willingness-to-pay survey and associated focus group discussions. Using the willingness-to-pay and affordability results obtained by the survey, a strategy was developed that stages various levels of development in accordance with what is affordable to the community.

Next will be project preparation, whereby the users will be given the opportunity to determine for themselves which options they want to see implemented, accepting the financial and institutional implications of that choice.

Unbundling Sewerage and Sanitation Investments
The Master Plan strategy has investigated the feasibility of initially implementing a decentralized approach to sewerage that will mean smaller investments resulting in sewerage charges appropriate to the affordability and willingness to pay of the users. The decentralized approach, however, will be compatible with a long-term centralized approach that may be implemented when users are able and willing to pay for the costs involved. Under the decentralized approach, sewerage can be provided to discrete areas in accordance with their ability and willingness to pay for the services.

The strategy also incorporates a separate sanitation approach whereby septic tanks will be retained and the sanitation projects can be implemented as separate projects from the sewerage systems.

For the urban poor areas, separate low cost sanitation systems can be implemented that may also incorporate public toilets for households without toilets. These can be community-based schemes implemented by the LGUs, HUDCC/NHA, NGOs or through bilateral or multilateral agency projects. In the future, any treatment facilities from these systems could be connected to the MWSS sewerage system when available and arrangements for charging agreed with the community owners.

8.3 Dirty Water (Sewage) Volumes and Quantity

The dirty water flow to sewerage systems was estimated from the projected water supply data. The total flow is composed of domestic, commercial and infiltration components. The industrial discharges were also estimated based on the industrial water supply but it is assumed these will not be connected to the proposed sewerage system. The combined domestic and commercial wastewater flow was estimated at 80% of the domestic and commercial supplies. The potential sewage generation rates for 2005, 2010, 2015, 2020 and 2025 are shown in the succeeding tables (**Tables 8.1 to 8.5**). These values are based on the reported and projected water supply data (based on water coverage targets) for the entire service area of MWSS. A constant daily infiltration flow rate of 7.5 m^3 per hectare was used for all the catchment areas.

The generation rates do not include the water supply drawn from private deep wells and deliveries. The industrial water supply for Las Piñas and Muntinlupa, for instance, was projected based on the actual MWSS water supply but these are insignificant when compared with industrial water consumptions sourced from private wells.

For the sewer analysis, the combined commercial and industrial flows were adjusted by a peak factor that ranged from 1.4 to 2.5, depending on the size of the network. The larger the network the lower value of peak factor was used. The infiltration rate was consequently added to the adjusted flow to determine capacities of the sewer lines and treatment works required.

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Table 8.1 - Potential Wastewater Production (Domestic, Commercial, Industrial and Infiltration) for 2005 for the MWSS Served Areas

CITY/ MUNICIPALITY		Population Served	Potential Wastewater (cu.m./day)				
			Domestic	Commercial	Industrial	Infiltration	TOTAL
I.	**WEST ZONE (MWSI)**						
A.	**National Capital Region**						
	Makati (part)	68,832	9,168	7,140	1,126	2,877	20,311
	Manila (part)	1,392,475	179,128	165,699	14,596	25,414	384,836
	Quezon City (part)	1,566,679	204,232	38,610	10,790	55,883	309,516
	Caloocan	1,305,994	163,824	16,218	7,100	39,843	226,985
	Las Piñas	335,689	44,714	6,707	102	24,045	75,567
	Malabon	330,538	40,590	7,094	7,795	11,973	67,453
	Muntinlupa	195,096	24,749	3,712	4	28,445	56,911
	Navotas	235,703	28,680	3,376	5,938	8,040	46,034
	Parañaque	498,242	64,413	12,661	2,902	33,319	113,296
	Pasay	355,122	45,765	27,889	2,310	12,279	88,243
	Valenzuela	512,489	64,369	7,185	3,320	33,387	108,261
B.	**Cavite**						
	Bacoor	218,707	26,980	1,084	32	9,293	37,388
	Cavite City	103,976	12,827	1,099	105	32,235	46,265
	Imus	79,351	9,789	84	4	72,758	82,634
	Kawit	62,565	7,718	521	79	12,503	20,821
	Noveleta	17,130	1,987	16	-	32,475	34,478
	Rosario	45,572	5,286	235	23	28,650	34,194
	Subtotal…West Zone	***7,324,161***	***934,219***	***299,331***	***56,226***	***463,416***	***1,753,192***
II.	**EAST ZONE (MWCI)**						
A.	**National Capital Region**						
	Makati (part)	392,647	52,301	23,891	4,443	21,096	101,730
	Manila (part)	180,313	23,195	10,596	1,970	2,210	37,971
	Quezon City (part)	722,137	94,138	43,002	7,997	45,885	191,021
	Mandaluyong	296,293	38,684	17,671	3,286	8,313	67,953
	Marikina	412,731	52,334	23,906	4,446	15,742	96,428
	Pasig	576,228	75,094	34,303	6,379	23,871	139,647
	Pateros	57,438	7,404	3,382	629	1,461	12,876
	San Juan	119,133	15,734	7,187	1,337	4,396	28,654
	Taguig	298,048	38,418	17,549	3,263	16,819	76,049
B.	**Rizal**						
	Angono	20,099	2,332	1,065	198	11,385	14,980
	Antipolo	172,747	21,310	9,734	1,810	291,833	324,687
	Baras	-	-	-	-	-	-
	Binangonan	-	-	-	-	-	-
	Cainta	185,192	22,845	10,436	1,941	32,250	67,472
	Cardona	-	-	-	-	-	-
	Jala-jala	-	-	-	-	-	-
	Morong	-	-	-	-	-	-
	Pililla	-	-	-	-	-	-
	Rodriguez	55,162	6,399	2,923	544	234,600	244,465
	San Mateo	102,969	12,702	5,802	1,079	39,690	59,274
	Tanay	-	-	-	-	-	-
	Taytay	141,535	16,418	7,500	1,395	20,363	45,675
	Teresa	-	-	-	-	-	-
	Subtotal…East Zone	***3,732,674***	***479,308***	***218,946***	***40,715***	***769,914***	***1,508,883***
	TOTAL	***11,056,835***	***1,413,527***	***518,277***	***96,941***	***1,233,330***	***3,262,075***

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Table 8.2 - Potential Wastewater Production (Domestic, Commercial, Industrial and Infiltration) for 2010 for the MWSS Served Areas

CITY/ MUNICIPALITY		Population Served	Potential Wastewater (cu.m./day)				
			Domestic	Commercial	Industrial	Infiltration	TOTAL
I.	**WEST ZONE (MWSI)**						
A.	**National Capital Region**						
	Makati (part)	60,001	7,992	9,708	1,547	2,877	22,125
	Manila (part)	1,362,213	175,235	225,311	20,052	25,414	446,011
	Quezon City (part)	1,699,517	221,549	52,501	14,824	55,883	344,756
	Caloocan	1,428,308	179,167	22,052	9,754	39,843	250,817
	Las Piñas	600,673	80,010	12,001	140	24,045	116,196
	Malabon	317,956	39,045	9,646	10,709	11,973	71,374
	Muntinlupa	389,732	49,440	7,416	6	28,445	85,307
	Navotas	258,011	31,395	4,590	8,157	8,040	52,183
	Parañaque	544,239	70,359	17,217	3,988	33,319	124,882
	Pasay	350,412	45,158	37,922	3,174	12,279	98,533
	Valenzuela	567,069	71,224	9,770	4,561	33,387	118,942
B.	**Cavite**						
	Bacoor	359,696	44,372	1,474	44	9,293	55,182
	Cavite City	105,650	13,033	1,494	144	32,235	46,906
	Imus	158,306	19,529	114	6	72,758	92,406
	Kawit	81,901	10,103	709	109	12,503	23,423
	Noveleta	44,032	5,108	22	-	32,475	37,605
	Rosario	106,938	12,405	319	31	28,650	41,405
	Subtotal...West Zone	***8,434,656***	***1,075,124***	***412,267***	***77,245***	***463,416***	***2,028,052***
II.	**EAST ZONE (MWCI)**						
A.	**National Capital Region**						
	Makati (part)	384,206	51,176	27,605	5,241	21,096	105,118
	Manila (part)	180,642	23,238	12,535	2,380	2,210	40,362
	Quezon City (part)	676,968	88,250	47,603	9,038	45,885	190,775
	Mandaluyong	310,882	40,589	21,894	4,157	8,313	74,952
	Marikina	429,446	54,454	29,373	5,577	15,742	105,146
	Pasig	648,316	84,489	45,574	8,653	23,871	162,587
	Pateros	56,673	7,305	3,940	748	1,461	13,455
	San Juan	118,932	15,708	8,473	1,609	4,396	30,185
	Taguig	449,943	57,997	31,284	5,940	16,819	112,039
B.	**Rizal**						
	Angono	42,679	4,951	2,671	507	11,385	19,513
	Antipolo	437,194	53,932	29,091	5,524	291,833	380,380
	Baras	-	-	-	-	-	-
	Binangonan	-	-	-	-	-	-
	Cainta	278,902	34,405	18,559	3,524	32,250	88,738
	Cardona	-	-	-	-	-	-
	Jala-jala	-	-	-	-	-	-
	Morong	-	-	-	-	-	-
	Pililla	-	-	-	-	-	-
	Rodriguez	163,666	18,985	10,241	1,944	234,600	265,770
	San Mateo	221,268	27,296	14,723	2,796	39,690	84,505
	Tanay	-	-	-	-	-	-
	Taytay	212,895	24,696	13,321	2,529	20,363	60,909
	Teresa	-	-	-	-	-	-
	Subtotal...East Zone	***4,612,612***	***587,469***	***316,886***	***60,167***	***769,914***	***1,734,435***
	TOTAL	***13,047,268***	***1,662,593***	***729,153***	***137,412***	***1,233,330***	***3,762,487***

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Table 8.3 - Potential Wastewater Production (Domestic, Commercial, Industrial and Infiltration) for 2015 for the MWSS Served Areas

	CITY/ MUNICIPALITY	Population Served	Potential Wastewater (cu.m./day)				
			Domestic	Commercial	Industrial	Infiltration	TOTAL
I.	**WEST ZONE (MWSI)**						
A.	**National Capital Region**						
	Makati (part)	51,698	8,148	11,125	1,775	2,877	23,925
	Manila (part)	1,319,161	198,824	258,192	23,005	25,414	505,434
	Quezon City (part)	1,817,217	278,718	60,163	17,007	55,883	411,770
	Caloocan	1,546,404	226,146	25,271	11,191	39,843	302,451
	Las Piñas	716,572	112,702	16,905	161	24,045	153,813
	Malabon	302,785	43,165	11,054	12,287	11,973	78,479
	Muntinlupa	430,730	63,910	9,587	7	28,445	101,948
	Navotas	268,413	37,836	5,260	9,359	8,040	60,495
	Parañaque	588,518	89,455	19,729	4,575	33,319	147,077
	Pasay	342,295	51,662	43,456	3,641	12,279	111,038
	Valenzuela	602,531	88,210	11,196	5,233	33,387	138,026
B.	**Cavite**						
	Bacoor	401,394	57,544	1,689	50	9,293	68,575
	Cavite City	104,612	14,997	1,713	165	32,235	49,110
	Imus	182,143	26,112	131	6	72,758	99,007
	Kawit	89,850	12,881	812	125	12,503	26,320
	Noveleta	49,631	5,956	25	-	32,475	38,456
	Rosario	130,419	15,650	366	36	28,650	44,702
	Subtotal…West Zone	***8,944,373***	***1,331,915***	***476,672***	***88,622***	***463,416***	***2,360,626***
II.	**EAST ZONE (MWCI)**						
A.	**National Capital Region**						
	Makati (part)	371,593	58,563	26,410	5,072	21,096	111,141
	Manila (part)	179,145	27,001	12,176	2,339	2,210	43,725
	Quezon City (part)	625,537	95,942	43,266	8,310	45,885	193,403
	Mandaluyong	322,918	49,497	22,321	4,287	8,313	84,417
	Marikina	442,354	65,539	29,555	5,676	15,742	116,513
	Pasig	722,104	110,569	49,862	9,576	23,871	193,878
	Pateros	55,357	8,352	3,767	723	1,461	14,304
	San Juan	117,541	18,314	8,259	1,586	4,396	32,555
	Taguig	681,764	102,868	46,389	8,909	16,819	174,986
B.	**Rizal**						
	Angono	96,413	11,570	5,217	1,002	11,385	29,174
	Antipolo	830,368	119,042	53,683	10,310	291,833	474,867
	Baras	11,477	1,377	621	119	17,550	19,668
	Binangonan	101,919	12,230	5,515	1,059	54,525	73,330
	Cainta	356,276	51,076	23,033	4,424	32,250	110,782
	Cardona	14,060	1,687	761	146	14,453	17,047
	Jala-jala	10,106	1,213	547	105	36,975	38,840
	Morong	16,814	2,018	910	175	29,805	32,907
	Pililla	19,829	2,379	1,073	206	16,980	20,639
	Rodriguez	228,555	27,427	12,368	2,375	234,600	276,770
	San Mateo	322,296	46,204	20,836	4,002	39,690	110,732
	Tanay	43,781	5,254	2,369	455	250,995	259,073
	Taytay	308,158	36,979	16,676	3,203	20,363	77,220
	Teresa	13,623	1,635	737	142	28,935	31,449
	Subtotal…East Zone	***5,891,986***	***856,734***	***386,352***	***74,201***	***1,220,131***	***2,537,419***
	TOTAL	***14,836,359***	***2,188,650***	***863,024***	***162,824***	***1,683,548***	***4,898,045***

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Table 8.4 - Potential Wastewater Production (Domestic, Commercial, Industrial and Infiltration) for 2020 for the MWSS Served Areas

	CITY/ MUNICIPALITY	Population Served	Potential Wastewater (cu.m./day)				
			Domestic	Commercial	Industrial	Infiltration	TOTAL
I.	**WEST ZONE (MWSI)**						
A.	**National Capital Region**						
	Makati (part)	43,943	6,925	12,822	2,045	2,877	24,669
	Manila (part)	1,261,987	190,207	297,572	26,495	25,414	539,687
	Quezon City (part)	1,911,860	293,233	69,339	19,587	55,883	438,042
	Caloocan	1,654,073	241,892	29,125	12,889	39,843	323,748
	Las Piñas	835,072	131,340	19,701	185	24,045	175,271
	Malabon	284,860	40,610	12,740	14,151	11,973	79,473
	Muntinlupa	474,829	70,453	10,568	8	28,445	109,474
	Navotas	275,867	38,886	6,062	10,778	8,040	63,767
	Parañaque	628,723	95,566	22,738	5,269	33,319	156,892
	Pasay	330,334	49,857	50,084	4,193	12,279	116,413
	Valenzuela	632,489	92,596	12,903	6,027	33,387	144,913
B.	**Cavite**						
	Bacoor	435,262	62,399	1,947	58	9,293	73,696
	Cavite City	100,701	14,437	1,974	190	32,235	48,835
	Imus	212,274	30,432	151	7	72,758	103,347
	Kawit	95,828	13,738	936	143	12,503	27,320
	Noveleta	54,385	6,526	29	-	32,475	39,030
	Rosario	154,631	18,556	422	41	28,650	47,668
	Subtotal…West Zone	***9,387,118***	***1,397,652***	***549,112***	***102,064***	***463,416***	***2,512,245***
II.	**EAST ZONE (MWCI)**						
A.	**National Capital Region**						
	Makati (part)	354,551	55,877	24,108	4,674	21,096	105,755
	Manila (part)	175,508	26,453	11,413	2,213	2,210	42,288
	Quezon City (part)	568,728	87,229	37,635	7,296	45,885	178,046
	Mandaluyong	331,374	50,793	21,915	4,249	8,313	85,269
	Marikina	450,155	66,695	28,776	5,579	15,742	116,792
	Pasig	794,589	121,667	52,494	10,177	23,871	208,210
	Pateros	53,419	8,060	3,478	674	1,461	13,673
	San Juan	114,765	17,881	7,715	1,496	4,396	31,488
	Taguig	844,040	127,353	54,947	10,652	16,819	209,771
B.	**Rizal**						
	Angono	209,508	25,141	10,847	2,103	11,385	49,476
	Antipolo	1,387,411	198,899	85,816	16,637	291,833	593,185
	Baras	30,369	3,644	1,572	305	17,550	23,072
	Binangonan	341,634	40,996	17,688	3,429	54,525	116,638
	Cainta	461,333	66,137	28,535	5,532	32,250	132,454
	Cardona	34,100	4,092	1,765	342	14,453	20,652
	Jala-jala	26,078	3,129	1,350	262	36,975	41,716
	Morong	42,068	5,048	2,178	422	29,805	37,453
	Pililla	51,316	6,158	2,657	515	16,980	26,310
	Rodriguez	291,592	34,991	15,097	2,927	234,600	287,615
	San Mateo	426,083	61,083	26,355	5,109	39,690	132,237
	Tanay	111,176	13,341	5,756	1,116	250,995	271,208
	Taytay	570,824	68,499	29,554	5,730	20,363	124,145
	Teresa	37,849	4,542	1,960	380	28,935	35,816
	Subtotal…East Zone	***7,708,471***	***1,097,710***	***473,611***	***91,818***	***1,220,131***	***2,883,270***
	TOTAL	***17,095,589***	***2,495,362***	***1,022,723***	***193,882***	***1,683,548***	***5,395,515***

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Table 8.5 - Potential Wastewater Production (Domestic, Commercial, Industrial and Infiltration) for 2025 for the MWSS Served Areas

	CITY/ MUNICIPALITY	Population Served	Potential Wastewater (cu.m./day)				
			Domestic	Commercial	Industrial	Infiltration	TOTAL
I.	**WEST ZONE (MWSI)**						
A.	**National Capital Region**						
	Makati (part)	36,831	5,805	14,389	2,292	2,877	25,362
	Manila (part)	1,191,956	179,652	333,938	29,696	25,414	568,700
	Quezon City (part)	1,978,540	303,461	77,813	21,954	55,883	459,110
	Caloocan	1,746,872	255,463	32,684	14,446	39,843	342,436
	Las Piñas	960,457	151,061	22,659	207	24,045	197,972
	Malabon	264,608	37,723	14,297	15,860	11,973	79,853
	Muntinlupa	515,889	76,546	11,482	9	28,445	116,481
	Navotas	279,944	39,461	6,803	12,081	8,040	66,385
	Parañaque	663,185	100,804	25,517	5,905	33,319	165,545
	Pasay	314,760	47,506	56,205	4,700	12,279	120,690
	Valenzuela	655,543	95,971	14,480	6,755	33,387	150,594
B.	**Cavite**						
	Bacoor	458,456	65,724	2,185	64	9,293	77,266
	Cavite City	94,199	13,504	2,215	213	32,235	48,167
	Imus	238,686	34,218	169	8	72,758	107,153
	Kawit	99,318	14,238	1,050	161	12,503	27,952
	Noveleta	57,911	6,949	32	-	32,475	39,457
	Rosario	178,159	21,379	473	46	28,650	50,548
	Subtotal…West Zone	***9,735,314***	***1,449,464***	***616,392***	***114,397***	***463,416***	***2,643,670***
II.	**EAST ZONE (MWCI)**						
A.	**National Capital Region**						
	Makati (part)	333,577	52,572	22,464	4,394	21,096	100,525
	Manila (part)	169,760	25,586	10,933	2,138	2,210	40,867
	Quezon City (part)	508,624	78,011	33,334	6,519	45,885	163,749
	Mandaluyong	335,752	51,464	21,991	4,301	8,313	86,068
	Marikina	452,302	67,013	28,635	5,600	15,742	116,990
	Pasig	863,297	132,188	56,484	11,047	23,871	223,591
	Pateros	50,897	7,680	3,282	642	1,461	13,064
	San Juan	110,638	17,238	7,366	1,441	4,396	30,441
	Taguig	949,194	143,219	61,198	11,969	16,819	233,205
B.	**Rizal**						
	Angono	292,250	35,070	14,985	2,931	11,385	64,371
	Antipolo	1,932,861	277,095	118,403	23,157	291,833	710,488
	Baras	56,370	6,764	2,890	565	17,550	27,770
	Binangonan	534,256	64,111	27,395	5,358	54,525	151,388
	Cainta	588,576	84,378	36,055	7,052	32,250	159,735
	Cardona	58,012	6,961	2,975	582	14,453	24,970
	Jala-jala	47,202	5,664	2,420	473	36,975	45,533
	Morong	73,829	8,859	3,786	740	29,805	43,191
	Pililla	93,157	11,179	4,777	934	16,980	33,870
	Rodriguez	367,350	44,082	18,836	3,684	234,600	301,202
	San Mateo	550,900	78,977	33,747	6,600	39,690	159,014
	Tanay	187,452	22,494	9,612	1,880	250,995	284,981
	Taytay	780,232	93,628	40,007	7,825	20,363	161,822
	Teresa	70,881	8,506	3,634	711	28,935	41,786
	Subtotal…East Zone	***9,407,372***	***1,322,740***	***565,207***	***110,544***	***1,220,131***	***3,218,622***
	TOTAL	***19,142,686***	***2,772,204***	***1,181,600***	***224,941***	***1,683,548***	***5,862,293***

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8.4 Pollution Load Analysis

The total pollution load received by various water bodies within the MWSS service areas comes from domestic, commercial and industrial sources. The pollution load for each source was estimated for each of the 31 catchments delineated in this study. The estimates considered the existing environmental infrastructure (i.e. sewerage and STPs) in 2005 and the proposed sewerage and sanitation improvement projects (including MTSP), which will be in place by 2025. This will represent the environmental benefits, which may be attributed to improved sewerage and sanitation within the planning period. The 2025 pollution load projections assumed compliance to the 1997 Concession Agreement targets on sewerage and sanitation.

8.4.1 Domestic Pollution Load

Per Capita BOD Loading

The 1969 Sewerage Master Plan study reported a fairly wide range of per capita BOD loadings resulting from its analyses, but it was concluded that an average BOD loading of 45 g BOD per capita-day (gpcd) could be deduced for domestic wastewater. The 1979 Sewerage Master Plan used a BOD load value of 50 gpcd for domestic wastewater.

The 1991 JMM Master Plan conducted sampling on sewage in the Central Sewerage System at the Tondo Pumping Station and on the Ayala system, which resulted in per capita BOD loadings of 38 gpcd and 37 gpcd, respectively. In the 1991 study of Pasig River Rehabilitation Project, the reported per capita BOD loads were 53 gpcd for the high-income group; 40 gpcd for middle-income group and 20 gpcd for low-income group.

The 1996 JICA Sewerage and Sanitation Master Plan used 40 gpcd for its 1995 load data increasing to 50 gpcd by 2015. Toilet wastes were considered to contribute BOD load of 10 gpcd where BOD load from sullage was assumed to increase from 30 to 40 gpcd over the study period.

The recent MTSP Master Plan for the East Zone used the BOD per capita load presented in **Table 8.6**.

Table 8.6 - Domestic per capita Pollution Loads based on BOD (gpcd)

Household Profile	BOD load in 2005			BOD load in 2025		
	Toilet	Sullage	Total	Toilet	Sullage	Total
Low-income	20	16	36	20	23	43
Middle-income	20	30	50	20	30	50
High-income	20	30	50	20	30	50
Average	20	25.3	45.3	20	27.7	47.7

Domestic BOD loadings in Western countries are generally higher than those in Asia (USA, 75 gpcd; Australia 60 gpcd). In Japan, the average value is in the order of 50 gpcd (toilet, 15-18 gpcd and sullage, 32-39). A value of 45 gpcd (toilet 20 gpcd, sullage 25 gpcd) was reported in Kuala Lumpur (Engineering Science, 1986) and in Bangkok 40 to 50 gpcd (Montgomery Watson, 1995).

The values in **Table 8.6** appear to accord fairly well with the recommendations of previous studies and with the values used in other locations similar to Metro Manila. Therefore, these BOD load assumptions were adopted for this study.

Estimating Domestic BOD Loads for Metro Manila

A number of reports have already estimated the BOD load discharges of Metro Manila. The most recent World Bank Environmental Monitor Report indicated an annual BOD pollution load of 192,000 tons BOD or equivalent to 526 tons/day. This report used 53 gpcd for the entire population of Metro Manila regardless of income profile. This value may already include commercial BOD load since the report only indicated domestic and industrial loadings to account for the total pollution load for Metro Manila.

The BOD loads associated with domestic sources for each catchment used in this Master Plan study were calculated using the 2005, 2015 and 2025 population projections of the MWSS service area. The average per capita BOD loads, 45.3 gpcd in 2005, 46.5 gpcd in 2015 and 47.7 gpcd in 2025 were multiplied by the population for each catchment. This resulted in 543 tons BOD/day (198,000 tons BOD per year) in 2005, 603 tons BOD/day (220,000 tons BOD per year) in 2015 and 784 tons BOD/day (286,000 tons BOD per year) in 2025 for the entire MWSS service area. The estimated BOD loads per catchment are shown in **Figure 8.1**. These estimates exclude preliminary treatment by septic tanks and the effects of the existing sewerage system in 2005.

The domestic load pollution distribution is shown in **Table 8.7**. The pollution load share of the West Zone is expected to decrease from 58% in 2005 to 49% in 2025. The load share of the East is conversely to increase from 32% to 44% in the same period.

Table 8.7 - Total Pollution Load Distribution from Domestic Sources for the East and West Catchments

Catchments	2005		2015		2025	
	Tons/day	%	Tons/day	%	Tons/day	%
West Zone	309	57	347	58	383	49
East-West Boundary	52	10	56	9	58	7
East Zone	182	33	200	33	343	44
TOTAL	543	100	603	100	784	100

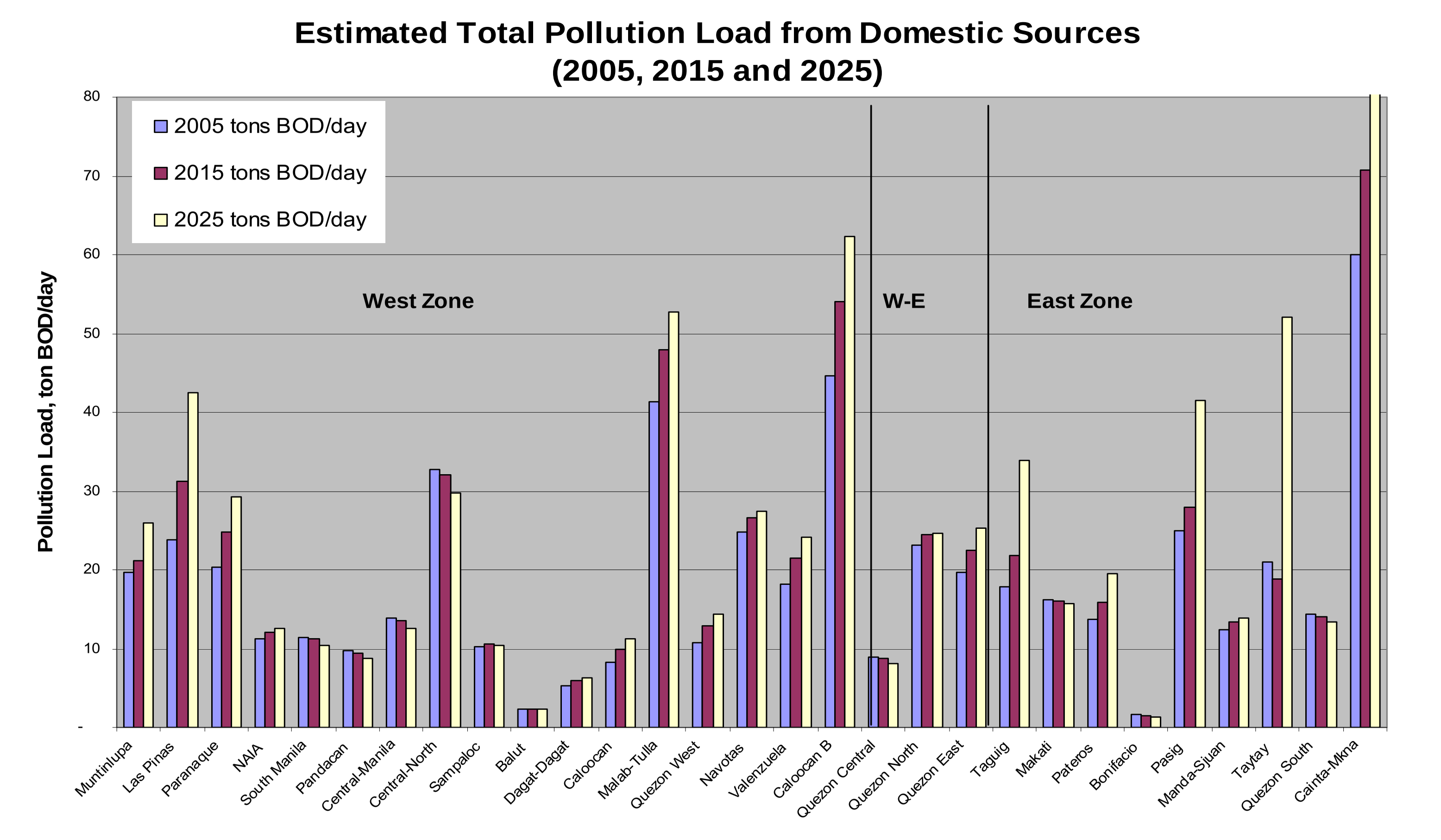

Figure 8.1 Estimated Total BOD Load from Domestic Sources for Metro Manila (2005, 2015 and 2025 Projections)

Expected Impact of Improved Sanitation and Sewerage Programs to BOD Loads

The improved sanitation and sewerage programs which will be implemented by MWSS through its concessionaires will have significant effects on the net pollution load being discharged to the river systems in Metro Manila.

The loads presented in **Figure 8.1** were adjusted to calculate the "net" pollution load as effected by septic tank treatment and the existing sewerage system. The existing septic tanks were estimated to conservatively remove 10% of the pollution load being discharged by every household. The MTSP master plan suggested another 10% improvement should these septic tanks be regularly desludged and maintained regularly at least once every five (5) years. Considering that about 12% of the MWSS service area is currently sewered with some treatment works, the total pollution load served by these facilities will be significantly reduced. It is assumed that these facilities can remove about 95% of the load, leaving about 5% of the load still being received by the river systems.

The 1997 Concession Agreement imposed high sewerage targets for almost all cities and municipalities in Metro Manila. If these sewerage targets are met, the net pollution load due to sewage may be greatly reduced. The net pollution loads for various catchments are shown in **Figure 8.2 and Table 8.8**.

Table 8.8 - Net Pollution Load Distribution from Domestic Sources for the East and West Catchments Considering Effects of Improved Sewerage and Sanitation

Catchments	2005		2015		2025	
	Tons/day	%	Tons/day	%	Tons/day	%
West Zone	225	55	217	55	35	17
East-West Boundary	35	9	34	9	5	2
East Zone	144	36	140	36	166	81
TOTAL	404	100	391	100	206	100

The high pollution load in the East Zone in 2025 (i.e. 81% against 17% of the West Zone) was attributed to a low 2025 sewerage target in the Rizal Area, particularly for Marikina, Taytay and Cainta. The population growth rates in these areas are greater than the NCR average.

8.4.2 Commercial Pollution Load

In previous master plans, the contaminants associated with commercial pollution load were roughly represented by domestic waste discharges. The commercial wastewater is often estimated to contain similar BOD content with domestic wastewater (i.e. 250 to 300 mg/l BOD).

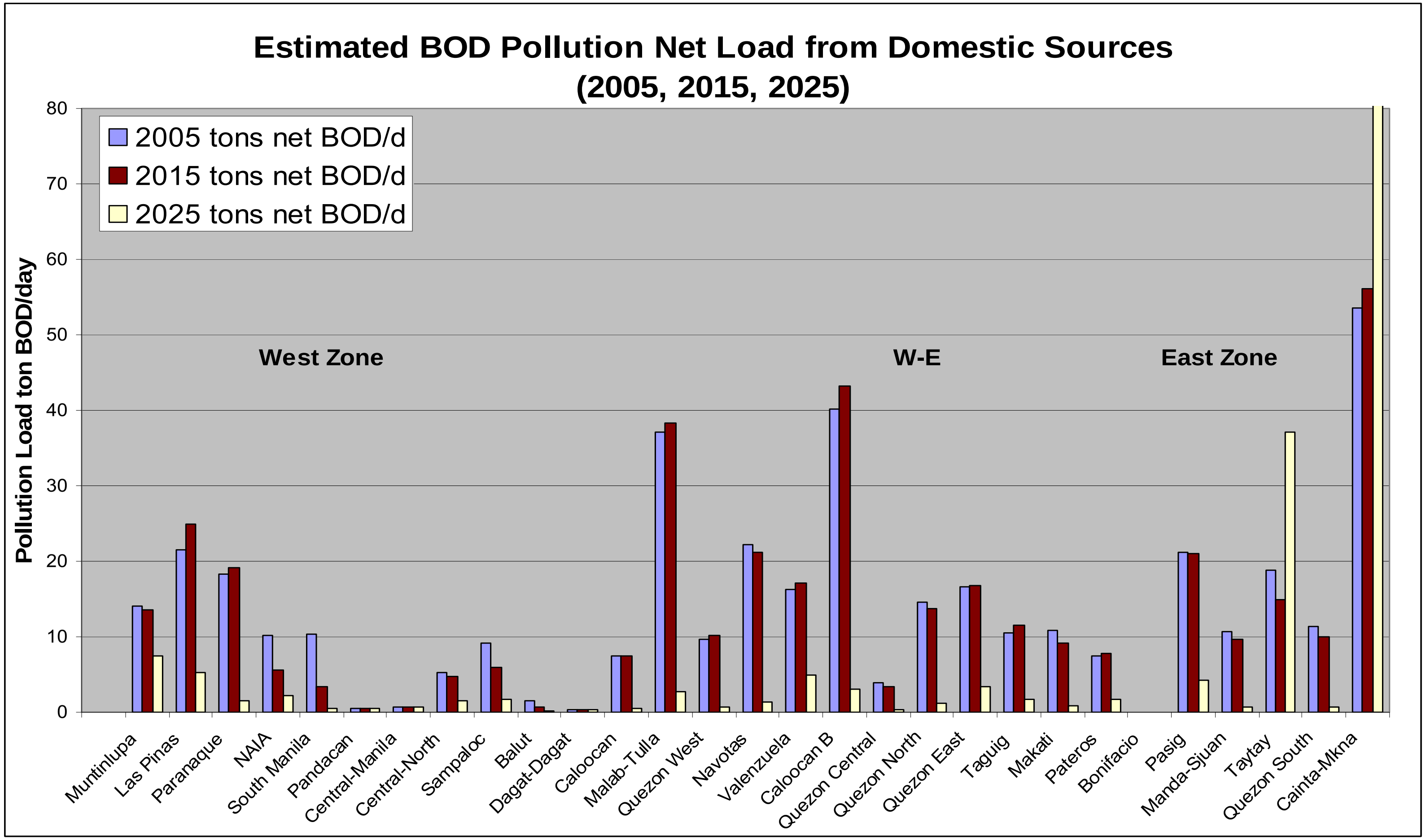

Figure 8.2 Estimated Net BOD Load from Domestic Sources for Metro Manila (2005, 2015 and 2025 Projections)

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In general, aside from human wastes, pollution loads from commercial sources contain other constituents such as surfactants, cleaning chemicals, oil and grease, and solids from food preparations. Increased usage of these chemical cleaning agents in most commercial establishments also results in potential inclusion of volatile organic compounds, traces of heavy metals and even insecticides in the commercial wastewater streams.

The commercial flow rate was estimated as a percentage of the total water supply. In the previous master plans, this ranged from 20% to 45% of the total commercial water supply (NJS, 2005). For this master plan study, the commercial wastewater flow was estimated from the actual water supply of MWCI and MWSI commercial bills. The estimates for 2025 were projected in the water supply master plan update. Eighty percent of the commercial water supply was assumed to be generated as commercial wastewater flow.

The BOD loading of commercial load was also increased to 500 mg/l from the 250 mg/l previously used in the NJS report in 2005. Wastewater treatment plants of commercial establishments are currently designed on the basis of 400 to 800 mg/l BOD. The net BOD loading was calculated based on the existing sewerage systems in 2005 and the proposed sewerage improvement projects in 2015 and 2025. The total and net BOD loads from commercial sources for all the sub-catchments are shown in **Tables 8.9** and **8.10**.

Table 8.9 - Total Pollution Load Distribution from Commercial Sources for the East and West Catchments

Catchments	2005		2015		2025	
	Tons/day	%	Tons/day	%	Tons/day	%
West Zone	136	54	212	53	271	57
East-West Boundary	20	8	29	7	30	6
East Zone	97	38	161	40	178	37
TOTAL	253	100	402	100	479	100

Table 8.10 - Net Pollution Load Distribution from Commercial Sources for the East and West Catchments Considering Effects of Improved Sewerage and Sanitation

Catchments	2005		2015		2025	
	Tons/day	%	Tons/day	%	Tons/day	%
West Zone	67	42	76	37	19	22
East-West Boundary	14	9	18	9	3	3
East Zone	77	49	112	54	64	75
TOTAL	158	100	206	100	86	100

As in the case of domestic load, commercial pollution load in 2025 is greatly affected by the low sewerage target of MWCI in the east concession area.

8.4.3 Industrial Pollution Load

Accepting Industrial Effluents to Sewerage Systems

In the 1969 Master Plan, it was reported that acceptance of industrial effluents into the sewers were generally discouraged by regulatory agencies. This was despite the case that where available, sewers generally had the capacity to accept these wastes provided that pre-treatment was provided such that the sewers would not be damaged or the treatment processes inhibited by the trade waste. An institutional and legal framework was suggested to implement this policy.

In 1971, MWSS adopted Regulation 75-71 disallowing acceptance of any industrial wastewater into sewers. This resolution is still in effect today. It was considered that no effective system was in place to monitor the pollution load of the industrial waste and that damage to sewers and the treatment process may result from acceptance without adequate controls.

Nevertheless, the 1979 Master Plan recommended acceptance of industrial wastes on condition that an industrial wastewater management program was implemented, where industrial waste regulations (similar to a pre-treatment standards) were proposed before allowing industrial wastewater into the sewerage system. The rationale was that the volume was small, thereby having little influence on the sewer pipe size. The BOD loading, although significant, affects only secondary treatment which was not proposed until some time in the future. Many small industrial firms may not also be able to afford pre-treatments costs, resulting in continued pollution of the watercourses.

Estimating Industrial BOD Loading for Metro Manila

The 1996 JICA Master Plan and the 2005 East Concessionaire Master Plan Update both adopted the load projection generated by the Industrial Efficiency and Pollution Control (IEPC) Program, a World Bank commissioned project in 1992. The IEPC project conducted an industrial discharge survey and estimated an industrial wastewater generation in 1990 of about 270,000 m^3/day with a corresponding BOD load of 392 tons/day. The pollution load was adjusted to 304 tons/day after removing industrial facilities outside the MWSS jurisdiction area.

The 1996 JICA Sewerage Master Plan redistributed the industrial loads into each sub-basin area identified for the MWSS service area. It was assumed that waste minimization programs will be implemented by the industry sector to effect a linear decrease of pollution load from 1995 to 2015. The master plan further assumed that no new sources with significant wastewater load will be constructed within the Metro Manila area since industrial developments are now being directed outside the NCR. The master plan projected a reduction in BOD loading from 304 tons BOD/day in 1995 to 130 tons BOD/day in 2015.

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This master plan also differed from the earlier studies (i.e. 1979 MP) and recommended that industrial wastewater should be prohibited from entering the sewerage system and suggested that industrial facilities should be responsible for treatment of their wastes for discharge to water bodies based on the DENR standards. The reasons given for this were:

- The MWSS and DENR policy on industrial wastewater prohibits it to enter the sewer system and the main purpose of the sewerage system should be on domestic wastewater;
- In 1996, the BOD loading for industrial raw wastewater (based on IEPC data) was 53% of the total loading. It was reasoned that eventually, secondary treatment of the sewage will be necessary and the treatment of industrial wastes will be at a high cost. Thus the sewerage system should be constructed primarily for domestic wastewater; and
- The existing effluent standard of the DENR/EMB should be respected and if these standards are strictly observed, treated wastewater can be discharged into the river system.

Most Recent Estimates on Industrial Pollution Load

The 2003 World Bank Philippine Environment Report on Water Quality reported that in 1998, the industrial pollution load for Metro Manila alone was already at 138,000 metric ton of BOD per year, which is equivalent to 378 tons BOD/day indicating that the industrial load reductions projected in the 1996 master plan were not being effected.

However, since 1998, an Environmental User Fee System (EUFS) has been actively implemented in LGUs under the jurisdiction of the LLDA with regard to effluent discharges. It was recently extended to those LGUs under the jurisdiction of DENR/EMB. This, coupled with the passing of the Clean Water Act, is likely to result in improved enforcement of effluent standards and a reduction in industrial pollution. In fact, despite the overall increase in industrial pollution loading reported by the 2003 World Bank Report, the proportion of pollution of Pasig River attributable to commercial and industrial wastes has been decreasing as shown in **Table 8.11** (PRRP Report). Furthermore, the projections used in this master plan study will need to be compared and corrected with the results of the upcoming EMB initiative to update the industrial database and wastewater discharge inventory to be undertaken in 2005-2006.

Table 8.11 - Estimated Percentage Contributions of Three Major Sources of Pollution to the Pasig River System, 1991 and 1998

Type of Wastes	1991	1998
Liquid Domestic Wastes	45%	60%
Solid Domestic Wastes	10%	5%
Commercial and Industrial	45%	35%
Total	100%	100%

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It is therefore reasonable to assume that industrial waste loading will continue to decrease as a result of these policies as well as the likelihood that industrial activity within Metro Manila will not expand significantly and may, in fact, reduce as more industries choose to relocate outside the capital. Some impacts may also be expected from the DBP Project that is providing incentives and loan facilities for small and medium enterprises (SMEs) to install treatment facilities and thereby reduce their environmental penalties resulting from stricter implementation of the EUFS.

This Master Plan study considered the IEPC pollution load and used the industrial water supply as provided by the MWSS to its concession areas. These industrial water usages were adjusted to consider the sources other than MWSS water (i.e. deep well) used by industrial facilities. The projected industrial wastewater generation rates for the west, east and boundary zones are presented in **Table 8.12**.

Table 8.12 - Industrial Wastewater Generation Rates (m^3/day) as Projected from the Industrial Water Supply

Catchments	2005		2015		2025	
	m^3/day	%	m^3/day	%	m^3/day	%
West Zone	144,821	53	181,139	55	194,763	59
East-West Boundary	21,957	8	26,481	8	23,702	7
East Zone	107,503	49	121,353	37	113,006	34
TOTAL	274,281	100	328,973	100	331,471	100

As in the case of domestic and commercial load estimates, the pollution load attributed from industrial sources were estimated for each of the major catchments. The total and net pollution loads are shown in **Tables 8.13** and **8.14.** The assumed average percent compliance to existing effluent regulations (CWA and EUFS) in 2005 is 40%, with a linear increase to 60% in 2015 and 80% in 2025.

Table 8.13 - Total Pollution Load Distribution from Industrial Sources for the East and West Catchments

Catchments	2005		2015		2025	
	Tons/day	%	Tons/day	%	Tons/day	%
West Zone	230	53	288	55	310	59
East-West Boundary	35	8	42	8	38	7
East Zone	171	39	193	37	180	34
TOTAL	436	100	523	100	528	100

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Table 8.14 - Net Pollution Load Distribution from Industrial Sources for the East and West Catchments Considering Effects of Improved Compliance to CWA and EUFS

Catchments	**2005**		**2015**		**2025**	
	40% compliance		60% compliance		80% compliance	
	Tons/day	%	Tons/day	%	Tons/day	%
West Zone	138	53	115	55	63	59
East-West Boundary	21	8	17	8	8	7
East Zone	103	39	77	37	35	34
TOTAL	262	100	209	100	106	100

1. The wastewater quantity used in calculating the pollution load is 1,452 mg/l. This was the value reported in the 1992 IEPC report which was estimated based on 596 industrial firms representing sixteen industrial sectors.
2. Industrial water supply to the service areas for 2015 will remain the almost same until 2025. This means no significant increase in industrial activities will be realized in Metro Manila.

Based on this master plan's projection, projected industrial water usage will remain almost constant from 2015 to 2025 with the west zone still carrying about 55 to 59% of the total industrial wastewater flow. Assuming the following compliance targets for DENR/EMB standards, industrial pollution loading may be expected to decrease from 262 tons/day in 2005 to 209 tons/day in 2015 and 106 tons/day in 2025 as shown in **Table 8.14**.

- Year 2005: 40% of all industrial firms have sufficient industrial treatment facilities meeting the 50 mg/l BOD requirement
- Year 2015: 60% of all industrial firms have sufficient industrial treatment facilities meeting the 50 mg/l BOD requirement
- Year 2025: 80% of all industrial firms have sufficient industrial treatment facilities meeting the 50 mg/l BOD requirement

Impact of Recent Regulations to Industrial Load Discharges

Given the legislation is now in place to control the discharge of industrial effluent to water bodies in Metro Manila and the critical situation with regard to collection and treatment of domestic waste, in the short and medium term it is probably prudent to continue to disallow industrial effluent into the sewers and to concentrate on collecting and treating domestic waste. This is likely to still result in a considerable decrease in pollution loading for the service area.

However, in the longer term as sewerage coverage in Metro Manila increases, it would appear desirable that industrial effluent is also discharged into the sewerage system and treated together with the domestic sewage. This situation is catered for in the Clean Water Act, whereby MWSS or the concessionaires will need to develop pre-treatment standards and a special Trade Waste Group. It would be desirable that the pre-treated effluent be at least equivalent to domestic sewage and that all elements that would either damage the sewers or seriously inhibit the treatment process be removed prior to discharge. It may be possible to include some pollution loading in excess of domestic sewage quality provided it would not adversely affect the system. A charging structure would need to be developed by MWSS or the concessionaires such that the increased treatment costs would be borne by the polluter.

The projected industrial wastewater flows in 2025 are 330,000 m^3/day or 8% of the total projected wastewater flow (assuming all industries connect). This should not result in a major cost due to increase in diameter of trunk sewers, although the secondary and tertiary sewers would need to be designed accordingly to accept the localized flows. There may, however, be increased treatment requirements and costs should a system be established that will accept wastes stronger than domestic sewage. It is not, however suggested that a policy of acceptance of industrial wastewater be implemented until towards the end of the master planning period or by around 2020.

The implementation of a policy to accept industrial wastes will require the establishment of a division within either MWSS of the concessionaires to monitor industries to ensure that they are discharging wastewater to sewers in accordance with the agreed pre-treatment standards and to enforce cost penalties for non-compliance. Initially this group would need to undertake audits of all industries prior to connection to develop agreements related to the quantity and quality of trade waste discharges. The required organization of this division is discussed further in Chapter 13 – Institutional Requirements.

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9. Sanitation Master Plan to 2025

A detailed analysis of the current situation and proposed strategy for development of sanitation facilities is included in *Strategic Action Paper No.9 – Sanitation Strategy for Metro Manila.* The following outlines the findings from this analysis that defines the sanitation strategy for the MWSS service area during the Master Plan period until 2025.

9.1 Sanitation Design Criteria

The Code of Sanitation (PD 856), promulgated in December 23, 1975 by then President Ferdinand E. Marcos, has been the basis of sanitation practices. The 1995 Implementing Rules and Regulations (IRR) for Chapter XVII of the Code particularly contained provisions for management of septage including prescribed guidelines for construction, cleaning and maintenance of septic tanks for areas not covered by sewerage systems.

With the continuous degradation of the river systems due to indiscriminate dumping of septage collected from individual septic tanks, the DOH in 2004 issued supplemental implementing rules and regulations for Chapter XVII to cover stricter guidelines on collection, handling, transport, treatment and disposal of septage.

Any individual, firm or operator, government or private sector, who are engaged or will be engaged in the collection/desludging, handling, transport, treatment and disposal of sludge and septage is required to secure an Environmental Sanitation Clearance (ESC) prior to operation. The ESC shall be issued by the Secretary of Health or the Director of the concerned Center for Health Development (CHD) as his duly authorized representative.

Section 6 of the supplemental IRR recommended mandatory septage processing and treatment prior to disposal. Treated septage must be properly disposed off either via landfill or land application. Prior to disposal, the sludge must be analyzed for nitrogen, phosphorus, potassium, pathogens, essential and heavy metals. In the absence of a Philippine set of standard limits, the DOH and DA currently recommend the adoption of USEPA limits and procedures for septage handling, processing and disposal.

The following are the minimum requirements for the construction of septic tanks:

- Construct multi-chamber septic tanks, requiring a minimum of two chambers;
- The capacity is based on the number of bedrooms or apartment units in dwelling occupancies, or the estimated waste/sewage design flow rate or the number of plumbing fixture units, whichever is greater. The volume of the septic tank should be at least 5 m3 allowing at least one-day retention time;
- Provide inspection ports and access manholes; and
- Line septic tank bottoms and shall be constructed of solid durable materials.

9.2 Sanitation Targets

9.2.1 MWCI Sanitation Targets

1997 Sewerage and Sanitation Concession Agreement

The terms of agreement set forth in the Concession Agreement (CA) specified the population targets for the provision of sewerage and sanitation coverage for each city and municipality in the service area. The basis of the targets came from the served population. The targets were to be achieved until the end of the concession period of 2021. These targets are shown in **Table 9.1**.

Table 9.1 – Sewerage and Sanitation Coverage Targets for East Service Area

City/ Municipality	2001		2006		2011		2016		2021	
	Sewer	Sanitation	Sewer	Sanitation	Sewer	Sanitation	Sewer	Sanitation	Sewer	Sanitation
NCR										
Quezon	0%	24%	0%	21%	83%	16%	87%	12%	98%	2%
Mandaluyong	0%	0%	0%	0%	100%	0%	100%	0%	100%	0%
Makati	22%	0%	52%	0%	100%	0%	100%	0%	100%	0%
Marikina	0%	63%	0%	79%	0%	73%	0%	64%	0%	60%
Pasig	0%	83%	41%	58%	68%	32%	68%	27%	68%	25%
Pateros	0%	0%	60%	0%	100%	0%	100%	0%	99%	0%
San Juan	0%	0%	0%	0%	100%	0%	100%	0%	100%	0%
Taguig	0%	0%	52%	0%	75%	0%	84%	0%	100%	0%
RIZAL										
Angono	0%	19%	0%	30%	0%	49%	0%	44%	0%	41%
Antipolo	0%	57%	0%	53%	0%	63%	0%	50%	0%	44%
Baras	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Binangonan	0%	12%	0%	21%	0%	26%	0%	23%	0%	22%
Cainta	0%	38%	0%	40%	0%	34%	0%	28%	14%	27%
Cardona	0%	10%	0%	13%	0%	12%	0%	10%	0%	10%
Jala-jala	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Morong	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pililla	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Rodriguez	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
San Mateo	0%	66%	0%	65%	0%	58%	0%	49%	0%	44%
Tanay	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Taytay	0%	82%	0%	78%	0%	70%	0%	60%	15%	54%
Teresa	0%	25%	0%	25%	0%	23%	0%	21%	0%	20%
Total Area	**3%**	**38%**	**16%**	**32%**	**51%**	**27%**	**52%**	**24%**	**55%**	**19%**

2003 Rate Rebasing for Sanitation

Due to the sizeable cost of attaining the targets of the 1997 CA, MWCI sough to revise the implementation of the schedules and targets through revisions in the previous master plan. It was noted that such an undertaking would amount to PhP 50,000 million, including the cost for land acquisition of about 47 ha for the different STPs.

Aside from the projected high cost of implementation stated above, other issues such as technical and socio-political issues were pointed out. These were:

- Poor and congested road network;
- Heavy population density;
- Unwillingness to pay for sewerage services; and
- Unavailability of land for STP sites.

Due to the aforementioned reasons, sewerage projects recommendations made in the 1996 master plan were forgone in favor of a more decentralized system, consisting of smaller scale STPs. Medium to high rise housing projects are to be developed with STPs sites using government land. As a result, there would be a reduction of sewerage coverage, which shall be compensated by higher sanitation coverage. Revised sanitation targets from the 2003 Rate Rebasing are shown in **Table 9.2.**

Table 9.2 – Sanitation Coverage Targets for East Concession Area based on 2003 Rate Rebasing

City/ Municipality	2006	2011	2016	2021
Mandaluyong	99.5%	96%	90%	85%
Makati (Part)	60%	62%	72%	77%
Quezon City (Part)	87%	80%	84%	83%
Pasig	91%	90%	88%	86%
San Juan	100%	100%	82%	59%
Taguig	95%	75%	74%	80%
Marikina	100%	100%	100%	100%
Pateros	100%	100%	100%	100%
Antipolo	100%	100%	100%	100%
Cainta	100%	100%	100%	100%
San Mateo	100%	100%	100%	100%
Taytay	100%	100%	100%	100%
Angono	100%	100%	100%	100%
Binangonan	0%	0%	100%	100%
Cardona	0%	0%	100%	100%
Baras	0%	0%	100%	100%
Jala-jala	0%	0%	100%	100%
Morong	0%	0%	100%	100%
Pililla	0%	0%	100%	100%
Tanay	0%	0%	100%	100%
Teresa	0%	0%	100%	100%
Weighted Total	**78%**	**75%**	**91%**	**92%**

Source: 2003 Rate Rebasing

The MTSP and the 2005 East Concession Master Plan have proposed sewage and septage treatment works for small pockets of catchments located throughout the service area. This decentralized approach for sewage and septage treatment is more economical compared to the centralized system proposed in the 1996 Master Plan. Funding of the MTSP is being provided by World Bank via Land Bank of the Philippines.

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9.2.2 MWSI Sanitation Targets

1997 Sewerage and Sanitation Concession Agreement

The 1997 Concession Agreement also stipulated the obligations of MWSI with respect to sewerage and sanitation in the West Zone. Sanitation and sewerage coverage targets are indicated in **Table 9.3**. The CA also required compliance with environmental laws and pertinent standards on wastewater discharge and the provision of septic and sanitation cleaning services.

Table 9.3 - Sewerage and Sanitation Coverage Targets for MWSI

City/Municipality	2001		2006		2011		2016		2021	
	Sewer	Sanitation	Sewer	Sanitation	Sewer	Sanitation	Sewer	Sanitation	Sewer	Sanitation
NCR										
Manila	55	9	71	9	77	9	83	9	91	9
Pasay	0	73	0	68	0	66	16	47	95	0
Quezon*	0	41	0	37	0	38	0	97	54	45
Caloocan	3	30	2	61	2	47	32	42	79	21
Las Piñas	0	46	0	57	0	50	0	41	50	27
Malabon	2	7	2	42	2	39	38	35	94	6
Muntinlupa	0	27	44	36	57	31	54	26	61	24
Navotas	3	14	3	65	3	60	36	54	90	10
Parañaque	0	53	0	59	0	53	0	46	52	42
Valenzuela	0	67	0	90	0	80	24	68	59	36
Cavite										
Cavite City	0	100	0	89	0	84	0	91	0	86
Bacoor	0	52	0	67	0	60	0	56	0	50
Imus	0	11	0	15	0	15	0	24	0	24
Kawit	0	67	0	68	0	61	0	52	0	47
Noveleta	0	28	0	41	0	39	0	35	0	33
Rosario	0	14	0	25	0	23	0	20	0	18
Total Area	**16**	**43**	**20**	**46**	**21**	**43**	**31**	**39**	**66**	**27**

Source: Concession Agreement

2003 Rate Rebasing for Sanitation

The rate rebasing determination for MWSI was performed by the MWSS Regulatory Office (RO), who in turn hired the services of the UP Econ Foundation. The resolution of the office was released in October 30, 2002.

Under the 2003 rate rebasing, MWSI proposed sewerage targets as set in the 1997 CA uniformly by five years starting 2006. This moving forward of sewerage targets by MWSI was cited as necessary due to move forward to major delays in the implementation of MSSP 3 and 4 and the refusal of customers to connect to sewers or have their septic tanks desludged. The revised targets are shown in **Table 9.4.**

The current investment projects being undertaken in the West Zone Concession Area are parts of the implementation of the Manila Second Sewerage Project. No other investment project has currently been proposed for achieving the sewerage and sanitation targets in the 2003 Rate Rebasing. While the drafting of a sewerage master plan was undertaken in 2000, the draft final report was never adopted as an official document. This draft master plan recommended expanding the sewerage system in the west concession area.

The moving forward of sewerage targets for MWS will have significant impacts on the sanitation and sewerage services for the West Concession Area by the end of the concession period. There is a need for MWSI to outline its programs for meeting even these revised targets on increasing the sewerage and sanitation coverage.

Table 9.4- Sanitation Coverage Targets for West Concession Area based on 2003 Rate Rebasing

City/Municipality	2006	2011	2016	2021
Manila	9%	9%	9%	9%
Pasay	68%	66%	47%	0%
Quezon City	37%	38%	97%	45%
Caloocan	61%	47%	42%	21%
Las Piñas	57%	50%	41%	27%
Malabon	42%	39%	35%	6%
Muntinlupa	36%	31%	26%	24%
Navotas	65%	60%	54%	10%
Parañaque	59%	53%	46%	42%
Valenzuela	90%	80%	68%	36%
Cavite City	89%	84%	91%	86%
Bacoor	67%	60%	56%	50%
Imus	15%	15%	24%	24%
Kawit	68%	61%	52%	47%
Noveleta	41%	39%	35%	33%
Rosario	25%	23%	20%	18%
Weighted Total	**46%**	**43%**	**39%**	**27%**

9.3 Septic Tank and Septage Volume Projections

9.3.1 Septic Tank Projections

The National Statistics Office (NSO) 2000 census on Population and Housing shows that about 84% of households in the NCR have access to a septic tank. The same reference indicates that 72% of the households in both Rizal and Cavite provinces have septic tanks. **Table 4.11** in **Chapter 4** shows the estimated number of households in the MWSS service area with septic tanks in the year 2000 is around 2.17 million (NSO 2000). This is 82% of the number of household in the MWSS service area and 84% of the number of households in the National Capital Region (NCR).

The current and projected population increase in the MWSS service areas in this study are based on the NSO 2000 census and were presented in **Table 4.1**.

For the NCR cities and municipalities, with the exception of Las Piñas, Muntinlupa, Navotas and Taguig, the percentages of households with septic tanks were assumed to remain constant up to design year 2025. For Las Piñas, Muntinlupa, Navotas and Taguig, they were projected to increase with the construction of new buildings/dwellings to correspond with the considerable increases in population.

The number of septic tanks is expected to increase to 1.30 million and 1.75 million by year 2015 and 2025, respectively, for the East Concession and to 1.67 million and 1.81 million in the same years for the West Concession (**Table 9.5**) (see Chapter 9 Annex 9-1 **-** Estimated Number of Septic Tanks, 2005 – 2025).

Table 9.5 - Number of Septic Tanks

Concession Area	Estimated No. Of Individual Septic Tanks (1000)					
	2001	2005	2010	2015	2020	2025
East	859	952	1,104	1,305	1,502	1,755
West	1,374	1,468	1,571	1,666	1,747	1,810
Total	2,233	2,420	2,675	2,971	3,249	3,565

9.3.2 Potential Septage Volume for Collection

Many septic tanks in the NCR are not accessible for desludging, either because the tanks have no access manholes, or structures have been built over them, or the septic tanks are located in areas with roads that are very narrow or impassable by any type of vehicle. The 1991 Manila Second Sewerage Project Feasibility Study Report estimated the accessibility of septic tanks in the cities of Manila, Quezon, Caloocan and Pasay at around 60 % and 90 % for the rest of the NCR. It assumed septic tank accessibility at around 74 % for the whole MWSS service area.

For this study, assuming 80 % accessibility, an average septic tank volume of 5.0 m^3, a desludging interval of 6 years and 300 collection days per year, the potential daily septage collection is estimated to reach around 6,603 m^3 and 7,922 m^3 by 2015 and 2025, respectively (**Table 9.6** and Chapter 9 Annex 9 - 2 - Potential septage volume collections 2005 – 2025).

Table 9.6 – Potential Septage Generation

Concession Area	Potential Septage Volume Collection (m^3/d)					
	2001	2005	2010	2015	2020	2025
East	1,909	2,116	2,454	2,900	3,337	3,899
West	3,052	3,263	3,492	3,703	3,883	4,023
Total	4,961	5,379	5,946	6,603	7,220	7,922

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9.4 Concessionaires' Programs for Sanitation

9.4.1 MWCI Programs

a. MWCI Sanitation Targets

From the outcome of the 2003 Rate Rebasing, MWCI intend to maximize the sewerage service coverage, at a minimum cost, and with the least disruption to customers through a decentralized approach. MWCI also and to take over the operation and maintenance of private sewerage systems. **Table 9.2** shows the MWCI revised sanitation targets as per the 2003 Rate Rebasing submission. These targets have been approved by the MWSS Board of Trustees.

The MTSP was developed to comply with the 2003 Rate Rebasing targets for sewerage and sanitation, in particular with the service targets for 2010. A component of MTSP includes SpTPs. The septage treatment facilities will not only meet the 2010 sanitation targets, but will continue to serve the East Concession Area in the future and are considered part of the long term strategy for sanitation.

MTSP has an estimated cost of PhP 4.3 billion including physical and price contingencies and taxes, of which PhP 2.76 billion is for sanitation.

b. Sanitation Requirements within the Master Plan Study Period

1) Collection System (Vacuum tankers)

Presently, MWCI is providing sanitation services by desludging septic tanks in the East Concession Area, complementing a number of private desludging companies. MWCI presently has a fleet of one 5 m^3 and fourteen 10 m^3 vacuum trucks which is relatively new. Half was delivered in 2001 and the other half in 2004. Through an Asian Development Bank (ADB) loan, MWCI is increasing their fleet by six 5 m^3 and thirty 10 m^3 trucks. Delivery will take place in years 2006 and 2007. Also under a World Bank (WB) Loan, an additional 70 units of vacuum tankers will be procured with delivery target date of 2008. **Table 9.7** below summarizes the number of units of the vacuum tankers.

Table 9.7 - Number of Vacuum Tankers

No. Of Units	Capacity of Tankers (m^3)	Status
14	10	Existing
1	5	Existing
30	10	Awarded, delivery in 2006-07 (ADB loan)
6	5	Awarded, delivery in 2006-07 (ADB loan)
60	10	For procurement, delivery in 2008 (MTSP-WB)
10	5	For Procurement, delivery in 2008 (MTSP-WB)
121		Total

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2) Treatment System

Table 9.8 (see Chapter 9 Annex 9-3) estimates the septage to be collected and treated from 2005 to 2025. It would be necessary to provide for new collection and treatment facilities by year 2015. This study therefore proposed to construct a new SpTP (1600 m^3/day) for Rizal Province at Binangonan or Cardona area by 2025. These areas will remain agricultural up to 2025 onwards. The option for natural system processes for treating septage can be seriously considered such as drying beds for sludge dewatering and stabilization ponds for treating filtrate. Since it is not anticipated that sewerage services will be available in Rizal Province during the Master Plan period, the facility would be designed to treat septage alone. However, once sewerage services are provided, the plant could be converted into a sewerage/septage treatment plant.

Table 9.8 - Septage Treatment System Capacity

Location	Septage Treatment Capacity (m^3/day)				
	Year 2005	Year 2010	Year 2015	Year 2020	Year 2025
Antipolo	-	600	600	600	600
Taguig/San Mateo	-	1400	1400	1400	1400
Total	-	*2000*	*2000*	*2000*	*2000*
Required (MTSP)[1]		1427	2029	2695	3089
Excess/(Backlog)	-	223	(29)	(695)	(1089)
Required (Updated-this master plan)[2]	1264	1505	2162	2867	3582
Excess/(Backlog)	(1264)	495	(162)	(867)	(1582)

1. Requirements for combined sewer system alternative.
2. Based on 2003 Rate Rebasing.

It would be necessary to procure additional vacuum tankers as shown below. There will be two trips/vacuum tanker/day. It is assumed that approximately 10 % of the septage will be collected by private contractors.

Concessionaire	No. Of Tanks		Procured by Year
	5 m^3	10 m^3	
MWCI	-	2	2015
	31	110	2020
	5	33	2025
Total	36	145	

9.4.2 MWSI Programs

a. MWSI Sanitation Targets

The highlights of the MWSI sanitation targets are:

- MWSI will catch up with all their targets in all areas by end of year 2006;

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- For NCR, MWSI will drastically increase their sanitation service from year 2001 through year 2006; and
- For Cavite, MWSI started providing sanitation service in year 2004 and will catch up with their targets by year 2006.

The current MWSI sanitation coverage targets are shown in **Table 9.4.**

b. Sanitation requirements of MWSI to meet its 2003 targets:

1) Collection System

MWSI currently has the following existing 32 collection units:

Type of Unit	No. Of Units
Mobile Dewatering Units	7
10 m^3 vacuum sludge tankers	19
4 m^3 vacuum sludge tankers	6
Total	32

2) Treatment System

Table 9.9 - Septage Treatment System Capacity

Location	Septage Treatment Capacity (m^3/day)				
	Year 2005	Year 2010	Year 2015	Year 2020	Year 2025
Dagat-Dagatan	300	300	300	300	300
Total	300	300	300	300	300
Required (Updated)[1]	1347	1412	1810	1064	1124
Excess/(Backlog)[1]	(1047)	(1112)	(1510)	(764)	(824)
Required (Updated)[2]	1347	1431	1873	1423	1790
Excess/(Backlog)[2]	(1047)	(1131)	(1573)	(1123)	(1490)

Note: 1. Based on 2003 Rate Rebasing
2. Based on 2003 Rate Rebasing considering STED system.

For the proposed sewerage master plan, it is recommended that the reticulation utilize the small-bore, gravity sewerage that collects septic overflow, with Septic Tank (Septic Tank Effluent Disposal) for conveyance to treatment facilities. The septic tanks would require regular pump out to keep their solids less than a third of the tank volume. As a result, additional septage treatment capacities would also be needed to treat the septage coming from the septic tanks of the sewered areas.

Table 9.9 above also presents the 2003 rate rebasing requirements for sanitation as well as the sanitation requirements for the STED systems. No adjustments were made for MWCI since they have reduced their sewerage targets and have significantly increased their sanitation services.

As shown in **Table 9.9** there is deficit in the septage collection and treatment facilities up to 2025 (see Chapter 9 Annex 9-4).

Additional SpTP capacity (1,573 m^3/day) capacity is required by year 2015. The following actions are therefore proposed:

a) Expand Dagat-Dagatan SpTP (additional 400 m^3/day) by year 2010 and expand up to 1,000 m^3/day by year 2025. The strategy calls for the construction/installation of a similar process equipment as the existing plant;
b) Construct a new SpTP (500 m^3/day) in the Parañaque or Las Piñas area by year 2025. The strategy entails a mechanical process, i.e. provision for screening/degritting facilities, screw press dewatering equipment and filtrate treatment facilities like SBR. Lime stabilization is also required;
c) Utilize excess capacity of the East Zone of about 495 m^3/day for year 2010; and
d) Procurement of vacuum tankers as shown below.

Concessionaire	**No. Of Tanks**		**Procured by Year**
	5 m^3	10 m^3	
MWSI	6	40	2010
	5	42	2015
	4	20	2020
	11	54	2025
Total	26	156	

Note: Based on 2003 Rate Rebasing and the proposed STED system.

The Dagat-Dagatan and the Parañaque/Las Piñas septage treatment facilities may be combined sewage/septage treatment plants should sewerage services be available in those areas by the time the additional septage facilities are required. If not, the SpTPs may be converted to accept sewage as well as septage when sewerage services are eventually provided.

9.5 Combined MWCI and MWSI Septage Treatment

The overall septage collection plan is shown in **Figure 9.1** for both NCR and other MWSS water supply areas. The San Mateo SpTP will serve Quezon City, Marikina and San Juan. The Food Terminal Inc. (FTI) SpTP will serve Mandaluyong, Pasig, Makati, Pateros, Taguig and most towns of Rizal. The Antipolo SpTP will serve Makati, Mandaluyong, Pateros, San Juan and Taguig. The proposed Parañaque SpTP will serve the south and the existing Dagat-Dagatan serves the West Zone. It is obvious that some adjustments will be needed in actual practice to minimize travel distances.

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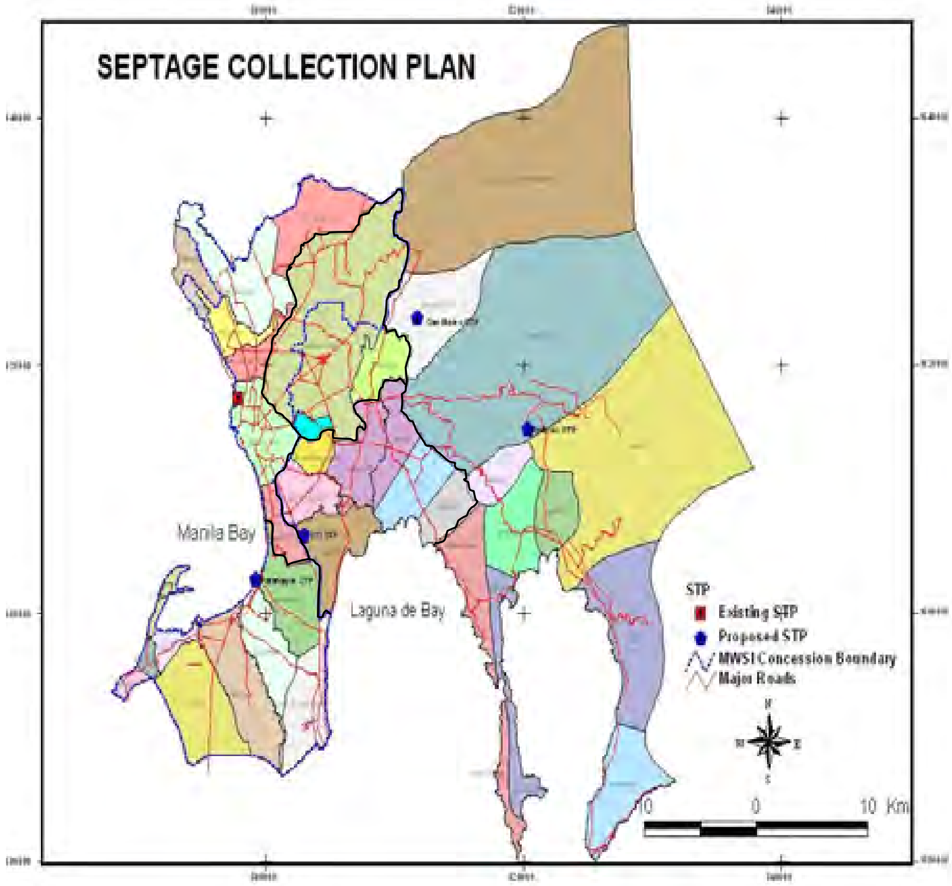

Figure 9.1 Septage Collection Plan

The septage volumes to be collected and treated for MWCI and MWSI have different future trends. The septage treatment requirements for MWCI will increase while the requirements for MWSI decrease from 2015 to 2020. MWCI would need a treatment plant capacity of 1,600 m^3/day by 2025 while MWSI would need a treatment capacity of 1,573 m^3/day by year 2015.

If the excess capacity of MWCI can be utilized by MWSI between the years 2010 to 2015, it would not be necessary for MWSI to construct the 1600 m^3/day septage treatment plant by 2015, which it would not need from years 2020 to 2025.

The proposed septage treatment capacities are shown in **Table 9.10**.

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Table 9.10 - Combined MWCI and MWSI Septage Treatment

Location	Septage Treatment Capacity (m^3/day)				
	Year 2005	Year 2010	Year 2015	Year 2020	Year 2025
MWCI					
Excess/(Backlog)	(1264)	495	(162)	(867)	(1582)
Prop. Plant Capacity at Rizal	-	-	*800*	*800*	*1600*
MWSI					
Excess/(Backlog)	(1047)	(1131)	(1573)	(1123)	(1490)
Prop. Plant Capacity at Dagat-dagatan & Paranaque		*600*	*1000*	*1200*	*1500*
Combined					
Total Excess/(Backlog)		(636)	(1735)	(1990)	(3072)
Total Prop. Plant Capacity		**600**	**1800**	**2000**	**3100**

Note: Based on 2003 Rate Rebasing and proposed STED system.

For the above scheme, the Dagat-Dagatan SpTP should be expanded to an additional capacity of 1,000 m^3/day by 2025. The proposed new plant in Parañaque or Las Piñas area would be constructed to a capacity of only 500 m^3/day. The Parañaque or Las Piñas SpTP should be located in the reclaimed area along Manila Bay where the proposed STP for the sewerage system will be located (Chapter 10).

Cardona and Binangonan are adjacent towns of Rizal province that are predominantly rural with agriculture and fishery as their main industries. The estimated total investment cost is PhP 3.50 billion (PhP 2.49 billion for the plant and land, and PhP 1.01 billion for the vacuum tankers) for the new Binangonan or Cardona Septage Treatment Plant (see Chapter 9 Appendix for the Summary of Investment Cost).

The estimated investment cost is about PhP 1.53 billion for the additional expansion of 1,000 m^3/day at Dagat-Dagatan, PhP 1.08 million including cost of land for the new facilities at Parañaque or Las Pinas and PhP 1.03 billion for the vacuum tankers for the West Zone.

The summary of the operation and maintenance costs for the SpTPs and the vacuum tankers are shown in **Table 9.11**.

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Table 9.11 - Summary of Operation and Maintenance Costs for the SpTPs and Vacuum Tankers

Location	Operation and Maintenance Costs (P million)			
	Year 2010	**Year 2015**	**Year 2020**	**Year 2025**
MWCI				
Plant (Rizal)		*65.36*	*65.36*	*130.72*
MWSI				
Plant (Dagat-dagatan)	*32.68*	*49.02*	*65.36*	*81.70*
Plant (Paranaque or Las Pinas)	16.34	32.68	32.68	40.85
Total	**49.02**	**147.06**	**163.40**	**253.27**
MWCI				
Vacuum Tankers	124.84	111.32	146.12	183.27
MWSI				
Vacuum Tankers	53.04	96.22	73.38	91.50
Total	**177.88**	**207.54**	**219.50**	**274.77**

The investment costs, operation and maintenance costs and cost of disposal are shown in the Chapter 9 Annexes 9-5 and 9-6, respectively.

9.6 Sanitation Strategies

Several constraints and issues were identified in Chapter 6 for the existing sanitation conditions and facilities in the MWSS service area, and on the implementation of the sanitation programs. The following options/strategies were formulated to address these issues:

a) ***Short term***

1) *Increase accessibility of septic tanks*

- LGUs to conduct surveys to identify/verify locations of inaccessible septic tanks;
- Formulate strategies to address existing scenarios to make tanks accessible or replace inaccessible tanks;
- Where appropriate, LGUs to issue notices to households to replace inaccessible septic tanks in accordance with Sanitation Code;
- Set up a special desludging team(s) to be assigned to identify problem areas to consult with homeowners. The vacuum tankers are to be equipped with extended suction hoses and high power pumps to reach the septic tanks which cannot be accessed due to the narrow alleys/roads;
- Coordinate with the household to remove obstructions or to implement new installations;
- Temporarily evacuate occupants during desludging, if necessary; and

- If the problem is common in an area and it is not possible to build new septic tanks in each house due to lack of space, a communal septic tank may be constructed to serve clusters of houses.

2) *Conduct a survey on the actual sizes of the septic tanks*

- This has impact on the septage treatment capacities and the number of vacuum tankers required.

3) *Review septic tank designs*

- Encourage multi-chamber septic tanks, requiring a minimum of two chambers;
- Conduct trials of performance of septic tanks with anaerobic filters (reported to remove 80% of BOD loading – see 3.4.2 above);
- The volume of the septic tank should be at least 5 m^3 allowing at least one-day retention time;
- Provide inspection ports and access manholes;
- Line septic tank bottoms;
- Locate septic tanks in the most accessible part of the lots, e.g. near the entrance of the property; and
- Subject to performance evaluation, employ anaerobic filter septic tank where appropriate, and particularly where space is limited due to smaller footprint.

4) *Reconsider resumption of sea disposal*

For the 1994 MSSP, ocean disposal was the immediate and inexpensive strategy for the disposal of septage pumped out from septic tanks to jumpstart the treatment-capability restoration of the most number of septic tank units. Two barge loading stations (each 500 m^3/day capacity) were built primarily for the purpose of ocean disposal.

Renewal of the 1-year disposal permit by the Philippine Coast Guard may be sought for the following reasons:

- The environmental concerns raised by the LGUs of Bataan and Zambales provinces could be addressed properly by the Multi-partite Monitoring Team (MMT);
- Dispersion modeling of septage disposed at the deep-sea site over 60 km offshore indicated insignificant effect on the nearest shores including the Manila Bay. Changes in water quality can be monitored by the resumption of observations at the existing monitoring stations offshore Bataan and Zambales;
- The proposed three (3) Septage Treatment Plants (total capacity – 2,000 m^3/d), presently in the bidding process will be operational in about 2 years or late 2007 at the earliest; and

- Actual sea disposal by barges to be closely monitored through GPS logging to ensure proper buffer zones are being followed (sea disposal in the past was reported to be near shore in the wrong location).

5) *Interim use of Sewage Treatment Plants (STPs) for septage treatment*

With only one SpTP operating at present and three still to operate at the earliest in 2007 and with some STPs operating under capacity, the STPs may be considered as an option for septage treatment. Furthermore, even if the four SpTPs become all operational in the future, their distances from the urban centers are still considerable and the vacuum tankers would have to travel through the busy streets of Metro Manila. There would be savings in transportation costs if the areas with STPs can also service the needs for septage management in the area.

In contrast to sewage, septage contains about twenty times the BOD and over 250 times the suspended solids in sewage (**Table 9.12**). When it is intended for co-treatment with sewage in a sewage treatment plant (STP), some process modifications will be required, as discussed in the following:

- Preliminary treatment

Most STPs perform preliminary screening and de-gritting of raw wastewater. The incorporation of septage treatment would require separate degritting and screening because of the large amount of solids in the septage.

- Primary treatment

In treatment processes that do not usually have primary settlers (i.e. trickling filters and aerated lagoons), a primary clarifier will be required to ease the BOD loading in the ensuing biological process.

- Biological Process

The whole biological treatment will have to be reviewed in terms of BOD loading, MLSS in tank, F: M and/or sludge age (SRT), but particularly aeration capacity.

- Chlorination

Coliform counts in septage and sewage are similar (**Table 9.12)**. The polishing steps (chlorination/ disinfection) should account for the extra load of pathogenic microorganisms on the treatment plant.

- Sludge handling

A STP that accepts septage for co-treatment with sewage is expected to generate more sludge that will require treatment (including disinfection because of pathogens).

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Table 9.12 - Typical Sewage and Septage Characteristics

Parameter	Sewage	Septage
BOD (mg/L)	150-350	6,000
COD (mg/L)	300-700	15,000
Suspended Solids (mg/L)	50-150	10, 000- 40,000
Total Nitrogen (mg/L)	50-60	700
Total Phosphorus (mg/L)	8-15	100
Fecal coliform (CFU/100 mL)	10^8-10^9	10^8-10^9

Alternatively, septage can be dewatered and only the leachate from the dewatering facility will be accepted by the STP. Either way, dewatering capacity will need review. Septage leachate/filtrate has a BOD of less than 1000 mg/L. In general, the required process modifications for septage co-treatment will depend on ratio of septage to sewage in the influent. Higher ratios mean higher BOD loads and sludge quantities. Lower ratios imply minor to no process modifications. It will also depend on how closely loaded the STP is to its original design.

b) Medium term

1) Advocate/recommend to DOH/DA/DENR for improved IRR.

Section 6 of the supplemental IRR of the Code of Sanitation recommended mandatory septage and domestic sludge processing and treatment prior to disposal. Treated or processed domestic sludge and septage must be properly disposed off via landfill and/or land application (the latter being more sustainable). However, the Code did not specify pertinent standard limits for the characteristics of sludge prior to disposal.

Section 8 of the CWA also tasked the DOH to develop standards and guidelines for the disposal of septage and domestic sludge. For land application, the DA is tasked to develop necessary standards prior to land application of the bio-solids.

The Bureau of Soil and Water Management (BSWM) of the Department of Agriculture has yet to establish allowable and acceptable limits for bio-solids characteristics for the purpose of agricultural productivity enhancement. The DOH is also mandated to develop similar limits (both for sludge and bio-solids) for protection of public health and the receiving water environment.

2) Establish long term agreement for lahar application

Early results of the septage application to lahar areas were promising. The septage application to the sugarcane plantation increased the nutrient content of the areas which resulted into higher yield of sugarcane. There appears to be a local demand by the farmers for the septage. It is proposed that long-term use of septage on the lahar areas be explored. The program will require continued monitoring to eventually decide the overall sustainability of this disposal option. The existing barge loading stations may be considered in the transport of the sludge/septage to the lahar areas to reduce transport costs.

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c) Medium to Long term

1) Construct additional SpTPs

Septage treatment plants are proposed to be constructed as shown below (**Table 9.13).** These installations would be constructed as combined sewage/septage treatment plants where STPs are to be provided within the same time frame as the requirement for SpTPs. If the SpTPs precede the need for STPs, the septage plants would eventually be transformed into combined sewage/ septage plants once sewerage is introduced into the respective area.

Table 9.13 – Proposed Septage Treatment Plants

Location	Septage Treatment Capacity (m^3/day)			
	Year 2010	Year 2015	Year 2020	Year 2025
MWCI				
Plant Capacity (Rizal)		*800*	*800*	*1600*
MWSI				
Plant Capacity (Dagat-dagatan)	*400*	*600*	*800*	*1000*
Plant Capacity (Paranaque)	*200*	*400*	*400*	*500*
Combined				
Total Plant Capacity	**600**	**1800**	**2000**	**3100**

Note: Based on 2003 Rate Rebasing and the proposed STED system.

It would be necessary to procure a total of 363 vacuum tankers as follows in **Table 9.14**:

Table 9.14 – Proposed Number of Vacuum Tankers

Concessionaire	No. of Tanks		Procured by Year
	5 m^3	10 m^3	
MWCI	-	2	2015
	31	110	2020
	5	33	2025
sub-total	*36*	*145*	
MWSI	6	40	2010
	5	42	2015
	4	20	2020
	11	54	2025
sub-total	*26*	*156*	
Total	62	301	

Note: About 10 % of the requirement is assumed to be handled by private contractors.

A sensitivity analysis was undertaken to assess the impact of the different septage volumes (3 m^3, 4 m^3 and 5 m^3) being desludged per septic tank on the septage treatment plant capacities and the required number of vacuum tankers (see *SAP 9*). The smaller septage volumes being desludged may indicate undersized or improperly designed septic tanks. With the smaller septic tanks, more frequent desludging would be required. With the increased frequency of desludging, there are actually increased requirements in septage treatment plant capacities and number of vacuum tankers.

10. Sewerage Master Plan to 2025

10.1 Bases for Sewerage Planning

The bases used for the sewerage planning in the 2005 MP were:

- Contractual sewerage coverage specified by the Concession Agreements until 2021 and rate rebasings approved by the MWSS-Regulatory Office;
- Preliminary engineering criteria as set by planning and design guidelines of the MWSS and standard practices;
- Sewage and commercial dirty water projections for each of the city / municipality, where contractual sewerage coverages are specified;
- Identification of critical areas (i.e. pollution “hot spots”) not covered by the Concessionaires’ contractual sewerage coverage that need to be urgently addressed between 2021 and 2025; and
- Longer-term strategy for sewerage coverage beyond the Master Plan period of 2025.

The planning horizon for the Sewerage Master Plan (SMP) was 20 years and as such the SMP was developed for the time horizons of 2010, 2015, 2020, and 2025.

10.2 Sewerage Design

10.2.1 Sewerage Coverages

Sewerage coverage specified in the concession agreements as a function of time are expressed as the percentage of the total population of the city / municipality, where water service is provided by the MWSS concessionaire. Sewerage coverages adopted for the project are shown in **Table 10.1** and illustrated graphically in **Figures 10.1** and **10.2**. For example, in **Figure 10.1**, Manila has interpolated contractual sewerage coverages [of the water-served population] of 71% for 2010, 76% for 2015, and 81% for 2020. All figures were interpolated between the actual written contractual sewerage coverages as was given by the 2003 Rate Rebasing. The original 1997 and the modified 2003 Rate Rebased sewerage coverages are shown in Chapter 9 for the period of 1997 to 2021.

The sewerage coverages for 2025 for all the municipalities and cities resulted from the planning conducted as part of this study.

10.2.2 Catchment Areas

Using the topographic map of Metro Manila covering the East and West Zone service areas of the MWSS, some 31 sewerage drainage catchments were delineated as shown in **Figure 10.3** and listed in **Table 10.2**. The Table indicates the area of each of the catchments including the area of the existing sewerage. The total area of the 31 catchments is 63,197 ha of which 13% is covered by existing systems. The total catchment area exceeds the Metro Manila (or National Capital Region) by about 6%.

Table 10.1 - Sewerage Coverage for the MWSS Service Area

City / Municipality	Percent Sewerage Coverages***							
	2006	2010*	2011	2015*	2016	2020*	2021	
West Zone	RR	interpolated	RR	interpolated	RR	interpolated	RR	SMP 2025
Manila (92%)	55	68	71	76	77	82	83	91
Quezon City (63%)	0	0	0	0	0	0	0	11
Makati (12%)	-	-	-	-	-	-	-	-
Pasay	0	0	0	0	0	13	16	25
Caloocan	3	2	2	2	2	26	32	38
Las Piñas	0	0	0	0	0	0	0	25
Malabon	2	2	2	2	2	31	38	38
Muntinlupa	0	35	44	54	57	55	54	61
Navotas	3	3	3	3	3	29	36	36
Parañaque	0	0	0	0	0	0	0	20
Valenzuela	0	0	0		0	19	24	24
East Zone								
Manila (8%)	-	-	-	-	-	-	-	-
Quezon City (37%)	13	19	20	17	16	17	17	17
Makati (88%)	40	38	38	28	28	24	23	23
Mandaluyong**	1	3	4	9	10	14	15	15
Marikina	0	0	0	0	0	0	0	19
Pasig**	9	10	10	12	12	14	14	44
Pateros	0	0	0	0	0	0	0	100
San Juan	0	0	0	14	18	36	41	59
Taguig**	5	21	25	26	26	21	20	51
Cainta**	0			5		5		5
Taytay**	0	0		5		5		5

* Interpolated sew erage coverage from the 2002/2003 Rate Rebasing by MWSS-RO
** Includes coverages by MTSP and existing systems
*** Coverage target expressed as percentage of the w ater-served population
- no target indicated

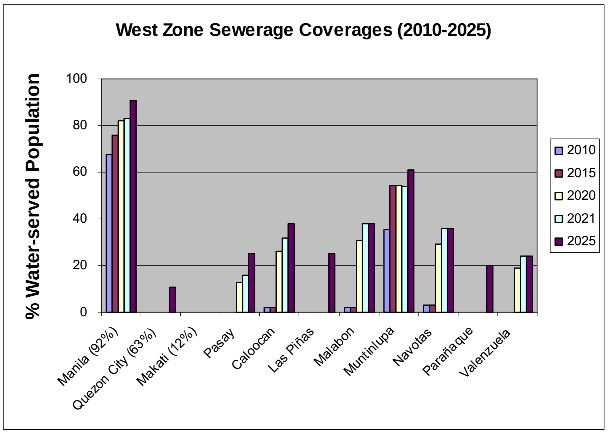

Figure 10.1 Sewerage Coverages for the West Zone for Years 2010 - 2025

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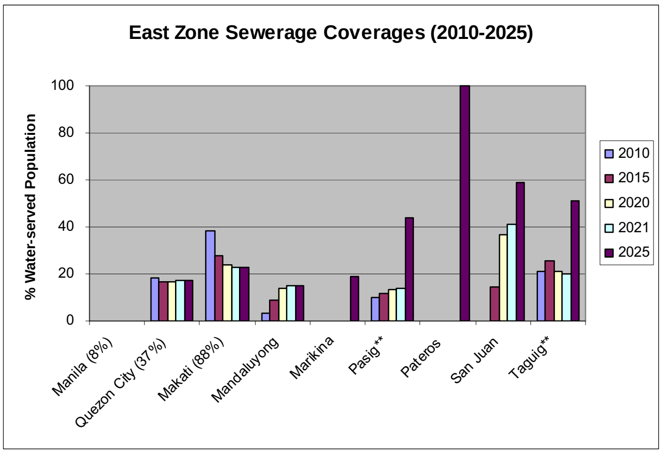

Figure 10.2 Sewerage Coverages for the East Zone for Years 2010 - 2025

Particular sewerage systems were often planned to cover more than one drainage catchment, e.g. in an area with relatively flat terrain, where dirty water can be pumped over catchment divides. In a rolling or highly irregular terrain, a sewerage catchment may also involve several small sewerage systems to avoid excessive pumping over the sub-catchments.

10.2.3 Sewage Flow Estimates

The sewerage flows were estimated from the water demand projections for each city / municipality as presented in Chapter 8. Domestic, commercial and industrial flows were projected. Only domestic and commercial dirty waters were considered for the sewage flow estimates as industrial wastewater was assumed to be separately treated and not currently allowed in MWSS sewers.

The generated sewage flow was calculated as 80% of the total of domestic and commercial water demands plus infiltration to the system, i.e.

Sewage Flow = 0.80 x (domestic + commercial) + Infiltration, (1)

where infiltration rate was assumed to be uniformly 7.5 m^3/ha/day. The infiltration rate was multiplied by the area over which it flowed to determine the total infiltration. The flows are those presented in Chapter 8, Tables 8.1 to 8.5.

The sewerage coverage for a planning year for each city / municipality was averaged over the entire city / municipality area. Sewage flow from a sub-catchment (attributed to a node in the network) was calculated as the product of the sub-catchment area and the average sewage flow of the city / municipality covered by the sub-catchment. Sewage flow was calculated using equation (1) for the given area.

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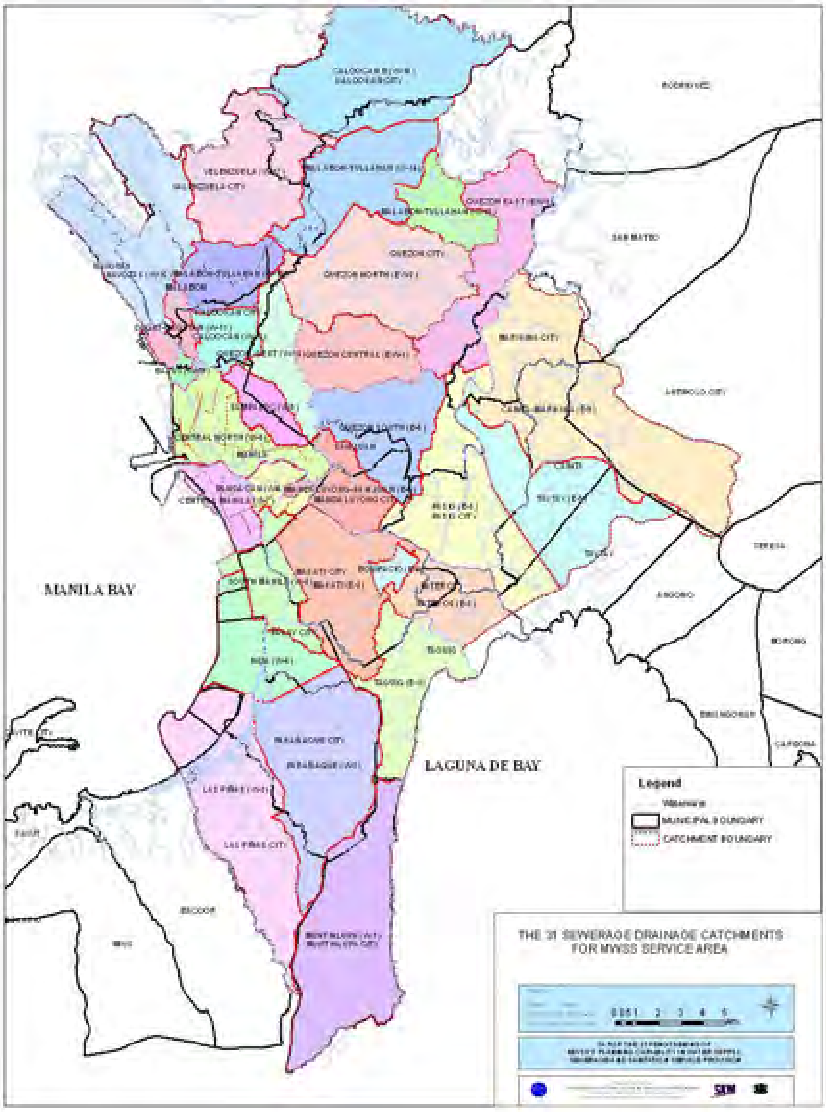

Figure 10.3 The 31 Sewerage/Drainage Catchments for MWSS Service Area

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Table 10.2 -The 31 Sewerage Catchments and Areas

Catchment Area / Name	Catchment No. / Name	Area, ha.	Existing sewered Areas, ha	2005 Sewered Area (%)
I West Metro Manila Region				
(a) South Manila Area	1 W-1 Muntinlupa	3,949	850	22%
	2 W-2 Las Pinas	3,928	-	-
	3 W-3 Paranaque	3,648	-	-
	4 W-4 Pasay - NAIA	1,657	-	-
	5 W-5 South Manila	1,167	-	-
(b) Manila Area	6 W-6 Pandacan	500	500	100%
	7 W-7 Central-Manila	713	713	100%
	8 W-8 Central-North	1,715	1,492	87%
	9 W-9 Sampaloc	654	-	-
	10 W-10 Balut	140	79	56%
II North Metro Manila Region				
(c) Calo-Mala (Dagat-dagatan) Area	11 W-11 Dagat-Dagat	520	520	100%
	12 W-12 Caloocan	717	-	-
	13 W-13 Malabon-Tullahan	989	-	-
(d) Caloocan Novaliches Area	14 W-18 Caloocan B	4,084	-	-
(e) Navotas-Malabon-Valenzuela Area	15 W-16 Navotas	3,130	-	-
	16 W-17 Valenzuela	2,835	-	-
III Central Metro Manila Region				
(f) QC Novaliches-QC North Area	17 W-14 QC Novaliches	2,027	-	-
	18 W-19 Malabon	1,489	-	-
(g) Quezon West & Central Area	19 W-15 Quezon West	1,079	-	-
	20 EW-1 Quezon Central	1,502	466	31%
(h) QC North & East Area	21 EW-2 Quezon North	3,329	265	8%
	22 EW-3 Quezon East	2,432	67	3%
IV East Metro Manila Region				
(i) Pasig-Taytay Area	23 E-1 Taguig**	1,875	656	35%
	24 E-2 Makati	2,322	819	35%
	25 E-3 Pateros**	1,495	661	44%
	26 E-7 Taytay	2,835	-	0%
(j) QC South-SanJuan-Manda-Pasig Area	27 E-4 Bonifacio	249	249	100%
	28 E-5 Pasig**	3,294	439	13%
	29 E-6 Manda-San Juan	1,036	32	3%
	30 E-8 QC South	2,074	381	18%
(k) Marikina-Cainta Area	31 E-9 Cainta-Marikina	5,817	37	1%
** With planned sewerage coverage by MTSP	TOTAL	63,197	8,226	13%
	Metro Manila	59,674	8,226	14%

10.2.4 Sewage Pollution Loads

BOD loads as given in **Table 8.6** were used. The BOD load in 2005 was assumed for low, middle, high income groups and average of 36, 50, 50, and 45.3g BOD/person/day, respectively. By 2025, these loads were projected to be 43, 50, 50, and 47.7 gBOD/person/day, respectively.

The BOD loads associated with domestic sources for each catchment used in this study were calculated, using the 2005, 2015, and 2025 population projections for the MWSS service area. These numbers were in turn multiplied by the per capita BOD production to obtain the total catchment BOD load as was seen in **Figure 8.1**.

Eighty percent of the commercial water supply was assumed to be generated as commercial wastewater flow. These are summarized in **Tables 8.9 and 8.10**.

The projected industrial wastewater generation rates for the west, east and boundary zones are included in **Table 8.12**.

10.2.5 Hydraulic Modelling

The trunk sewer system was simulated using commercial software, Sewer CAD©. Sewer CAD© is a design and analysis tool for planning and implementing sewerage systems, for developing and computing sanitary (sewage flow) loads, and to dynamically simulate the hydraulic response of the entire system (including gravity collection and pressure force mains).

The software utilizes industry standard equations and relationships for hydraulic flow (see write up below) and has built in basic parameters like roughness coefficients for pipe types. Sewer CAD© was developed by the Haestad Methods Solution Center.

Sewer CAD© follows the following basic principles for the modeling of the networks such as the Conservation of Mass given by equation (2),

$$M(t+\Delta t) - \mathrm{M(t)} = M(in) + \mathrm{M(out)} + \mathrm{M(produced)}, \qquad (2)$$

Where	M	=	mass
	t	=	time at the start (applied to system mass)
	$t+\Delta t$	=	time at the end (applied to system mass)
	in	=	mass entering the defined system
	out	=	mass exiting the defined system
	produced	=	mass produced by a chemical or bio-reaction,

the Conservation of Energy or Bernoulli's relationship as given in equation (3),

$$\frac{P_1}{\rho_1 g}+\frac{V_1^2}{2g}+Z_1=\frac{P_2}{\rho_2 g}+\frac{V_2^2}{2g}+Z_2+h_f+\eta W_{pump}+Q \qquad (3)$$

Where	$P_{1,2}$	=	pressure at reference planes 1 & 2, Pa
	$V_{1,2}$	=	velocity at reference planes 1 & 2, m/s
	$Z_{1,2}$	=	height at reference planes 1 & 2, m
	g	=	gravitational constant, 9.807 m/s^2
	h_f	=	total friction, m
	$\rho_{1,2}$	=	liquid density reference planes 1 & 2, kg/m^3
	W_{pump}	=	work required by the pump, m
	η	=	pump efficiency, 0 to 1
	Q	=	heat, and

Manning's equation as depicted in equation (4)

$$Q = \frac{k}{n} A\, R_h^{2/3} + S^{1/2}, \qquad (4)$$

Where	Q	=	liquid flow, m/s
	n	=	roughness coefficient, is 0.013 / 0.010 / 0.012 for concrete / PVC / steel, respectively
	k	=	constant
	A	=	area, m^2
	R_h	=	hydraulic radius, m, and
	S	=	slope.

The Sewer CAD© interface allows for the integration of CAD for a more accurate representation of the sewer system. Required inputs are pipe length and material, infiltration, as well as minimum and maximum slope, velocity, and ground cover. Manhole data includes ground elevation and sanitary loading. Inputs for a pumping station include wet well level and pump capacities. Sewer CAD© will then assess the aforementioned conditions to design the initial system.

The computed sanitary flow load per node was factored with a peak factor as seen in equation (5) that anticipates a higher peaking factor at lower flows, viz.

$$\text{Peak Factor} = 1.3 + \frac{3}{Q^{0.4}}, \qquad (5)$$

Where	Q	=	sewage average dry weather flow (ADWF), volume/time

Sewer CAD© generates reports for the gravity and pressure pipes, manholes, pumps and wet wells. The optimized design includes the pipe sizes, slopes and invert elevations, and manhole depth. Profile for the system shows the hydraulic and energy grade lines of the system to determine any critical portions of the system.

File output of the Sewer CAD© is convertible to a spreadsheet format, to facilitate spreadsheet calculations or graphics presentations.

10.3 Sewerage & Treatment Strategies

The analyses for the preferred methodologies for the type of sewerage to be used in this Master Plan were presented in **Chapter 7**. The recommended sewerage approaches of the 2005 Master Plan are the following points:

- New developments should utilise traditional gravity sewerage and treatment where possible;
- Keep the septic tanks (over 2m already) but pump them regularly for solids for treatment and catch the liquid overflow for treatment;
- Have decentralized Sewage Treatment Plants that are also capable of receiving septage solids as opposed to separate SpTPs;
- Use Combined & Small-bore Sewerage in Decentralised Approach for all of the MWSS service area; and
- Move sewage from East to West, away from Laguna de Bay water source in continually more centralized plants.

10.3.1 Sewerage Methodologies

The Multi-criteria analysis in **Chapter 7** yielded the following systems as preferred in the following order:

1. *Combined Gravity Drainage (stormwater & dirty water);*

   This system had the lowest cost and the least disruption to traffic. It is essence what is being practiced presently in MM with using the storm drains as sewers. Its chief disadvantages are the negative human health aspect, particularly with children that often play in the drains, and the fact that the inclusion of stormwater complicates the hydraulics at any downstream treatment facility. The drains can be covered in some areas to minimize human exposure and excessive flows can be bypassed during storm events. For this study, flows in excess of 1.5 x ADWF were bypassed.

   It is recommended that combined drainage be used where possible but gradually replaced with the separate systems (no storm flows). Where needed, larger bore sewerage piping (trunk mains) may be needed to convey the combined storm flow/ sewage to a treatment plant.

2. *Small Bore Gravity Sewerage, with Septic Tank (Septic Tank Effluent Disposal [STED]); and*

   This system involves directing the overflow from septic tanks through small bore pipes to a small bore sewerage reticulation system. The system requires that subcontractors engaged in laying the small bore, gravity pipes be trained in this activity. Periodic sewage pump stations would be needed when the gravity gradients become too steep. Septic tanks would by necessity have to be regularly pumped out for solids by the institutional water authority. A larger institutional involvement is also required to manage the sewers for clogs, but 2.2 m septic tanks would favor its application in MM. Some septic tanks will require replacement / repair to fully implement this reticulation.

   Where possible, larger-bore gravity sewerage should be utilized for new developments.

3. *Small Bore Gravity Sewerage, No Septic Tank (termed "condominial", carries only dirty water).*

   This system has been used in Brazil mostly to deliver sewerage to a large sector of population, including lately middle and upper income levels. The system also requires that subcontractors engaged in laying the small bore, gravity pipes be trained in this activity. Moreover, institutional involvement is substantial as clogging does occur. Although the MCA analysis made this the second preferred option, the STED system would have more applicability for Metro Manila due to the large number of septic tanks.

10.3.2 Dirty Water Treatment Strategies

The preferred designs for the type of dirty water treatment for use throughout the MM service area were also presented in **Chapter 7**. The Multi-criteria analysis yielded the following treatment preferences in the following order:

1. *Anaerobic [UASBR] – Aerobic [SBR]*

   The Upflow Anaerobic Sludge Blanket [anaerobic] Reactor, followed by a Sequencing Batch [aerobic] Reactor was the preferred option for biologically treating sewage. This process combination eliminates the need for primary sedimentation and a sludge digester, produces far less sludge, and produces biogas that can be used for the generation of electricity in excess of what is used for treatment. The SBR "polishes" the anaerobic treated effluent to produce DENR Class C effluent. This process combination has been used successfully in Brazil and India and has a particular advantage in tropical environments.

2. *Aerobic [SBR]*

   In some drainage catchments, particularly those with considerable dilution, the use of only a SBR may be the preferred treatment choice.

10.4 An Optional Sewage Treatment Plant for the MCSS

The Clean Water Act (CWA) of 2004, which regulates land based pollution sources, will impose future restrictions on the discharge of sewage to Manila Bay. Once fully implemented, CWA will require more stringent effluent limits on organic loading such as BOD and nutrients. At this point in time (2005), several issues must still be clarified by MWSS with the DENR on the coverage of the CWA and its impact to the Manila Central Sewerage System (MCSS) system. The MCSS provides centralized sewerage for the west concession area of 2,620 ha or about 65% of Manila.

There have been no recent thorough studies conducted to ascertain the assimilative capacity of Manila Bay, particularly in receiving domestic wastewater discharges from the outfall. But there are a number of reports and studies that infer deteriorating conditions of water quality of the bay. A thorough study is needed to define whether the discharge from MCSS (a point source) is actually contributing to continued degradation of the water quality of the Bay. Only then, can recommendations be made regarding the need for a MCSS treatment plant. A treatment plant, if required for the MCSS, would come at considerable cost (PhP 3.2 billion for EPT system) and would likely subtract from sewerage efforts around the rest of the MWSS Service Area. The 2005 Master Plan did not consider the current information of sufficient overview and detail to warrant recommending a MCSS treatment plant.

The peak capacity of the Tondo pump station is 432 MLD. At present, except for screening, no treatment is effected to the wastewater received by the Tondo Pumping Station. A diffuser at the end of the outfall imparts at least a 40:1 dilution (JMM Master Plan Report, 1979). A potential STP would be located at the bayshores of Manila Bay (on reclaimed land), near the alignment of current outfall diffuser.

An EPT is often implemented via chemical precipitation, using coagulants and polymer. The process would enhance the solid separation in the primary settling tanks. Solids removal may be up to 90% while BOD removal may be maximized up to 50%. Most of the BOD associated with the solids will be removed, while the chemical precipitation will take some of the dissolved BOD. The downside of this system is the great volume of solids (estimated below at over 500 tons per day), which will require land disposal.

Figure 10.4 shows a proposed schematic process for the Manila Central Sewerage System using the EPT with chemical addition prior to discharge to Manila Bay via the outfall diffuser.

Since the EPT facility comprises only primary treatment, the required land area for a 400 MLD plant ranges from 5 to 8 ha. This land would require reclamation from Manila Bay, itself a costly exercise.

The second MCSS treatment option is a complete biological treatment system capable of meeting the 100-mg/l BOD limit for Class SC. This will include a preliminary treatment, a partial biological treatment system, and a secondary sludge handling and dewatering facility.

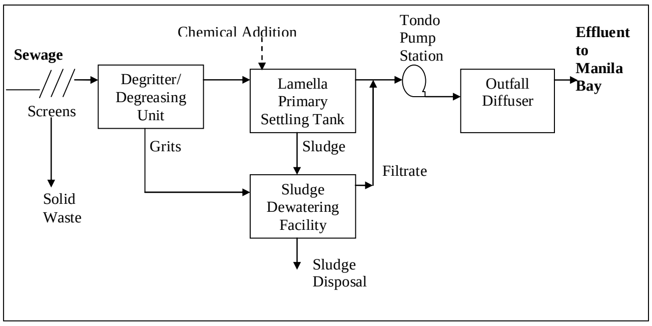

Figure 10.4 An EPT system as an option for MCSS

Based on unit costs from the PhilAqua Study (2000) for the West Zone Sewerage, the estimated cost of the 400 MLD EPT plant is PhP 3 billion. A treatment works site of 6 ha is required, which is likely at reclaimed land preferably nearby the bay outfall alignment not far inland from the Pasig River banks at Manila Bay. At an estimated reclaimed cost of PhP 20,000 per sq.m including site development, the total treatment works cost is estimated at PhP 3.0 billion.

10.5 Biosolids Management

The estimated sludge production for the UASB-SBR and stand-alone SBR treatment options to be used in the proposed decentralized treatment plants is shown in **Table 10.3**. The sludge production in the UASB-SBR process is considerably less, owing to the lower sludge produced during the anaerobic degradation in the UASB.

Table 10.3 - Daily Production of Dewatered (20%) Sludge

Sewage Flow (MLD)	UASB SBR	SBR
	m^3/day	m^3/day
5	28	43
10	55	86
20	111	173
50	273	431

The sludge generated in this UASB-SBR process is easier to dewater and more biologically stable (i.e. less putrescible) and possibly, can be used in agricultural areas as a soil conditioner and/or marketed as fertilizer. Proposed STPs include those found in the northern and southern catchments (Caloocan, Malabon, Manila, Parañaque, and Muntinlupa). The sludge generated in inland STPs may be hauled for off-site disposal or land application either as liquid sludge or dewatered sludge.

An enhanced primary system for a proposed Central Sewerage System treatment plant can be expected to produce, at 400 MLD, 300 mg TS/L and 90% removal, 540 tons per day of 20% [dewatered] solids, not including the extra solids from use of a coagulant.

From the treatment plant at the reclaimed bayshore, these solids would have to be barged to a suitable disposal location. Land transport would not be feasible.

10.6 Sewerage Network

A trunk sewerage network for each of the catchments is shown in its entirety in **Figure 10.5**. This would comprise a centralized system well beyond Master Plan horizon of 2025.

For the 31 catchments, a total of 25 trunk systems were developed. The trunk system forms the backbone of the sewerage for a catchment or a cluster of catchments with the flow leading westward to Manila Bay.

The trunk sewer system is schematized by a pipe node network, where a node covers a reticulation area (or sub-catchment) where sewage is collected and inputted to the node. The pipe connecting the nodes conveys the flow. Hydraulic analysis was performed with Sewer CAD© software.

It should be noted, that a number of the proposed trunk systems cross the current East-West Zone concession boundary.

The 2005-2025 Sewerage Master Plan was developed on the basis of moving towards this long-term strategy.

10.7 Sewerage Master Plan for the Drainage Catchments

The sewerage master plans (SMPs) for 2010, 2015, 2020 and 2025 were developed as shown respectively in **Figures 10.6** to **10.9**. The 2025 plan is a recommended plan with sewerage coverage for densely populated areas to maintain the sewerage investment momentum at the end of the concession period in 2021.

In the aforementioned figures, the existing and proposed sewered areas, trunk mains layout and treatment plant locations are indicated. Also indicated is the sewerage coverage of the MTSP. The backbone of the long-term centralized sewerage plan that forms the basis for the decentralized systems to be implemented during the Master Plan period is shown in **Figure 10.5**.

The detailed description of the proposed systems are presented in the following sub-sections. Discussions of alternatives considered for each system, the proposed trunk mains and sewage treatment plant options / locations and cost estimates are summarized in sub-sections below and in the Appendices.

10.7.1 South Metro Manila Area Catchment (W-1 to W-6)

The South Manila Area systems cover the cities of Muntinlupa, Parañaque, Las Piñas and Pasay, or five delineated catchments with a total area of 14,348 ha. The Muntinlupa, Las Piñas and Parañaque catchments are each over 3,600 hectares, mainly residential and commercial development with a number of industrial zones. Topography is rolling at the upper areas of the catchments, with well-defined drainage. Except for the Muntinlupa catchment that drains to the Laguna de Bay, all systems drain westward to Manila Bay.

In the long-term centralized strategy, sewage flows from all the 5 catchments plan would be directed to a potential centralized South Treatment Works located on reclaimed land in Manila Bay as shown in **Figure 10.5.** Subject to the environmental requirements for discharge to the Manila Bay at the time of implementation, it is likely that enhanced primary treatment may be required prior to the discharge by means of a bay outfall. However, during the Master Plan timeframe, decentralized systems are proposed for each of the catchments.

At present, except for Pasay, potable water supply is constrained in this area. In about 2015, sufficient water could be available from a potential Laiban Dam development. This increased availability of water will have an adverse environmental impact in terms of the generated sewage. Sewerage systems should be established, particularly in Las Piñas and Parañaque. Contractual sewerage coverage is not required in these areas within the concession period. The 2020 to 2025 time horizon has provided sewerage coverage for Las Piñas and Parañaque.

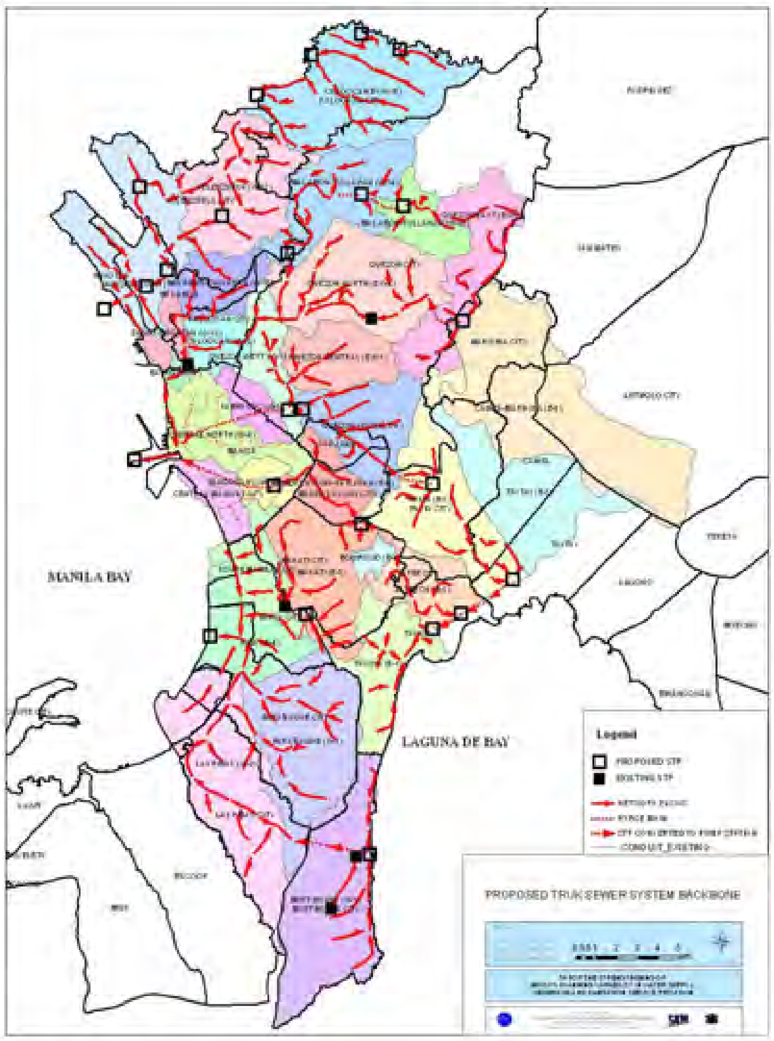

Figure 10.5 Proposed Trunk Sewer Backbone for the 31 Sewerage Catchments

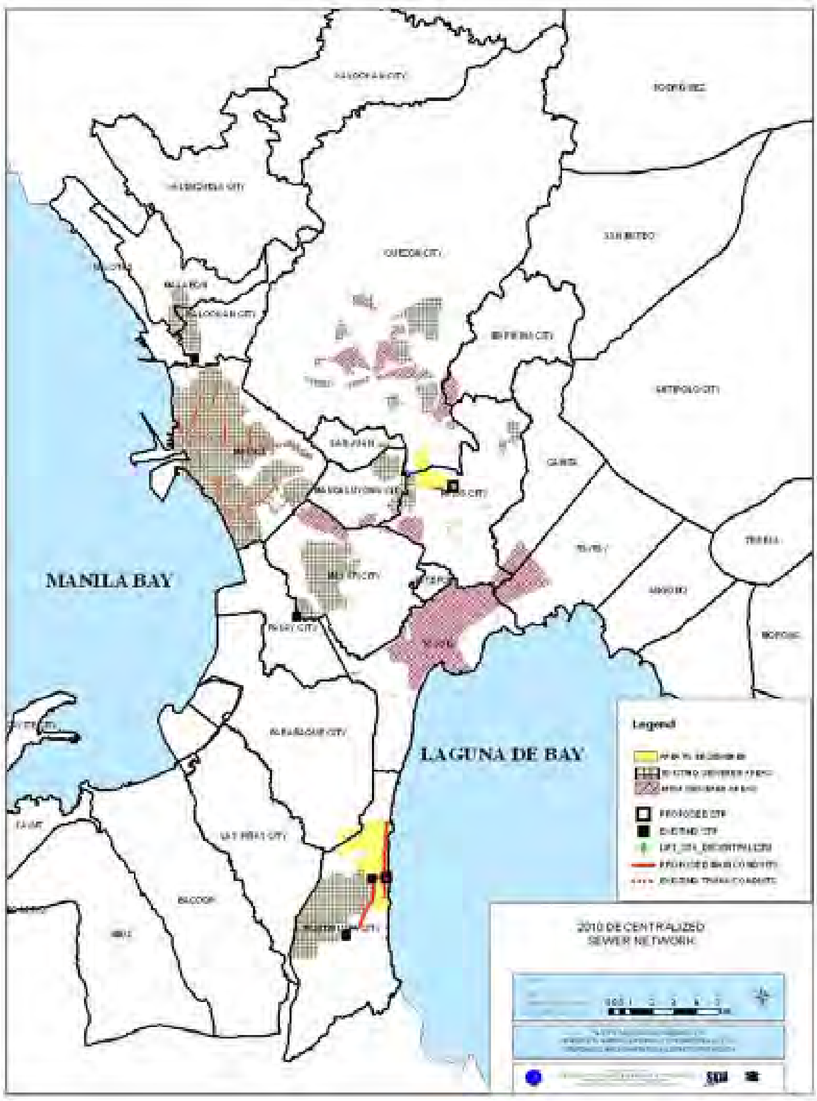

Figure 10.6 Proposed Sewerage Master Plan for Year 2010

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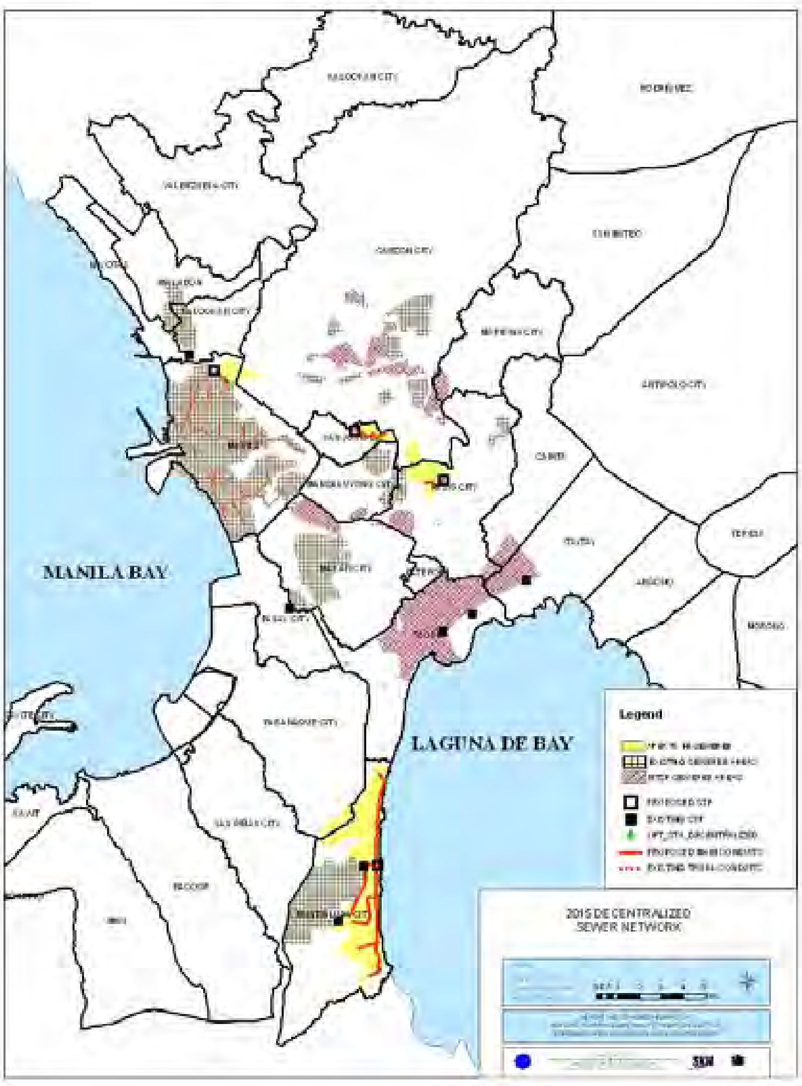

Figure 10.7 Proposed Sewerage Master Plan for Year 2015

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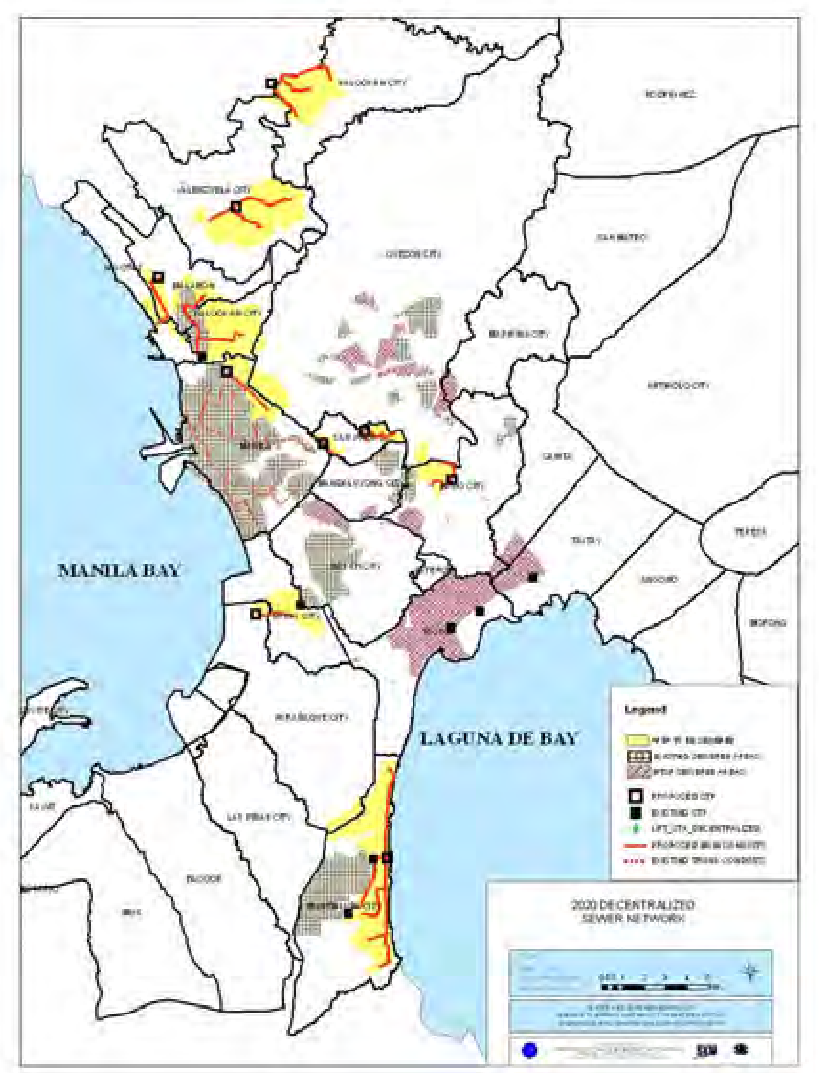

Figure 10.8   Proposed Sewerage Master Plan for Year 2020

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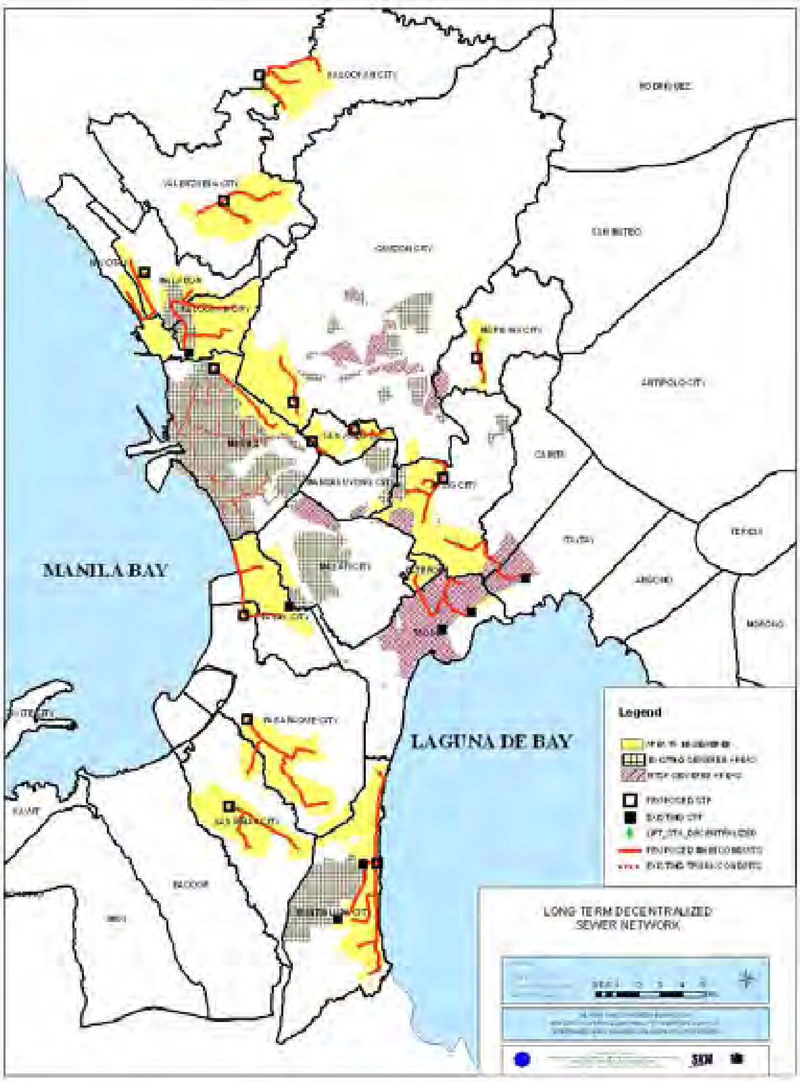

Figure 10.9 Proposed Sewerage Master Plan for Year 2025

10.7.1.1 Muntinlupa Sewerage System (Catchment W-1)

The Muntinlupa System (catchment area of 3,949 ha) covers the whole city of Muntinlupa and a small portion of the upper fringe of the Parañaque catchment. Land use at the catchment is mostly residential with dense settlements along the old highway traversing the bayshore area. Planned residential subdivisions cover a large part of the area, including the upscale Ayala-Alabang and Filinvest-Alabang residential and commercial development with existing sewerage facilities. The National Bilibid Prison with vast land property still undeveloped is located in the catchment. There remain large open areas, particularly at the upper portions of sub-catchments in the south.

Sewerage coverage targets for Muntinlupa were specified in the Concession Agreements for as early as 2001, and increasing towards the end of the concession period in 2021. The early targets for sewerage are justified by the need to protect the freshwater Laguna Lake, considered as a source of potable water for Metro Manila. In 2005, the existing sewerage system operated by a private entity covers 850 hectares or about 22% of the catchment area.

Two sewerage options were considered during planning: (a) maintain the existing two sewerage systems and their STPs and build one new STP for the newly sewered areas; or (b) decommission the existing STPs and centralize to a new STP. The latter option is the more expensive. Option (a) was followed with a new UASB-SBR STP to be located at the bayshore area. The plant will have a capacity of 40 MLD by 2010 and will be expanded to 60 MLD by 2020. Proposed reticulation is a combined system from the residential subdivisions, where good storm drainage exists that is convenient to connect to the trunk mains. STED reticulation is proposed for the bayshore areas which have dense non-uniform clustered settlements.

The proposed sewerage plan is shown in **Figure 10.10** and the facilities and costs are summarized in **Table 10.4**.

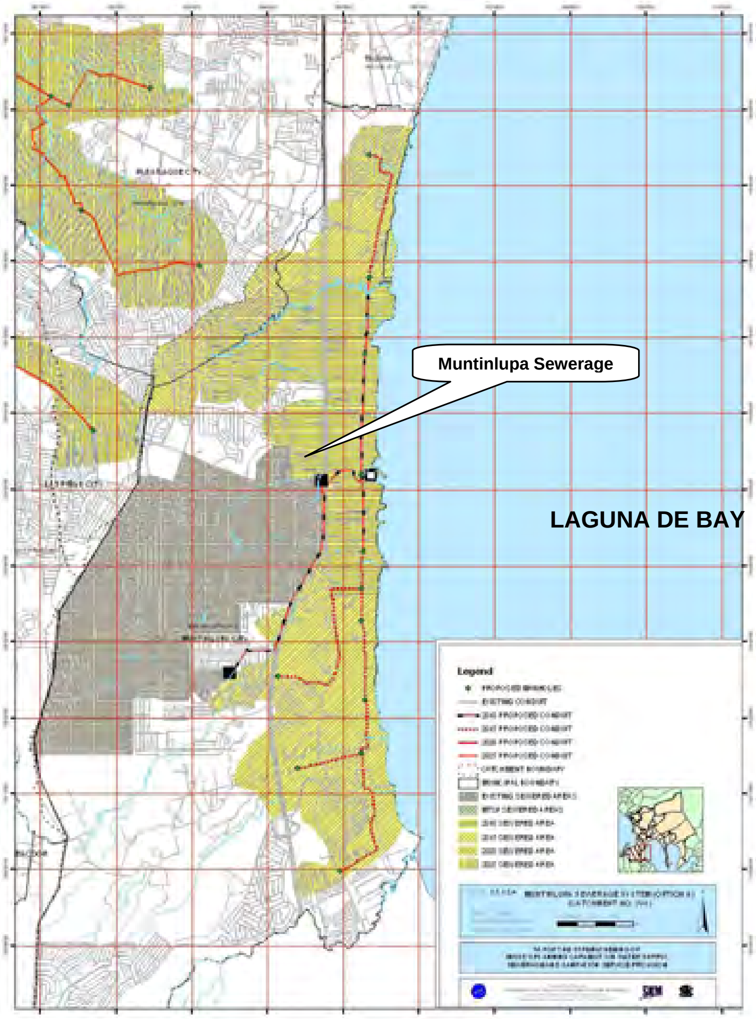

Figure 10.10 Proposed Muntinlupa Sewerage System

Table 10.4 - Sewerage Schedule for the Proposed Muntinlupa System

Pasay Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	0	0	230	425	**655**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	15	27	**42**
	Increment trunk sewers total length (m), (∅375mm - ∅1350mm)	0	0	3,325	4,433	**7,758**
	Required STP Area (ha)	0	0	0.79	1.44	**2.23**
	* includes existing sewered 750 ha					
	Costs in P million					
	STP Land Cost	0	0	198	360	**558**
	STP Incremental Cost:	0	0	380	684	**1,065**
	Sewer Trunks Cost:	0	0	112	496	**608**
	Reticulation Cost :	0	0	414	765	**1179**
	Total	0	0	1,104	2,305	**3,409**

By 2010, a coverage of 35% of the water-served population is required. The existing system is inadequate to meet the coverage requirement and the bayshore residential areas are given the priority coverage. A trunk main runs through the old highway leading to a STP located at the midway section of the elongated city.

The new Bilibid Prison property, that may be considered for urban renewal under the proposed Metro Manila Urban Services for the Poor Project (see Section 5.6.3), forms part of the Muntinlupa System and is incorporated in 2015.

Towards the end of the concession period in 2021, the Muntinlupa system will have sewerage coverage of 2,080 ha, or about 53% of the whole city area serviced by 3 STPs, including two existing ones, with a total capacity of 82 MLD. The total proposed trunk sewer (250 to 1200 mm dia) length is 19.8 km.

10.7.1.2 Pasay Sewerage System (W-4 part)

Pasay City (1,805 ha of city area) is located south of Manila and is densely populated at 197 persons/ha in 2005 but projected to decrease to 183 person/ha in 2020. Generally, the city like Manila is low-lying and flooding occurs during typhoons and high tide conditions. Considering this condition, a STED system is proposed with a 15 MLD decentralized treatment plant.

Sewerage coverage of 16% of the population by 2021 is specified by the concession agreement. This is satisfied by the proposed sewerage system which will cover 13% of the City or an area of 230 ha in 2020. A new STP, trunk lines and reticulation works will be installed. By 2025, the system will be expanded to 25% or a total reticulation area of 655 ha. New trunk lines, reticulation works will be installed and the STP expanded to a total 42 MLD.

The proposed sewerage plan is shown in **Figure 10.11** and the facilities and costs are summarized in **Table 10.5**.

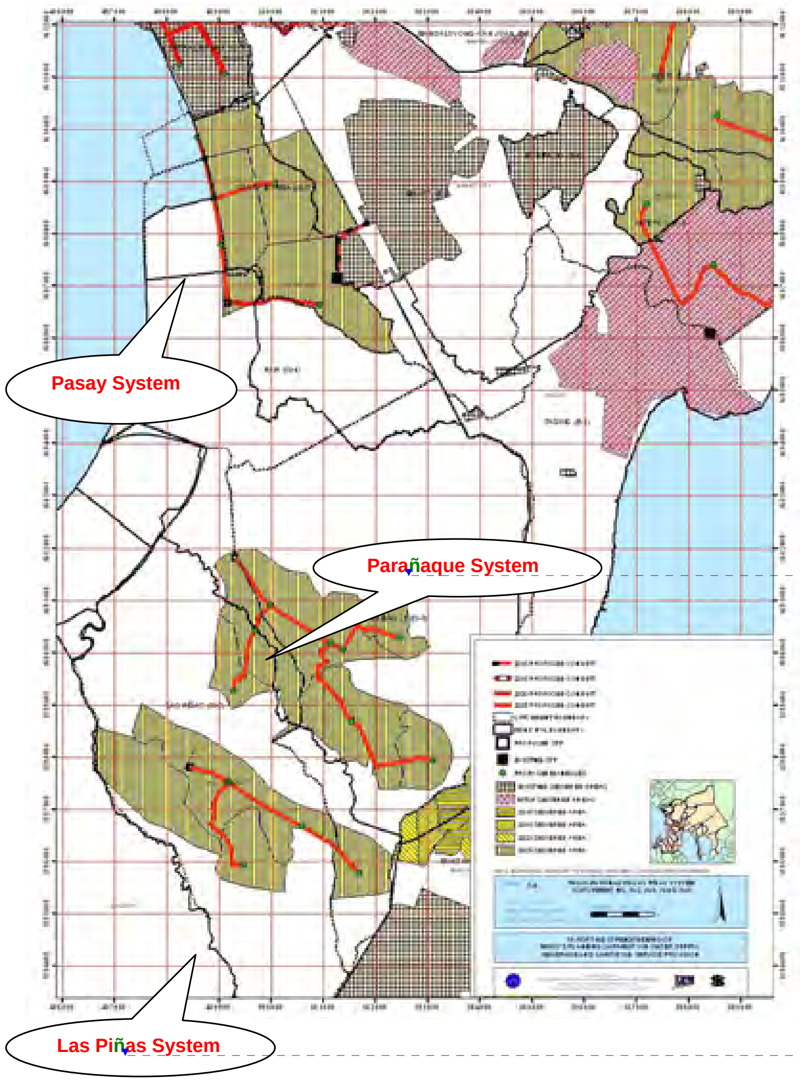

Figure 10.11 Proposed Pasay, Parañaque, & Las Piñas Sewerage Systems

Table 10.5 - Sewerage Schedule for the Proposed Pasay System

Pasay Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	0	0	230	425	**655**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	15	27	**42**
	Increment trunk sewers total length (m), (∅375mm - ∅1350mm)	0	0	3,325	4,433	**7,758**
	Required STP Area (ha)	0	0	0.79	1.44	**2.23**
	* includes existing sewered 750 ha					
	Costs in P million					
	STP Land Cost	0	0	198	360	**558**
	STP Incremental Cost:	0	0	380	684	**1,065**
	Sewer Trunks Cost:	0	0	112	496	**608**
	Reticulation Cost :	0	0	414	765	**1179**
	Total	0	0	1,104	2,305	**3,409**

10.7.1.3 Las Piñas Sewerage System (W-2)

Las Piñas City, with a land area of 3,299 ha, is bordered by Parañaque, Muntinlupa, Bacoor and Manila Bay at the north, east, south and west sides respectively. At its bayshore, a large land reclamation started in the late 1990s but is now on-hold.

In 2005, Las Piñas City has a population of 559,481 and a density of 170 person/ha. Population is projected to 754,286 in 2015 and population density of 294 person/ha in 2025.

Landuse for Las Piñas or essentially the catchment is 62% residential, 16% commercial, 17% open space and the rest is industrial and commercial. Due to proximity to Manila and good road access with other areas, there are large number of residential subdivisions of middle to high income groups.

Catchment W-2 with an area of 3,928 ha covers the City and beyond. The proposed Las Piñas sewerage system of 1,249 ha in 2025 will cover about 38% of the city area.

The elongated catchment has a rolling terrain at its south east end and becomes flatter northwest towards the bay. The Las Piñas River traversing the catchment provides the main drainage way towards Manila Bay.

The proposed sewerage plan is also shown in **Figure 10.11** and the facilities and costs are summarized in **Table 10.6**.

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Table 10.6 - Sewerage Schedule for the Proposed Las Piñas System

Las Pinas Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	0	0	0	1249	**1,249**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	0	80	**80**
	Increment trunk sewers total length (m), (∅300mm - ∅900mm)	0	0	0	4,807	**4,807**
	Required STP Area (ha)	0	0	0	5.5	**5.5**
	Costs in P million					
	STP Land Cost	0	0	0	550	**550**
	STP Incremental Cost:	0	0	0	1,918	**1,918**
	Sewer Trunks Cost:	0	0	0	179	**179**
	Reticulation Cost :	0	0	0	1,919	**1,919**
	Total	0	0	0	4,566	**4,566**

10.7.1.4 Parañaque Sewerage System (W-3)

Parañaque City (4,657 ha city area) is located south of Manila, bordered by Pasay City and Makati in the north and by Las Piñas City in the south. Population density in 2005 is 107 persons/ha. No sewerage coverage is required up to the end of the concession period in 2021. However, with a potentially improved water supply from a Laiban Dam development and the upper-income communities opting for an improved environment by a sewerage system, it is planned to provide sewerage coverage for the area by 2025.

The sewerage plan for 2025 targets a sub-catchment incorporating a community with a large capacity to pay as shown in **Figure 10.11**. This sub-catchment will require a 32 MLD UASB-SBR STP to treat the sewage flow from 961 ha of STED reticulation area. A total of 9.4 km of sewer trunk mains (375 to 750 mm dia) will be laid to the STP located at the west end of the catchment.

The proposed sewerage plan is shown in **Figure 10.11** and the facilities and costs are summarized in **Table 10.7**.

Table 10.7 - Sewerage Schedule for the Proposed Parañaque System

Paranaque Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	0	0	0	961	**961**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	0	32	**32**
	Increment trunk sewers total length (m), (∅375mm - ∅750mm)	0	0	0	9,408	**9,408**
	Required STP Area (ha)				1.68	**1.68**
	Costs in P million					
	STP Land Cost	0	0	0	168	**168**
	STP Incremental Cost:	0	0	0	789	**789**
	Sewer Trunks Cost:	0	0	0	251	**251**
	Reticulation Cost :	0	0	0	1,352	**1,352**
	Total	0	0	0	2,559	**2,559**

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10.7.2 Manila Area (Catchments W-7, W-8, & W-9)

This 3,772 –hectare catchment area within Manila City is mostly served by the existing Manila Central Sewerage System. The system consists of 7 lift stations and 1 main pumping station with a 1800 mm dia. outfall that extends 2 km offshore in Manila Bay. The existing system, built originally in the 1908, underwent major expansions in the 1980s. Most recently, the lift stations were rehabilitated with new pumps and major cleaning/ repair made to the trunk mains.

For various reasons, the Central Sewerage System is operating at surcharge condition with the present population, where water consumption is constrained by a low supply. In 2005, the population density of Manila is 389 persons/ha and projected to decrease to 355 persons/ha in 2020. In the future, water supply is expected to be more abundant from new sources. The present system may then need to be evaluated for its capacity to accept future sewage flows.

10.7.2.1 East Manila Sewerage System (W-9)

Catchment W-9 with an area of 654 ha covers a small 16% of the City area. The proposed Manila East (or Sampaloc) sewerage system of 399 ha in 2025 will cover about 60% of the catchment, resulting to an overall 91% sewerage coverage for Manila.

The proposed Manila east sewerage system consists of a trunk main with STED reticulation. A combined system was not recommended due to poor storm drainage system and the high cost of separate system like the MCSS was a disadvantage.

In 2015 Manila East sewerage system will cover 76 percent of the catchment area. A new STP with a capacity of 30 MLD adequate until 2020 will be constructed. Trunk lines and reticulation works will be constructed. In 2020 the sewerage system will be expanded to 82% coverage with a new trunk line and reticulation works. A small expansion in the reticulation area resulting to 83% coverage will be made in 2025.

The proposed sewerage plan is shown in **Figure 10.12** and the facilities and costs are summarized in **Table 10.8**.

Table 10.8 - Sewerage Schedule for the Proposed Manila East System

Manila East Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	0	80	172	147	**399**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	30	0	32	**62**
	Increment trunk sewers total length (m), (∅900mm - ∅1200mm)	0	972	1,741	1,743	**4,456**
	Required STP Area (ha)	0	1.53	0	1.68	**3.21**
	Costs in P million					
	STP Land Cost	0	428	0	470	**899**
	STP Incremental Cost:	0	732	0	789	**1,521**
	Sewer Trunks Cost:	0	36	61	79	**176**
	Reticulation Cost :	0	144	310	265	**718**
	Total	0	1,340	370	1,603	**3,314**

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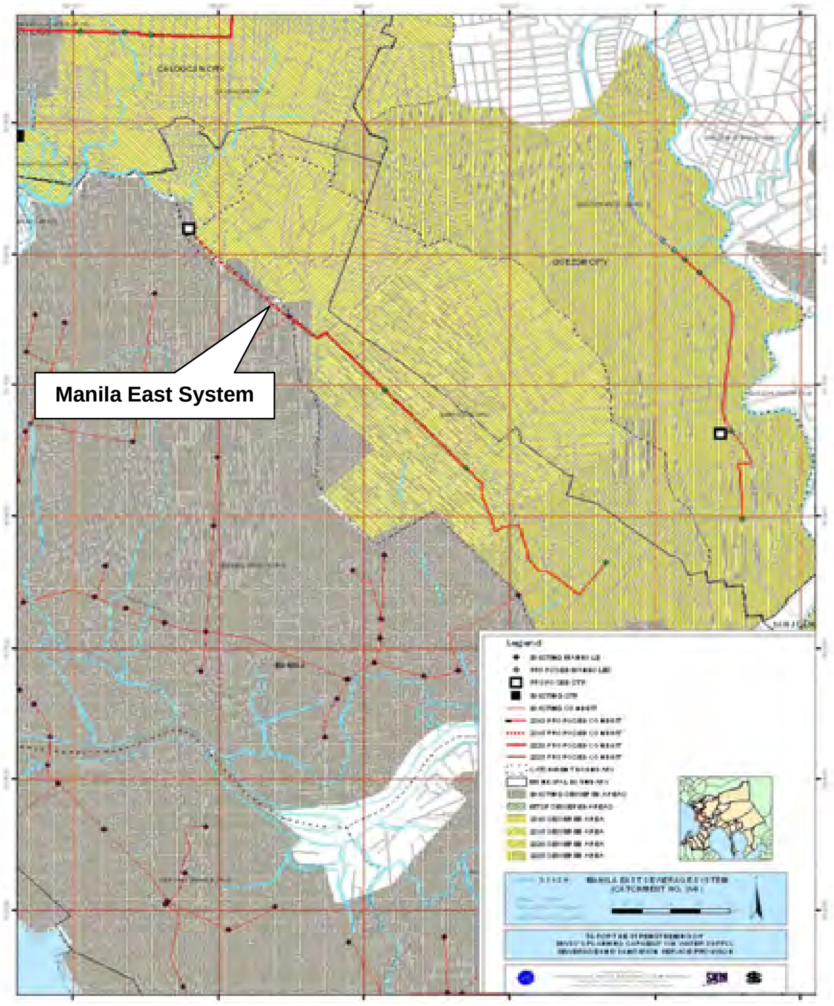

Figure 10.12 Proposed Manila East (Sampaloc) Sewerage Systems

10.7.3 Caloocan-Malabon (Dagat-Dagatan) Catchments Area (W-11, W-12 & W-13)

These three catchments of 2,225-hectare area covers the existing Dagat-Dagatan sewerage system and a proposed north extension of the system to cover the south area of Malabon and another branch to served the west part of Caloocan. The existing Dagat-dagatan sewerage system, serving a land reclamation / housing development by NHA is located within these catchments, including the new Smokey Mountain re-development and bayshore land reclamation projects.

This area is characterized by a flat terrain with westward drainage flow to the Malabon River. The Dagat-Dagatan area (catchment W-11) is a reclaimed area for housing and commerce, where shipping warehouses / depots are located.

The treatment ponds of the Dagat-Dagatan system are proposed to be upgraded in the future to a more intensive treatment system like an UASB-SBR scheme, thus optimizing the use of the 10-hectare area.

10.7.3.1 Caloocan– South Malabon Sewerage System (W-12, & W-13)

Catchments W-12 and W-13 with an area of 1,706 ha cover the border areas of Malabon and Caloocan. The proposed 1,692 ha sewerage system will essentially cover these two catchments.

Terrain in these contiguous catchments is flat with elevations varying from 2 to 20 m. Drainage is provided by several creeks / esteros traversing the catchments. The area is essentially build-up with commercial, residential and mix-use use development. Due to the proximity to sea ports, many industries have located in the area.

The proposed sewerage system is an expansion of the Dagat-dagatan system in 2020. The existing sewerage has conventional separate reticulation system. The area is prone to flooding and a STED reticulation was used for its lower costs than the conventional separate system.

The recommended trunk mains and service pipes are planned to be completed by 2020 to meet the sewerage coverage for the 2003 Rate Rebasing.

The proposed sewerage plan is shown in **Figure 10.13** and the facilities and costs are summarized in **Table 10.9**.

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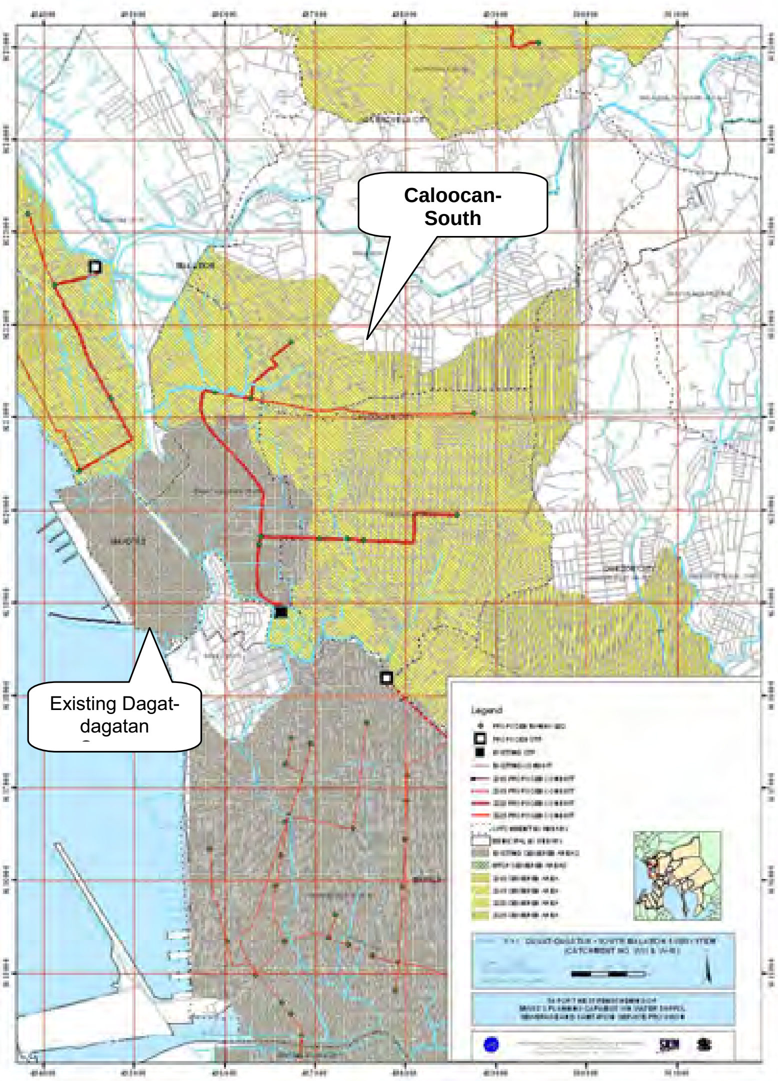

Figure 10.13 Proposed Caloocan – South Malabon Sewerage System

Table 10.9 - Sewerage Schedule for the Proposed Manila East System

Dagat-dagatan-South Malabon Sewerage System	2010	2015	2020	2025	Total
Summary of Facilities					
Incremental Sewerage Coverage (Reticulation) (ha):	0	0	1,692	0	1,692
Incremental Sewage Flow (STP Capacity) (Mld):	0	0	93	0	93
Increment trunk sewers total length (m), (∅600mm - ∅1350mm)	0	0	6,686	0	6,686
Required STP Area (ha)	0	0	4.72	0	4.72
Costs in P million					
STP Land Cost	0	0	472	0	472
STP Incremental Cost:	0	0	2,107	0	2,107
Sewer Trunks Cost:	0	0	226	0	226
Reticulation Cost :	0	0	2,061	0	2,061
Total	0	0	4,866	0	4,866

10.7.4 QC Novaliches and QC North Catchments (W-14 & W-19)

These catchments lie in Quezon City and there are no specified sewerage coverage targets. There are large residential subdivisions and a rapidly growing commercial development. Septage services will be provided in these areas.

10.7.5 Navotas-Malabon-Valenzuela Catchments (W-13, W-16, W-17 & W-18)

These 4 drainage catchments cover the cities of Navotas, part of Malabon and the west portion of Valenzuela with a total area of 6,700 ha. In 2005, the population of Navotas and Malabon are respectively 245,524 and 330,538 or equivalent densities of 228 and 210 person/ha. Malabon is projected to decline in population with an estimated density of 168 person/ha in 2025, but Navotas will increase its density by 21%.

Land uses in the catchments are considered similar to the city-wide uses which is dominantly residential (37% to 70%) and industrial (21% to 35%). Particularly for Navotas and Malabon, their proximity to sea ports has made them ideal for the location of industries.

10.7.5.1 Navotas Sewerage System (W-16 part)

The 3,130-ha Catchment W-16 covers Navotas, part of Malabon and part of Valenzuela. Due to the flat terrain, two sewerage systems are proposed for this catchment: the Navotas system servicing Navotas and Malabon and the Valenzuela system that services Valenzuela and also part of Malabon.

The terrain is mainly flatlands with meandering rivers affected by tidewater. Spots of land are at Elevation 2 m, and a major portion of the land is below the 2 m level.

The proposed sewerage system will service the residential areas and commercial establishments built along the roadways.

The 2021 targets for the rate rebasing are to be met with the proposed options for 2020. The options presented are for the use of conventional and STED systems. This can be attributed to the fact that the area is low-lying and highly prone to flooding.

The layout of the trunk mains for both options shall remain the same. Works shall be completed by 2020 to satisfy the 2021 Rate Rebasing sewerage targets.

The proposed sewerage plan is shown in **Figure 10.14** and the facilities and costs are summarized in **Table 10.10**.

Table 10.10 - Sewerage Schedule for the Proposed Navotas System

Navotas Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	0	0	425	0	**425**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	17	0	**17**
	Increment trunk sewers total length (m), (∅250mm - ∅900mm)	0	0	3,109	0	**3,109**
	Required STP Area (ha)	0	0	0.95	0	**0.95**
	Costs in P million					
	STP Land Cost	0	0	95	0	**95**
	STP Incremental Cost:	0	0	424	0	**424**
	Sewer Trunks Cost:	0	0	109	0	**109**
	Reticulation Cost :	0	0	765	0	**765**
	Total	0	0	1,393	0	**1,393**

10.7.5.2 Valenzuela Sewerage System (W-17 part)

The 2,835-ha Catchment W-17 lies mainly in Valenzuela City, but also encroaches the west portion of Caloocan North. The proposed Valenzuela sewerage system covers 1,011 ha within the catchment and services mainly Valenzuela. Extension of the trunk mains in the future will cover the Caloocan North area. The proposed sewerage system covers about 23% of the city area.

Topography of the catchment is a rolling terrain at the east portion (elevations 16 to 32 m) to near flat at the west and mid sections with elevations 10 to 14 m. A system of creeks and tributaries provides efficient drainage leading to the Meycauayan River.

A STED system is proposed mainly because the drainage has not been fully developed in these areas. Combined drainage was ruled out due to numerous industries found within the area.

The proposed 2020 system shall accommodate the 2021 targets set by the 2003 Rate Rebasing.

The proposed sewerage plan is shown in **Figure 10.15** and the facilities and costs are summarized in **Table 10.11.**

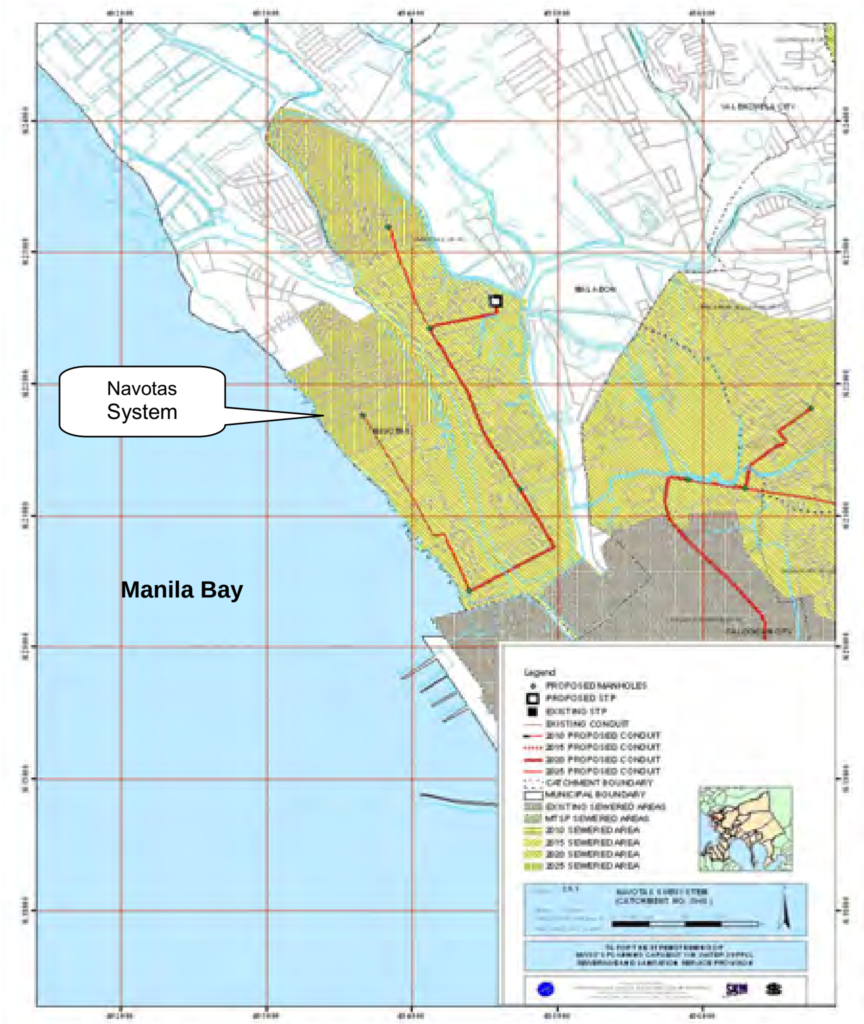

Figure 10.14 Proposed Navotas Sewerage System

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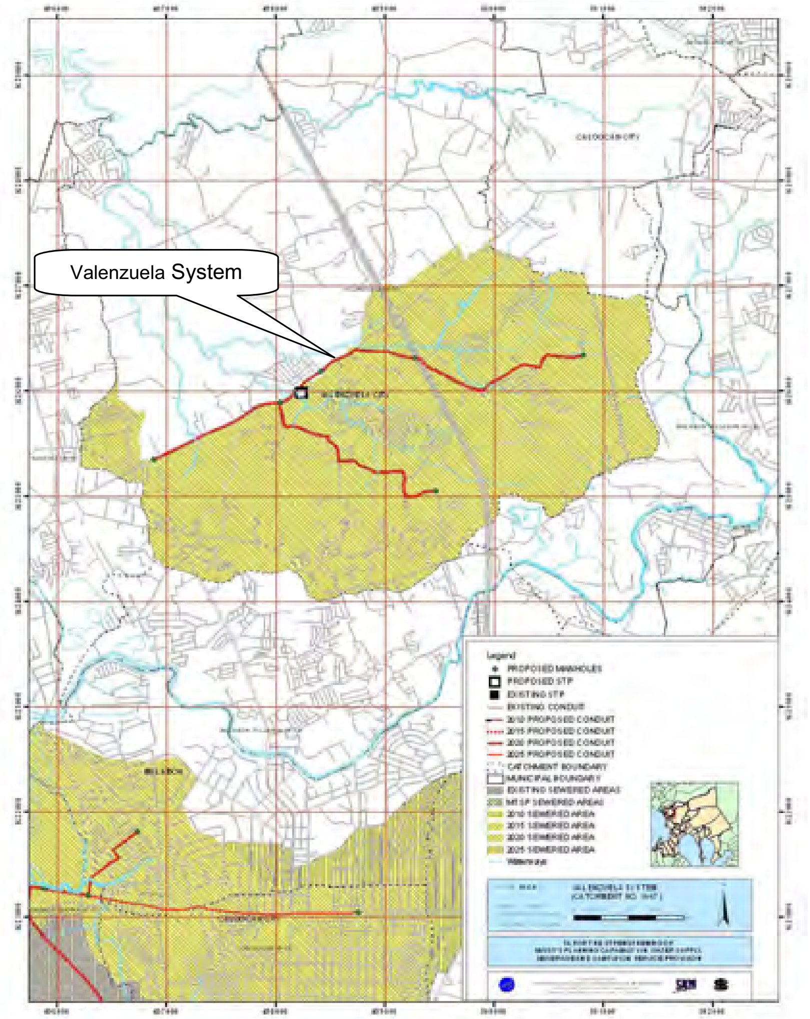

Figure 10.15 Proposed Valenzuela Sewerage System

Table 10.11 - Sewerage Schedule for the Proposed Valenzuela System

Valenzuela Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	0	0	1,011	0	**1,011**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	32	0	**32**
	Increment trunk sewers total length (m), (∅250mm - ∅900mm)	0	0	7,960	0	**7,960**
	Required STP Area (ha)	0	0	1.68	0	**1.68**
	Costs in P million					
	STP Land Cost	0	0	168	0	**168**
	STP Incremental Cost:	0	0	770	0	**770**
	Sewer Trunks Cost:	0	0	247	0	**247**
	Reticulation Cost :	0	0	1,820	0	**1,820**
	Total	0	0	3,005	0	**3,005**

10.7.5.3 Caloocan North Sewerage System (W-18 west part)

The 4,084-ha Catchment W-18 lies in Caloocan North area, and has several sub-catchments drained by creeks that are tributary to the Meycauayan River. The proposed sewerage system covers 629 ha or 15% of Catchment W-18. Topography is highly rolling to undulating terrain with elevation from 28 to 60 m.

A STED reticulation system is proposed because of poor drainage. The undesirable color of liquid flows in the creeks observed during the visit is evident that combined drainage is not possible due to industrial plant effluents.

As with the other nearby systems, the proposed 2020 system will accommodate the specified coverage targets in 2021.

The proposed sewerage plan is shown in **Figure 10.16** and the facilities and costs are summarized in **Table 10.12**.

Table 10.12 - Sewerage Schedule for the Proposed Caloocan North System

Caloocan North Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	0	0	629	0	**629**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	36	0	**36**
	Increment trunk sewers total length (m), (∅375mm -∅750mm)	0	0	7,819	0	**7,819**
	Required STP Area (ha)			1.88		**1.88**
	Costs in P million					
	STP Land Cost	0	0	188	0	**188**
	STP Incremental Cost:	0	0	860	0	**860**
	Sewer Trunks Cost:	0	0	157	0	**157**
	Reticulation Cost :	0	0	1,131	0	**1,131**
	Total	0	0	2,337	0	**2,337**
Central Metro Manila Sewerage		**2010**	**2015**	**2020**	**2025**	**Total**

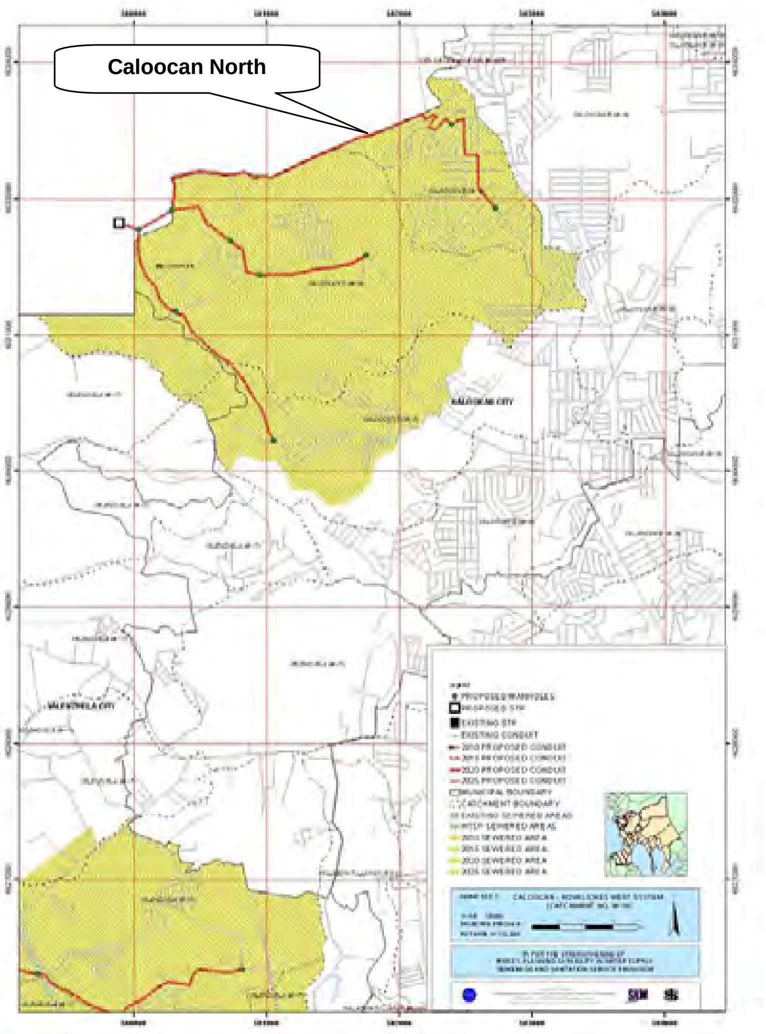

Figure 10.16 Proposed Caloocan North (Novaliches) Sewerage System

10.7.6 QC North & East Catchments (EW-2 & EW-3)

This large area of 5,760 hectares covers the north and east part of Quezon City of rolling to irregular terrain. A good drainage system exists. Most of the area is residential development, with large open areas.

In the Quezon North area, a number of small sewerage systems exist, including the University of the Philippines sewerage system. No sewerage coverage is required during Concession period. In the future beyond Master Plan period a decentralized system to expand the existing systems is likely, which can eventually join the Dagat-Dagatan system.

10.7.7 QC West & Central Catchments (W-15 & EW-1)

This area covers 2,581 hectares, varying from flat terrain at the west to gently rolling topography in the east. It is a relatively dense development of residential and commercial establishments.

Several small sewerage systems are operating, with the systems in the East Zone Concession upgraded recently. No sewerage coverage is required within the Concession period but a system covering QC west zone is proposed by this Master Plan by 2025. In the future the existing small systems could be centralized or integrated into a large system leading to the Central Sewerage System treatment works.

To enhance the environment of this west part of Quezon City bordering Manila and Caloocan, a new decentralized sewerage system is proposed as described below.

10.7.7.1 QC West System (W-15)

This catchment has an area of 1,079 hectares, located at the northwest corner of Quezon City. It is bordered in the west by an unsewered catchment of the large Manila Central Sewerage System. Population density in the area is similar to nearby Manila, about 197 persons/ha.

The proposed QC West sewerage system of 541 ha planned for 2025 will cover about 50% of the catchment, and contributes to the overall sewerage coverage for Quezon City.

The proposed sewerage system covers a predominantly residential area with scattered commercial establishments along the major roads. Storm drainage consists of open canals and covered drains. Improved and lined canals convey run-off to tributaries to the San Juan River.

The sewerage options for the QC West system differ only as to the use of STED or combined drainage or both types of reticulation. The proposed combined drainage system covers a larger area than STED reticulation due to the use of the built-up drainage systems like lined canals.

The layout of the two options varies due to the additional catchment area of the combined system option. The combined drainage option utilizes the lined canal traversing the entire W-15 catchment. Although the cost per hectare is less, the capital investment for the additional areas is much greater than using the recommended STED system.

The proposed sewerage plan is shown in **Figure 10.17** and the facilities and costs are summarized in **Table 10.13**.

Table 10.13 - Sewerage Schedule for the Proposed QC West System

QC West Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Sewerage Coverage (Reticulation) (ha):	0	0	0	541	**541**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	0	32	**32**
	Increment trunk sewers total length (m), (∅250mm - ∅900mm)	0	0	0	3,259	**4,235**
	Required STP Area (ha)	0	0	0	1.68	**1.68**
	Costs in P million					
	Required STP Area (ha)	0	0	0	1.68	**1.68**
	STP Land Cost	0	0	0	336	**336**
	STP Incremental Cost:	0	0	0	770	**770**
	Sewer Trunks Cost:	0	0	0	103	**103**
	Reticulation Cost :	0	0	0	974	**974**
	Total	0	0	0	2,182	**2,182**

10.7.8 QC South-San Juan-Mandaluyong-Pasig West Catchments (E-5, E-6, & E-8)

With an area of 7,758 ha, these three catchments in the East Zone cover the south part of Quezon City, the municipality of San Juan, and cities of Pasig and Mandaluyong. The catchment is predominantly residential and commercial development.

There exist a number of small sewerage systems, like those at Mandaluyong and Pasig cities. The large commercial establishments located in the area are required to install treatment plants for their generated wastewater.

Early sewerage coverage is specified for Pasig and San Juan, i.e. 2010 and 2015 respectively but none for the south part of Quezon City.

10.7.8.1 San Juan Sewerage System (E-6 & E-8)

The town of San Juan straddles catchment E-6 and E-8, thus two small systems are proposed in order to meet the required sewerage coverage specified in the concession agreement.

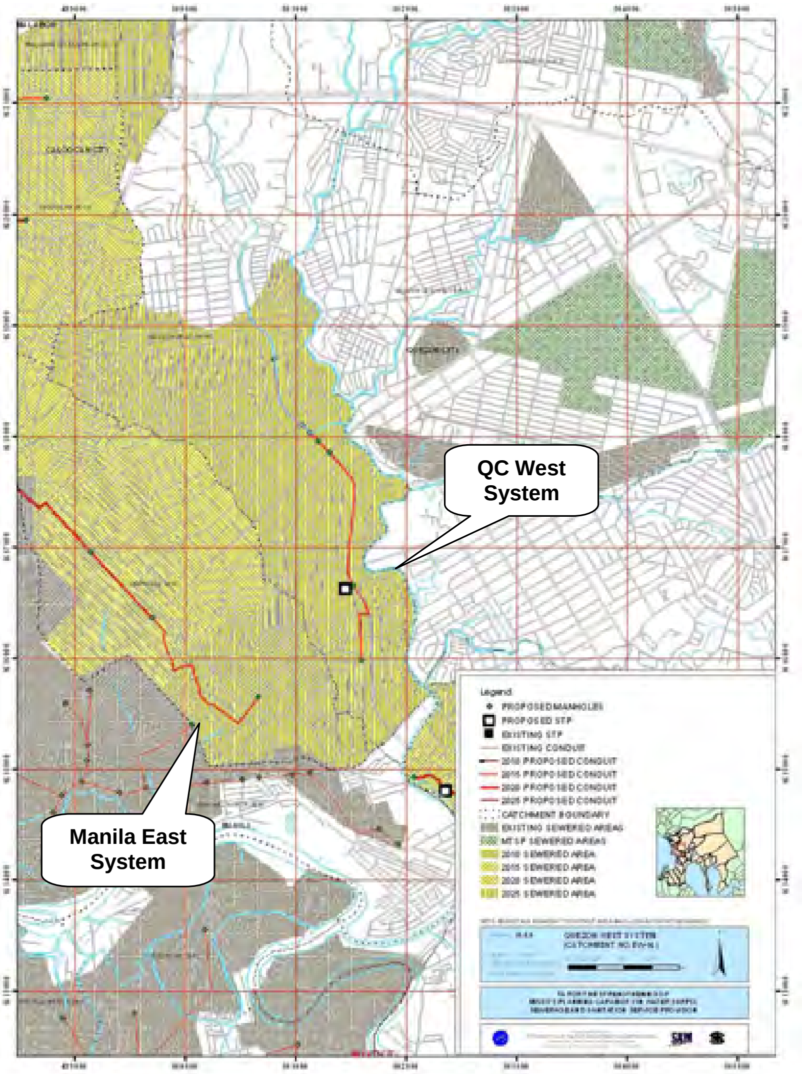

Figure 10.17 Proposed Quezon West Sewerage System

San Juan is a small town of 595 ha with a population density of 200 persons/ha in 2005 and is projected to decline to 186 person/ha in 2025. Present land use is 60% residential, 17% commercial, 15% open space, and minimal industry and institution.

The catchments are slightly undulating terrain, and within are located well-planned residential development provided with good drainage along paved roads. Commercial establishments abound along the main roads. Drainage canals traversing the area have been improved.

Sewerage for San Juan is required starting 2015 with a coverage of 63 ha and expands to 327 ha by 2025. Sewerage systems to be located in two separate catchments are proposed.

Conventional, STED and combined drainage systems were the options considered for the south (E-6) catchment. The drainage condition of the area can be used for a combined drainage system because the required drainage rehabilitation requires less capital. For all options, the development plan for the system should be in place by 2020 and expanded in 2025.

Development for the options for the north (E-8) catchment should be on-line by 2015. Continuous expansion is required until 2025, together with the sewerage development in E-6, will have a 59% coverage area. Although the combined drainage system yielded a smaller capital cost, a larger STP would require a larger STP lot size, which cannot be accommodated in the proposed site. Because of this constraint, the STED system was recommended to be more suitable in confining the service area.

The proposed sewerage plan is shown in **Figure 10.18** and the facilities and costs are summarized in **Table 10.14**.

Table 10.14 - Sewerage Schedule for the Proposed San Juan System

San Juan Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Sewerage Coverage (Reticulation) (ha):	0	63	129	135	**327**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	5	11	0	**16**
	Increment trunk sewers total length (m), (∅200mm - ∅450mm)	0	1,933	1,680	1,600	**5,213**
	Required STP Area (ha)	0	0.35	0.55	0	**0.9**
	Costs in P million					
	Required STP Area (ha)	0	0.35	0.55	0	**0.9**
	STP Land Cost	0	70	110	0	**180**
	STP Incremental Cost:	0	135	295	0	**430**
	Sewer Trunks Cost:	0	21	5	3	**29**
	Reticulation Cost :	0	113	92	151	**356**
	Total	0	339	502	154	**995**

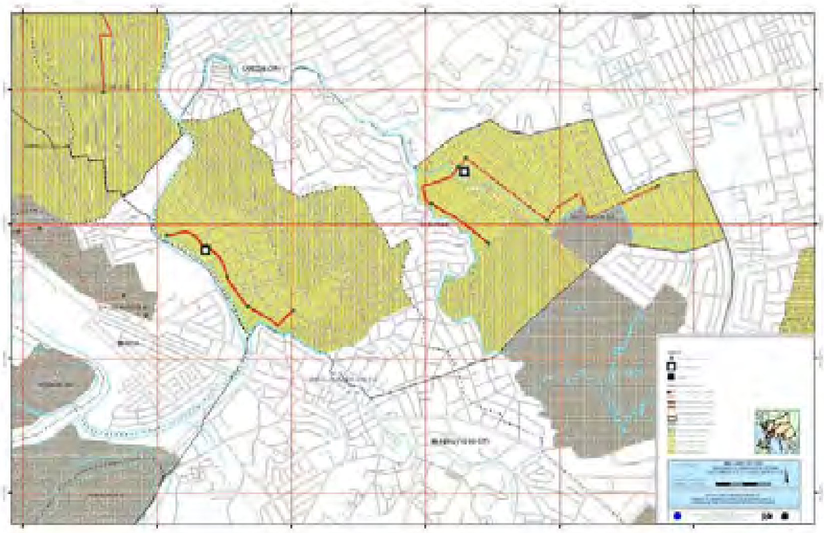

Figure 10.18 Proposed San Juan Sewerage-Systems

10.7.8.2   Pasig Sewerage System (E-5 West Part)

The proposed sewerage system covers the west part of Pasig City, that has a population density of 185 persons per ha in 2005 and a projected 278 persons per ha in 2025. Sewerage was considered a priority by this study for this densely populated city.

Topography of Pasig City west of the River is multi-level flatlands with steep slopes at transitions from the higher flatlands (about elevation 50) to the flat areas bordering the river (elevation 10 m). Lined canals and creeks leading to the Pasig River provide effective drainage of the catchment.

Conventional, STED and combined drainage systems were costed and the latter prevailed as the least costly. The presence of a lined canal leading to Marikina River can be intercepted and treated. The utilization of the combined drainage can service a larger area due to the good drainage conditions in the catchment.

The proposed sewerage plan is shown in **Figure 10.19** and the facilities and costs are summarized in **Table 10.15**.

Table 10.15 - Sewerage Schedule for the Proposed Pasig System

Pasig Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Sewerage Coverage (Reticulation) (ha):	119	61	61	328	**569**
	Incremental Sewage Flow (STP Capacity) (Mld):	8	1	4	22	**35**
	Increment trunk sewers total length (m), (∅200mm - ∅600mm)	0	1,143	1,742	5,362	**8,247**
	Required STP Area (ha)	0.45	0	0.9	1.19	**2.54**
	* excludes existing sewered 27 ha					
	Costs in P million					
	STP Land Cost	63	0	126	167	**356**
	STP Incremental Cost:	210	0	400	540	**1,151**
	Sewer Trunks Cost:	0	24	14	110	**147**
	Reticulation Cost :	77	40	40	213	**370**
	Total	350	63	579	1030	**2023**

10.7.9 Pasig-Taytay Catchments (E-5)

The 3,294-ha catchment E-5 is bounded in the east by the Mangahan Floodway and in the west by the Napindan River. It covers Pasig City and the west borders of Cainta and Taytay.

Pasig City has an area of 3,101 ha and is traversed about midway by the Pasig River. Settlement is dense in the area west of the Pasig River and a sewerage system is proposed for this area to improve the environment.

The south part of the catchment bordering the Laguna de Bay is covered by the MTSP project. The proposed Pasig sewerage system will expand the MTSP system northward to cover the City east of the Pasig River.

Pasig-Taytay Sewerage System (E-5)

The proposed Pasig East-Taytay sewerage system covers the portion of Pasig east of the Pasig River and extends south to the MTSP site at the lake shore.

The Pasig-Taytay System is integrated with combined drainage under the MTSP program, wherein about 51% sewerage coverage is attained for Pasig-Taytay catchment.

Due to the increasing population density of Pasig City (estimated at 275 persons per ha in 2025), the area is recommended for sewerage by expanding the MTSP system. By 2025, the proposed expansion will cover 375 ha of combined reticulation area, served by a 7.3 km trunk main, leading to the MTSP STP, along Sandoval Avenue. This treatment facility is proposed to be expanded by 32 MLD. The storm drains are to be improved and/or rehabilitated.

The proposed sewerage plan is shown in **Figure 10.20** and the facilities and costs are summarized in **Table 10.16**.

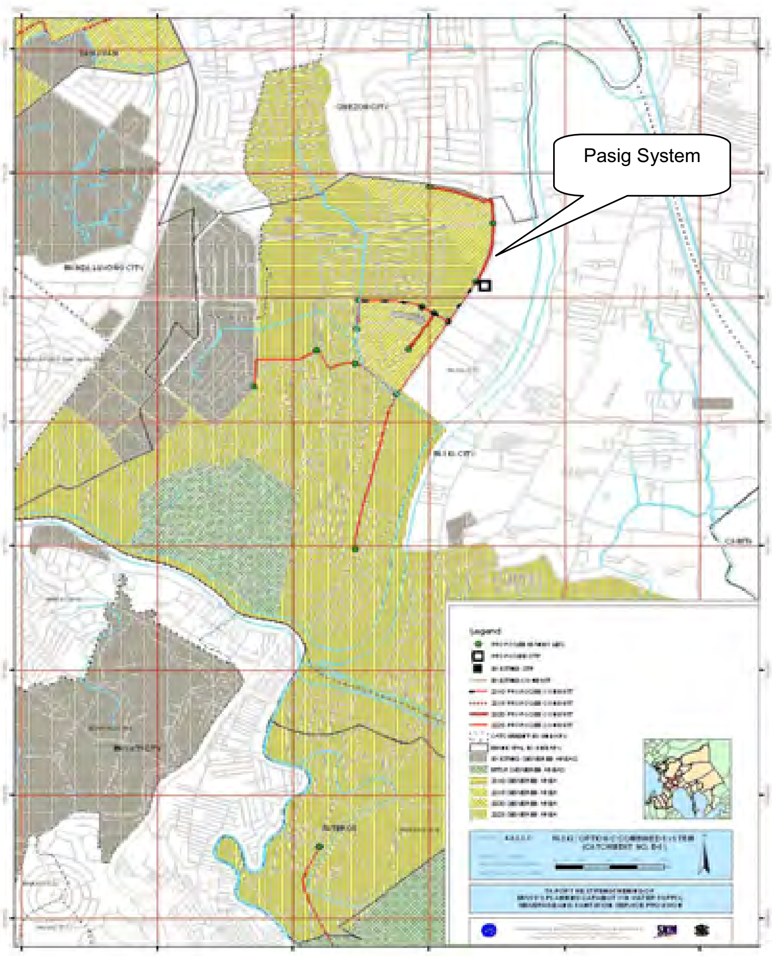

Figure 10.19 Proposed Pasig Sewerage-Systems

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Table 10.16 - Sewerage Schedule for the Proposed Pasig East-Taytay System

Pasig East-Taytay Sewerage System	2010	2015	2020	2025	Total
Summary of Facilities					
Sewerage Coverage (Reticulation) (ha):	0	0	0	375	**375**
Incremental Sewage Flow (STP Capacity) (Mld):	0	0	0	32	32
Increment trunk sewers total length (m), ∅250mm - ∅1350mm)	0	0	0	5,490	**5,490**
Required STP Area (ha)	0	0	0	1.68	**1.68**
Costs in P million					
STP Land Cost	0	0	0	84	**84**
STP Incremental Cost:	0	0	0	770	**770**
Sewer Trunks Cost:	0	0	0	212	**212**
Reticulation Cost :	0	0	0	248	**248**
Total	0	0	0	1,313	**1,313**

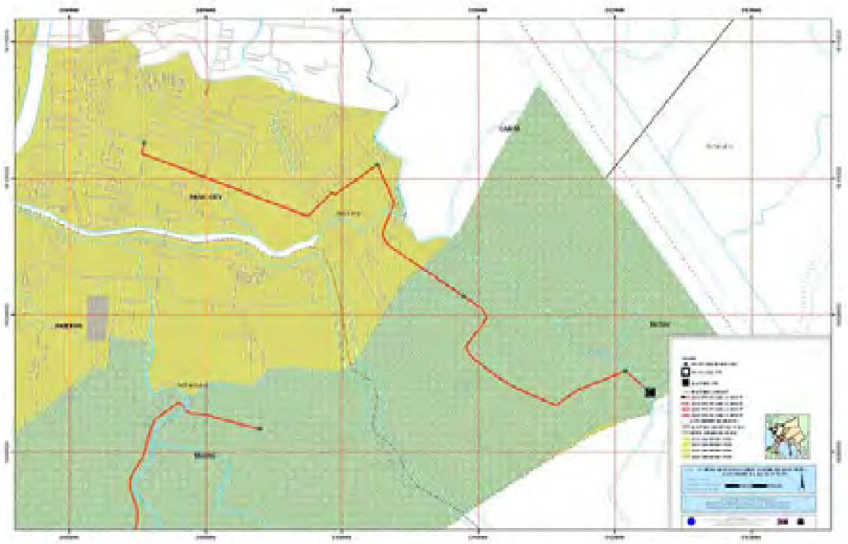

Figure 10.20 Proposed Pasig East-Taytay Sewerage-Systems

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10.7.10 Taguig-Pateros Area Catchments (E-1, & E-3)

The adjoining catchments E-1 and E-3 (total area of 3,370 ha) cover Taguig City, Pateros town and partly Makati City. Pateros, with an area of 185 ha, is the smallest town in Metro Manila but densely populated (311 person/ha in 2005). Taguig City, along the coast of Laguna de Bay, has an area of 2,752 ha, with a quite dense population of 201 person/ha in 2005. Population in Pateros is projected to decline in the future, while settlements will increase in Taguig due to its large open spaces.

Taguig-Pateros Sewerage System (E-1, E-3)

The proposed Taguig-Pateros system is an expansion of the planned MTSP sewerage with an additional 400 ha that will provide full coverage of Pateros town and the portion of Pasig City west of the Napindan River. Including the 1,317-ha MTSP sewerage, the expanded system will cover 1,717 ha by 2025.

The options presented for the Taguig expansion are to be operational in 2025. As with the Taytay system, the proposed sewage system is combined drainage. Conventional and STED systems were evaluated as well, but combined drainage was still the least costly option.

The proposed sewerage plan is shown in **Figure 10.21** and the facilities and costs are summarized in **Table 10.17**.

Table 10.17 - Sewerage Schedule for the Proposed Taguig-Pateros System

Taguig-Pateros Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Sewerage Coverage (Reticulation) (ha):	0	0	0	400	**400**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	0	26	**26**
	Increment trunk sewers total length (m), (∅900mm - ∅1350mm)	0	0	0	4,890	**4,890**
	Required STP Area (ha)	0	0	0	1.39	**1.39**
	Costs in P million					
	STP Land Cost	0	0	0	278	**278**
	STP Incremental Cost:	0	0	0	633	**633**
	Sewer Trunks Cost:	0	0	0	174	**174**
	Reticulation Cost :	0	0	0	450	**450**
	Total	0	0	0	1,535	**1,535**

10.7.11 Marikina-Cainta Catchment (E-9)

The Marikina-Cainta catchment has a large area of 5,817 ha and covers essentially the whole of Marikina City, the northern half of Cainta, and parts of Antipolo and Pasig City. In the catchment, settlement is dense at the Marikina and Pasig portions but sparse at Cainta and Antipolo.

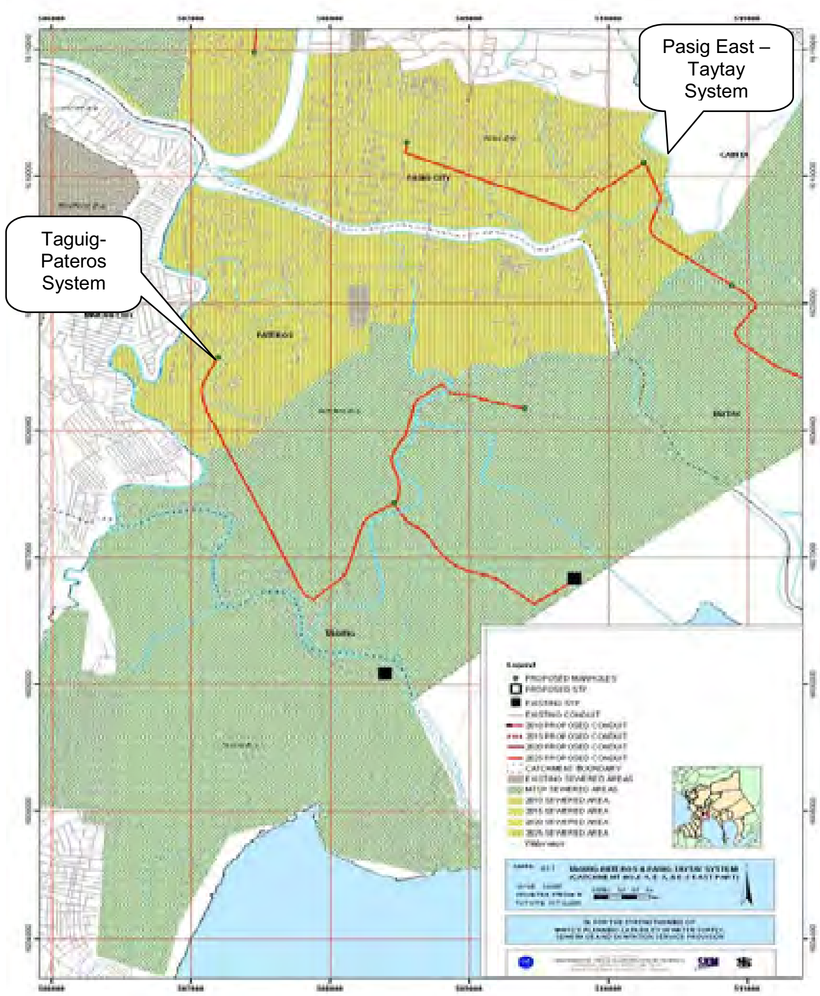

Figure 10.21 Proposed Taguig-Pateros Sewerage Systems

There exists no sewerage system in the catchment, except the few small community systems in the NHA housing development in Cainta. No sewerage coverage is required by the concession agreement for this area. However, due to the need to reduce pollution of the Marikina River, the upstream portion of the Pasig River, sewerage coverage is recommended.

The proposed Marikina system will cover an area in Marikina which is at the west part of Catchment E-9.

Marikina Sewerage System (E-9 West Part)

Marikina City (2,150 ha city area) is located east northeast of Manila City. The Marikina River, a tributary to the Pasig River, traverses the west portion of the city. The River is a focus of environmental improvement for the City, with recreation parks and riverbank beautification projects along the river.

Marikina in 2005 has a population density of 192 persons/ha, similar to Pasay City. Sewerage coverage is aimed at managing the impact of a dense population as well as to protect the river water quality.

The proposed Marikina sewerage system will serve a 320-ha strip (about 15% of the city area) of dense residential settlement along the east bank of the Marikina river. Elevations vary from 10 m to 14. The trunk mains are laid parallel the east river bank.

The proposed Marikina sewerage system is planned to be operational in 2025 with a coverage of 19% of the population. STED reticulation is considered most suited to the development in the catchment.

The proposed sewerage plan is shown in **Figure 10.22** and the facilities and costs are summarized in **Table 10.18**.

Table 10.18 - Sewerage Schedule for the Proposed Marikina System

Marikina Sewerage System	2010	2015	2020	2025	Total
Summary of Facilities					
Sewerage Coverage (Reticulation) (ha):	0	0	0	320	**320**
Incremental Sewage Flow (STP Capacity) (Mld):	0	0	0	17	**17**
Increment trunk sewers total length (m), (∅300mm - ∅900mm)	0	0	0	3,200	**3,200**
Required STP Area (ha)				0.95	**0.95**
Costs in P million					
STP Land Cost				95	**95**
STP Incremental Cost:	0	0	0	437	**437**
Sewer Trunks Cost:	0	0	0	108	**108**
Reticulation Cost :	0	0	0	384	**384**
Total	0	0	0	1,024	**1,024**

Figure 10.22 Proposed Marikina Sewerage-Systems

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10.8 Costings

Using 2005 unit prices, the costs of the various works for the sewerage systems were estimated.

10.8.1 Bases of Costings

10.8.1.1 Unit Cost Information

For cost estimation, the adopted pipe materials and corresponding sizes are tabulated as follows:

Item	Pipe Material	Pipe Size
1	Polyvinyl Chloride (PVC)	350mmϕ and below
2	Fiberglass Reinforced Pipe (FRP)	375mmϕ to 1000mmϕ
3	Reinforced Concrete Pipe (RCP)	1050mmϕ and above
4	Ductile Iron Pipe (DI)	For all forced mains

For 900mmϕ sewer manholes, the adopted spacing criteria are:

Item	Pipe Size	Manhole Spacing
1	425mmϕ and below	50m
2	450mmϕ to 1050mmϕ	80m
3	1100mmϕ and above	120m

The minimum depth of cover criteria are:

Item	Description	Minimum Depth of Cover
1	Sewer laterals & submains (200mmϕ – 575mmϕ)	1.5m
2	Mains and trunks (600mmϕ – 3000mmϕ)	2.0m
3	Sublaterals not subject to traffic loads	1.0m

A cost database was developed for the cost estimates. This database was extracted from the MTSP Feasibility Study (2004), MSSP Dagat-Dagatan STP bid proposal (2002), MWSS contractor bids (2002) and various related projects of the Consultant. The base prices were adjusted by Philippine price indices for inflation to reflect 2005 prices. Unit prices are ‘as installed’ prices, inclusive of materials, labor, equipment, contractor’s overhead and profit. **Table 10.19** is an excerpt of the database used in the cost estimation.

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Table 10.19 - Unit Costs for Various Civil and Mechanical Works

UNIT COSTS			
Item	**Description**	**Unit**	**Unit Cost (PhP)**
1	Structure Excavation	cu.m.	697.00
2	Backfill incl disposal & compaction	cu.m.	2,081.00
3	Concrete Pavement Breaking	cu.m.	9,508.00
4	Concrete Pavement	cu.m.	5,078.00
5	Concrete	cu.m.	4,840.00
6	Rebars	kg	39.00
7	Formwork	sq.m.	506.00
8	*PVC Pipe*		
8.1	100mm-dia.	l.m.	770.00
8.2	150mm-dia.	l.m.	940.00
8.3	200mm–dia.	l.m.	1,085.00
8.4	250mm–dia.	l.m.	1,340.00
8.5	300mm–dia.	l.m.	2,358.20
9	*Ductile Iron Pipe*		
9.1	1950mm (76")-dia.	l.m.	124,424.70
9.2	1650mm (66")-dia.	l.m.	88,658.20
9.3	1500mm (60")-dia.	l.m.	73,004.40
9.4	1350mm (54")-dia.	l.m.	58,836.90
9.5	1200mm (48")-dia.	l.m.	41,083.80
9.6	1050mm (42")-dia.	l.m.	34,961.00
9.7	900mm (36")-dia.	l.m.	29,889.00
9.8	750mm (30")-dia.	l.m.	24,870.50
9.9	700mm (26")-dia.	l.m.	23,074.30
9.10	650mm (26")-dia.	l.m.	21,278.00
9.11	600mm (24")-dia.	l.m.	19,479.40
9.12	525mm (20")-dia.	l.m.	18,308.10
9.13	500mm (20")-dia.	l.m.	17,917.60
9.14	450mm (18")-dia.	l.m.	16,465.00
9.15	400mm (16")-dia.	l.m.	15,045.50
9.16	350mm (14")-dia.	l.m.	10,207.50
9.17	300mm (12")-dia.	l.m.	7,180.00
9.18	275mm (10")-dia.	l.m.	5,677.00
9.19	250mm (10")-dia.	l.m.	4,174.00
9.20	200mm (8")-dia.	l.m.	2,978.00
9.21	150mm (6")-dia.	l.m.	2,026.00
9.22	100mm (4")-dia.	l.m.	1,225.00

UNIT COSTS			
Item	**Description**	**Unit**	**Unit Cost (PhP)**
10	*FRP Pipe*		
10.1	375mmϕ	l.m.	6,780.20
10.2	400mmϕ	l.m.	7,832.90
10.3	450mmϕ	l.m.	8,630.00
10.4	525mmϕ	l.m.	9,999.60
10.5	600mmϕ	l.m.	11,577.80
10.6	700mmϕ	l.m.	14,006.70
10.7	750mmϕ	l.m.	15,360.30
10.8	900mmϕ	l.m.	19,977.30
11	*Concrete Pipe*		
11.1	1050mm-dia. + 1.50m excavation	l.m.	15,500.00
11.2	1200mm-dia. + 1.50m excavation	l.m.	17,970.00
11.3	1300mm-dia. + 1.50m excavation	l.m.	20,470.00
11.4	1350mm-dia. + 1.50m excavation	l.m.	21,170.80
11.5	1500mm-dia. + 1.50m excavation	l.m.	23,000.00
11.6	1650mm-dia. + 1.50m excavation	l.m.	25,487.90
11.7	1800mm-dia. + 1.50m excavation	l.m.	28,449.90
11.8	1950mm-dia. + 1.50m excavation	l.m.	31,419.90
11.9	2100mm-dia. + 1.50m excavation	l.m.	34,621.40
11.10	2250mm-dia. + 1.50m excavation	l.m.	38,054.30
11.11	2400mm-dia. + 1.50m excavation	l.m.	41,718.60
11.12	2550mm-dia. + 1.50m excavation	l.m.	45,614.30
12	*Pumps*		
12.1	500lps	set	3,347,000.00
12.2	234lps, 15m TDH	set	2,132,000.00
12.3	200lps	set	1,997,000.00
12.4	150lps	set	1,772,000.00
12.5	100lps	set	1,547,000.00
12.6	48lps, 20m TDH	set	1,322,000.00
13	*900mmϕ Sewer Manhole*		
13.1	depth ≤1.5m	each	60,000.00
13.2	depth >1.5m	each	81,000.00

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10.8.1.2 Land

For pumping/lift stations, land has to be acquired within the various catchment areas. The prevailing market values of commercial lots are shown in **Table 10.20**.

Table 10.20 - Market Prices of Lots in Metro Manila

LOT AREA PRICES		
Item	**Location**	**Unit Price (Php/sq.m.)**
1	Caloocan	10,000.00
2	Pasig	14,000.00
3	Taytay	5,000.00
4	Makati	22,000.00
5	Pasay	25,000.00
6	Taguig	20,000.00
7	Quezon City	20,000.00
8	Manila	28,000.00
9	Muntinlupa	20,000.00
10	Parañaque	10,000.00
11	San Juan	20,000.00
12	Malabon	10,000.00
13	Valenzuela	10,000.00

10.8.1.3 Reticulation Network

The costs of reticulation pipe network were computed for sample typical developed areas in Metro Manila with a layout of conventional separate system and small bore system for the collection of septic tank effluent (or STED). The sample sites have areas ranging from 50 to 180 hectares. Combined drainage (storm sewer) cost database were developed from various DCCD site development projects were used.

The reticulation unit cost covers supply and installation of service connections and pipe network including manholes, engineering & construction supervision, profit and taxes. The unit cost estimates for the reticulation options were as follows:

- STED - PhP 1.8 million/ha
- Separate (conventional) - PhP 2.2 million/ha
- New combined storm sewer - PhP 1.3 million/ha
- Storm sewer rehabilitation (combined) - PhP 0.65 million/ha

Annual O & M costs for the reticulation and trunk mains were estimated at 0.75% of the capital costs. For a 100-ha sewer-served area, the annual O & M for STED reticulation would be estimated at PhP 1.35 M for instance for instance.

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10.8.1.4 Pumping / Lift Stations

For the pumping lift stations, the cost estimates (excluding land acquisition) adopted were as follows:

- Lift station civil works - PhP 15,000/sq.m floor area
- Pump units - Refer to "Unit Costs" in **Table 10.19**

10.8.1.5 Sewage Treatment Plants

Cost curves were developed for the UASB-SBR and stand-alone SBR systems based on preliminary designs for flows of 5, 10, 20, and 50 MLD. Unit costs used were 2005 prices. The fitted equation for the cost estimates is given below and the cost curves are illustrated in **Figures 10.23 and 10.24**.

UASB / SBR System

Capital Cost = 0.043 * $Q^{0.944}$
Annual O & M Cost = 0.011 * $Q^{0.856}$

SBR System

Capital Cost = 0.052 * $Q^{0.923}$
Annual O & M Cost = 0.013 * $Q^{0.849}$

where the cost is in PhP million and the flow rate Q is in m^3/day.

The plots of the cost curves are shown in **Figures 10.23** and **10.24,** respectively, for the capital cost and O&M cost.

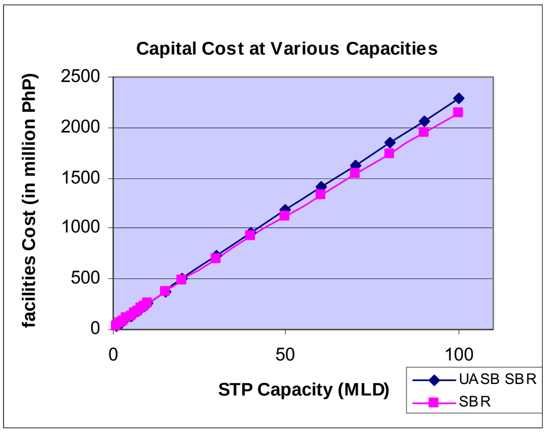

Figure 10.23 Capital Cost Curves for UASB-SBR Sewage Treatment Plant

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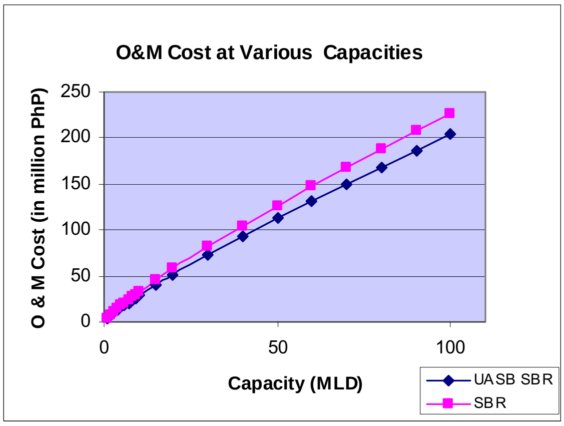

Figure 10.24 O & M Cost Curves for UASB-SBR Sewage Treatment Plant

Capital Costs - Based on a preliminary design / layout of the UASB-SBR and SBR plant, the capital cost was estimated that included the following: civil works with site development, supply and installation of the electrical-mechanical-instrumentation equipment/ & works, ancillary works, commissioning, engineering / construction management, profit, contingencies and taxes.

O&M Cost - The operation cost covered power, chemicals, sludge handling/disposal, and personnel. Annual maintenance cost was estimated at 2% of total capital cost.

10.9 Summary of the Facilities, Costs and Implementation Schedule

10.9.1 Summary of Facilities and Costs

The overall summary of the facilities and costs for the 15 sewerage systems are shown in **Table 10.21** and has the following highlights:

- Sewage reticulation covers a total area of 11,757 ha at a cost of PhP 16.003 billion in 2025;
- By 2025, a total of 99.91 km of sewer trunks with diameter 250 mm to 1350 mm is installed at a cost of PhP 3.148 billion;
- Sixteen new UASB-SBR Sewage Treatment Plants are proposed with an aggregate capacities of 612 MLD and a total cost of PhP 15.549 billion;
- A total of 34.04 ha need to be acquired for the STPs by 2025 at an estimated cost of PhP 5.036 billion;
- The grand total capital cost of the proposed sewerage master plan is estimated at about PhP 51.657 billion including 30% for contingency;

- The unit cost of sewerage development is PhP 4.39 million per ha including land cost or PhP 3.84 million per ha excluding land cost.

The distribution of the capital costs for the proposed Metro Manila Sewerage Master Plan is as follows: Reticulation system - 40.3%, Trunk mains – 7.9%, STP – 39.1% and Land – 12.7%.

The present sewerage coverage is 8,226 ha or about 14% of the NCR or Metro Manila. With the implementation of the SMP, the coverage is projected to increase to 33% in 2025.

Table 10.21 - Overall Summary of Facilities and Costs of Metro Manila Sewerage

Item / Description	2005 Existing	2010	2015	2020	2025	Total
Selected Option Costs, million Php						
(1) STP Area & Land Cost						
(a) Required STP Area (ha)		2.46	1.98	11.02	17.13	32.59
(b) STP Land Cost		**465**	**509**	**1,426**	**2,505**	**4,905**
(2) STP Cost		**1,618**	**867**	**5,083**	**7,333**	**14,901**
(3) Sewer Trunks Costs		**117**	**386**	**1,363**	**1,761**	**3,627**
(4) Reticulation Costs		**1,115**	**1,270**	**5,406**	**6,566**	**14,357**
(a) Conventional		0	0	0	0	0
(b) Combined		440	39	40	2,189	2,708
(c) STED		675	1,231	5,348	4,046	11,300
(d) Existing Storm sewer Rehab		0	0	0	330	330
Total Cost of Facilities & Land (M Php)		**3,315**	**3,032**	**13,277**	**18,165**	**37,789**
30% Contingencies		**995**	**910**	**3,983**	**5,449**	**11,337**
Total Cost of Facilities & Land (M Php)		**4,310**	**3,942**	**17,261**	**23,614**	**49,126**
Summary of Facilities						
(1) Trunk Main (300-1350 mm dia): total length (m)		**7,235**	**14,418**	**15,988**	**47,061**	**84,702**
(2) Reticulation Areas, (ha.)		**1,124**	**1,208**	**3,414**	**6,844**	**12,590**
(a) Conventional		0	0	0	0	
(b) Combined		449	60	61	1,386	
(c) STED		675	1,148	3,325	4,002	
(d) Existing Storm sewer Rehab		0	0	28	1,456	
Total Sewered Area (ha)		1,124	1,208	3,414	6,844	
(3) UASB-SBR STP Capacity, (Mld)		**48**	**35**	**210**	**300**	**593**
Incremental Number of STPs		2	2	6	6	**16**

10.9.2 Implementation Schedule

The implementation schedule for the Metro Manila sewerage master plan to 2025 is presented in **Figure 10.25**. For each of the time horizons: 2010, 2015, 2020 and 2025, a five-year implementation period is provided to enable the planned sewerage to be on-line at the planning horizon. Construction of the reticulation systems is a continuous five-year activity for each planning horizon, while land acquisition for the STPs is an early activity.

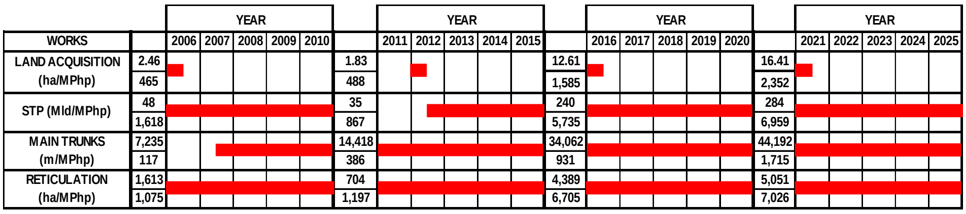

Figure 10.25 Overall Implementation Schedule for the Metro Manila SMP

10.10 STPs and Estimates of Bio-solids Production

There are 16 sewage treatment plants of UASB-SBR systems proposed to be installed A summary of the proposed STPs and the bio-solids they will generate is presented in Table **10.22**.

Table 10.22 - Summary of STPs and Bio-solis Production

Item #	Location	City/ Municipality	Type of Improvement	Treatment Process	STP Area Requirement (Ha)	2010			2015			2020			2025		
						Type of Reticulation	STP Capacity (MLD)[2]	Sludge Generation (m^3/yr)	Type of Reticulation	STP Capacity (MLD)	Sludge Generation (m^3/yr)	Type of Reticulation	STP Capacity (MLD)	Sludge Generation (m^3/yr)	Type of Reticulation	STP Capacity (MLD)	Sludge Generation (m^3/yr)
1	Kaunlaran St. adjacent to Dampalit River, Concepcion	Malabon	New	UASB - SBR	0.95							S	17 (17)	34,310			
2	Maysan Road near Sampaguita St., Bahayang Pag-asa Subd.	Valenzuela	New	UASB - SBR	1.68							S	32 (32)	64,240			
3	Dagat-Dagatan Ave., MWSI STP site	Caloocan	Existing - with extension	UASB - SBR	4.72							S	93 (93)	186,698			
4	Cabatuhan St. near Bignay-Llano Road, Llano	Caloocan (No	New	UASB - SBR	1.68							S	36 (36)	72,270			
5	PCSO Compound (formerly Quezon Institute) E. Rodriguez Sr. Ave.	QC	New	UASB - SBR	0.90										S	16 (16)	32,120
6	Bagong Farmers Avenue. Near Marikina River (Tumana)	Marikina	New	UASB - SBR	0.95										S	17 (17)	34,310
7	Manila North Cemetery	Manila	New	UASB - SBR	3.21				S	30 (11)	22,265	S	30 (38)	77,015	C	62 (62)	124,465
8	Ortigas Ave. near Xavier St., Green Hills	San Juan	New	UASB - SBR	0.55				S	5 (4)	8,030	S	10 (8)	16,060	C	10 (10)	20,075
9	F. Manalo St. corner Valenzuela St., San Perfecto	San Juan	New	UASB - SBR	0.35							C	6 (4)	8,030	C	6 (6)	12,045
10	General Mills Compound, Eagle St., Ugong, near Marikina River	Pasig	New	UASB - SBR	2.53	C[3]	8 (8)	16,060	C	8 (9)	18,250	C	16 (13)	26,280	C	35 (35)	70,263
11	Hon. Sandoval Ave. near Manggahan Floodway & Laguna de Bay	Taytay	MTSP - with extension	UASB - SBR	1.68										C	32 (32)	64,240
12	F. Manalo St. near. Tipas River and Laguna de Bay	Taguig	MTSP - with extension	UASB - SBR	1.39										C	26 (26)	52,670
13	D. Macapagal highway near corner NAIA Road	Pasay	New	UASB - SBR	2.10							S	15 (15)	30,660	S	27 (27)	85,045
14	Sucat Road corner Bernabe St., Bernabe Subd. (near EVACOM)	Parañaque	New	UASB - SBR	1.68										S	32 (32)	64,970
15	Alabang-Zapote Road beside Uniwide Sales Metromall	Las Piñas	New	UASB - SBR	4.03										S[4] & C	80 (80)	162,060
16	San Guillermo St. adjacent to Alabang River and Laguna de Bay	Muntinlupa	New	UASB - SBR	3.53	S[4] & C	50 (17)	73,000	S	50 (24)	115,340	S	70 (61)	129,940	S	70 (70)	147,825
TOTAL							25	89,060		48	163,885		317	645,503		413	870,087

[1] UASB-SBR - Upflow Anaerobic Sewage Blanket - Sequencing Batch Reactor
[2] Values in () represent actual flows to the STP
[3] Combined Sewerage System
[4] Septic Tank Effluent Disposal (STED) System

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11. Proposed Subsidy Policy

11.1 Financing Sewerage, Sanitation and Wastewater Management

The benefits from improved sanitation, and therefore the appropriate financing arrangements, are complex. At the lowest level, households place a high value on sanitation services that provide them with a private, convenient and odor-free facility, which removes excreta and wastewater from the property or confines it appropriately on-site (see **Figure 11.1).** However, there are clearly benefits, which accrue at a more aggregate level and are therefore externalities from the point of view of the household. Willingness-to-pay surveys have shown that households are willing to pay for the first category of service benefits, but their interest in paying for external (environmental) benefits that they consider beyond their concern is questionable.

At the next level (i.e. the block) households in a particular block value services which remove excreta from the block as a whole. Moving up to a level to that of the neighborhood, residents' value service, which remove excreta and wastewater from the neighborhood, or which renders these wastes innocuous through treatment. Similarly, at the level of the city, the removal and/or treatment of wastes from the city and its surroundings are valued. Cities, however, do not exist in isolation – wastes discharged from one city pollute the water supply of downstream cities and of other users.

Accordingly, groups of cities in a river basin can perceive the collective benefit of environmental improvement. Finally, because the health and well being of a nation as a whole may be affected by environmental degradation in a particular river basin, there are sometimes additional national economic, health and environmental benefits from wastewater management in that basin.

The fundamental principle of public finance is that costs should be assigned to different levels in this hierarchy, according to the benefits accruing at the different levels. This suggests that the financing of sanitation, sewerage and wastewater treatment should be allocated as follows:

- Households pay the costs incurred in providing on-site facilities (bathrooms, toilets, sewerage connections);
- The residents of a block collectively pay the additional costs incurred in collecting the wastes from individual homes and transporting these to the boundaries of the block;
- The residents of a neighborhood collectively pay the additional costs incurred in collecting the wastes from the blocks and transporting these to the boundary of a city (or of treating the city wastes);
- The stakeholders in a river basin assess the value of different levels of water quality within a basin and decide on the level of quality they wish to pay for, and on the distribution of responsibility for paying for the necessary treatment and water quality management activities; and
- The nation, for the achievement of broader public health or environmental benefits, may decide to pay collectively for meeting more stringent treatment standards.

11.2 Existing Sewerage and Sanitation Tariff

In accordance with the terms of the Concession Agreements, the current tariff structure includes two surcharges on the Water Charge[1]:

- The Environmental Charge equivalent to 10% of the Water Charge to cover the cost of desludging septic tanks and expanding the sewerage system; this is levied on all customers and the current average charges (January 2005) are PhP 2.50 per m^3 of water consumed (West Zone) and PhP 1.53 per m^3 of water consumed (East Zone); and

- The Sewerage Charge equivalent to 50% of the Water Charge to cover the cost of wastewater treatment and expansion of sewerage services; this is levied on customers who are connected to the sewerage system and the current average charges are PhP 12.50 per m^3 of water consumed (West Zone) and PhP 7.66 per m^3 of water consumed (East Zone).[2]

Under the terms of the Concession Agreements, project capital expenditures are allowed to be recovered through tariff adjustments, i.e. through increased prices to customers. This provision allows for cost recovery through cross-subsidy,[3] as the cost of a project is passed on to all customers in the concession area, whether or not they are directly benefiting from the project.

11.3 Sewerage and Sanitation Cost Recovery

11.3.1 Framework

The provision of sewerage and sanitation services in urban areas is important for the protection of the environment and the maintenance of public health. The benefits from these projects can be shared by all or a large proportion of the entire community, not just in the local communities concerned. However, these projects involve substantial costs and the issue is the fair and

[1] The Water Charge consists of the basic water tariff, CERA and FCDA. The basic water tariff is currently PhP 19.72 per m^3 of water consumed (West Zone) and PhP 3.94 per m^3 of water consumed (East Zone). CERA is the Currency Exchange Rate Adjustment and was fixed in the Concession Agreements at PhP1.00 per m^3 of water consumed. FCDA is the Foreign Currency Differential Adjustment, a rate adjustment for foreign currency differentials with respect to present and future foreign exchange losses, including all accruals and carrying costs; the FCDA was adopted in Amendment No.1 (October 2001) and was implemented in January 2002 at PhP 4.07 per m^3 of water consumed (West Zone) and PhP 2.24 per m^3 of water consumed (East Zone); it is currently PhP 4.24 per m^3 of water consumed (West Zone) and PhP 0.38 per m^3 of water consumed (East Zone).

[2] Fees for connection to the public sewer depend on the distance from the connection point. For connections located less than 25 meters from the connection point, the current fee is PhP 6,200; for those located more than 25 meters from the connection point (or for non-residential customers), the current fee ranges from PhP 15,000 to PhP 30,000 for a standard length of 12 to 15 meters.

[3] Cross-subsidy occurs where some customers pay more for services used than the cost of providing these services while other customers pay less than the cost of services they consume, i.e. where part of the costs of supplying one customer is funded from payments by other customers.

reasonable sharing of these costs. The key matters for decision are who should pay what costs and how should current charges be adjusted to reflect these additional costs.

The components of the decision are shown in **Figure 11.1,** with a sharing of costs at each stage between 0% and 100%. The existing situation in Metro Manila is that the customers connected to the sewerage system pay a Sewerage Charge while all customers, whether connected or not, pay an Environmental Charge (or Common Charge).

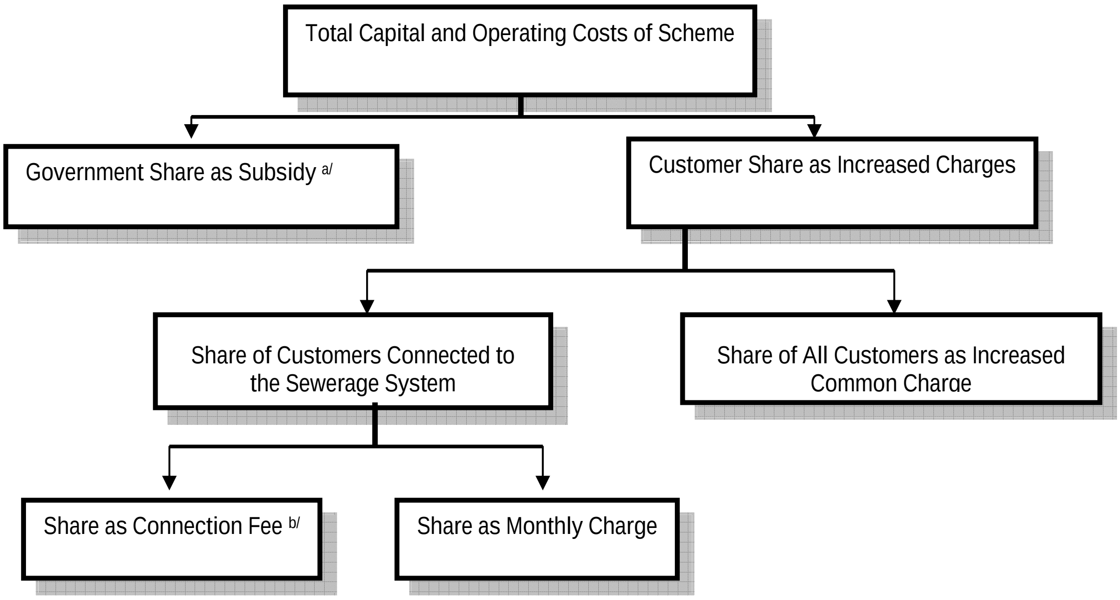

Figure 11.1 - Cost Sharing Framework

Notes:

a/ For schemes which are not commercially viable but required for environmental, social and other reasons.

b/ Can be paid either up-front or by installments on monthly bill.

11.3.2 Pricing Principles

The general principle for economic pricing of infrastructure services is that the users of the services or those who benefit from the provision of the services, should pay for the resources consumed in providing the services – commonly referred to as the 'user pays' or 'beneficiary pays' approach[4]. This contrast with the 'public good' approach, where it is difficult to identify, measure and price the relative benefits accruing to users or beneficiaries from the provision of infrastructure services. In this situation, infrastructure

[4] An alternative approach is the 'polluter pays' approach, where the costs of repairing or preserving the environment are recovered from those who pollute the environment. However, in the case of domestic discharges, the 'polluter' and the 'user' are one and the same, the 'beneficiaries' may include wider than the local community.

services are funded by government taxation revenues and the entire community pays for the provision of the services.

It is considered that the primary beneficiary of sewerage and sanitation projects is the local community, which is directly connected to the scheme. Residents will benefit from a healthier and more pleasant living environment, property owners will gain from increased land value and the improved amenity of the area will encourage the provision of social infrastructure and flow-on commercial activities. However, environmental and public health benefits may also accrue to the wider community through the protection of public health, the environment, waterways and economic activities associated with the environment and waterways such as fisheries, tourism and recreation facilities.

Cost sharing between the wider community and local residents is therefore appropriate in the case of sewerage and sanitation projects. However, under the 'user pays' approach to funding the portion of project costs from local households who benefit directly from the project, prices should ideally reflect the full economic costs of providing the services to each customer group. Theoretically, this situation requires that the price for the marginal cubic meter of sewage discharged by a customer group (referred to as the economically efficient price) reflect the marginal costs of transporting, treating and disposing of the sewage.

However, the application of economic pricing principles in providing sewerage and sanitation services to the household sector is particularly difficult. The number of options for using tariffs to reflect the costs of discharges by specific customer groups is limited in practice. Measuring domestic discharges is neither practical nor affordable and, in any case, households have limited opportunities to respond to economically efficient prices – they may be able to reduce the volume of discharges to some degree but it may be difficult to reduce the pollutant loads.[5]

In practice, charging for household sewage discharges is based on one of two methods:

1. Charges are set on the basis of a service provided – referred to as a service or access charge – and maybe independent of volume discharged by an individual household.

2. Charges are set on the basis of the use made of the service by an individual household – referred to as a usage charge – where either:

    (a) The volume of discharges is estimated as a proportion of the water volumes supplied to the household (discharge factor) and then multiplied by a unit cost of sewage treatment, or
    (b) A surcharge on the water bill is applied.

[5] Generally, where tariffs reflect the cost of providing the service, appropriate price signals are given to customers to encourage the efficient use of the service. If the price is less than the cost of delivering the service, this can encourage the over use of the service. Similarly, if price is higher than the cost of delivery, then this can encourage the under use of the service.

In method (1), a sewerage service charge is applied based on factors such as size and type of property, water meter size, etc. In method (2), water usage is reflected in the charge for domestic discharges because there is some correlation between water consumption and the volume of discharge (particularly for reticulated sewerage) and because domestic-type sewage typically comprises mainly water. However, there is little benefit in using method 2(a) given that the discharge factor is assumed [6] and in the absence of a measure of the true unit cost of treating household sewage.

Method 2(b) is used in Metro Manila, where both the Environmental Charge and the Sewerage Charge are set as a percentage of the water charge.[7]

The levying of uniform service (fixed) or usage (variable) charges for services that provide similar outcomes across the same service area is an administratively efficient and equitable means of charging for sewerage and sanitation services to residential customers.[8] However, it does result in some customers cross-subsidizing others[9] and is not entirely consistent with a strict 'user pays' view of charging, i.e. a customer group should pay the full costs of services consumed by that group.

11.3.3 Pricing Strategies

In practice, in deciding on the appropriate cost sharing arrangement, the pricing outcomes for sewerage and sanitation services should:

- Be based on full recovery of capital and operating costs;[10]
- Relate to least cost technology in terms of meeting environmental and public health outcomes;
- Be fair in terms of costs being recovered from those who will benefit from them, including the wider community;
- Be affordable and subject to willingness to pay considerations;

[6] The factor typically ranges from 25% to 90%.
[7] This is also the case for non-residential customers (small business, commercial and industrial). However, non-residential customers on average pay more than the average residential customer for the same volume of water consumed. This is fair from the perspective of charging for sewerage and sanitation services, since many commercial and industrial discharges will not be the same strength as normal domestic sewage. Many utilities impose an additional charge for customers who discharge other than normal domestic-strength discharges, to reflect the additional costs of treatment.
If the Environmental Charge and the Sewerage Charge were combined, the surcharge would need to increase from 10% to 12.5%. This would result in additional payments for non-sewered customers of, on average, PhP 27 per month (West Zone) and PhP 17 per month (East Zone).
[8] The principle which underpins the practice of charging uniform prices for similar service outcomes to similar customers is often referred to as 'postage stamp' pricing.
[9] For example, those receiving service from a low cost system (e.g. a small decentralized system) cross-subsidize those receiving service from a high cost system (e.g. a major reticulated system).
[10] Prices should reflect the long run marginal cost of supply. In practice, this is approximated by the average incremental cost (AIC) of supply.
AIC = PV(additional investment + O&M expenditure)/PV(additional sewage discharge), where PV (present value) is calculated over life of the assets created using weighted average cost of capital as discount rate.

- Minimize disincentives to connect to new sewerage and sanitation schemes; and
- Remove cross-subsidies where possible and make remaining cross-subsidies transparent.

Where it can be demonstrated that substantial environmental and public health benefits are likely to flow to the wider community, it is appropriate to recover only a portion of the project capital costs from local households who benefit directly from the project, subject to willingness to pay and affordability considerations. A capital contribution charge (CCC) can be calculated according to the following formula:

$$CCC = \frac{\textit{\% of actual capital cost of infrastructure servicing area considered viable}}{\textit{Number of existing properties to be serviced in the area}}$$

Viability can be considered in terms of willingness to pay and affordability considerations and to minimize disincentives to connect to new schemes.[11]

The capital costs used in the calculation should be net of the costs of renewing existing infrastructure or providing infrastructure for servicing new development lots. Where the capital works include renewal of existing assets or provision for servicing of new developments, the capital cost should be apportioned according to estimates of properties affected. Recovery of renewal costs could be made via an increase in the common sewerage charge. The levying of a charge on developers could be considered for recovery of the costs of providing infrastructure servicing new lots (refer below).

The capital contribution charge can be paid at the time of connection or availability of sanitation services, either by a one-off up-front payment or by installments. The annual CCC should be calculated based on an amortization method over a period of up to 20 years.[12] The interest rate used in the amortization calculation should be the weighted average cost of capital at the time of availability of sewerage and sanitation services.[13]

The remaining capital costs will be paid by the wider community via an increase in the common sewerage charge. Also, operating costs will be recovered through the common sewerage charge.

Where it cannot be demonstrated that projects will provide substantial environmental and public health benefits to the wider community, local households will be required to pay the full capital costs. It is proposed that a net present value (NPV) methodology be used to calculate the maximum capital contribution charge.

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[11] Customers will incur additional expense for the cost of connecting their property to the scheme (e.g. plumbing and inspection costs).
[12] 20 years is the expected asset life.
[13] At any time, the total of all outstanding CCC installments may be paid in a lump sum. The lump sum payable in this case may be calculated as the net present value of all outstanding installments, calculated at the same interest rate used in the initial amortization calculation.

There may be situations where the concessionaire is directed by the MWSS/National Government to provide sewerage services to a particular area where local households cannot afford the capital contribution charge and it is not commercially viable for the concessionaire to provide the services. The cost of the non-commercial component of this investment should be fully disclosed and should ideally be paid to the concessionaire as a social program.

An alternative source of funding for servicing new land developments in an area is via a charge on land/property developers. Recovery of the full costs of infrastructure capacity augmentation required to service new developments can be achieved through a combination of developer charges, which are up-front service charges paid by land/property developers and periodic charges, which are paid in the monthly bill by the eventual householder.

Developer charges therefore contribute to ensuring the financial viability of extensions of urban infrastructure. They are generally passed on by the developer in the price of each parcel of land/property purchased by individuals. The most appropriate and transparent approach to calculating developer charges is use of the net present value methodology, referred to above.

In other countries, both developing and developed, the capital and recurrent costs of sewerage systems are covered through charges, which are assessed on the value of property. Under this scheme, the charge can be applied as a surcharge on the property tax or as a direct separate tax on the assessed value of the property. These may be referred to as Uniform Annual Charges where all ratepayers are levied a sewerage charge that is related to the value of their property. The major advantage of this scheme is that it at least indirectly reflects differences in ability to pay. However, for the specific case of MWSS/Concessionaires, there are administrative constraints in the implementation of this scheme because of lack of accessibility to property value database which is under the jurisdiction of Local Government Units.

Table 11.1 summarizes the proposed cost recovery strategies for the different situations set out above.

Table 11.1 - Proposed Cost Recovery Strategies

	Capital Costs	Annual Operating Costs
Where willingness to pay/affordability issues are significant		
Cost sharing appropriate [a/]	% allocated to Gov't as subsidy	100% allocated to all customers [b/]
	% allocated to all customers [b/]	
Where willingness to pay/affordability issues are not significant		
Cost sharing appropriate [c/]	% allocated to local customers [d/]	100% allocated to all customers [b/]
	% allocated to all customers [b/]	
Cost sharing inappropriate[e/]	100% by local customers [f/]	

- **Notes:**

a/ Where it can be demonstrated that substantial environmental and public health benefits are likely to flow to the wider community and/or provision of services is not commercially viable.

b/ Via an increase in the common sewerage/sanitation charge.
c/ Where it can be demonstrated that substantial environmental and public health benefits are likely to flow to the wider community and provision of services is commercially viable.
d/ Via a capital contribution charge to be paid at time of connection or availability of sanitation services, either by a one-off payment or by installments.
e/ Where it cannot be demonstrated that substantial environmental and public health benefits are likely to flow to the wider community or in the case of new land developments.
f/ Via a capital charge calculated net of future operating profits expected from providing services to the area.

11.4 Viability Considerations for Proposed Cost Recovery Strategies

Cost recovery strategies need to have regard to customer willingness to pay and affordability. These two considerations are assessed below.

11.4.1 Willingness to Pay Survey Results

As outlined in **Chapter 10**, Willingness to Pay (WTP) Survey was conducted in April 2005 of 2,000 households in areas where sewerage system expansion or upgrade of sanitation systems are proposed. Respondents were asked to express their willingness to pay for the following options of improvement of sewerage and sanitation services.

The Willingness-to-Pay Survey as part of this study showed that about 75% of respondents were willing to pay an additional 20% on top of their water bill for improved sewerage or sanitation services.

11.4.2 Affordability Thresholds

The generally accepted guideline by international funding agencies for household expenditure on water supply, sewerage and sanitation services is no more than 5% of average household income. The WTP survey findings indicate that households in Metro Manila are willing to pay, on average, less than this threshold level. This may be because many survey respondents believe that the MWSS should be responsible for paying for the improved services.[14]

Table 11.2 gives the results of an affordability analysis of the proposed improvements to sewerage and sanitation services in the West Zone and East Zone. The table shows that:

For sanitation services:

- For the low income area in the West Zone, the current tariff rates are already at level with the affordability level of consumers (based on the guideline of 5% of average household income), thus their WTP rate is over 5%;

[14] This was by far the most frequent response given in the WTP Survey to the question as to why a household was not willing to contribute to the improvement costs.

- Overall, the willingness of consumers to pay additional charge for sanitation is lower than their affordability level; and
- The percentage of WTP to pay additional sanitation charge is inversely proportional to their income, meaning the higher their income level, the lower is their WTP rate.

For sewerage services:

- For the West Zone, average sewerage charge based on affordable rate is about PhP 11.70 per m^3;
- Sewerage charge for the East Zone is higher at PhP 18.28 per m^3, based on their affordability level; and
- It may be assumed that improved sewerage services will be suitable only to upper income area households and to some households in the middle income area.

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Table 11.2 – Affordability Analysis for Improved Sewerage and Sanitation Services

	Household Type			
	Blighted/ Low Income Area	Middle Income Area	Upper Income Area	All H'holds [a/]
West Zone: Sanitation				
Water consumed (m^3/mth) [b/]	29	41	52	37
Water charge (P/m^3) [c/]	14.26	16.75	19.04	15.88
Sanitation charge (P/m^3)				
Based on WTP rate [b/]	3.29	3.87	4.40	3.67
Based on affordable rate [a/]	3.14	8.55	30.60	12.47
Total water bill (P/mth)				
Based on WTP rate	509	846	1,219	723
Based on affordable rate	505	1,038	2,581	1,049
H'hold Mean Income (P/mth)	10,008	20,614	51,429	20,856
Water bill as % of income				
Based on WTP rate b/	5.1%	4.1%	2.4%	3.5%
Based on affordable rate [a/]	5.0%	5.0%	5.0%	5.0%
East Zone: Sanitation				
Water consumed (m^3/mth) [b/]	29	41	52	37
Water charge (P/m^3) [c/]	8.95	10.44	11.91	9.91
Sanitation charge (P/m^3)				
Based on WTP rate [b/]	2.66	3.10	3.54	2.94
Based on affordable rate [a/]	8.39	14.81	37.66	18.37
Total water bill (P/mth)				
Based on WTP rate	337	555	803	476
Based on affordable rate	503	1,035	2,578	1,046
H'hold Mean Income (P/mth)	10,008	20,614	51,429	20,856
Water bill as % of income				
Based on WTP rate	3.4%	2.7%	1.6%	2.3%
Based on affordable rate [a/]	5.0%	5.0%	5.0%	5.0%
West Zone - Sewerage				
Water consumed (m3/mth) [b/]	29	41	52	37
Water charge (P/m^3) [e/]	14.26	16.75	19.04	15.88
Sewerage charge (P/m^3)				
Based on affordable rate [d/]	2.57	7.71	29.50	11.72
Total water bill (P/mth)				
Based on affordable rate	488	1,003	2,524	1,021
H'hold Mean Income (P/mth)	10,008	20,614	51,429	20,856
Water bill as % of income				
Based on affordable rate [d/]	4.9%	4.9%	4.9%	4.9%
East Zone - Sewerage				
Water consumed (m3/mth) [b/]	29	41	52	37
Water charge (P/m^3) [e/]	8.95	10.44	11.91	9.91
Sewerage charge (P/m^3)				
Based on affordable rate [d/]	8.41	14.66	37.35	18.28
Total water bill (P/mth)				
Based on affordable rate	503	1,029	2,562	1,043
H'hold Mean Income (P/mth)	10,008	20,614	51,429	20,856
Water bill as % of income				
Based on affordable rate [d/]	5.0%	5.0%	5.0%	5.0%

Notes:

a/ Mid range of affordability within each household type.

b/ From WTP Survey (results tabulated separately for East and West zones). The estimate for sanitation services for the west area will be lower because willingness to pay is 11% compared to 14% for sewerage services. (Refer to Table 5.1)

c/ As at January 2005 excluding Environmental Charge. Includes 10% VAT.

d/ Mid range of affordability within each household type.

e/ As at January 2005 excluding Environmental Charge and Sewerage Charge. Includes 10% VAT.

11.5 Cost Recovery and Subsidy Analysis

11.5.1 Recovery Tariff

Table 11.3 presents the results of imposing a tariff equivalent to the financial average incremental cost (AIC) of providing improved sewerage and sanitation services. The financial AIC provides a measure of the long run marginal cost of providing sewerage and sanitation services (refer to Section 11.2.3). It is therefore the target tariff level, as it represents financial adequacy and sustainability from the perspective of the service provider.

The financial AICs are derived, using capital expenditure plans prepared for the two Concession Areas. They include both the investment costs and the incremental operation and maintenance costs of the improved services. **Table 11.3** shows that:

For Sanitation

- For the West Zone, computed AIC is PhP 1.69 per m^3 for septage treatment and collection with cost recovery factors ranging from 217% (for an average tariff rate based on WTP Survey results) to 737% (for an average tariff rate that is affordable for an average household).
- For the East Zone, sanitation has an AIC of PhP 2.67 per m^3 for septage treatment and collection and cost recovery factors ranging from 110% (for an average tariff rate based on WTP Survey results) to 689% (for an average tariff rate that is affordable for an average household).
- Because of the low AIC, both the WTP and affordability rates will cover all costs of septage treatment and collection.

For Sewerage

- For the West Zone, sewerage average incremental cost is PhP 31.79 per m^3 of sewage discharge. Cost recovery factor is 45% for capital and 212% for operations and maintenance cost, giving an average recovery of 37%. These are based on average tariff that is considered affordable to consumers.
- For the East Zone, average incremental cost is PhP 22.60 per m^3 of sewage discharge and cost recovery factor of 104% for capital and 368% for operations and maintenance cost, or an average recovery of 81% for capital, operations and maintenance.

Financial subsidies are not required to achieve the intended use of the improved sanitation services since both WTP and affordable rates are enough to cover the costs of both the septage treatment and collection. But for the improved sewerage facilities, the required subsidy ranges from approximately 20% to 90% of the average incremental cost of improvement depending on whether WTP or affordable rates are used. Without the payment of these subsidies, the environmental benefits of the improved sewerage facilities will not be fully realized.

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Table 11.3 – Subsidy Analysis for Improved Sewerage and Sanitation Services

	Charge based on Existing Rate [a/]	Charge based on WTP Survey [b/]	Affordable by Household Type [c/] Blighted/ Low Income Area	Middle Income Area	Upper Income Area	All H'holds
West Zone: Sanitation						
Average Tariff (P/m^3)	1.59	3.67	3.14	8.55	30.60	12.47
AIC Septage Treatment (P/m^3)			**1.18**			
Recovery of STP AIC	135%	311%	266%	725%	2593%	1057%
AIC Septage Collection (Pm^3)			**0.51**			
Recovery of AIC Septage Collection	311%	718%	614%	1674%	5989%	2440%
Average STP & Collection Cost (P/m^3)			**1.69**			
Recovery of STP & Collection Cost	94%	217%	185%	506%	1810%	737%
East Zone: Sanitation						
Average Tariff (P/m^3)	0.99	2.94	8.39	14.81	37.66	18.37
AIC Septage Treatment (P/m^3)			**2.12**			
Recovery of STP AIC	47%	139%	395%	697%	1772%	865%
AIC Septage Collection (Pm^3)			**0.54**			
Recovery of AIC Septage Collection	183%	544%	1550%	2735%	6956%	3394%
Average STP & Collection Cost (P/m^3)			**2.67**			
Recovery of STP & Collection Cost	37%	110%	315%	555%	1412%	689%
West Zone: Sewerage						
Average Tariff (P/m^3)	1.59	3.67	2.57	7.71	29.50	11.72
AIC (P/m^3)			**26.27**			
Financial Subsidy (P/m^3)	24.68	22.60	23.70	18.56	-3.24	14.55
AIC Recovery	6%	14%	10%	29%	112%	45%
Average O&M Cost (P/m^3)			**5.53**			
O&M Cost Recovery	29%	66%	46%	140%	534%	212%
Average AIC of Capital and O&M (P/m^3)			31.79			
Recovery of Capital and O&M Cost	5%	12%	8%	24%	93%	37%
East Zone: Sewerage						
Average Tariff (P/m^3)	0.99	2.94	8.41	14.66	37.35	18.28
AIC (P/m^3)			**17.63**			
Financial Subsidy (P/m^3)	16.64	14.69	9.23	2.98	-19.71	-0.65
AIC Recovery	6%	17%	48%	83%	212%	104%
Average O&M Cost (P/m^3)			**4.96**			
O&M Cost Recovery	20%	59%	169%	295%	752%	368%
Average AIC of Capital and O&M (P/m^3)			**22.60**			
Recovery of Capital and O&M Cost	4%	13%	37%	65%	165%	81%

Notes:

a/ Environmental Charge as at January 2005.

b/ Based on stated willingness to pay of 14% more of water bill for West Zone and 17% for East Zone (these are averages across all respondents).

c/ Assumes maximum ability to pay for water and sanitation of 5% of average household income.

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11.5.2 Implications for Cost Recovery Strategies and Tariff Structure

The subsidy analysis shows that customers are generally likely to pay no more than the cost of sanitation services and the annual operating costs of the improved sewerage facilities. In terms of the cost recovery strategies shown in **Table 11.1**, this indicates that it is appropriate to allocate these costs to all customers, not just those receiving the improved services, via a common sewerage/sanitation charge.

As discussed in Section 11.2.2, this charge can be levied through the monthly water bill as a usage charge per m^3 of water consumed (the current arrangement for charging for sewerage and sanitation services) or as a uniform service (or access) charge per household connection. **Table 11.4** shows the tariff rate for each method for the East Concession Area.

Table 11.4 - Illustration of Calculation of Affordable Sanitation Tariffs [a/]

	Household Type		
	Blighted/Low Income Area	**Middle Income Area**	**Upper Income Area**
Household mean income [b/]	10,008	20,614	51,429
Average water consumed [b/]	29	41	52
Existing water bill [c/]	286	471	681
Usage Charge (per m^3 of water consumed)			
Additional sanitation charge [d/]	77	109	139
New water bill	363	580	820
% of household mean income	3.6%	2.8%	1.6%
Service Charge (per household)			
Additional sanitation charge [d/]	98	98	98
New water bill	384	569	779
% of household mean income	3.8%	2.8%	1.5%

(Peso per month unless otherwise indicated, 2005 prices)

Notes:

a/ Using East Zone in Table 11.3.
b/ From Table 11.2.
c/ Based on January 2005 average tariff rates for each household type of P9.85/m^3, P11.48/m^3 and P13.10/m^3, respectively.
d/ Based on recovering P2.66/m^3 of water consumed (from Appendix 1 & 2 of Chapter 12). For Service Charge, average water consumption is 37m^3/month.

Table 11.4 shows that:

- The annual operating costs associated with the sewerage and sanitation improvements can be recovered from all household connections through a usage charge, varying from PhP 77 to PhP 139 per month, or a uniform service (access) charge of PhP 98 per month;
- The usage charge increases the Environmental Charge (currently 10%) to 20% of the sum of the basic water tariff, FCDA and CERA; and

- The charges shown result in the water bill being within the guideline amount of less than 5% of average household income used by international funding agencies.

11.5.3 Subsidy Options

The subsidy analysis shows that customers generally are able and willing to pay for the annual operation and maintenance costs of the improved sewerage services and the full cost of sanitation (septage treatment and collection). However, they can only partly afford to contribute to the capital costs of the sewerage services.

Subsidies for this service could be paid by government through capital grants. A capital grant can be given during project implementation for a specific purpose, e.g. design and construction of a sewage treatment plant or acquisition of land for STP sites. Alternatively, a capital grant can be given each year during which the new services are being used, to repay the debt service associated with debt financing of capital works.

The use of developer charges (refer Section 11.3.3) is a more restrictive non-debt source of funds for capital works. Generally, the charges cover capital works that can be clearly linked to a specific development and are able to be costed separately from system or catchment-wide expenditures. However, affordability still remains an issue as the charges are normally paid by land/property developers and then passed on in the price of each parcel of land/property purchased by individuals.

Another form of subsidy that can be applied is through cross-subsidy from the high to low income groups. Under the Usage Charge concept, the water tariff could be made more progressive by increasing the User Charge paid by the middle and upper income groups while ensuring that the low income groups do not pay more than the generally acceptable percentage of household income (assumed to be 5%). This has the benefit that additional income could be raised through the Water Tariff (which is not seen by the consumers to be a sewerage charge and is therefore apparently more acceptable) as well as through the Usage Charge.

11.6 Recommendations for Sewerage Charging

From the preliminary evaluation of available data, the following conclusions can be made:

- While the primary beneficiary of sewerage and sanitation projects is the local community, which is directly connected to the system, it should also be considered that overall benefits may also accrue to the wider community through the protection of public health, the environment, and economic activities. Cost sharing between the wider community and local residents is therefore appropriate in the case of sewerage and sanitation projects;

- In practice, charging for household sewage discharges is based on one of two methods: (1) Service or Access Charge where charges are set based on the service provided; or (2) Usage Charge where charges are set on the basis of the use made of

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the service by an individual household. The levying of a uniform Service or Usage Charge for services that provide similar benefits across the same service area is an administratively efficient and equitable means of charging. However, it does result in some customer's cross-subsidizing others;

- Cost recovery of sewerage improvement projects can be realized only partially. Based on the result of the willingness to pay survey and the affordability analysis, any sewerage charge will be sufficient to recover only the annual operating and maintenance (O&M) costs, not the capital costs;

- For the low-income group, current water charges are already approaching the same level as the generally acceptable percentage of household income (assumed to be 5%). This means that any further tariff adjustments to recover investment costs will be beyond the affordability of the low-income group;

- Capital costs can be recovered by including them in the Water Charge (as currently done). Also, capital expenditure could be funded from National Government subsidy in the form of direct budgetary outlay or other forms of grant. However, based on discussions with MWSS officials, the subsidy option is currently not likely; and

- The scope for increasing charges is greater for the high-income group due to better affordability. Current charges are only equivalent to about 2.0% of household income for this group. One option to maximize the cost sharing ability of the high-income group is by implementing progressive charging. Progressive charging implies a higher charge for higher water usage and sewage discharge. This can be achieved through an increasing block tariff structure, like the existing water charges structure. A minimum charge may be retained, so as not to further burden the low-income group. 13.

12. Financial and Economic Analyses

12.1 Introduction to Financial Analysis

In accordance with the Terms of Reference of the TA for Strengthening MWSS' Planning Capability, the financial analysis of the proposed sewerage and sanitation improvement plans was undertaken. The focus of this financial study was on the impact of the cost of the Master Plan on the tariff being charged by the concessionaires to their customers. Financial parameters of the projects were identified and the financial impact evaluated.

In analyzing the Plan's financial viability, the discounted cash flow technique was used in determining the Average Incremental Cost (AIC) and the Financial Internal Rate of Return (FIRR). Cash flows were projected over the concession period and also over a 40-year period from year 2006 to 2045. The latter approach would remove the bias from residual values that might be derived if the projection period were limited to the concession period (2021). Furthermore, the operations and maintenance costs for each program would have fully worked out their cost implications with the use of longer term projection period.

The financial evaluation was done separately for the sanitation and sewerage components. Likewise, a separate evaluation was conducted for the two concession areas, East Zone and West Zone, since the existing tariff differs between the two concession areas.

Since the cost of the project can be passed on to the household consumers, viability was looked at from the point of view of the affordability of the sanitation and sewerage charges and the willingness and the ability of the consumers to pay the adjusted rates.

12.2 Financial Costs

12.2.1 Sanitation

The assumptions used were as follows:

- Capital cost includes cost for land acquisition, construction of Septage Treatment Plant and acquisition of vacuum tankers. These are presented in **Table 12.1**.
- Contingency of 30% was added to the basic cost.
- Prices are at 2005 level.
- Exchange rate at US$1 = PhP 56.00.
- Implementation schedule followed the targets set in the engineering study.
- Operation and maintenance costs and disposal of sludge are as estimated by the Engineers and discussed in this Plan. These are summarized in **Table 12.2**.

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Table 12.1 - Summary of Proposed Capital Investment Costs for Sanitation (PhP Million)

		Total	2010	2015	2020	2025
Septage Treatment Plant	**Capacity**					
Rizal	800 m^3/day	973.0		973.0		
Rizal (Expansion)	800 m^3/day	941.0				941.0
Dagat-dagatan	400 m^3/day	470.4	470.4			
Dagat-dagatan (Expansion)	600 m^3/day	705.6		235.2	235.2	235.2
Paranaque/Las Pinas	500 m^3/day	827.8	475.0	235.2		117.6
Total		***3,917.8***	***945.4***	***1,443.4***	***235.2***	***1,293.8***
Vacuum Tanker	**Unit**					
MWCI		780.6				
Vacuum Tanker (5 m^3)	31	112.8			112.8	
	5	18.2				18.2
	0	0.0				0.0
Vacuum Tanker (10 m^3)	2	9.0		9.0		
	110	492.8			492.8	
	33	147.8				147.8
MWSI		793.5				
Vacuum Tanker (5 m^3)	6	21.8	21.8			
	5	18.2		18.2		
	4	14.6			14.6	
	11	40.0				40.0
Vacuum Tanker (10 m^3)	40	179.2	179.2			
	42	188.2		188.2		
	20	89.6			89.6	
	54	241.9				241.9
Total		***1,574.2***	***201.0***	***215.3***	***709.8***	***448.0***
T O T A L		***5,492.0***	***1,146.4***	***1,658.7***	***945.0***	***1,741.8***
T O T A L (With Contingency)		***7,139.5***	***1,490.4***	***2,156.3***	***1,228.5***	***2,264.3***

NOTES:

Exchange Rate US$1 = PhP 56.00

Cost of Tankers

Vacuum Tanker (5 m^3)	$65,000.00
	PhP 3,640,000.00
Vacuum Tanker (10 m^3)	$80,000.00
	PhP 4,480,000.00

Table 12.2 – Operation and Maintenance Costs for Sanitation Facilities

Septage Treatment Plant	PhP 0.082 Million/m^3/year
Vacuum Tanker (5 m^3)	PhP 0.92 Million/tanker/year
Vacuum Tanker (10 m^3)	PhP 1.05 Million/tanker/year
Sludge Disposal	As estimated by Engineers

12.2.2 Sewerage

For sewerage the assumptions used were as follows:

- Capital cost includes cost for land acquisition, construction of Sewage Treatment Plant, construction of main trunks and reticulation. Details are shown in **Table 12.3.**
- Contingency of 30% was added to the basic cost.
- Prices are at 2005 level.
- Exchange rate at US$1 = PhP 56.00.
- Implementation schedule followed the targets set in the engineering study.
- Operation and maintenance costs were as estimated by the Engineers.

Table 12.3 - Summary of Proposed Capital Investment Costs for Sewerage

Component	Year of Implementation	Project Cost (PhP Million)	
		West Zone	East Zone
Phase 1	2010		
Land Acquisition		402	63
Sewerage Treatment Plant		1,408.00	210
Trunk Sewer Pipe		117	-
Reticulation		998	77
Sub-Total Cost		***2,925.00***	***350***
Phase 2	2015		
Land Acquisition		428	70
Sewerage Treatment Plant		732	135
Trunk Sewer Pipe		341	45
Reticulation		1,044.00	153
Sub-Total Cost		***2,545.00***	***403***
Phase 3	2020		
Land Acquisition		1,329.00	236
Sewerage Treatment Plant		5,041.00	695
Trunk Sewer Pipe		912	19
Reticulation		6,574.00	131
Sub-Total Cost		***13,856.00***	***1,081.00***
Phase 4	2025		
Land Acquisition		1,884.00	624
Sewerage Treatment Plant		4,949.00	2,380.00
Trunk Sewer Pipe		1,108.00	606
Reticulation		5,580.00	1,309.00
Sub-Total Cost		***13,521.00***	4,919.00
Total Capital Costs (All Stages)		**32,847.00**	***6,753.00***
Total Capital Costs (With Cont.)		**42,701.10**	***8,778.90***

12.3 Financial Revenues

Incremental revenue was computed to determine the level of tariff that would generate recovery of the capital expenditure and operating costs of the Master Plan. The incremental tariff was multiplied by the projected capacity of the facilities to derive incremental revenue. For the purpose of this financial analysis, the incremental revenues are likewise expressed in 2005 prices.

12.3.1 Sanitation

The financial benefits of the proposed Plan will be materialized as an increase in revenue, resulting from increased number of septic tanks that will be desludged. The increase in septic tanks desludged will be made possible by the two components of the Proposed Plan, the construction of Septage Treatment Plants and the acquisition of vacuum tankers.

It was further assumed that there will be additional income from private collection tankers that will also service the desludging of individual septic tanks. They are expected to dispose of their collected septage at the Septage Treatment Plants. This could be regulated by the Local Government Units concerned who will require the use of the SpTPs and monitor the operations of these private collection tankers. As per the engineering design, it was estimated that 10 percent of septic tanks will be serviced by these private collection tankers.

Three scenarios of tariff levels were analyzed. The scenarios are:

- Tariff based on calculated AIC with discount rate of 10.4%;
- Tariff based on WTP rate computed from the Survey Results; and
- Tariff based on affordability of consumers (total tariff assumed to be not more than 5% of household income).

Table 12.4 summarizes the proposed tariff for each scenario.

Table 12.4 - Tariff Rates for Sanitation

	WEST ZONE	EAST ZONE
Water consumed (m^3/mth)	37	37
Water charge (PhP/m^3) [a/]	15.88	9.91
Sanitation charge (PhP/m^3)		
Based on AIC [b/]	1.69	2.67
Based on WTP rate [c/]	3.67	2.94
Based on affordable rate [d/]	12.47	18.37

a/ As at January 2005 excluding Environmental Charge. Includes 10% VAT.
b/ Based on Average Incremental Cost computation with discount rate of 10.4%.
c/ From WTP Survey (results tabulated separately for East and West Zone).
d/ Average mid range of affordability from each household type .

12.3.2 Sewerage

For sewerage, the financial benefits of the proposed Plan will come from the increase in sewerage connections made possible by the two components of the proposed Plan, i.e. the construction of Sewage Treatment Plants and the laying out of trunk mains and reticulation to connect individual households. **Table 12.5** summarizes the tariff for Sewerage.

Table 12.5 – Tariff Rates for Sewerage

	WEST ZONE	EAST ZONE
Water consumed (m^3/mth)	37	37
Water charge (P/m^3)	23.09	14.42
Sewerage charge (P/m^3)		
Based on AIC	26.27	17.63
Based on WTP rate	3.51	2.45
Based on affordable rate	11.72	18.28

12.4 Result of Financial Analysis

12.4.1 Average Incremental Cost

The annual stream of costs and benefits were discounted using a discount rate of 10.4 percent. Details of the analyses are presented in Chapter 12.

From the summary tables presented above, it is shown that for sanitation, the tariff based on AIC is lower compared to WTP and Affordability rates. Significantly, this is not true for the case of Sewerage where the AIC rates for both West Zone and East Zone are much higher than the WTP and Affordability rates.

12.4.2 Financial Internal Rate of Return

The incremental tariff that would give a Financial Internal Rate of Return equal to the Weighted Average Cost of Capital or give a net present value of zero to the net financial benefits using the WACC as the discount rate. The WACC has been set at 10.4 percent in the last rate rebasing and was also used in this Study. The following table presents a summary of FIRR given various levels of tariff – based on AIC, WTP and Affordability rates.

Table 12.6 – Summary Result of Financial Internal Rates of Return

Sanitation		
Based on AIC [b/]	11.9%	26.3%
Based on WTP rate [c/]	47.8%	17.9%
Based on affordable rate [d/]	130.0%	130.3%
Sewerage		
Based on AIC	10.4%	10.4%
Based on WTP rate [c/]	-	-
Based on affordable rate [d/]	-	-0.6%

12.4.3 Affordability of Tariff Rates

The Concession Agreement between MWSS and the two concessionaires, MWCI and MWSI, allows the concessionaires to recover all costs related to the project through the rate rebasing mechanism. The proposed investment plans can be considered financially viable if the resulting incremental charges remain acceptable to the consumers. A study of the impact of the Plan to existing tariffs, therefore, becomes a crucial determinant of financial viability from the point of view of consumers, MWSS and the two Concessionaires.

One significant aspect for MWSS is the provision that allows for cross-subsidy, wherein the cost of the project is passed on to all customers, whether or not they are directly benefiting from the improvement. Cross subsidy may be necessary specifically for the Sewerage Component.

From **Table 12.7**, a number of significant points can be noted.

For Sanitation:

- The AIC rates for both West Zone and East Zone are within the consumers' willingness to pay for increased charges and their affordability to pay for such increases.
- In both Zones, while some level of increases in charges are acceptable to the consumers, these willingness are way below their computed affordability.
- Based on AIC, sanitation charges are about 11% and 27% of water tariff for the West Zone and East Zone, respectively. This compares with the existing Environmental Charge of 10% of water tariff.
- The total water bill will be about 2.2% to 3.1% of the household mean income of PhP 20,856 per month.

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Table 12.7 – Affordability Analysis for Improved Sanitation Services

	WEST ZONE	EAST ZONE
Water consumed (m^3/mth)	37	37
Water charge (PhP/m^3)	15.88	9.91
Sanitation charge (PhP/m^3)		
Based on AIC	1.69	2.67
Based on WTP rate	3.67	2.94
Based on affordable rate	12.47	18.37
Financial Internal Rate of Return		
Based on AIC [b/]	11.9%	26.3%
Based on WTP rate [c/]	47.8%	17.9%
Based on affordable rate [d/]	130.0%	130.3%
Sanitation Charge as % of Water Charge		
Based on AIC [b/]	11%	27%
Based on WTP rate [c/]	23%	30%
Based on affordable rate [d/]	79%	185%
Total water bill (PhP/month)		
Based on AIC	650	465
Based on WTP rate	723	476
Based on affordable rate	1,049	1,046
Household Mean Income (PhP/month)	20,856	20,856
Water bill as % of income		
Based on AIC	3.1%	2.2%
Based on WTP rate [c/]	3.5%	2.3%
Based on affordable rate [d/]	5.0%	5.0%

For Sewerage:

- The AIC rates for both West Zone and East Zone are way above the consumers' willingness to pay for increased charges and their affordability to pay for such increases.
- In both Zones, while some level of increases in charges are acceptable to the consumers, these willingness are much lower than their computed affordability.
- Based on AIC, sanitation charges are 165% and 178% of water tariff for the West Zone and East Zone, respectively. Compared with the existing Environmental Charge of 50% of Water Tariff, these again are significantly high.
- The total water bill will be about 6% to 9% of the household mean income of PhP 20,856 per month.

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Table 12.8 – Affordability Analysis for Improved Sewerage Facilities

	WEST ZONE	EAST ZONE
Water consumed (m^3/month)	37	37
Water charge (PhP/m^3) [a/]	23.09	14.42
Sewerage charge (PhP/m^3)		
Based on AIC	26.27	17.63
Based on WTP rate [c/]	3.51	2.45
Based on affordable rate [d/]	11.72	18.28
Financial Internal Rate of Return		
Based on AIC	10.4%	10.4%
Based on WTP rate [c/]	-	-
Based on affordable rate [d/]	-	-0.6%
Sewerage Charge as % of Water Charge		
Based on AIC [b/]	165%	178%
Based on WTP rate [c/]	22%	25%
Based on affordable rate [d/]	74%	184%
Total water bill (P/month)		
Based on AIC	1,826	1,186
Based on WTP rate [c/]	984	624
Based on affordable rate	1,288	1,210
Household Mean Income (PhP/month)	20,856	20,856
Water bill as % of income		
Based on AIC	8.8%	5.7%
Based on WTP rate [c/]	4.7%	3.0%
Based on affordable rate [d/]	6.2%	5.8%

a/ As at January 2005 including Environmental Charge. Includes 10% VAT.
b/ Based on Average Incremental Cost computation with discount rate of 10.4%.
c/ From WTP Survey (results tabulated separately for East and West Zone).
d/ Average mid range of affordability from each household type .

12.5 Conclusion

The computed AIC for the Sanitation Component is still within the willingness to pay and affordability of consumers. However, this is not true for the Sewerage Component since the willingness to pay and affordability of consumers would only cover the operations and maintenance but not the recovery of capital investment.

MWSS is considering the revision of the existing tariff structure by eliminating the 50% charge on sewerage and increasing the environmental charge of 10%, to say, 15%. This would in a way resolve this problem since there would be cross-subsidy among consumer groups like those not connected to the sewerage system will subsidize those connected to the system. This would likewise lower the tariff to a more affordable level since the cost will be passed on to other consumers. This can be justified by the fact that benefits from these projects are shared by all or a large proportion of the entire community, not just in the local community concerned. This would likewise eliminate the reaction of the consumers of not wanting to connect to the sewerage system due to increased cost on their part.

12.6 Introduction to Economic Analysis

The economic analysis assesses the economic viability of the sewerage and sanitation improvements projects proposed in the SSMP that was prepared as part of the TA for Strengthening MWSS's Planning Capability.

The assessment was undertaken by quantifying project costs and benefits using resource cost and 'willingness to pay' measures incremental to a 'base case', defined as the situation without the proposed SSMP improvements. The 'base case' assumed that the present levels of service provided by the existing sewerage and sanitation systems will continue. Effectively, this means that environmental sanitation conditions in the cities will continue to deteriorate as population increases.

The assessment was undertaken using conventional cost-benefit analysis and the discounted cash flow technique. A 40-year evaluation period was adopted, recognizing that many of the SSMP projects are proposed to be implemented beyond the current concession period to 2022.

The economic analysis was based on information from the Willingness to Pay Survey of households undertaken as part of the SSMP preparation, on the engineering, environmental, social, financial and other investigations during the TA and on economic evaluation parameter values relevant to environmental sanitation projects. Data were obtained in the following areas:

- Facilities to be provided in implementing the SSMP;
- Capital costs of facilities;
- Annual operating and maintenance (O&M) costs of the facilities; and
- Projections of the number of households to benefit from the improved sewerage and sanitation services.

The economic evaluation was carried out on projects selected as the least cost or most cost effective way of meeting sector demands or needs, in terms of scale, location, technology and timing (refer to Chapter 7).

12.7 Economic Costs

The economic costs of capital works and annual operation and maintenance were calculated from the financial cost estimates on the following basis:

- Price contingencies were excluded but physical contingencies included because they represent real consumption of resources. A contingency allowance of 30% was been added to the base cost estimates;

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- Import duties and taxes were excluded because they represent transfer payments. They have been estimated at 33% of foreign costs and 10% of local costs;
- The existence of unemployment and under-employment for unskilled workers within the Manila economy means that the opportunity cost of unskilled labor can be considered to be lower than its wage rate – a conversion factor of 0.6 of the market wage rate is used to estimate the shadow wage rate; the unskilled labor component is estimated at 40% of local capital costs and 50% of local O&M costs;
- The market wage rate for skilled labor and the acquisition cost of land were considered to represent opportunity costs, as both factors are in demand; and
- All costs were valued using the domestic price numeraire, to enable an easier comparison with the information used to measure benefits (e.g. a significant component of benefit is the willingness to pay of households for the improved services). Foreign costs net of duties and taxes was adjusted by the shadow exchange rate factor of 1.2; foreign costs as a percentage of capital costs are estimated at 65% for sanitation services and 30% for sewerage services; and as a percentage of O&M costs at 20% for both options.

The effects of loss of access and other types of disruption to residents due to works during the construction phase were excluded because of the difficulties of measurement. However, the selected option in an area was chosen to minimize disruption wherever possible.

Tables 12.9 & 12.10 present the economic costs used in the cost-benefit analyses and the flows of expenditure in five-year intervals, for sanitation services and sewerage services respectively. Costs for the former were based on adjusted rate rebasing to consider STED system; costs for the latter exclude proposed expansions of STPs that serve existing or MTSP sewered areas.[1]

Incremental O&M cost represents the increase in annual O&M expenditure compared to the 'base case' situation, i.e. without implementation of the SSMP. It was estimated by applying the following percentages to capital costs: 7% for septage treatment plants, 10% for sewerage treatment plants,[2] 7% for trunk mains, 3% for reticulation pipes and 25% for vacuum tankers[3] (with tanker replacement assumed every ten years).

[1] These expansions are for STPs in the following schemes in the East CA: Pasig-Taytay (32 MLD) and Taguig-Pateros (25 MLD), both in 2025; and in the West CA: Dagat-Dagatan (91 MLD) and Pasay (15 MLD), both in 2020.
[2] Refer Figures 10.21 & 10.22.
[3] Allows for cost of sludge disposal.

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**Table 12.9 - Cost Estimates for Sanitation Services Option Economic Analysis [a/]
(PhP Million in 2005 prices)**

	Five Years to				
	2010	**2015**	**2020**	**2025**	**Total [b/]**
Base Cost [c/]					
Septage Treatment Plants	946	1,443	235	1,294	**3,918**
Tankers	201	215	710	448	**1,574**
Total [b/]	1,147	1,533	945	1,742	**5,492**
Economic Cost	1,174	1,697	967	1,783	**5,621**
Incremental O&M Cost	116	429	674	1,047	
As % of economic cost [d/]	*10%*	*15%*	*18%*	*19%*	

Notes:
a/ Based on adjusted rate rebasing to consider STED system.
b/ Totals may not sum exactly due to rounding.
c/ Excludes allowance for planning contingency of 30%.
d/ Expressed as percentage of cumulative economic cost.

**Table 12.10 - Cost Estimates for Sewerage Services Option Economic Analysis
(PhP Million in 2005 prices)**

	Five Years to				
	2010	**2015**	**2020**	**2025**	**Total [a/]**
Base Cost [b/]					
Land for STPs	465	488	1,585	2,688	**5,226**
STPs [c/]	1,618	867	5,736	7,729	**11,939**
Trunk Mains	117	386	931	1,817	**3,251**
Reticulation	1,075	1,197	6,705	7,864	**16,841**
Total [a/]	3,275	2,938	12,336	18,708	**37,257**
Economic Cost	3,345	3,024	12,547	19,120	**38,036**
Incr'tl O&M Cost	191	332	876	1,816	
As % of economic cost [d/]	*6%*	*5%*	*5%*	*5%*	

STPs – Sewerage Treatment Plants
Notes:
a/ Totals may not sum exactly due to rounding.
b/ Excludes allowance for planning contingency of 30%.
c/ Excludes cost of STP expansions that will benefit existing or MTSP sewered areas (base cost of PhP 4.0 million).
d/ Expressed as percentage of cumulative economic cost.

12.8 Valuing Economic Benefits

The benefits of improved sewerage or sanitation services will be the improved environmental and living conditions and public health that a better functioning system of sewage and wastewater collection and treatment provides. This will be achieved through the more effective removal of sewage and wastewater from in and around living areas and prevention of sewage and wastewater from entering drains, canals and natural water bodies (streams and rivers) and, in some areas, broken water supply pipelines. Improved disposal of sewage and wastewater will result also in more pleasant surroundings through a reduction in odor and an improvement in the aesthetic quality of drains, canals, natural water bodies, low-lying areas and other areas where wastewater is disposed of.

However, quantifying environmental and health benefits is difficult because of the need for data to establish the magnitude of the impacts of the improvements and to separate out the effects of an improved sewerage system from other factors such as personal hygiene habits, housing standards, water quality, etc.

Difficulties in estimation meant that benefits which are more readily valued generally were used in the economic evaluation of environmental improvements – for example, stated willingness to pay for improved services; increased property values; avoided economic costs for households or businesses from not having to undertake certain activities necessitated by the poor delivery of environmental sanitation services. Revenues from service tariffs or charges also were used but these are generally not good indicators of willingness to pay for improved sewerage and sanitation services because they do not reflect the costs of such services; also, often there has been no history of paying explicitly for environmental services and many people consider that such services should be provided by the government from general taxation revenue.

12.8.1 Willingness to Pay

Information on willingness to pay for improved sewerage and sanitation facilities and services was collected in the WTP Survey of 2,000 households in the MWSS service area conducted during June 2005 as part of this TA. The survey methodology and results are discussed in detail in a separate report, *Report on Willingness to Pay Survey* (June 2005). Responses were generally favorable towards willingness to pay, with the majority of respondents stating a relatively high willingness to pay for different options of sewerage and sanitation services. This positive attitude may be attributed to the following key factors:

- The significant value accorded by respondents to the importance of sewerage and sanitation for them to sustain health and cleanliness; and
- The respondents' recognition of the need to improve the sanitation and sewerage systems for them to sustain health and cleanliness.

Table 12.11 derives the per household WTP values used as measures of economic benefit in the cost-benefit analyses of the sanitation and sewerage services options. It has been assumed that households have a time frame of about six years when considering WTP for the perceived benefits of improved services, rather than an unlimited time frame – six years is consistent with the average frequency of households' emptying their septic tanks.

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Table 12.11 - Derivation of Per Household WTP Values as Measures of Economic Benefit

	Sanitation Services Option		Sewerage Services Option	
	East CA	West CA	East CA	West CA
% of households stating WTP [a/]	85%	68%	86%	55%
% of monthly water bill				
- for households stating WTP [a/]	20%	20%	20%	20%
- for all households [a/]	17%	14%	17%	11%
Per household WTP amount				
PhP per month [b/]	125	140	125	180
Present value [c/]	7,500	8,400	7,500	10,700

Notes:
a/ From *Report on Willingness to Pay Survey*, June 2005, Table 3.
b/ From *SAP No.12*, *Draft Policy on Sewer Charges*, November 2005, Table 5.3.
c/ Derived using PV factor of 5.6 assuming real interest rate of 2% over six years.

12.8.2 Changes in Property Values

The improvement in the environment, together with some perception of health benefits, may be reflected in the amounts people are willing to pay for property either in terms of rent or the purchase price of the house. The environmental characteristics of the area in which a property is located are sources of variations in property values between different locations.[4]

For example, improved sewage disposal may be part of a range of characteristics associated with a particular property option; individuals who value a new or upgraded sewerage system may be willing to pay more for property with “good” disposal than for a property with “bad” disposal. Following the same reasoning, people may be willing to pay more for housing in areas where they are “less exposed” to environmental degradation and unpleasant surroundings caused by sewage odor, dumped sewage/septage, stagnant wastewater, etc.

Quantification of the benefits associated with environmental improvements can be done by comparing property values in areas which are “less exposed” to environmental degradation and unpleasant surroundings with property values in those areas which are “more exposed” to environmental degradation and unpleasant surroundings. It may be sometimes necessary to attribute a portion of the difference in property values to the effects of an improved sanitation or sewerage system alone, as the complementary investments in other environmental sanitation components (such as the drainage or solid waste collection system) may not be being made.

[4] Other sources include the attributes of the building itself (e.g. amount and quality of accommodation available) and access to places of work and to commercial, institutional and recreational facilities.

It was not possible to undertake a detailed comparative survey of property values in this TA, so the following conservative assumptions was made of the property value differentials due to a particular environmental difference between properties:[5]

- Sewerage (combined) system – 3% increase in property values;
- Effective septic tank cleaning/sludge disposal services – 1% increase in property values.

These differentials apply to properties within system catchment or service areas. Existing property values were estimated from data collected in the WTP Survey of households on monthly rental or housing loan payments, together with assumptions on property market parameters. The assumptions and results are shown in **Table 12.12**.

Table 12.12 Derivation of Average Market Value of Housing, Both Concession Areas

Average monthly payment (PhP/month) [a/]	PhP 3,700
% of average household expenses	*31%*
% of average household income	*18%*
Estimated market value (PhP in 2005 prices) [b/]	PhP 932,400

Notes:
a/ From *Report on Willingness to Pay Survey*, June 2005, Figures IV-4 & IV-5 and Annex A.
b/ Assumes a 2.5% real rate of return from rental of residential property over 30 years (present value factor of 21). Taken together with capital value growth of 2.5% per year in real terms, this equates to a total real rate of return on residential property investment of 5% per year (or about 12% in nominal terms).

12.8.3 Avoided Health Care Costs

The WTP Survey collected information on the total medical care expenses of households. Drawing on statistics presented in Section 2.8, it was assumed that:

- 25% of these expenses comprised the costs of treating environmental sanitation diseases;
- Improved sewerage system reduces the incidence of these diseases by one-third; and
- Effective septic tank cleaning/sludge disposal services reduce the incidence of these diseases by one-sixth.

The derivation of per household avoided health care costs using these assumptions is shown in **Table 12.13**.

[5] The assumed differentials in property value may also include some perception of health costs but it is felt that the degree of double counting would be minor. Sensitivity analysis showed that the EIRR is very insensitive to changes in the property value increase assumptions.

Table 12.13 - Derivation of Per Household Avoided Health Care Costs, Both Concession Areas

	Sanitation Services Option	Sewerage Services Option
Average monthly medical care (PhP/month) [a/]	PhP 3,200	
% of average household expenses	*27%*	
% of average household income	*15%*	
% on environmental sanitation diseases [b/]	25%	
% reduction in incidence of environmental sanitation diseases [b/]	33%	16.5%
Per household avoided health care costs (PhP /month)	PhP 264	PhP 132

Notes:
a/ From *Report on Willingness to Pay Survey*, June 2005, Figures IV-4 & IV-5 and Annex A.
b/ Drawing on statistics presented in Section 2.8.

12.8.5 Septage Treatment Plant Capacity

For the sanitation services option, there is an additional economic benefit associated with the construction of the septage treatment plants – the capacity that is to be utilized by private septic tank cleaning contractors. It is proposed that 10% of the septic tanks will be serviced by private contractors who will be required to transport the septage to the treatment plants operated by the concessionaires.

For the purpose of measuring economic benefits, it is assumed that private contractors will be charged a treatment fee equivalent to 90% of the average incremental economic cost of treatment (that is approximately PhP 560/m^3 in the East CA and PhP 780/m^3 in the West CA).[6]

12.8.5 Exclusions

The following benefits of improved environmental sanitation, a cleaner city and better waterway environment have not been quantified:

- Private and public costs of flooding due to canals and drains clogged with sewage/wastewater, including traffic disruption, road repair and building repair;
- Private costs of cleaning homes after sewerage system overflows/backflows;
- Public cost of treating diseases due to poor environmental sanitation;
- Private and public costs of mosquito control;
- Effects on businesses and industries, such as aquaculture and fisheries and agriculture; and
- Effects on tourism and tourist-related businesses.

[6] 90% converts the AIC in economic prices to financial prices, assuming a weighted average financial cost of capital of 10.4% for the concessionaires.

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12.9 Economic Cost-Benefit Analysis

This section summarizes the results of both the main cost-benefit analysis and the sensitivity analysis. Each SSMP option was compared to the situation without implementation of the Master Plan, using the discounted cash flow technique and an economic opportunity cost of capital of 12%. The evaluation period allowed for 40 years from 2005, with costs and benefits during the SSMP implementation period being determined from an indicative implementation schedule for each investment component. The discount year was taken as 2005 and all values in the following tables are expressed in 2005 prices.

To avoid potential double-counting of the benefits measured by willingness to pay, the per household benefit measures of increased property values and avoided health care costs were applied only to the proportion of households who stated that they would not be willing to pay for improved services.[7] For the proportion of households expressing willingness to pay, it is likely that the WTP amount may include some perception of improved environmental conditions and reduced medical expenses – to include increased property values and avoided health care costs may result in double-counting of benefits for these households.

The parameter values and the detailed cost and benefit schedules on which the results are based are given in Chapter 12.

12.9.1 Main Cost-Benefit Analysis

Table 12.14 presents the results of the main cost-benefit analysis. The table shows that the overall EIRR of the sanitation services option was estimated to be 24% and that of the sewerage services option was 26%. Individual concessionaire area EIRRs for the sanitation services option were 23% (East) and 24% (West) and, for the sewerage services option, 33% (East) and 22% (West). All options had EIRR values exceeding the economic opportunity cost of capital of 12% and can be considered economically viable.
The sewerage services option is preferable to the sanitation services option in terms of maximizing the economic contribution of the capital expenditure involved, because of its higher net present value for each concessionaire area and overall.

12.9.2 Sensitivity Analysis

Sensitivity analysis of the overall options was undertaken in order to assess the robustness of the economic results to changes in benefit and cost variables. The following changes were analyzed:

- Capital cost overrun of 10%;
- 10% increase in annual O&M costs;
- 10% reduction in benefits;

[7] In the East CA, 14% for sanitation and 15% for sewerage; in the West CA, 45% for sanitation and 32% for sewerage.

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- Combination of the above changes.

The results are summarized in **Table 12.15**. The table shows that the EIRR is more sensitive to a reduction in benefits than increases in capital or recurrent costs; however, the outcome is the same as for the main cost-benefit analysis, with all options being economically viable.

Table 12.14 - Cost-Benefit Analysis of SSMP Options a/

	Sanitation Services			Sewerage Services		
	East CA	West CA	Overall b/	East CA	West CA	Overall b/
Present Value (PhP million) c/						
Costs						
Capital costs	581	1,064	1,644	1,361	7,643	9,004
O&M costs	208	708	916	443	2,316	2,758
Total costs b/	789	1,772	2,561	1,803	9,959	11,762
Benefits						
Willingness to pay	1,053	2,548	3,601	3,226	14,393	17,619
Increased property value	22	13	35	97	142	239
Avoided health care costs	89	60	149	388	566	954
Septage treatment capacity	131	131	263			
Total benefits b/	1,296	2,752	4,048	3,711	15,101	18,812
Economic Return Measures						
Net present value (PhP million) b/	507	980	1,487	1,907	5,142	7,049
EIRR (%) d/	23%	24%	24%	33%	22%	26%

Notes:
a/ From Annex A & B.
b/ Totals may not sum exactly due to rounding.
c/ In 2005 prices. Discounted to 2005 at 12% real discount rate.
d/ EIRR for Sewerage Services East CA is imputed using benefit-cost ratio relativities.

Table 12.15 - Results of Sensitivity Analysis of SSMP Options (EIRR)

	Sanitation Services			Sewerage Services		
	East CA	West CA	Overall b/	East CA	West CA	Overall b/
Main cost-benefit analysis a/	**23%**	**24%**	**24%**	**33%**	**22%**	**26%**
Capital cost overrun b/	22%	22%	22%	29%	19%	23%
Increased O&M costs c/	23%	23%	23%	32%	21%	25%
Reduced benefits d/	21%	21%	21%	28%	19%	22%
Combination of above	19%	18%	18%	24%	17%	19%

Notes:
a/ From Table 12.14.
b/ 10% increase in capital costs.
c/ 10% increase in annual O&M costs.
d/ 10% reduction in benefits.

12.9 Conclusion on Economic Analysis

The main cost-benefit analysis has shown that all options are economically viable, with the calculated EIRR values exceeding the economic opportunity cost of capital. The sensitivity analysis demonstrated the robustness of these results with respect to variations in benefit or cost parameter values, with all options remaining economically viable in the tests undertaken.

For both options, the calculated EIRR values are considered to be minimum estimates of economic return - there are a number of economic benefits of reduced pollution, a cleaner city and improved waterway environment that have not been quantified (refer **Section 12.8.5**).

13. Institutional Development

13.1 General

The institutional component of this sewerage and sanitation master plan has addressed the role of MWSS and the Regulatory Office in the context of the concession framework. It also considers the manner in which each of the concessionaire implements its responsibilities in regard to sewerage and sanitation. These are not discussed in detail since this is subject to the contractual arrangements under the Concession Agreement. In addition, strategic longer term planning is addressed in terms of the institutional considerations, which may emerge.

Like other parts of the master plan, this section should be read in conjunction with the following reports prepared as part of this study:

1. Strategic Action Paper No.1 – Institutional, Environmental and Physical Targets for the Water Supply Sector, Volume 2
2. Strategic Action Paper No. 7 – Review of Relevant Regulations relating to Sanitation and Sewerage
3. Strategic Action Paper No. 8 - Sewerage Strategy For Metro Manila
4. Strategic Action Paper No. 9 – Sanitation System Strategy for Metro Manila
5. Strategic Action Paper No. 11- Least Cost Options for Sewerage and Sanitation Approaches
6. Working paper No.1 – Role of MWSS
7. Working Paper No.2 – Asset management Issues
8. Working Paper No.3 – Key Performance Indicators and Business Efficiency Measures

13.2 Institutional Framework for Service Provision

In 1997, as part of the Government's policy on private sector involvement in public utility service delivery, water and wastewater services to the MWSS service area were privatized by awarding concession contracts.

The key features of the concessions established in the service area are:

1. The city has been split into two service areas (East and West).

2. The bids were accepted and evaluated in terms of the proposed reduction in tariff, which would be accepted by the successful concession bidder.

3. The contracts were negotiated and the concessions awarded after employee numbers had been substantially reduced.

4. There was extensive planning prior to bids being called, including a major marketing/public relations program to sell the concept.

5. The successful bidders were required to assume the existing debt of MWSS and to service it during the period of the concession. The debt, however, was disproportionately (approximately 90%) held in one concession area (the West Zone).

The concession agreements have resulted in four entities being directly involved in water and sewerage service provision in the city:

Two concessionaires, **Maynilad Water Services Inc. (MWSI),** which operates in the west of the city**,** and **Manila Water Company (MWCI)** which operates in the east.

The Regulatory Office is established as the representative of the customers and is created under provisions of the concession agreements. It is established to be responsible for monitoring the concession agreements generally and to monitor specifically the performance of the concessionaires including sponsoring technical and financial audits. The Regulatory Office also has the role of facilitating and implementing changes to rates and charges.

The MWSS Corporate Office has responsibility for the retained functions, i.e. those not passed to the concessionaires, facilitating the performance by the concessionaires of their obligations, managing the Umiray-Angat Transbasin Project (UATP)**,** managing the loans which are in the name of MWSS but serviced under the agreements by the concessionaires and managing and where appropriate disposing of the "retained assets", i.e. those assets not conceded for the duration of the agreement. Notably the Corporate Office takes responsibility in some respect for supply of raw water i.e. water before treatment, and generally acts on behalf of the concessionaires for Raw Water Access management.

By default it is the representative of the asset owners i.e. the Government and people of the Philippines. Conceptually the relationship between the four entities is shown in **Figure 13.1** below.

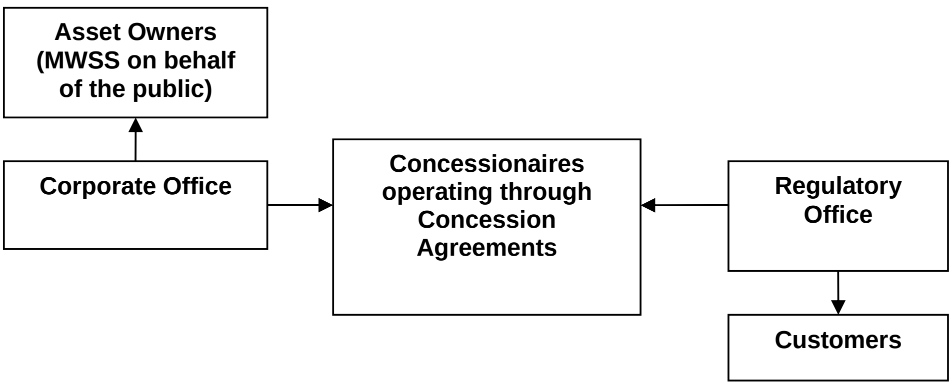

Figure 13.1 Conceptual Relationship

The two MWSS entities and the concessionaires formally relate through the concession agreements and through an annual review (see **Figure 13.2**). There is however substantial day-to-day liaison with the Corporate Office and the Regulatory Office.

The concession agreements are explicitly between MWSS and the relevant concessionaire. The agreements are for a limited period (25 years) and all rights, assets (except for cash), duties and entitlements revert from the concessionaires to MWSS on expiry of the concession period.

Since the commencement of the concessions, there have been several significant events which have impacted on the concept, in particular the devaluation of the Philippines Peso in late 1997 which coincided with the El Niño-based severe drought. The MWSI concession claimed substantial hardship as a result of the devaluation and other causes and submitted a case for adjustment of rates as well as other issues.

13.3 Role of MWSS

13.3.1 Overall Responsibility

MWSS is constituted under Republic Act No. 6234 (1971). It is not a registered company under Philippine Law but in common with many water and sanitation agencies internationally operates, as a government-owned, autonomous statutory corporation. Essentially, the defining duty for the company is to provide water and sewerage services to its defined service area, which is dominated by Metro Manila.

Within the concession-based delivery framework, the direct service delivery is delegated to the concessionaires, together with the right to operate the asset set. The assignment of the right to use the assets does not include transfer of title and ownership of assets existing at the commencement of the concession is retained in title by MWSS.

As noted above, under the concession agreements MWSS operates primarily through two agencies, the Regulatory Office and the Corporate Office.

13.3.2 Regulatory Office

Constitution/Enabling Legislation
The Regulatory Office is constituted in concept under *Article 11* and in detail under *Exhibit A* of the Concession Agreement. The features of *Exhibit A* are:

- The Office is composed of 5 appointed members who are demonstrably independent of MWSS and the Concessionaires. The members act as a governance board for the Office operations;
- The Office shall be physically separate from the MWSS and the Concessionaires;

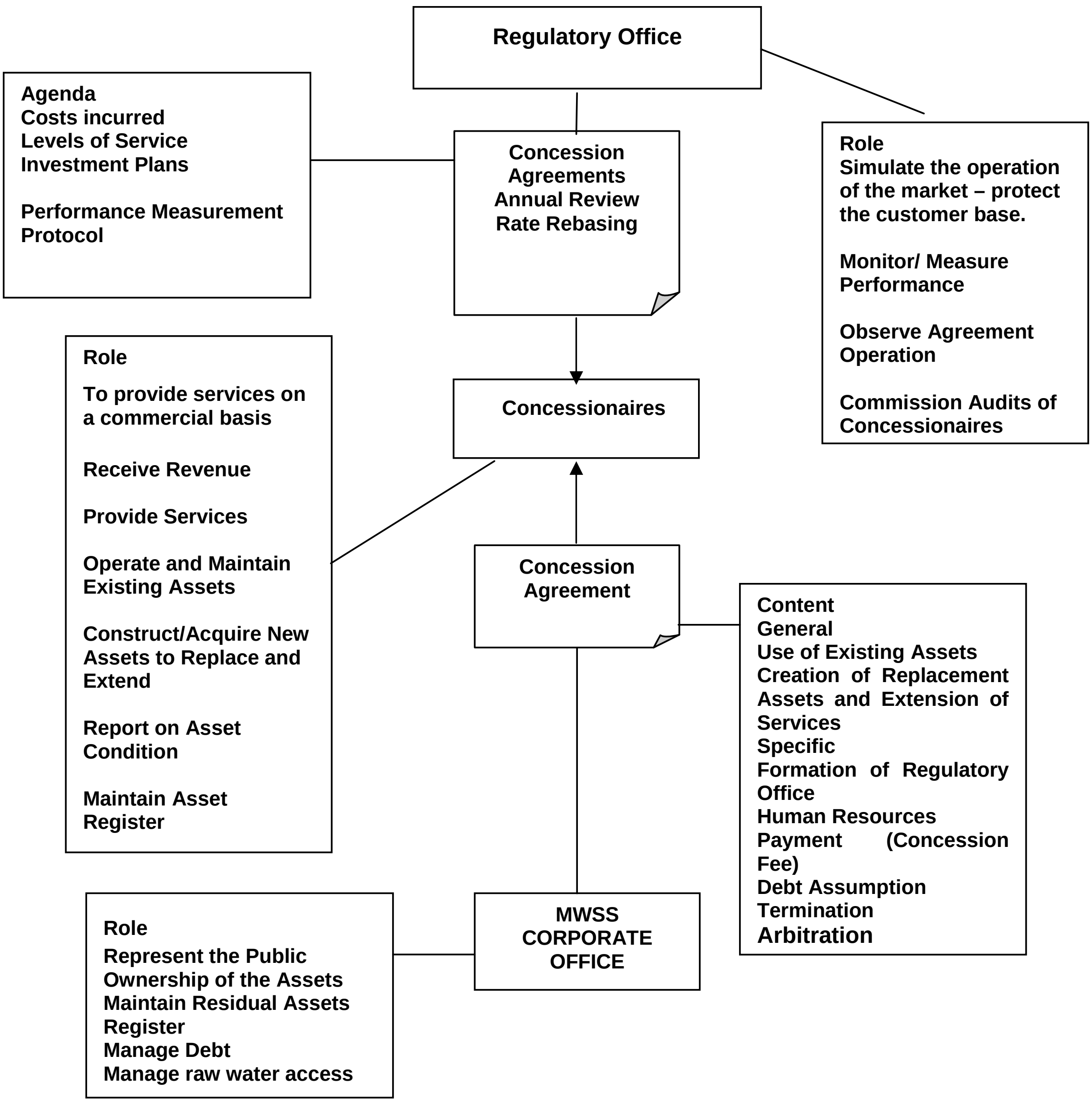

Figure 13.2 Institutional Framework

- The staff of the Office shall be employees of MWSS for payroll and associated purpose but should otherwise be independent of MWSS and the concessionaires;

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- The mandate of the Office is nominally to implement the provisions of the Concession agreements. In actuality the role of the Office will evolve in detail over time but is generally consistent with single sector economic and performance regulation as it is practiced internationally; and
- There is intent to extensively use consultants to augment the economic, financial and technical competence of the employees.

Business Plan
The Mission of the Office is declared in its Information Kit as:

(i) To ensure that the quality and level of service provided by the Concessionaires meet global standards and (ii) To balance the interests of the stakeholders.

The Office is established as an organization comprising four areas:

- Technical (Performance) Regulation;
- Financial/Economic (including financial modeling & analysis);
- Customer Service Performance; and
- Administration and Legal.

There are approximately 70 employees.

Performance
The stakeholders as well performing regard the Regulatory Office and generally all requirements of the concession agreements have been met.

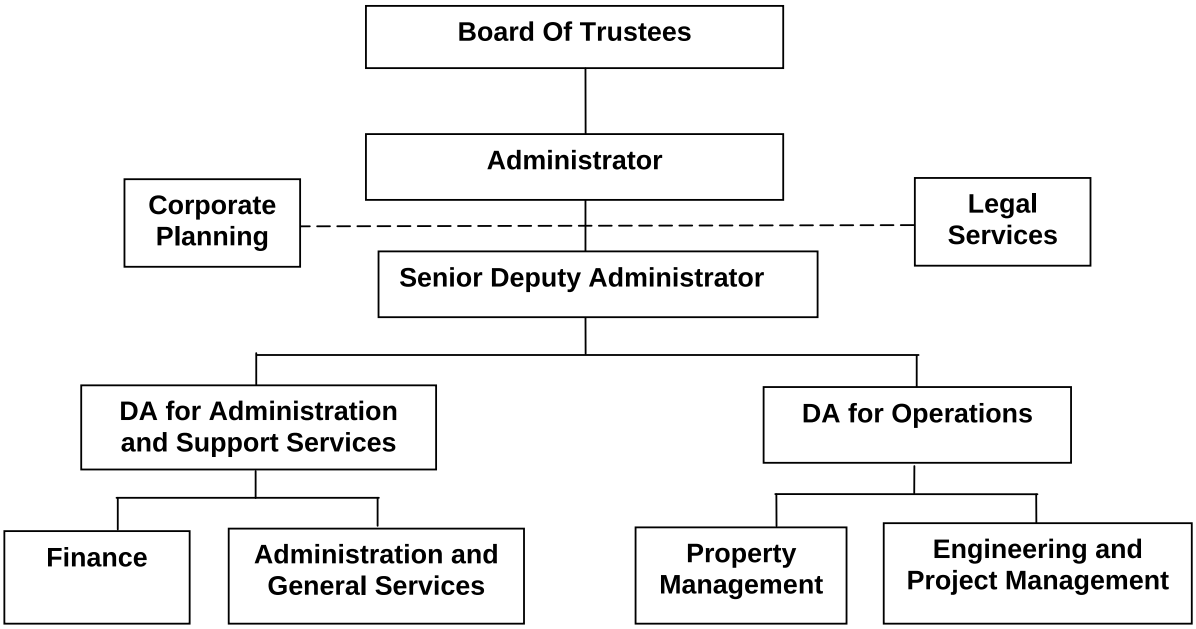
The Office was supported in 2003 by an ADB financed Technical Assistance Project, which addressed the practices, methodologies and procedures followed by the Office. The project methodology was generally focused on capacity building by workshops.

13.3.3 Corporate Office

Constitution/Enabling Legislation
The Corporate Office of MWSS is not explicitly defined by legislation or by the Concession agreements. It arises in general out of *Article 8* of the Concession Agreement, which specifies the “Retained Functions” of MWSS. These are essentially:

- Facilitating the operations of the Concessionaires (by reinforcing the role of the concessionaires as an agent of MWSS as a principal);
- Loan Administration;
- Managing the “retained” assets, i.e. those not assigned to the concessionaires;
- General accounting and administration (particularly in regard to the financial arrangements with the concessionaires, e.g. in payment of the Concession Fee; and
- Managing and operating the raw water conveyance of the Umiray-Angat Trans basin Project (UATP).

The functional organization of the Corporate Office is shown in **Figure 13.3.** A more detailed description of the MWSS organizational structure is provided in *Working Paper No.1 The Role of MWSS.*



Source: MWSS Website www.mwss.gov.ph updated

Figure 13.3 Organization of MWSS Corporate Office

The responsibilities of these groups are not explicitly stated in any of the concession documentation but are seen as:

Finance To administer the debt portfolio of MWSS generally.

To administer the payments by the Concessionaires of the Concession Fee.

Administrative and General Services To administer personnel affairs and perform general services functions.

Property Management To oversee the retained assets, principally the real property (land and buildings) such as the complex in Quezon City, which houses the administration of the Corporate Office, the Regulatory Office, the Concessionaire Administrations and other entities.

Engineering and Project

Management	To oversee and manage major projects such as UATP for which the Concessionaires are not responsible; To oversee the provision of raw water to the concessionaires; To oversee master planning projects such as the Manila Sewerage Project and the project that this paper is being prepared under.

Notably, the last two functions of the Engineering and Project Management group occur by default in that they are essential to the provision of services and span both concessions and there is no responsibility otherwise specified in the concession agreements.

13.4 The Concessionaires

13.4.1 General Responsibilities

The duties and responsibilities of the Concessionaires in relation to sewerage are detailed in *Article 5* of the Concession Agreement. The concessionaires are to:

- Provide a sewerage service to properties connected to sewer mains in the concession area;
- Provide a septage collection service to unconnected property;
- Make new connections on request from property owners in accordance with priorities prescribed in the concession agreement; and
- Overall meet specified performance standards.

The Concessions are structured on the achievement of gradual performance targets set for a range of parameters of water and sewerage service coverage and quality. The sewerage targets are shown in Chapter 10. They have generally been reduced during the concession period to date to allow a greater focus on water supply.

13.4.2 Manila Water Company

Corporate Structure
Manila Water Company, Inc. (MWCI) is owned by a consortium, which includes Ayala Corporation (a large Manila based Conglomerate) as majority shareholder and United Utilities, which is a subsidiary of North West Water Company of U.K.

The company launched an Initial Public Offering (IPO) in February 2005, which closed on March 9, 2005 and was heavily oversubscribed. The shares listed on the Philippines Stock Exchange (PSE) on March 18, 2005.

The company shares are currently quoted at PhP 6.40 (7 October 2005) on the PSE, indicating a current market capitalization of approximately US$ 235 Million. Based on the 31 December Balance Sheet Net Assets of US$ 123 Million there is an implied value of the Concession business of approximately US$ 112 Million.

Organizational Structure and Management

The company has a fairly standard organizational structure consisting of an operations functional group matched by a Project Delivery (Asset Development) group together with support groups in Business Management, Planning and Regulation, Finance and Human Resources Management reporting to the company President.

To a large extent, the company's top and middle management have backgrounds outside of MWSS and often come from other Ayala entities.

Several functions are outsourced including leak repairs, civil construction and bill delivery/ cash collection. Pumps are vendor maintained.

Asset management is well developed with an asset register developed for 90+% of above groundwater assets and a system of reporting whereby the condition of below ground assets is reported whenever breaks are prepared.

Operational Performance

MWCI has the East Concession, which includes many of the economic growth areas of Manila such as Makati, Cainta and Antipolo. Operational performance is generally regarded as meeting license requirements satisfactorily although there is concern in regard to lack of progress in sewerage coverage. This is generally considered to be due to customer unwillingness to connect (due to increased charges for sewerage connected property) rather than lack of availability of service.

MWCI have installed a comprehensive suite of SAP software, which is an internationally well-regarded business system targeted at operational performance. It will be interfaced with the ArcInfo and ArcView packages and the Asset Register.

Operational sewerage performance data for MWCI for the years 2002 to 2004 is shown in **Table 13.1**.

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Table 13.1 – Sewerage Operational data for Manila Water Company Inc.

Indicator	2002	2003	2004
Population Served	3.4 M[1]	3.21 M[1]	3.45M
No. of Water Connections	369,699	396,778	425,802
Water Production (MLD)	1,663	1,578	1,518
Water Service Coverage	82.1%	75.0%	78%
Sewerage Service Coverage	2.9%	7.4%	6.9%
No. of Sewer Connections	10,520	29,334	29,406
Septic Tanks Desludged	5,724	11,130	17,674
Water Availability (hrs/day)	21	21	21
No. of Staff	1,516	1,515	1,516

Source: MWSS Regulatory Office
Note : Population Served is derived from connection data on a tenement ratio of 9.2 persons per connection in 2002. The ratio was subsequently revised to 8.3 from 2003 onwards.

Capital Expenditure and Expansion Commitments for Water Supply and Sewerage

Actual and planned capital expenditure is detailed in **Table 13.2** below.

Table 13.2 – Capital Expenditure Actual and Planned

Period	Direct (PHP Billion)	Concession Fee Based (PHP Billion)	Total (PHP Billion)
Actual to Dec 31 2005	6.4	2.5	8.9
Water System	34.8	105.5	140.3
Wastewater System	7.1		7.1
Management and Overhead System	2.9		2.9
Total Planned (2005-2022	**44.8**	**105.5**	**150.3**

Source: IPO Document MWCI
Notes:
Direct expenditure is recoverable over the concession period.
Concession fee based expenditure is funded through MWSS loans.

It can be seen that capital expenditure is dominated by water system expenditure with no long-term (concession fee based) expenditures occurring and only 12% of direct expenditure being for the wastewater system.

13.4.3 Maynilad Water Services

Corporate Structure

Maynilad Water Services Inc. (MWSI) underwent a capital rehabilitation, which has resulted in 84% of the equity in the company being held by MWSS. This was a swap of debt for equity and creates a significant issue in regard to the appropriateness of the Regulatory Office remaining within the MWSS corporate framework. The remaining equity will be held by the Suez group, which is an existing minority shareholder.

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It is the intent of MWSS that its majority ownership of MWSI will be interim, i.e. for a maximum of approximately two years with the ownership returning to the private sector by sale of its holding or by a comprehensive sale of the company.

Organizational Structure and Management
MWSI has a similar flat structure to MWCI. Its management generally has been drawn more from previous MWSS employees rather than new employees.

Operational Duties and Responsibilities
MWSI has the Western concession, which is reportedly dominated by older infrastructure, particularly in water distribution mains with consequent high levels of main breaks.

The relevant sewerage operational data for MWSI is shown below in **Table 13.3.**

Table 13.3 – Sewerage Operational data for Maynilad Water Services Inc.

Indicator	2002	2003	2004
Population Served	5.27[1] M	4.75[1] M	4.88 M
No. of Water Connections	573,194	585,953	602,821
Water Production (MLD)	2,362	2,313	2,276
Water Service Coverage	77.7%	68.9%	69.9%
Sewer Service Coverage	10%	9.6%	9.1%
No. of Sewer Connections	57,555	56,305	55,080
Septic Tanks Desludged	9,843	16,017	7,645
Water Availability (hrs/day)	21	21	21
No. of Staff	2,427	2,381	2,369

Source: MWSS Regulatory Office
Note: Population Served is derived from connection data on a tenement ratio of 9.2 persons per connection in 2002. The ratio was subsequently revised to 8.3 from 2003 onwards.

Capital Expenditure and Expansion Commitments
The MWSI capital program is subject in the main to the Rehabilitation Plan. An indication of the likely capital expenditures is given in a concept paper, prepared by MWSI, which is intended to lead to World Bank funding for major infrastructure as shown in **Table 13.4**.

It is notable that the Operations Support and Medium Term programs (directed at business expansion) are dominated by water supply expenditure and sanitation (septage management) coverage and there are no significant expenditures on sewerage works. Sewerage development is nominally planned for post 2010 but is unspecified.

Table 13.4 – MWSI Planned Sewerage Capital Expenditure 2004-2010

Program Component	Indicated Expenditure (2004-2010) (PHP Million)
3R (Recover Reallocate Resell) Program	7,626
3R Support Program	1,799
Operations Support	2,213
Medium Term	2,124
Total	**13,762**

Source: Concept Paper for the World Bank Package MWSI

13.5 Institutional Issues for MWSS Organization

13.5.1 General

Establishment of the concessions in August 1997 was the largest ever private sector participation project in the water and sanitation sector in the world and was carried out within the constraints of urgency and limitations in regard to the legislative capability available. In addition, the concessions involved multinational participation and substantial debt.

In late 1997, there were very significant shifts in the foreign exchange value in many Asian currencies including the Philippine Peso. The result of both the preparation constraints on the project from within and the financial issues from without resulted in several issues emerging. Furthermore, there was a major raw water shortage from late 1997 to the end of 1998.

The financial and other issues that have arisen to date include:

1. The provisions for raw water access;
2. Long term planning for the sector;
3. The financial impacts of currency devaluation;
4. Asset Management;
5. Planning for the end of the concession;
6. Regulation;
7. Raw Water Protection and Coordination; and,
8. MWSS Resources for Project Implementation.

These issues are not specific to sewerage and sanitation and are discussed in detail in *Strategic Action Paper No 1*. Those that have some relation to sewerage and sanitation are noted and briefly discussed below. Some can be addressed through the strengthening of several departments within the MWSS Corporate Office, which is discussed in *Working Paper No.1 – Role of MWSS* and summarized below.

13.5.2 Developing MWSS Corporate Office

The MWSS needs to retain within the organization a strong competence level based on a small core of professionals in the fields of water resources planning, sewerage planning, engineering and project management to determine the need for and oversee the conduct of outsourced services for major water sources development and address the many strategic cross concession issues in regard to sewerage and sanitation.

Long-Term Strategic Planning
At present, by default, long-range planning is being undertaken by MWCI and MWSI.

This has two constraints:

1. The planning horizons are nominally set at the end of the concession contract (Year 2022). This may be extended by a consideration by each company of the

likelihood of the concession being retained. This is, of course, appropriate to the business interests of each concessionaire and they would be significantly remiss to take a different approach.

2. The planning of each of the concessionaires is appropriately directed at their individual business interests and not at the long-term interests of the overall customer base.

A further consideration is available capital funding (apart from strategies like BOT).

In regard to debt and capital funding, the concession agreements are specific in providing for the servicing of "existing loans" by the concessionaires through the concession fees. There is no explicit provision for new debt to be sourced by MWSS and serviced through the concession agreements. This is particularly limiting in respect to multilateral lenders which have significant limitations on loans made to non-government entities.

As a consequence new borrowings are either:

1. Undertaken by the concessionaires on commercial terms with lenders taking account of the provisions of the concession agreement in setting the terms. Lenders have included bilateral lenders such as Danida, International Finance Corporation (the private sector focused operation of the World Bank) and commercial banks;

2. Concessionary (soft) loans sourced by MWSS from providers such as the World Bank with arrangements being established outside of the concession agreements for the concessionaires to service the debt.

13.5.3 Asset Management Issues

For a more detailed assessment of Asset management Issues, reference is made to *Working Paper No. 2 – Asset Management Issues.*

Water and sewerage/sanitation assets are notable in that:

- The useful asset life can range from three to five years in the case of pumps and motors, up to decades in the case of civil structures such as pumping stations and ultimately to centuries in the case of sewer mains;

- Long lived assets such as sewer mains and water mains are often buried below land and road surfaces with consequent difficulty in regard to assessment of their condition;

- Accounting for asset usage (i.e. depreciation) is complicated by changes in technology, e.g. local water reservoirs established to maintain a pressure head in urban areas are now replaced with variable speed pressure pumps which accomplish the same purpose without alienating valuable city land. As a consequence asset depreciation is often based not on the historical cost of the asset but on the replacement cost of the asset potential. This is referred to as the Modern Equivalent Engineering Reference Asset (MEERA). Under this principle the reservoir may be valued in the accounts of an entity on the basis of the cost of a replacement pump.

Sector performance is thus driven in the long term by the quality of its asset management. Effective private sector participation as well as public management of infrastructure relies on the asset owners having reliable and comprehensive asset data with asset management systems and sound expertise.

Creation of an asset register is therefore essential in that it provides a database of asset condition against which the assets returned at the end of the concession can be reconciled and intermediate repairs, maintenance, replacements, augmentations, and disposals can be reconciled.

Currently the assets are being documented in a fragmented manner via:

1. Creation of an apparently very robust asset register in the East concession;
2. Limited creation of a register of some assets in the West concession; and
3. Documentation of the "residual" assets (generally real property) within the Corporate office.

This fragmentation is exacerbated by the concessionaires regarding the asset registers as corporately valuable. This attitude is commercially appropriate but forebodes badly for the documentation at the end of the concession period, which will be essential for decision-making by the asset owners (MWSS), the concessionaires, other bidders for the concessions, and other stakeholders including the RP government.

Asset Information in the Concession Framework

Concessions are based on the owner of an asset conceding the use of the asset to another party in return for consideration paid by the Concessionaire.

In any concession, particularly a long term one, information pertinent to the assets becomes the core of the relationship between the asset owner and the concessionaire. This is principally because the concessionaire has a clear economic incentive to extract a maximum value from the asset (which may be by depleting it), whereas the asset owner will have an opposite incentive of ensuring that the asset value (its service potential) is maintained or any depletion (depreciation) is minimized.

Furthermore, as the concession period approaches expiration and consequent renewal/ re-bidding, the possession of asset information, in regard to both nature and condition of the assets, achieves greater value since the information is the basis on which the costs of providing services in the new concession period will be assessed. It is therefore important that the asset owner retains and extends this information during the concession period so that it can be passed to potential bidders for the next period. The alternative is for the information to only be held by the existing concessionaire, who thus has a critical competitive advantage when the concession is re-bid.

If the concession is not re-bid, the criticality of the asset information can increase as the nature and condition of the assets, which are passed back to the owner will be the basis of the terms under which the termination occurs.

Repair or Replace Decisions

Decisions on repair or replacement of assets in the water and sanitation sector are a major component of asset management. Failure of assets will generally have a strong impact on customers and the environment. The impact will be financial, regulatory and on corporate "image". These failure impacts must be assessed against the cost and other impacts of asset replacement such as traffic disruption in the case of pipelines.

At the current time, decision-making is the sole right and responsibility of the concessionaires with the Regulatory Office taking a role through the review process associated with Rate Rebasing. This results in the decisions being generally taken in consideration of the business considerations of the concessionaires (modified by the customer focused regulatory concerns). There is no direct input on behalf of the long-term asset owners.

In the early stages of the concession period, the absence of the long term asset owners in the decision making is of generally minor consequence and it is noted that there is concern by the concessionaires that extending the decision process to include the owners will cause significant delay and ultimately economic loss.

In the middle and later stages of the concession, however, there arises scope for decisions to be made based on the remaining period of the concession rather than on the very long term associated with asset lives. This is problematic but there is reluctance to overly "bureaucratize" decision processes.

A possible solution would be for the Regulatory Office, in the middle term of the concession (2008-2012), to continue in its review role but to take advice from the Asset Management group of the Corporate Office in relation to decisions taken.

In the fourth and fifth terms (2013-2022), the Corporate Office as representatives of the Asset Owners should participate in any decision-making, which involves assets where lives will directly extend beyond the concession period.

Asset Condition Monitoring

It was noted above that there is a requirement in the Concession Agreements for regular Asset Condition Reports to be submitted to the Regulatory Office.

This reporting is desirable on the basis that the role of the Regulatory Office is essentially to monitor the performance of the Concessionaires in respect to the service commitments under the agreements and to assess the capability of the Concessionaires to maintain their performance in the future.

The consequence is that Asset Condition is a necessary consideration in respect to assessing future capability and service levels. However, it must be noted that the objectives of the Regulatory Office are quite different to those of the Corporate Office in its nominal role as the manifestation or representation of the asset owners. Generally, the assessment horizon for the Regulatory Office will be:

- Short to medium term, e.g. to the next Rate Rebasing date;
- At a high level, e.g. at primary water main; and
- Based on possibility of the asset set failing and causing an inability to meet service commitments.

The planning and assessment horizon for the Corporate Office will be:

- Longer term and focused on the end of the Concession Period and beyond;
- At a detailed level and generally at the lowest replaceable construction unit, e.g. a pipe length between manholes; and
- Directed at retaining/maximizing economic value in the assets.

There is, therefore, a need to provide more detailed asset condition data to the Corporate Office and for the Office to be strengthened to permit it to manage the data.

13.5.4 Concession Planning

The Need for Concession Planning
Concessions are a common form of long-term Private Sector Participation around the world. They apply in the water sector in Europe, many parts of Asia, South America and elsewhere.

Concessions are based on an assignment of assets, rights, and responsibilities.

A major feature is for the asset set to be clearly defined in quantum and condition by both the asset owner who has to ensure that the asset is not being inappropriately depleted by the concessionaire and the concessionaire who has to ensure that the asset is not being excessively enhanced at the concessionaire's expense or detriment. The critical time for assessment of asset quantum and condition is at the start of the management period and at the end of the period.

Concession Planning at MWSS
There is an emerging requirement for active concession planning by MWSS. The need is moderate currently as the concession period is now approaching the tenth year but will become critical by 2010.

The key objective will be to ensure that decisions are made by the concessionaires which are in accordance with the best interests of the asset owners and the customers, e.g. that capital replacement decisions are in accord with least-cost long term plans, and that MWSS as asset owners are placed in the strongest negotiating position possible when (and if) new concession bids are called in 2021.

Regardless of the options chosen possession of the asset register (including condition information will be critical and commercially extremely valuable for the owners (MWSS), the current concessionaires and potential new entrants.

13.5.5 The Regulatory Office

The establishment of clear and effective regulatory systems is critical to the autonomy of water service providers. They are established to constrain service providers' operations so as to avoid exploitation of the environment and customers in the corporation's or agency's pursuit of its commercial objectives. Frequently, the frameworks also have a provision to provide protection to other stakeholders such as community groups, which are not necessarily customers.

The concession agreements do not *per se* demand a totally independent Regulatory Office in that there is an acceptance of reliance on MWSS being the ultimate controller of the Regulatory Office albeit with defined independence requirements in regard to location and staffing (it is notable, however, that the Regulatory Office is located in the same building complex as both concessionaires and MWSS). It is reported that this association of the Regulatory Office with MWSS was necessary due to the urgency with which the overall privatization process took place and the possible cost burden (which is borne by the concessionaires) of total independence. This is acceptable currently although it is noted that the 2003 ADB TA project made a recommendation to relocate the Regulatory Office physically away from MWSS and to provide greater emphasis on independence.

The impending possibility that MWSS will take a significant and perhaps majority shareholding in MWSI changes the situation. Having a Regulator, which is a functioning arm of the owner of one of the concessionaires, will create tensions which must be avoided.

13.5.6 Recommendations on MWSS Organization

13.5.6.1 Long Term Strategic Planning

The current framework for long term planning, which relies primarily on the plans developed by the concessionaires, has consequently significant risks in terms of loss of synergy and of deriving solutions which are sub-optimal.

To adequately perform long-term strategic planning and project management for water supply, sewerage and sanitation services in the Metro Manila area, MWSS would need to reinforce its present staff. While it is cost efficient to outsource most of the project planning, detailed engineering and construction management services, engagements of this nature are relatively short term.

It is proposed that long term strategic planning be undertaken by an additional department/function group, the ***Master Plan and Lender Liaison Division*** under the Engineering and Project Management Department within the MWSS Corporate Office as discussed below. This new group will specifically address the future beyond the horizon of the concession agreements and liaise with donors and lenders (both concessionary and commercial) in regards to financial needs to undertake long-term developments.

13.5.6.2 Financial Issues

Firstly, the need to more effectively manage debt suggests that MWSS has to take a primary role as a borrower of record in transactions with concessionary lenders and effectively operate as a merchant bank.

Secondly, the swap of debt for equity undertaken by MWSS in respect to the MWSI restructure, even if only on a temporary basis, reinforces the need that the Regulatory Office be made fully independent under its own legislation, as recommended below.

Thirdly, the choice of divestiture strategy from MWSS will be very critical and overall is expected to be the basis of the terms of reference for a separate consultancy.

13.5.6.3 Asset Management

The following recommendations are made to address the issues related to the need for the MWSS Corporate Office to more effectively manage and monitor the assets being used by the concessionaires.

Retention of Existing Information
It is understood that drawings exist of most of the water system and all of the sewerage system in 1:2000 scale on a work-as executed basis. Some of these drawings are retained in the MWSS vault while one or other of the concessionaires have borrowed others. The drawings generally indicate materials used, e.g. pipe material and date of installation. They are thus vital to the asset management process.

The drawings that have been borrowed by concessionaires should be immediately returned and physical security of these drawings should be assigned to a senior manager in the MWSS Corporate Office who should take responsibility for copying them in a secure manner and making them available to appropriate stakeholders.

Establishment of Concession Based Asset Registers

This master planning project includes in the methodology the intent to create a Geographic Information System, which can contain spatial data on both the water and sewerage systems which are maintained by the concessionaires. The system will be established using the ArcView Mapping Package.

ArcView has the capability of establishing quantitative (attribute) data alongside the spatial data set and the establishment of the data is discussed in *Strategic Action Paper No.5 – The Use of GIS and Modeling.*

It is recommended that the data collection for each system asset node and segment should include specific asset data including:

1. Installation Date
2. Historical Cost (actual or estimate)
3. MEERA Cost

4. Condition
5. Remaining Life
6. Residual Value

This data collection should be based on copies of the drawings noted above and on the concessionaire data, which should be reconciled against records of capital expenditure, which has been included in rate rebasing submissions.

The data collection project should be undertaken by the Concessionaires and should be controlled by the Corporate Office who should employ a rigorous audit process. Alternately, the data collection should be undertaken by a joint group or by contractors but in all cases with a rigorous audit/ quality assurance process. The cost of the project will be substantial and outside the ambit of the Master Plan project to estimate. Multilateral donor assistance will probably be appropriate particularly given that such a project and the resulting asset register will be a valuable case study in applying asset management principles and technology in a developing country.

The development of the asset-based registers would be in conjunction with the establishment of a GIS function within the Corporate Office.

Strengthening the Corporate Office for Asset Management
It is recommended that the Corporate Office establish an **Asset Management Group** within the Corporate Planning Department under the Office of the Senior Deputy Administrator. The Group will be responsible for:

- Coordinating the establishment of a comprehensive asset register which is compatible with the asset registers developed by the concessionaires;
- Participating in the Asset Condition Report process in association with the Regulatory Office;
- Establishing a long term process to prepare for the expiry of the current concession period; and
- Supporting the activities and responsibilities of the Concession Planning group, which has been recommended for establishment with Corporate Planning.

Initially, the GIS function would be housed within the asset management group in Corporate Planning. However, should the GIS function expand to become an enterprise-based GIS, a separate GIS Center may be established as a new division within the Corporate Planning Department.

This staffing would be supplemented by consulting assistance supplied under the asset register development and otherwise.

13.5.6.4 Concession Planning

In order to ensure adequate information is in place for decision-making with regard to the future after the end of the current concession period, it is recommended that the MWSS Corporate Office include a **Concession Planning Group** within the Corporate Planning

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Department under the Office of the Senior Deputy Administrator. This group would have the following broad responsibilities:

1. Monitoring and where appropriate participating in the asset maintenance/ repair/replacement/disposal process, particularly as the end period is approached and there is increasing incentives for gaming by the concessionaires;

2. Appropriate and comprehensive accounting of the asset set that is made available by the concessionaire for return;

3. Establishing the options that are available to provide services after the period end that may include, for example, a rollover of the existing concession(s), a call for submissions for the next concession period or a reversion to some other institutional form of supply; and,

4. Managing the process of commissioning the consequent framework for the new period.

13.5.6.5 Regulatory Office

Although the concession agreements do not *per se* demand a totally independent Regulatory Office, it is noted that the 2003 ADB TA project on Regulation recommended a separate location (physically separate from MWSS) and greater emphasis on independence for the Regulatory Office.

Moreover, the impending possibility that MWSS will take a significant and perhaps majority shareholding in MWSI, albeit on a temporary basis, changes the situation. Having a Regulator, which is a functioning arm of the owner of one of the concessionaires, will create tensions, which must be avoided.

As a consequence, it is recommended that legislation be developed (based on the current concession agreement provisions) which will totally separate the Regulatory Office both geographically and conceptually from the other participants in the framework.

13.5.6.6 MWSS Resources for Project Implementation

As discussed in the sections above, it is apparent that MWSS will need to take a greater role in the planning, lender liaison and management of the implementation of major water source development programs. Significant MWSS resources will be required to manage and support the implementation activities. Some of the activities involved include:

- Project management responsibilities;
- Assistance in acquiring land and rights-of-way for project structures; and
- Leadership and coordination of resettlement programs for families living in proposed reservoir areas.

Based on an assessment of current resources, additional personnel with considerable project management experience in major water supply developments will be needed.

Recent MWSS experience with resettlement for the proposed Laiban Dam development, confirms that the effort required planning and implement resettlement of families occupying watershed areas is substantial and involves resolution of complex issues. Formation of a dedicated taskforce led by MWSS and involving relevant government agencies, NGOs and community representation under a people participatory approach is recommended to promote a successful outcome on resettlement issues in a reasonable period of time.

13.5.6.7 MWSS Corporate Office Strengthening

Many of the above recommendations require a strengthening of some departments within the MWSS Corporate Office to enable them to better manage the concession contracts, but most importantly to ensure effective long-term strategic planning. The proposed strengthening is discussed in detail in *Working Paper No.1 – The Role of MWSS* and is summarized in this section.

To address the recommendations made above, the following changes are proposed in the structure of the MWSS Corporate Office as indicated in **Figure 13.4**.

(a) That Corporate Planning be restructured as a Line Department with clear responsibility for:
- Creation of an Asset Management System;
- Concession Planning;
- Government Relations;

(b) That a new Department for Raw Water Planning and Access Management be created under the Office of the Deputy Administrator for Operations; and

(c) That a new Division for Master Planning and Lender Liaison be created under the Engineering and Project Management Department.

The functions and anticipated competencies for each department are indicated in **Table 13.5**.

Cost of Implementing the Organizational Changes in MWSS
The cost of implementing the Institutional Development Plan results primarily from:

1. The cost of additional personnel required to strengthen the MWSS Corporate Office;
2. The cost of establishing a GIS function in the MWSS Corporate Office;
3. The costs involved in the operation and maintenance of Angat Dam and Reservoir (including catchment management and security) should these functions be transferred to MWSS following privatization of the Angat hydro-electric generating facilities;
4. The costs involved in asset data collection to develop an asset management system within MWSS, either in-house of through a consultancy contract;

5. The costs of additional resources on an as needed basis for management of implementation of major water source programs; and
6. The cost of a consultancy to assist in the development of the strategy related to the rehabilitation of the West Zone concession.

The costs of the additional personnel required to strengthen the MWSS Corporate Office as outlined and for establishing a GIS facility in the Corporate Office have been estimated and are indicated below. Costs for the other elements of the Plan have not been estimated as they depend largely on the strategy adopted and are outside the scope of this study to estimate.

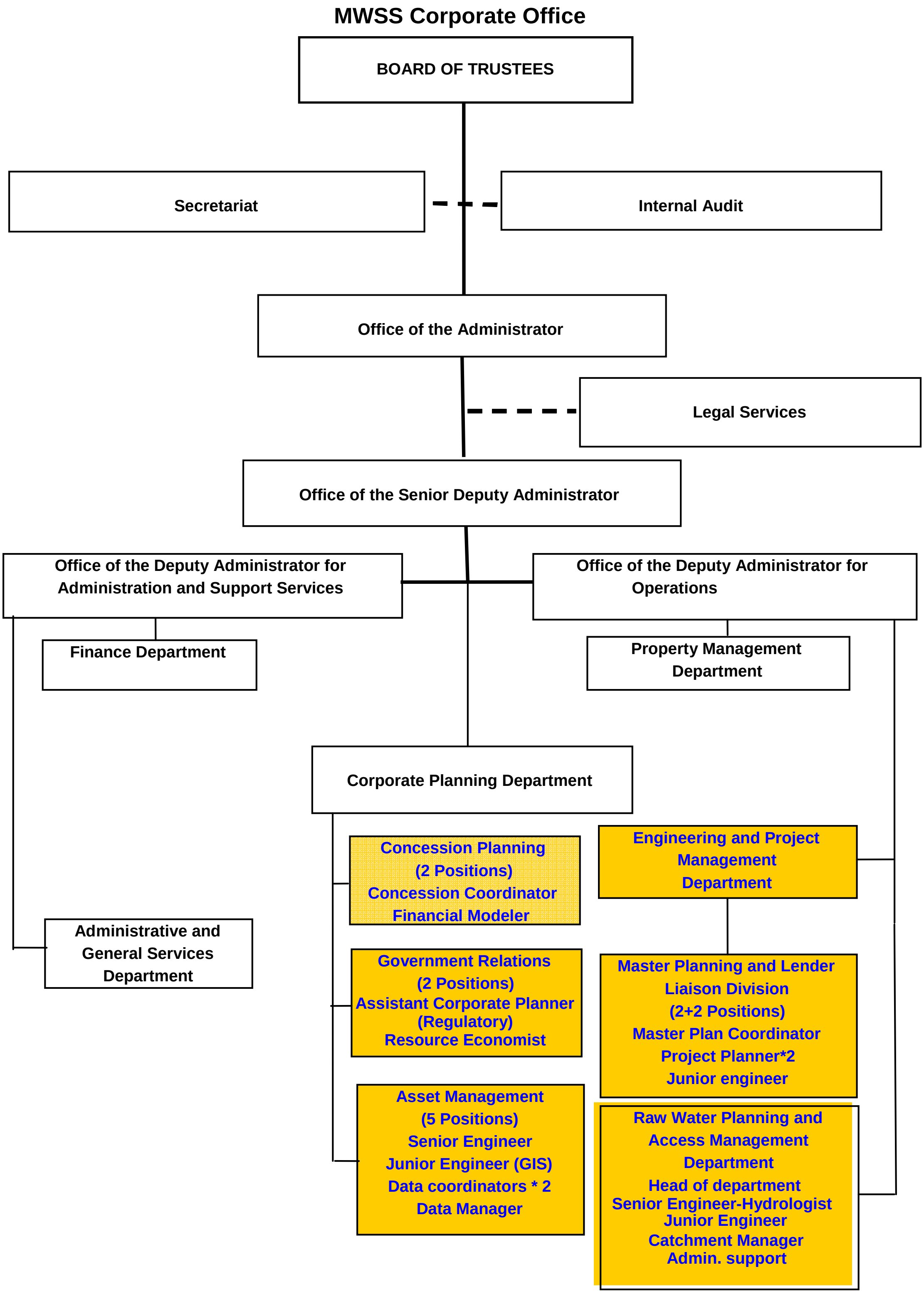

Figure 13.4 Proposed Functional Structure

Table 13.5 – New Departments and Additional Function for MWSS Corporate Office

Department/Division	Function	Competencies	Staffing
Technical Planning and Monitoring (Master Planning and Lender Liaison Division)	Master Planning and Lender Liaison for long term water supply services to Metro Manila. This is a new function and will specifically address the future beyond the horizon of the concession agreements and liaise with donors and lenders in regard to financial needs to undertake master plans and long-term programs.	Civil Engineering Mechanical Engineering Engineering Investigation and Analysis	Specifically identified positions arising out of the development of master plans are: Master Plan Coordinator Project Planner (2) Junior Engineer
Raw Water Planning (and Supply) (Raw Water Planning and Access Management Department)	This is a new department that will report to the Office of the deputy Administrator and will address (i) Long Term Water Demand Planning and Management (ii) Raw Water Supply Planning (iii) Raw Water Access Negotiation and Management (iv) Catchment Management	Hydrology Urban Economics and Planning Negotiation Skills Community Consultation and Relations Environmental Management	Head of Department Senior Engineer/Hydrologist Junior Engineer Catchment Manager Admin. Support
Corporate Planning and Asset Management	This is a revision of the existing Corporate planning function. Conceptually the department's role is to draw together the government agencies and regulators, current and future concessionaires and MWSS as strategic components of water and sanitation service provision. In general the functions that the department will carry out are: (i) Developing Water, Sewer, Sanitation Sector Strategy in association with central agencies (ii) Negotiating with Government Regulators (iii) Business Planning (iv) Concession Planning particularly in regard to termination/rollover preparation (v) Asset management of the total asset base on behalf of the public owners in cooperation with the Regulator	Policy analysis Economic analysis Resource Economics Strategic Planning Negotiation skills Financial modeling and analysis Data analysis and Management relative to the asset base	**Corporate Policy and Planning** Head of Department **Concession Planning** Concession Coordinator Financial Modeler **Government Relations** Assistant Corporate Planner (Regulatory) Resource Economist **Asset Management** Senior Engineer Junior Engineer (GIS) Data Coordinator (2) Data Manager
Finance	This department retains its current functions will have a greater focus on capital management. Its general functions are: (i) Corporate Accounting as a government-owned corporation (ii) Financial Planning in particular sourcing of debt for long term asset development and on lending where appropriate to concessionaires (iii) Loan Administration in cooperation with Regulatory Commission	Financial Accounting Financial Analysis Financial Management	
Personnel	This department groups together the currently separate functions of: • Personnel • Secretariat • Legal Services A particular need is for personnel planning which moves away from the redundancy management which was needed following the implementation of the concessions to forward planning	Professional Skills	

Impact of Additional Personnel in the Corporate Office Budget

The proposed new department, Raw Water Planning and Access Management Department under the Office of the Deputy Administrator for Operations, and the transformation of the Corporate Planning Department from the staff function to line function will result into additional annual budget for personnel cost of about PhP 12.27 Million, shown in **Table 13.6**. This amount represents about 9.6% of the 2005 personnel cost budget of the Corporate Office (PhP 127.23 Million) or 6.4% of the total MWSS personnel cost budget of PhP 191.82 Million (Corporate Office and Regulatory Office).

Currently, there are 38 contractual positions in the CO, which is almost the same number as the vacant positions (37). As the vacant positions are filled up, the contractual positions would consequently diminish. The budget for personnel cost is being prepared based on the approved positions. Therefore, the PhP 12.27 million would have to be added to the total budget to determine its effect in the financial situation of the Corporate Office.

A comparison of the 2005 Budget and the "Increased Budget" brought about by the proposed additional personnel in the Corporate Office shows that the budget can still absorb the additional cost.

Table 13.6 - Comparison of the Corporate Office 2005 Budget and "Increased Budget" Brought About by the Proposed Additional Personnel (In Million Pesos)

Description	2005 Budget	Increased Budget
SOURCES OF FUNDS		
Concession Fees – Corporate Operating Budget	154.11	154.11
Collection of Accounts Receivable	38.57	38.57
Miscellaneous Income	142.95	142.95
Total	**335.63**	**335.63**
APPLICATION OF FUNDS		
Personnel Cost	127.23	139.50
Maintenance and Other Operating Expenditures	150.80	150.80
Equipment Outlay	7.50	7.50
Total	**285.53**	**297.80**
SURPLUS	**50.10**	**37.83**

The additional cost of PhP 12.27 Million was based on the additional personnel as shown in the proposed Revised Functional Structure. The positions recommended were compared to the positions defined in the Qualification Standards (QS) issued by the Civil Service Commission, Revised 1997 to determine the Salary Grade of the position.

In addition, there would be a cost of PhP 2.5 million over three years to develop a GIS function within the new Asset Management Division focused only on asset management and an additional PhP 15 Million should it become appropriate to extend to GIS function to an enterprise-wide activity within the MWSS Corporate Office.

13.6 Sewerage and Sanitation Specific Institutional Issues

13.6.1 Master Plan Strategy

This Master Plan is based on the following strategic concepts:

1. The current dominance of septic tanks (and septage management) as the means of sanitation provision will continue;

2. Piped and treated sewerage systems will be developed on a decentralized basis particularly through new development rather than through backlog provision;

3. There will be a longer term development of comprehensive piped and treated systems achieved via an evolutionary process whereby;

    a. Septic tank overflows to storm water drains are captured through dry weather flow interceptor pipes and pumped to treatment facilities.

    b. Connection to communal septic tanks (which are pumped out by tankers) or a small package treatment plant instead of individual septic tanks is preferred for new development and redevelopment. Then:

    c. Communal septic tank effluent or effluent from the package treatment plants may be pumped to interceptor (sewer mains) and finally:

    d. Communal septic tanks are replaced by direct connection to sewer mains.

This strategic framework is a significant diversion from previous master plan strategies and from the original concession agreements established in 1997 where comprehensive large-scale sewerage for the whole city was envisaged. The change in strategy is driven by the capital construction environment (the inability to establish underground access rights to lay sewers etc.) and the changes in sewerage targets in the concession agreements negotiated in the 2003 Rate Rebasing.

13.6.2 Strategic Context of Sewerage

There are overarching strategic issues, which prevail in the context of wastewater management in Manila (in common with many large cities).

This is due to some extent by the nature of sewerage and sanitation management, which is substantially different from water supply. The differences include:

- Sewerage (and sanitation) can be developed in discrete population areas, e.g. in new developments, with relatively low capital investments compared to the large scale investments needed for water, i.e. a small sewage treatment plant to serve a discrete population sector may be efficient whereas a small dam and water treatment plant will probably not be.

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- Sewerage networks have much longer lives than water supply assets. This is typified by stone sewers constructed by the Romans around the first century A.D. still being in operation in Rome and England and brick sewers constructed in China 500 years ago still operating.

- Sewerage (and sanitation) technologies have advanced more quickly than potable water technologies and with significant changes in technology. This has promoted a shorter-term strategic view of the sewerage/sanitation sub-sector than for water. At the same time, refurbishment technologies for sewer mains (such as plastic lining) have continuously improved so that the potential lives of sewer mains are increasing. In most developed urban environments, sewer mains have a notional (depreciable) life of 200 years or more compared to water main lives of approximately 60 years.

- Sewer mains fail on the basis of blockage and exfiltration (leakage to the environment). Water mains fail on the basis of the integrity of the system and infiltration (invasion from the surrounding environment).

- Sewerage and sanitation services have a different public (and political) perception to potable water services. Potable water is recognized as an essential for life and the cost of reticulated services to the consumers reasonably accepted. Sewerage and sanitation services however are desirable only in terms of the initial disposal with subsequent transport and treatment of waste seen as a “grudge purchase” by dischargers. Perversely, there is often public objection to environmental impacts of sewerage while there is lesser reaction to the environmental impacts of water source development.

Overall however, as is the case for water supply, there are general strategic issues, which must be addressed for the long term and on a public policy basis rather than in terms of commercial assessment. These issues include:

i. The development of sewerage as an alternative (for household and commercial disposal) to septic tank-based sanitation (or night soil collection) particularly in large urban environments;

ii. The desirability of development of disparate small-scale systems such as small communities with small (but expensive) package sewage treatment plants, which discharge effluent to golf courses, etc. (or recycle it);

iii. The effective regulation of septic systems in households, the establishment of customer databases and the downstream issues (in regard to drainage etc.) which can arise from ineffective regulation of sanitation;

iv. Maintaining effective dialogue and balance between the different public agencies and stakeholders involved in sewerage and sanitation such as Health, Environment, Urban Planning, Social Welfare and Citizens groups;

v. Tariffs and mandatory connection by customers to sewerage (where it is available) compared with customers continuing with existing septic facilities;

vi. Cross (concession) boundary issues such as the establishment of common networks;

vii. The implications of industrial waste discharge in the short and long term including the relationship and pricing issues which arise between DENR as environmental regulator, MWSS and the concessionaires as service providers and the industrial dischargers; and

viii. The development and management of receiving waters.

The consequence is that sewerage and sanitation master planning like water supply needs a focus and control which are above the regional boundaries and considerations which are established under the concession agreements but within the framework, i.e. within MWSS.

13.6.3 Regulatory Drivers

Sewerage and sanitation regulation is addressed in detail in Chapter 3 of this Master Plan and in *SAP 7 - Review of Relevant Regulations relating to Sanitation and Sewerage.*

Of significance institutionally are the Provisions (and consequent Implementing Rules and Regulations (IRR)) of the Clean Water Act 2004 (CWA) specifically:

- Section 8 which mandates connection of all sewage lines (property discharges) in highly urban areas to available sewerage systems by May 2009 and

- Section 13 which establishes a framework of permits and charges for discharge to receiving waters, i.e. pollution licensing.

Section 8 is thus a driver for sewerage planning and Section 13 is a driver for the effective sewage treatment (since it closes the cost framework from collection to discharge for sewerage and sanitation systems) as well as a driver for establishing industrial (trade waste) charges. A comprehensive review of the Clean Water Act is provided in *SAP 7*.

13.6.4 Organizational Issues on Sewerage and Sanitation

13.6.4.1 Septic Tank Management

Clause 5.2.4 of the concession agreement provides:

"The Concessionaire shall offer septic and sanitation cleaning services in the Service Area and, in addition, the Concessionaire shall meet the coverage target percentages of the total population in the designated municipality, at the time of the target, for such services, set out in Schedule 4 below by the dates specified at the time of the target for such services in that Schedule; provided, however, that Customers who request such services shall have first priority over those who do not request them. Septic and sanitation cleaning services are defined as the emptying of domestic septic tanks and subsequent sludge disposal at regular intervals of five to seven years."

There is some confusion as to what actually constitutes offering "a service". The consensus assumption is that if a property is offered a pump out service (generally the offer is communicated via the Barangay administration) then the service commitment is met. Where a property owner chooses to forgo the service, the choice is recorded as a waiver and the offer has been made and is counted towards the concession target.

Customers who request a pump out service outside of the rotation/ service frequency make an additional payment which ranges from PhP 803 to PhP 3,500 for domestic customers and a PhP 5,600 for commercial non-domestic customers. This charge acts a major disincentive to customers. At the same time, it is also a disincentive to the concessionaires since *SAP 9* estimates that the operating cost to pump out and dispose of septage is of the order of PhP 450 per m^3. When capital costs are added, the servicing cost to the concessionaires is above the current price in all circumstances.

There is also significant evidence (revealed in the Willingness-to-Pay survey and colloquially) of a lack of public knowledge of the obligation of the concessionaires to provide a pump out service. This is derived from the confusion of what the concession obligation really is, which is either:

i. To passively offer a service to property owners and occupants on a rotational basis or

ii. To actively promote the availability of the service to the general customer base and provide services.

It is generally interpreted that the obligation is primarily as in (i) as reflected in the practice of a property being counted as having been served if a pump out has been offered and refused. Cleaning (pump out of sludge) of septic tanks is carried out by concessionaires using vacuum pump equipped tankers and (for MWSI) mobile dewatering units. There are also private operators, who are to a large extent unregulated, in the market.

Pump out capacity is being expanded by tanker truck purchase funded by ADB and MTSP. The current and future transport capacity for septage and the daily production of septage is shown in **Table 13.7**.

At the rate of 2 trips per vehicle per day and an estimated 1.47 million tanks to be currently served, the current tank service frequency is every 29 years which is insufficient to avoid major incidence of overflow (which requires 5-7 year frequency). In fact, it is noted elsewhere in this master plan that most septic tanks in Manila are now completely filled with solids and are totally ineffective as digesters of sewage.

Consequently, raw sewage discharges to septic tanks actually go directly to the tank's overflow and generally into the storm water drainage system.

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Table 13.7 - Septage Transport Capacity vs. Production

	Current	By 2010	By 2025
Performance Required			
Total Transport Capacity (m^3)	484	1440	1440
Total Septage Production (m^3 per day)	2611	2918	4706
Necessary Trips per vehicle/ day to Meet Daily Production	6	2	3
Tank services per day to meet daily production	522	583	941
Service Frequency (years)	**17**	**6**	**5**
Performance Capability (maximum)			
Tank Service capacity per day	176	568	568
Tanks actually serviced in 2004 (daily average)	110		
Tanks to be serviced (Million)	1.55	1.84	2.41
Tanks per day at current rate (maximum estimated)	8800	3246	4242
Actual service frequency (years)	**29**	**11**	**14**

Source SAP 9, Regulatory Office and extrapolated data

From an institutional viewpoint the dominant characteristic of septage management as an alternative to piped sewerage is that septage management relies for its efficiency on active operational management. This compares with sewerage where capital investment is the dominant characteristic (internationally, the highest value asset set on the asset register for most comprehensive water and sewerage agencies is sewer mains).

Simplistically for sanitation, the sewerage pipe network (which is relatively static and underground) is replaced by a dynamic environment of trucks and pumps.

There are a number of technical/physical constraints noted in this section in relation to septage management. Complicating these constraints is the lack of accounting of wastewater revenues (the surcharge applied to water charges) insofar as the wastewater revenues are applied to wastewater management activities.

The situation is exacerbated by the fact that the true beneficiary of effective septage management is not the property occupier (although there are often odor problems associated with ineffective tanks) or the current service providers (the concessionaires).
The real beneficiaries, i.e. sufferers from bad septage management are the agencies responsible for the stormwater system, i.e. the local government units (LGUs) and MMDA

in the case of large drains. There is conceptually little incentive for the concessionaires to aggressively improve septage management efficiency.

It is notable that wastewater **revenues** from customers who have septic tanks are readily identified and can be readily accounted because they pay a different surcharge rate to sewerage connected customers. **Expenditures** on septage management are not so easily identified and are reasonably distorted by concessionaire overheads and common activities with water.

As a consequence, some alternative approaches emerge:

1. Stronger regulation is applied by the Regulatory Office so that revenues and expenditures for septage management are robustly audited financially and the efficiency of service provision is audited operationally. This implies that the sanitation surcharge of 10% on water charges is separately accounted of by the concessionaires rather than recognizing it as general income, i.e. fund accounting is applied.

2. Septic tank de-sludging and transport for treatment and disposal be outsourced to private contractors, while at the same time implementing stronger regulation as in 1) above. The concessionaires do not necessarily have any expertise as a fleet manager so this role is best provided by others. This may mean that the existing truck fleet of each of the concessionaires is fully divested or is leased to the contractor(s).

3. Wastewater revenues from septic tank served customers (net of collection costs) are transferred either to the LGUs or a separate sanitation agency that will then have the responsibility of providing a pump out service.

Conceptually, Alternative 3 appears attractive because:

a) It places the responsibility and the funding source with the entity, which will benefit from good management of septage collection.
b) It decentralizes and localizes the funding and service framework.
c) An incentive is given to the concessionaires to provide sewerage services so that they retain the revenues.
d) The current funding system (Environmental Charge set at 10% of the water account) is essentially a tax or levy and has no relationship to the service provided by the operator/concessionaire.
e) It avoids placing the RO in an ongoing monitoring/auditing role, which is inappropriate.

However, after discussion with several of the stakeholders including MWSS, the concessionaires, DENR, and MMDA, it was agreed that there were many constraints to this proposal, in particular the division of responsibility for septage management between different agencies, the issue of funding transfer from MWSS/concessionaires to the LGUs, the difficulties in monitoring the performance of the LGUs and the current responsibility for

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this service of the concessionaires under the Concession Agreement. This alternative was therefore not considered further.

Overall, however, there is an agreement that septage management is very central to the proposed sewerage and sanitation strategy for Manila. There is also general agreement that the operational management issues and complexity are already quite substantial and will increase dramatically. Consequently, the management structures must be reviewed and be assessed to ensure the service is provided effectively.

The appropriate time for an extensive review of the overall structure and mix of responsibilities is in preparation for the Rate Rebasing process in 2008. This is consistent with the likelihood of changes being necessary in the Concession Agreement and in the tariff structure. The review would follow on from acceptance of the Master Plan recommendations and be directed at institutional reform and capacity building to necessary to sustain the sewerage and sanitation strategy.

Recommendations

1. For the present, it is recommended that a stronger regulatory focus is placed on the concessionaires by the Regulatory Office in the area of septage management as discussed above and at the same time septic tank de-sludging and transport of septage by outsourced by the concessionaires.

2. A technical assistance project should be formulated to review the management structure for septage collection and processing in Manila. The project should take into account:

   - The recommended strategy for sanitation contained in this Master Plan and the consequent operational management requirements;
   - The responsibilities of the stakeholder agencies (notably both MWSS and MMDA have sewerage responsibility for Manila established in their legislation);
   - The management capabilities of the agencies;
   - The requirements for a more robust trade/industrial waste management, discharge monitoring and charging structure to be established (see below); and
   - The likely long-term financial and operational impacts of change in the management structure.

The project should be commissioned and carried out in sufficient time for recommended changes in responsibilities to be promulgated in legislation (where necessary) and submissions made by the restructured agencies prior to the rate rebasing process in 2007. This implies commissioning in 2006.

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13.6.4.2 Coordination of the Planning Process

The need for long term strategic planning generally in water supply and sewerage is discussed in Section 13.5.6. As is the case for water supply, sewerage and sanitation services require a strong planning and coordination function. This is due to:

i. The need to foreshadow and mitigate the impacts of population growth on society and the environment;

ii. The need to take advantage of new technologies while also taking advantage of the long asset lives available. This requires a strong proactive and long term approach to planning and in particular a need to avoid knee jerk reactions to new technologies and inefficient capital investments;

iii. The need to coordinate with and participate in the overall planning process in a large city such as Manila; and,

iv. Without proactive planning, the requirements of the CWA and specifically Section 8 of the CWA cannot be met in any way. This section provides that MWSS and the concessionaires, in coordination with the LGUs will be required to connect all existing sewage lines to an available sewerage system by May 2009. Meeting this objective requires robust long term plans which are developed to not only provide technical guidance but also support financial strategies including the capital works program for the sector and pricing options such as developer charges which are discussed in Chapter 11 in relation to pricing and are further discussed in the following sections.

13.6.4.3 Septic Tank Management

Earlier in this Master Plan, it has been reported that it is estimated that up to 30% of septic tanks in Metro Manila are inaccessible and can therefore not be de-sludged. There are also septic tanks that are improperly designed and therefore do not operate effectively. Although MWSS/concessionaires do provide a septic tank desludging service that is included in the water and environmental charges paid by consumers, there is a general lack of knowledge by consumers of the sanitation services. There also appears to be no obligation from the consumers to avail of these services. These issues greatly constrain the likelihood of significant environmental improvement from the sanitation programme. The following recommendations are therefore made with regard to septic tank management.

- LGUs in coordination with MWSS and the concessionaires undertake a survey of septic tanks in all properties;

- The survey is used to identify households with inaccessible septic tanks or improperly designed septic tanks;

- If not already in place, LGUs are to pass ordinances to require households to have septic tanks that are accessible for de-sludging, of a design required by the Sanitation Code and that the tanks must be emptied at no greater interval than seven years; and

- LGUs to issue notices to all households with inaccessible, malfunctioning or improperly designed septic tanks to either replace or modify the septic tanks such that they will meet the requirements of the Sanitation Code and be accessible for de-sludging. The household to be given up to one year to make the required improvements or face a penalty under the ordinance.

The ordinance to be promulgated by the LGUs for improvement of septic tanks will apply mostly to existing households as new households also fall under the Clean Water Act.. In order to provide the impetus for LGUs to pass and enforce this ordinance, MWSS and the concessionaires, with the possible assistance of MMDA, will need to be proactive in presenting the importance of these measures to the LGUs. Since the drains being managed by the LGUs are the primary sufferers of poor management of septic tanks, there should be a degree of self-interest from the LGUs in ensuring effective septic tank management.

13.6.4.4 Use of the Drains as Sewers in Combined Drainage

The sewerage strategy described in Chapter 10 included combined drainage as the least-cost strategy to be adopted in the short to medium term. Combined drainage means that septic tank effluent will be channeled to local storm drains prior to being intercepted and piped to through trunk sewers to sewage treatment plants. This strategy requires the use of LGU-owned drains as transporters of sewage as well as stormwater.

In order to ensure that the local drains are in adequate condition to transport the sewage, an allowance has been made in the costing for improvement to the drainage network where combined drainage in used. However, continued maintenance of the drainage network would be required and this is currently the responsibility of the LGUs. Provision of infrastructure improvements by one agency where the responsibility for maintenance is by a separate agency results in a series of mixed incentives and constraints institutionally and is not an ideal arrangement. The following alternative arrangements may be considered:

1. LGUs to contribute to drainage improvements where they are necessary for stormwater management and continue to be responsible for operation and maintenance of the drains. They have an incentive in this case to protect their investment in drainage improvements.

   The concessionaires will be responsible for the capital costs associated with sewage management.

2. The full cost of drainage improvements be provided by the concessionaires who will become responsible for those drains that are operating as combined drains.

Once separate sewerage is provided, responsibility for maintenance of the drains formerly used as combined drains reverts to the LGUs.

It is recommended that the approach outlined in Alternative (2) is adopted to ensure that the agency responsible for the sewerage service is in a position to ensure that the conduits are being properly maintained. While this will involve the concessionaires in some additional expense, this is essentially an element of the cost of a combined drainage system and if considered excessive, the concessionaires have the option of providing STED or separate sewerage i.e. alternative (2) presents as a least cost alternative (ultimately recovered through the rebasing process) to meeting the concessionaires responsibility.

Early consultation will be required between MWSS, the concessionaires, the LGUs and MMDA to agree on the approach and develop a framework by which the concessionaires will be able to assume responsibility for certain drains. The LGUs, although essentially being assisted in their designated role by the concessionaires, will need to be provided with some assurance that the drains will be maintained in a satisfactory condition.

13.6.4.5 Developer Charges

Developer charges are applied in many countries as a source of funding for servicing new land developments. They are generally applied as a requirement of planning authorities to ensure that adequate social resources (such as sanitation) are provided by developers of property for subdivision or redevelopment. Developer charges are applied in association with a planning requirement for developers to provide local infrastructure such as local piping and are paid by the developer who then bundles the charges in with his other capital costs for the development which he aims to recover from purchasers. As such developer charges are a one off capital, which ultimately becomes embedded in the true economic value of the property in the same manner as roads, which allow access to the property.

Strategically, an effective developer charges regime means that developers can establish their development’s access to large infrastructure (such as trunk sewers and treatment works) at a lower cost than physically providing the infrastructure (such as a small scale package treatment works).

Recommendation

A developer charges regime should be established for Manila to operate in conjunction with current regulations (such as Batas Pambansa 220) in regard to property development.

13.6.4.6 Trade Waste Management

Trade Waste is a term that is frequently used to define or differentiate waste discharges which are non-domestic in nature and characteristics and which arise from industrial and commercial processes. These discharges can range from heavy metals (such as chromium) from electroplating to greasy wastes from large food producer/ sellers.

A common framework for trade waste management is where:

The relevant environmental regulator (e.g. DENR) establishes a system of charges and permits whereby permission is given for wastewater (i.e. pollutant) discharges in return for charges or fees paid by the discharger. Dischargers can either be non-domestic property (i.e. industrial dischargers where wastewater is a by product of an activity) or operators of sewage treatment plant such as the concessionaires (where wastewater is the defined product of the sewerage activity).

Industrial dischargers have three options:

1. They can pay the specified charges;
2. They can modify their processes to reduce the pollutant loading and consequently moderate the charges imposed; and
3. They can discharge (if the option is available) to the sewage treatment plant operator.

The sewerage operator sets charges for the discharger on the basis of the full processing cost for the discharge plus any charges imposed by the regulator and borne by the sewerage operator because of the pollutant loading increase, which originated from the industrial operator.

The system has the advantage that industrial dischargers can make an economic decision as to which has the least cost: continuing the discharge and paying the direct charge to the regulator; discharging to the sewerage operator (at a trade waste charge rate which reflects the treatment and discharge costs) or modifying the process (e.g. establishing source capture of the pollutant) to minimize waste generation.

To reinforce the transaction processes, reasonable value judgments have to be made so that the wastewater charges are set by the regulator to reflect community values of the pollutant impact and that trade waste charges are set by the sewerage operator to reflect the marginal costs of treating and discharging the effluent.

For both the regulator and the sewerage operator, there is a need to establish strong monitoring and inspection to ensure that dischargers do not exploit the system.

Trade Waste Management in Manila

The CWA provides part of the trade waste framework insofar as establishing a charging framework for dischargers to waterways. Currently DENR and LLDA have established a monitoring process for dischargers to waterways through their respective Environmental User Fee Systems (EUFS) and these are in the process of being upgraded as part of the CWA requirements.

To complement the CWA, there is a need for the concessionaires to establish a monitoring and charging framework to address discharges by industrial and commercial processors to the sewerage systems. The monitoring system will require staffing which will add to the cost base, which is the subject of the next rebasing decision.

The monitoring system can then be used by the concessionaires to develop a trade waste fee system, which reflects the cost of treatment and the cost of wastewater charges on a volumetric basis (to address most of the capital investment in the treatment works and some of the operating cost) and on a pollutant load basis to reflect charges imposed under CWA and the remainder of the operating cost.

A concern that emerges is the current unregulated operation of private tankers, which pump out industrial and commercial wastes from premises and, it is reported, dispose of the often heavily toxic wastes in waterways or similar inappropriate locations. A concerted effort is needed to stop this operation.

Recommendations

1. While the Implementing Rules and Regulations have been issued for CWA, relevant action plans are still being developed by DENR. These plans should be developed as a priority, with consultation from MWSS, the concessionaires, the LGUs, and MMDA. The action plans will include establishing a discharge license framework which is based on load-based licensing for non-domestic waste content and a trade waste inspection program.

2. Following development of the action plans for CWA implementation, a trade waste management and tariff framework should be developed by the concessionaires as the operators of approved treatment plants.

13.7 Summary of Institutional Actions Required for Sewerage and Sanitation

Table 13.8 provides a summary of the recommended action plan to address the sewerage and sanitation institutional issues. As indicated in the summary, most of these actions have a high to extreme degree of urgency and should be acted upon within the next two years if a sustainable sewerage and sanitation sector in Metro Manila is to be realized.

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Table 13.8 - Sewerage and Sanitation Institutional Development Recommendation Summary

Action	Urgency	Priority
Institutional		
Commission a review of septage management and associated agencies.	In 2006	High
Organizational		
Establish Master Plan and Lender Liaison Division under the Engineering and Project Management Department within the MWSS Corporate Office.	Immediate	High
Corporate Planning be restructured as a Line Department with clear responsibility for • Creation of an Asset Management System • Concession Planning • Government Relations	Within 6 months	Very High
Establish an Asset Management Group within the Corporate Planning Department under the Office of the Senior Deputy Administrator. Commence centralized development of a comprehensive Asset Register for system assets.	Within 6 months	Very High
Establish a Concession Planning Group within the Corporate Planning Department under the Office of the Senior Deputy Administrator.	Within the next two years	Extreme
Financial / Tariff		
Develop Industrial/Trade Waste Management Processes	For 2008 Rebasing	High
Introduction of Developer Charges framework	For 2008 Rebasing	High
Management		
The 1:2000 drawings that have been borrowed by concessionaires should be immediately returned and physical security of these drawings should be assigned to a senior manager in the MWSS Corporate Office who should take responsibility for copying them in a secure manner and making them available to appropriate stakeholders.	Immediate	Extreme

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VOLUME 5
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FINAL REPORT

November 2005

SINCLAIR KNIGHT MERZ (PHILIPPINES), INC.

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Annex 9-1

Estimated Number of ISTs by City/Municipality

City / Municipality	Projected Population						Estimated % of Population with Septic Tanks						Estimated No. of ISTs					
	2001	2005	2010	2015	2020	2025	2001	2005	2010	2015	2020	2025	2001	2005	2010	2015	2020	2025
NCR - East	3,208,348	3,308,862	3,448,840	3,577,597	3,687,130	3,774,041							**858,987**	**952,301**	**1,104,320**	**1,305,151**	**1,501,614**	**1,754,556**
1 Mandaluyong City	279,455	296,293	310,882	322,918	331,374	335,752	87.6%	87.6%	87.6%	87.6%	87.6%	87.6%	53,218	56,424	59,203	61,495	63,105	63,939
2 Makati City(part)	398,445	392,647	384,206	371,593	354,551	333,577	75.1%	75.1%	75.1%	75.1%	75.1%	75.1%	65,050	64,104	62,726	60,667	57,884	54,460
3 Quezon City (part)	821,471	722,137	676,968	625,537	568,728	508,624	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	151,794	133,438	125,092	115,588	105,091	93,985
4 Pasig City	512,879	576,228	648,316	722,104	794,589	863,297	86.7%	86.7%	86.7%	86.7%	86.7%	86.7%	96,667	108,606	122,193	136,101	149,763	162,713
5 San Juan	116,883	119,133	118,932	117,541	114,765	110,638	93.0%	93.0%	93.0%	93.0%	93.0%	93.0%	23,631	24,086	24,045	23,764	23,202	22,368
6 Taguig	490,560	551,941	642,775	741,048	844,040	949,194	68.4%	68.4%	68.4%	68.4%	68.4%	80.0%	72,944	82,071	95,578	110,191	125,505	165,077
7 Marikina City	398,060	412,731	429,446	442,354	450,155	452,302	87.5%	87.5%	87.5%	87.5%	87.5%	87.5%	75,718	78,509	81,688	84,143	85,627	86,036
8 Pateros	57,839	57,438	56,673	55,357	53,419	50,897	90.8%	90.8%	90.8%	90.8%	90.8%	90.8%	11,417	11,338	11,187	10,927	10,544	10,047
9 Manila (part)	132,756	180,313	180,642	179,145	175,508	169,760	90.4%	90.4%	90.4%	90.4%	90.4%	90.4%	26,089	35,435	35,500	35,206	34,491	33,362
Rizal Province	1,811,899	2,230,624	2,878,931	3,686,046	4,672,308	5,859,921												
10 Antipolo City	504,654	639,804	857,242	1,137,491	1,491,840	1,932,861	74.0%	76.0%	78.5%	85.0%	85.0%	85.0%	81,183	105,707	146,290	210,189	275,666	357,159
11 Cainta	255,740	308,654	387,364	481,453	591,452	717,776	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	44,476	53,679	67,368	83,731	102,861	124,831
12 San Mateo	145,257	183,874	245,853	325,552	426,083	550,900	72.0%	74.0%	78.5%	85.0%	85.0%	85.0%	22,736	29,580	41,955	60,156	78,733	101,797
13 Rodriguez	121,951	149,087	190,309	240,584	300,610	371,061	70.0%	72.0%	78.5%	85.0%	85.0%	85.0%	18,558	23,335	32,477	44,456	55,548	68,566
14 Taytay	211,956	267,047	354,825	466,906	607,260	780,232	72.0%	74.0%	78.5%	85.0%	85.0%	85.0%	33,176	42,960	60,552	86,276	112,211	144,173
Municipal-Run systems																		
15 Angono	79,834	100,496	133,373	175,297	227,726	292,250	70.0%	72.0%	78.5%	85.0%	85.0%	85.0%	12,149	15,730	22,760	32,392	42,080	54,003
16 Binangonan	197,558	237,025	295,155	363,995	443,681	534,256	65.0%	70.0%	76.0%	80.0%	80.0%	80.0%	27,916	36,069	48,765	63,303	77,162	92,914
17 Cardona	40,249	45,233	51,727	58,582	65,576	72,515	65.0%	70.0%	76.0%	80.0%	80.0%	80.0%	5,687	6,883	8,546	10,188	11,405	12,611
RIZWADA																		
18 Baras	25,815	31,018	38,701	47,820	58,403	70,463	61.0%	65.0%	70.0%	85.0%	85.0%	85.0%	3,423	4,383	5,889	8,836	10,792	13,020
19 Jala-jala	24,369	28,724	34,948	42,110	50,151	59,003	58.0%	65.0%	70.0%	80.0%	80.0%	80.0%	3,073	4,059	5,318	7,323	8,722	10,261
20 Morong	44,158	50,832	59,966	70,059	80,900	92,286	72.0%	75.0%	78.0%	80.0%	80.0%	80.0%	6,912	8,288	10,168	12,184	14,070	16,050
21 Pililia	47,425	56,027	68,367	82,620	98,685	116,446	66.0%	68.0%	70.0%	80.0%	80.0%	80.0%	6,805	8,282	10,404	14,369	17,163	20,251
22 Tanay	81,667	95,441	114,826	136,816	161,125	187,452	65.0%	65.0%	76.0%	80.0%	80.0%	80.0%	11,540	13,486	18,971	23,794	28,022	32,600
23 Teresa	31,268	37,362	46,275	56,761	68,816	82,420	71.0%	72.0%	76.0%	80.0%	80.0%	80.0%	4,826	5,848	7,645	9,871	11,968	14,334
NCR- West	6,847,282	7,266,326	7,688,601	8,071,897	8,390,172	8,628,815							**1,373,476**	**1,468,342**	**1,571,328**	**1,666,217**	**1,747,532**	**1,810,524**
1 Manila City	1,402,472	1,392,475	1,362,213	1,319,161	1,261,987	1,191,956	88.0%	88.0%	88.0%	88.0%	88.0%	88.0%	268,299	266,387	260,597	252,361	241,424	228,026
2 Pasay City	345,046	355,122	350,412	342,295	330,334	314,760	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	67,509	69,480	68,559	66,971	64,631	61,583
3 Quezon City (part)	1,444,877	1,566,679	1,699,517	1,817,217	1,911,860	1,978,540	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	266,988	289,495	314,041	335,790	353,278	365,600
4 Paranaque	462,525	498,242	544,239	588,518	628,723	663,185	82.0%	82.0%	82.0%	82.0%	82.0%	82.0%	82,450	88,817	97,017	104,910	112,077	118,220
5 Las Pinas	484,978	559,481	652,906	754,286	860,899	970,158	76.0%	77.0%	79.0%	80.0%	82.0%	82.0%	80,127	93,652	112,130	131,180	153,465	172,941
6 Caloocan City	1,211,507	1,305,994	1,428,308	1,546,404	1,654,073	1,746,872	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	223,865	241,325	263,926	285,749	305,644	322,792
7 Makati City(part)	57,006	68,832	60,001	51,698	43,943	36,831	92.0%	92.0%	92.0%	92.0%	92.0%	92.0%	11,401	13,766	12,000	10,340	8,789	7,366
8 Malabon	337,155	330,538	317,956	302,785	284,860	264,608	86.0%	86.0%	86.0%	86.0%	86.0%	86.0%	63,033	61,796	59,444	56,608	53,256	49,470
9 Muntinlupa City	375,331	415,098	447,968	478,589	505,137	526,418	72.0%	73.0%	76.0%	78.0%	80.0%	82.0%	58,747	65,874	74,012	81,152	87,850	93,840
10 Navotas	230,677	245,524	258,011	268,413	275,867	279,944	74.0%	75.0%	77.0%	79.0%	80.0%	82.0%	37,109	40,031	43,189	46,097	47,977	49,903
11 Valenzuela	495,708	528,340	567,069	602,531	632,489	655,543	83.0%	83.0%	83.0%	83.0%	83.0%	83.0%	89,443	95,331	102,319	108,718	114,123	118,283
Cavite Province	792,979	889,205	1,001,005	1,100,830	1,179,874	1,231,999												
12 Cavite City	100,289	103,976	105,650	104,612	100,701	94,199	72.0%	74.0%	76.0%	78.0%	80.0%	80.0%	15,697	16,727	17,455	17,739	17,513	16,382
13 Bacoor	315,110	352,753	395,270	431,607	458,171	472,635	75.0%	76.0%	77.0%	79.0%	80.0%	85.0%	51,377	58,281	66,165	74,124	79,682	87,335
14 Imus	201,729	226,717	255,332	280,220	298,977	309,981	74.0%	75.0%	77.0%	79.0%	81.0%	83.0%	32,452	36,965	42,740	48,125	52,646	55,931
15 Kawit	64,751	72,750	81,901	89,850	95,828	99,318	80.0%	80.0%	80.0%	83.0%	85.0%	85.0%	11,261	12,652	14,244	16,212	17,707	18,352
16 Noveleta	33,181	38,068	44,032	49,631	54,385	57,911	61.0%	65.0%	70.0%	75.0%	80.0%	80.0%	4,400	5,379	6,701	8,092	9,458	10,071
17 Rosario	77,920	94,941	118,820	144,910	171,812	197,955	55.0%	60.0%	65.0%	70.0%	75.0%	80.0%	9,317	12,384	16,790	22,052	28,013	34,427
Total	**12,660,508**	**13,695,017**	**15,017,377**	**16,436,370**	**17,929,483**	**19,494,777**							**2,232,463**	**2,420,643**	**2,675,649**	**2,971,368**	**3,249,147**	**3,565,080**

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Annex 9-2

Total Potential Septage Volume by City/Municipality

City / Municipality	Projected Population						Estimated % of Population with Septic Tanks						Potential Septage Volume Collection (cum/d)					
	2001	2005	2010	2015	2020	2025	2001	2005	2010	2015	2020	2025	2001	2005	2010	2015	2020	2025
NCR - East													**1,909**	**2,116**	**2,454**	**2,900**	**3,337**	**3,899**
1 Mandaluyong City	279,455	296,293	310,882	322,918	331,374	335,752	87.6%	87.6%	87.6%	87.6%	87.6%	87.6%	118	125	132	137	140	142
2 Makati City(part)	398,445	392,647	384,206	371,593	354,551	333,577	75.1%	75.1%	75.1%	75.1%	75.1%	75.1%	145	142	139	135	129	121
3 Quezon City (part)	821,471	722,137	676,968	625,537	568,728	508,624	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	337	297	278	257	234	209
4 Pasig City	512,879	576,228	648,316	722,104	794,589	863,297	86.7%	86.7%	86.7%	86.7%	86.7%	86.7%	215	241	272	302	333	362
5 San Juan	116,883	119,133	118,932	117,541	114,765	110,638	93.0%	93.0%	93.0%	93.0%	93.0%	93.0%	53	54	53	53	52	50
6 Taguig	490,560	551,941	642,775	741,048	844,040	949,194	68.4%	68.4%	68.4%	68.4%	68.4%	80.0%	162	182	212	245	279	367
7 Marikina City	398,060	412,731	429,446	442,354	450,155	452,302	87.5%	87.5%	87.5%	87.5%	87.5%	87.5%	168	174	182	187	190	191
8 Pateros	57,839	57,438	56,673	55,357	53,419	50,897	90.8%	90.8%	90.8%	90.8%	90.8%	90.8%	25	25	25	24	23	22
9 Manila City (part)	132,756	180,313	180,642	179,145	175,508	169,760	90.4%	90.4%	90.4%	90.4%	90.4%	90.4%	58	79	79	78	77	74
Rizal Province																		
10 Antipolo City	504,654	639,804	857,242	1,137,491	1,491,840	1,932,861	74.0%	76.0%	78.5%	85.0%	85.0%	85.0%	180	235	325	467	613	794
11 Cainta	255,740	308,654	387,364	481,453	591,452	717,776	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	99	119	150	186	229	277
12 San Mateo	145,257	183,874	245,853	325,552	426,083	550,900	72.0%	74.0%	78.5%	85.0%	85.0%	85.0%	51	66	93	134	175	226
13 Rodriguez	121,951	149,087	190,309	240,584	300,610	371,061	70.0%	72.0%	78.5%	85.0%	85.0%	85.0%	41	52	72	99	123	152
14 Taytay	211,956	267,047	354,825	466,906	607,260	780,232	72.0%	74.0%	78.5%	85.0%	85.0%	85.0%	74	95	135	192	249	320
Municipal-Run systems																		
15 Angono	79,834	100,496	133,373	175,297	227,726	292,250	70.0%	72.0%	78.5%	85.0%	85.0%	85.0%	27	35	51	72	94	120
16 Binangonan	197,558	237,025	295,155	363,995	443,681	534,256	65.0%	70.0%	76.0%	80.0%	80.0%	80.0%	62	80	108	141	171	206
17 Cardona	40,249	45,233	51,727	58,582	65,576	72,515	65.0%	70.0%	76.0%	80.0%	80.0%	80.0%	13	15	19	23	25	28
RIZWADA																		
18 Baras	25,815	31,018	38,701	47,820	58,403	70,463	50.0%	55.0%	70.0%	85.0%	85.0%	85.0%	8	10	13	20	24	29
19 Jala-jala	24,369	28,724	34,948	42,110	50,151	59,003	50.0%	55.0%	70.0%	80.0%	80.0%	80.0%	7	9	12	16	19	23
20 Morong	44,158	50,832	59,966	70,059	80,900	92,286	50.0%	55.0%	70.0%	80.0%	80.0%	80.0%	15	18	23	27	31	36
21 Pililia	47,425	56,027	68,367	82,620	98,685	116,446	50.0%	55.0%	70.0%	80.0%	80.0%	80.0%	15	18	23	32	38	45
22 Tanay	81,667	95,441	114,826	136,816	161,125	187,452	60.0%	65.0%	76.0%	80.0%	80.0%	80.0%	26	30	42	53	62	72
23 Teresa	31,268	37,362	46,275	56,761	68,816	82,420	65.0%	72.0%	76.0%	80.0%	80.0%	80.0%	11	13	17	22	27	32
NCR - West													**3,052**	**3,263**	**3,492**	**3,703**	**3,883**	**4,023**
1 Manila City	1,402,472	1,392,475	1,362,213	1,319,161	1,261,987	1,191,956	88.0%	88.0%	88.0%	88.0%	88.0%	88.0%	596	592	579	561	536	507
2 Pasay City	345,046	355,122	350,412	342,295	330,334	314,760	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	150	154	152	149	144	137
3 Quezon City (part)	1,444,877	1,566,679	1,699,517	1,817,217	1,911,860	1,978,540	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	593	643	698	746	785	812
4 Paranaque	462,525	498,242	544,239	588,518	628,723	663,185	82.0%	82.0%	82.0%	82.0%	82.0%	82.0%	183	197	216	233	249	263
5 Las Pinas	484,978	559,481	652,906	754,286	860,899	970,158	76.0%	77.0%	79.0%	80.0%	82.0%	82.0%	178	208	249	292	341	384
6 Caloocan City	1,211,507	1,305,994	1,428,308	1,546,404	1,654,073	1,746,872	85.0%	85.0%	85.0%	85.0%	85.0%	85.0%	497	536	587	635	679	717
7 Makati City(part)	57,006	68,832	60,001	51,698	43,943	36,831	92.0%	92.0%	92.0%	92.0%	92.0%	92.0%	25	31	27	23	20	16
8 Malabon	337,155	330,538	317,956	302,785	284,860	264,608	86.0%	86.0%	86.0%	86.0%	86.0%	86.0%	140	137	132	126	118	110
9 Muntinlupa City	375,331	415,098	447,968	478,589	505,137	526,418	72.0%	73.0%	76.0%	78.0%	80.0%	82.0%	131	146	164	180	195	209
10 Navotas	230,677	245,524	258,011	268,413	275,867	279,944	74.0%	75.0%	77.0%	79.0%	80.0%	82.0%	82	89	96	102	107	111
11 Valenzuela	495,708	528,340	567,069	602,531	632,489	655,543	83.0%	83.0%	83.0%	83.0%	83.0%	83.0%	199	212	227	242	254	263
Cavite Province																		
12 Cavite City	100,289	103,976	105,650	104,612	100,701	94,199	72.0%	74.0%	76.0%	78.0%	80.0%	80.0%	35	37	39	39	39	36
13 Bacoor	315,110	352,753	395,270	431,607	458,171	472,635	75.0%	76.0%	77.0%	79.0%	80.0%	85.0%	114	130	147	165	177	194
14 Imus	201,729	226,717	255,332	280,220	298,977	309,981	74.0%	75.0%	77.0%	79.0%	81.0%	83.0%	72	82	95	107	117	124
15 Kawit	64,751	72,750	81,901	89,850	95,828	99,318	80.0%	80.0%	80.0%	83.0%	85.0%	85.0%	25	28	32	36	39	41
16 Noveleta	33,181	38,068	44,032	49,631	54,385	57,911	61.0%	65.0%	70.0%	75.0%	80.0%	80.0%	10	12	15	18	21	22
17 Rosario	77,920	94,941	118,820	144,910	171,812	197,955	55.0%	60.0%	65.0%	70.0%	75.0%	80.0%	21	28	37	49	62	77
Total	**12,660,508**	**13,695,017**	**15,017,377**	**16,436,370**	**17,929,483**	**19,494,777**							**4,961**	**5,379**	**5,946**	**6,603**	**7,220**	**7,922**

Assumptions:
1. Ave. septage /septic tank 5 m3
2.. Collection: 300 days/yr
3. Desludging frequency: every 6 years (5-7 years)
4. Accessibililty: 80%

SINCLAIR KNIGHT MERZ in association with DCCD Engineering Corporation

Annex 9-3

Projected Septage Volume Collected by City/Municipality (Rate Rebasing)

City / Municipality	Projected Population						Water Supply Coverage Targets (Rate Rebasing)					Sanitation Targets (Rate Rebasing)					Septage Volume Collected, m^3/day				
	2001	2005	2010	2015	2020	2025	2005	2010	2015	2020	2025	2005	2010	2015	2020	2025	2005	2010	2015	2020	2025
NCR - East																	**1,264.0**	**1,505.2**	**2,162.3**	**2,866.8**	**3,582.0**
1 Mandaluyong City	279,455	296,293	310,882	322,918	331,374	335,752	100	100	100	100	100	99.5	96	90	85	85	125	126	123	119	121
2 Makati City(part)	398,445	392,647	384,206	371,593	354,551	333,577	100	100	100	100	100	60	62	72	77	77	85	86	97	99	93
3 Quezon City (part)	821,471	722,137	676,968	625,537	568,728	508,624	**100**	100	100	100	100	87	80	84	83	83	258	222	216	194	173
4 Pasig City	512,879	576,228	648,316	722,104	794,589	863,297	**100**	100	100	100	100	91	90	88	86	86	220	244	266	286	311
5 San Juan	116,883	119,133	118,932	117,541	114,765	110,638	100	100	100	100	100	100	100	82	59	59	54	53	43	30	29
6 Taguig	490,560	551,941	642,775	741,048	844,040	949,194	**54**	**70**	**92**	100	100	95	75	74	80	80	94	112	167	223	293
7 Marikina City	398,060	412,731	429,446	442,354	450,155	452,302	**100**	100	100	100	100	100	100	100	100	100	174	182	187	190	191
8 Pateros	57,839	57,438	56,673	55,357	53,419	50,897	100	100	100	100	100	100	100	100	100	100	25	25	24	23	22
9 Manila City (part)	132,756	180,313	180,642	179,145	175,508	169,760	100	100	100	100	100	0	0	100	100	100	-	-	78	77	74
Rizal Province																					
10 Antipolo City	504,654	639,804	857,242	1,137,491	1,491,840	1,932,861	**27**	**51**	**73**	**93**	100	100	100	100	100	100	63	166	341	570	794
11 Cainta	255,740	308,654	387,364	481,453	591,452	717,776	**60**	72	**74**	**78**	**82**	100	100	100	100	100	72	108	138	178	227
12 San Mateo	145,257	183,874	245,853	325,552	426,083	550,900	**56**	**90**	**99**	100	100	100	100	100	100	100	37	84	132	175	226
13 Rodriguez	121,951	149,087	190,309	240,584	300,610	371,061	**37**	**86**	95	**97**	**99**	0	0	100	100	100	-	-	94	120	151
14 Taytay	211,956	267,047	354,825	466,906	607,260	780,232	**53**	**60**	**66**	**94**	100	100	100	100	100	100	51	81	127	234	320
Municipal-Run systems																					
15 Angono	79,834	100,496	133,373	175,297	227,726	292,250	**20**	**32**	**55**	**92**	100	100	100	100	100	100	7	16	40	86	120
16 Binangonan	197,558	237,025	295,155	363,995	443,681	534,256	0	0	**28**	**77**	100	0	0	100	100	100	-	-	39	132	206
17 Cardona	40,249	45,233	51,727	58,582	65,576	72,515	0	0	**24**	**52**	**80**	0	0	100	100	100	-	-	5	13	22
RIZWADA																					
18 Baras	25,815	31,018	38,701	47,820	58,403	70,463	0	0	**24**	**52**	**80**	0	0	100	100	100	-	-	5	12	23
19 Jala-jala	24,369	28,724	34,948	42,110	50,151	59,003	0	0	**24**	**52**	**80**	0	0	100	100	100	-	-	4	10	18
20 Morong	44,158	50,832	59,966	70,059	80,900	92,286	0	0	**24**	**52**	**80**	0	0	100	100	100	-	-	6	16	29
21 Pililia	47,425	56,027	68,367	82,620	98,685	116,446	0	0	**24**	**52**	**80**	0	0	100	100	100	-	-	8	20	36
22 Tanay	81,667	95,441	114,826	136,816	161,125	187,452	0	0	**32**	**69**	**100**	0	0	100	100	100	-	-	17	43	72
23 Teresa	31,268	37,362	46,275	56,761	68,816	82,420	0	0	**24**	**55**	**86**	0	0	100	100	100	-	-	5	15	27
NCR - West																	**1,347**	**1,412**	**1,810**	**1,064**	**1,124**
1 Manila City	1,402,472	1,392,475	1,362,213	1,319,161	1,261,987	1,191,956	100	100	100	100	100	9	9	9	9	9	53	52	50	48	46
2 Pasay City	345,046	355,122	350,412	342,295	330,334	314,760	100	100	100	100	100	68	66	47	0	0	105	101	70	-	-
3 Quezon City (part)	1,444,877	1,566,679	1,699,517	1,817,217	1,911,860	1,978,540	100	100	100	100	100	37	38	97	45	45	238	265	724	353	366
4 Paranaque	462,525	498,242	544,239	588,518	628,723	663,185	100	100	100	100	100	59	53	46	42	42	116	114	107	105	110
5 Las Pinas	484,978	559,481	652,906	754,286	860,899	970,158	60	92	95	97	99	57	50	41	27	27	71	115	114	89	103
6 Caloocan City	1,211,507	1,305,994	1,428,308	1,546,404	1,654,073	1,746,872	100	100	100	100	100	61	47	42	21	21	327	276	267	143	151
7 Makati City(part)	57,006	68,832	60,001	51,698	43,943	36,831	100	100	100	100	100	0	0	0	0	0	-	-	-	-	-
8 Malabon	337,155	330,538	317,956	302,785	284,860	264,608	100	100	100	100	100	42	39	35	6	6	58	52	44	7	7
9 Muntinlupa City	375,331	415,098	447,968	478,589	505,137	526,418	47	87	90	94	98	36	31	26	24	24	25	44	42	44	49
10 Navotas	230,677	245,524	258,011	268,413	275,867	279,944	96	100	100	100	100	65	60	54	10	10	56	58	55	11	11
11 Valenzuela	495,708	528,340	567,069	602,531	632,489	655,543	97	100	100	100	100	90	80	68	36	36	185	182	164	91	95
Cavite Province																					
12 Cavite City	100,289	103,976	105,650	104,612	100,701	94,199	100	100	100	100	100	89	84	91	86	86	33	33	36	33	31
13 Bacoor	315,110	352,753	395,270	431,607	458,171	472,635	62	91	93	95	97	67	60	56	50	50	54	80	86	84	94
14 Imus	201,729	226,717	255,332	280,220	298,977	309,981	35	62	65	71	77	15	15	24	24	24	4	9	17	20	23
15 Kawit	64,751	72,750	81,901	89,850	95,828	99,318	86	100	100	100	100	68	61	52	47	47	16	19	19	18	19
16 Noveleta	33,181	38,068	44,032	49,631	54,385	57,911	45	100	100	100	100	41	39	35	33	33	2	6	6	7	7
17 Rosario	77,920	94,941	118,820	144,910	171,812	197,955	48	90	90	90	90	25	23	20	18	18	3	8	9	10	12
Total	**12,660,508**	**13,695,017**	**15,017,377**	**16,436,370**	**17,929,483**	**19,494,777**											**2,611**	**2,918**	**3,972**	**3,931**	**4,706**

Note: Water Supply Rate Rebasing values in bold are proposed by Water Supply Masterplan.

Annex 9-4

Projected Septage Volume Collected by City/Municipality (Adjusted MWSI Rate Rebasing to include septage from STED system)

City / Municipality	Projected Population						Water Supply Coverage Targets (Rate Rebasing)					Sanitation Targets (Rate Rebasing)					Septage Volume Collected, m^3/day				
	2001	2005	2010	2015	2020	2025	2005	2010	2015	2020	2025	2005	2010	2015	2020	2025	2005	2010	2015	2020	2025
NCR - East																	**1,264.0**	**1,505.2**	**2,162.3**	**2,866.8**	**3,582.0**
1 Mandaluyong City	279,455	296,293	310,882	322,918	331,374	335,752	100	100	100	100	100	99.5	96	90	85	85	125	126	123	119	121
2 Makati City(part)	398,445	392,647	384,206	371,593	354,551	333,577	100	100	100	100	100	60	62	72	77	77	85	86	97	99	93
3 Quezon City (part)	821,471	722,137	676,968	625,537	568,728	508,624	**100**	100	100	100	100	87	80	84	83	83	258	222	216	194	173
4 Pasig City	512,879	576,228	648,316	722,104	794,589	863,297	**100**	100	100	100	100	91	90	88	86	86	220	244	266	286	311
5 San Juan	116,883	119,133	118,932	117,541	114,765	110,638	100	100	100	100	100	100	100	82	59	59	54	53	43	30	29
6 Taguig	490,560	551,941	642,775	741,048	844,040	949,194	**54**	**70**	**92**	100	100	95	75	74	80	80	94	112	167	223	293
7 Marikina City	398,060	412,731	429,446	442,354	450,155	452,302	**100**	100	100	100	100	100	100	100	100	100	174	182	187	190	191
8 Pateros	57,839	57,438	56,673	55,357	53,419	50,897	100	100	100	100	100	100	100	100	100	100	25	25	24	23	22
9 Manila City (part)	132,756	180,313	180,642	179,145	175,508	169,760	100	100	100	100	100	0	0	100	100	100	-	-	78	77	74
Rizal Province																					
10 Antipolo City	504,654	639,804	857,242	1,137,491	1,491,840	1,932,861	**27**	**51**	**73**	**93**	100	100	100	100	100	100	63	166	341	570	794
11 Cainta	255,740	308,654	387,364	481,453	591,452	717,776	**60**	72	**74**	**78**	**82**	100	100	100	100	100	72	108	138	178	227
12 San Mateo	145,257	183,874	245,853	325,552	426,083	550,900	**56**	**90**	**99**	100	100	100	100	100	100	100	37	84	132	175	226
13 Rodriguez	121,951	149,087	190,309	240,584	300,610	371,061	**37**	**86**	95	**97**	**99**	0	0	100	100	100	-	-	94	120	151
14 Taytay	211,956	267,047	354,825	466,906	607,260	780,232	**53**	**60**	**66**	**94**	100	100	100	100	100	100	51	81	127	234	320
Municipal-Run systems																					
15 Angono	79,834	100,496	133,373	175,297	227,726	292,250	**20**	**32**	**55**	**92**	100	100	100	100	100	100	7	16	40	86	120
16 Binangonan	197,558	237,025	295,155	363,995	443,681	534,256	0	0	**28**	**77**	100	0	0	100	100	100	-	-	39	132	206
17 Cardona	40,249	45,233	51,727	58,582	65,576	72,515	0	0	**24**	**52**	**80**	0	0	100	100	100	-	-	5	13	22
RIZWADA																					
18 Baras	25,815	31,018	38,701	47,820	58,403	70,463	0	0	**24**	**52**	**80**	0	0	100	100	100	-	-	5	12	23
19 Jala-jala	24,369	28,724	34,948	42,110	50,151	59,003	0	0	**24**	**52**	**80**	0	0	100	100	100	-	-	4	10	18
20 Morong	44,158	50,832	59,966	70,059	80,900	92,286	0	0	**24**	**52**	**80**	0	0	100	100	100	-	-	6	16	29
21 Pililia	47,425	56,027	68,367	82,620	98,685	116,446	0	0	**24**	**52**	**80**	0	0	100	100	100	-	-	8	20	36
22 Tanay	81,667	95,441	114,826	136,816	161,125	187,452	0	0	**32**	**69**	**100**	0	0	100	100	100	-	-	17	43	72
23 Teresa	31,268	37,362	46,275	56,761	68,816	82,420	0	0	**24**	**55**	**86**	0	0	100	100	100	-	-	5	15	27
NCR - West																	**1,347**	**1,431**	**1,873**	**1,423**	**1,790**
1 Manila City	1,402,472	1,392,475	1,362,213	1,319,161	1,261,987	1,191,956	100	100	100	100	100	9	9	**11**	**17**	**18**	53	52	62	91	91
2 Pasay City	345,046	355,122	350,412	342,295	330,334	314,760	100	100	100	100	100	68	66	47	**13**	**25**	105	101	70	19	34
3 Quezon City (part)	1,444,877	1,566,679	1,699,517	1,817,217	1,911,860	1,978,540	100	100	100	100	100	37	38	97	45	45	238	265	724	353	366
4 Paranaque	462,525	498,242	544,239	588,518	628,723	663,185	100	100	100	100	100	59	53	46	42	**62**	116	114	107	105	163
5 Las Pinas	484,978	559,481	652,906	754,286	860,899	970,158	60	92	95	97	99	57	50	41	27	**52**	71	115	114	89	198
6 Caloocan City	1,211,507	1,305,994	1,428,308	1,546,404	1,654,073	1,746,872	100	100	100	100	100	61	47	42	**44**	**53**	327	276	267	299	380
7 Makati City(part)	57,006	68,832	60,001	51,698	43,943	36,831	100	100	100	100	100	0	0	0	0	0	-	-	-	-	-
8 Malabon	337,155	330,538	317,956	302,785	284,860	264,608	100	100	100	100	100	42	39	35	**27**	**34**	58	52	44	32	37
9 Muntinlupa City	375,331	415,098	447,968	478,589	505,137	526,418	47	87	90	94	98	36	**44**	**58**	**57**	**63**	25	63	94	105	129
10 Navotas	230,677	245,524	258,011	268,413	275,867	279,944	96	100	100	100	100	65	60	54	**17**	**28**	56	58	55	18	31
11 Valenzuela	495,708	528,340	567,069	602,531	632,489	655,543	97	100	100	100	100	90	80	68	**55**	**66**	185	182	164	139	173
Cavite Province																					
12 Cavite City	100,289	103,976	105,650	104,612	100,701	94,199	100	100	100	100	100	89	84	91	86	86	33	33	36	33	31
13 Bacoor	315,110	352,753	395,270	431,607	458,171	472,635	62	91	93	95	97	67	60	56	50	50	54	80	86	84	94
14 Imus	201,729	226,717	255,332	280,220	298,977	309,981	35	62	65	71	77	15	15	24	24	24	4	9	17	20	23
15 Kawit	64,751	72,750	81,901	89,850	95,828	99,318	86	100	100	100	100	68	61	52	47	47	16	19	19	18	19
16 Noveleta	33,181	38,068	44,032	49,631	54,385	57,911	45	100	100	100	100	41	39	35	33	33	2	6	6	7	7
17 Rosario	77,920	94,941	118,820	144,910	171,812	197,955	48	90	90	90	90	25	23	20	18	18	3	8	9	10	12
Total	**12,660,508**	**13,695,017**	**15,017,377**	**16,436,370**	**17,929,483**	**19,494,777**											**2,611**	**2,936**	**4,035**	**4,290**	**5,372**

Note: 1. Water Supply Rate Rebasing values in bold are proposed by Water Supply Masterplan.
2. Sanitation Targets (Rate Rebasing) of MWSI in bold adjusted to consider the STED/combined systems requirements for septage treatment plants
3. Rate rebasing targets used for 2005, 2010, 2015, 2020 are rate rebasing targets of 2006, 2011, 2016, 2021 respectively

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Annex 9-5

Investment Cost for Proposed SpTPs and Vacuum Tankers

(Based on adjusted rate rebasing to consider STED systems)

	2005	2010	2015	2020	2025	Total (P million)	With 30 % Contingencies
MWCI							
o Rizal							
SpTP (m^3/d)			800		800		
Land (ha)			4.00				
Amount (P million)			*973*		*941*	***1,914***	2,488
MWSI							
o Dagat-dagatan							
SpTP (m^3/d)		400	200	200	200		
Amount (P million)		*470*	*235*	*235*	*235*	***1,176***	1,529
o Paranaque							
SpTP (m^3/d)		200	200		100		
Land (ha)		3.00					
Amount (P million)		*475*	*235*		*118*	***828***	1,076
Sub-total (SpTP)		**946**	**1,443**	**235**	**1,294**	**3,918**	5,093
MWCI							
o Vacuum Tankers							
5 m3				31	5		
10 m3			2	110	33		
Amount (P million)			*9*	*606*	*166*	***781***	1,015
MWSI							
o Vacuum Tankers							
5 m3		6	5	4	11		
10 m3		40	42	20	54		
Amount (P million)		*201*	*206*	*104*	*282*	***794***	1,032
Sub-total (Tankers)		**201**	**215**	**710**	**448**	**1,574**	2,046
Total		**1,147**	**1,659**	**945**	**1,742**	**5,492**	**7,139**
Grand Total (with 30 % contingencies)						**7,139**	
Cost of sludge disposal (P million)							
MWCI		6.77	9.73	12.90	16.12		
MWSI		6.28	8.43	6.40	8.05		
Total		*13.05*	*18.16*	*19.30*	*24.17*		

Note:
Unit Price of SpTP (\$/m^3/d) = 21,000.00
Conversion of \$ to P 56.00
Land (ha) = 3.00
Cost of Land in Rizal (P/ m2) 800.00
Cost of Land in Paranaque (P/m2) 8,000.00
Cost of 5 m^3 tanker (\$/unit)= 65,000.00
Cost of 10 m^3 tanker (\$/unit) = 80,000.00
Only 90 % of vacuum tankers are assumed to be purchased by concessionaire, rest by private contractors
Cost of sludge disposal to lahar areas = P 300/m^3

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Annex 9-6

O & M Cost for Proposed SpTPs and Vacuum Tankers
(Based on adjusted 2003 rate rebasing and proposed STED systems)

	2005	2010	2015	2020	2025
MWCI					
o Rizal					
SpTP (m^3/d)			800	800	1,600
Amount (P million)			*65.36*	*65.36*	*130.72*
MWSI					
o Dagat-dagatan					
SpTP (m^3/d)		400	600	800	1,000
Amount (P million)		*32.68*	*49.02*	*65.36*	*81.70*
o Paranaque					
SpTP (m^3/d)		200	400	400	500
Amount (P million)		*16.34*	*32.68*	*32.68*	*40.85*
Sub-total (SpTP)		**49.02**	**147.06**	**163.40**	**253.27**
MWCI					
o Vacuum Tankers					
5 m3		17	16	31	36
10 m3		104	92	112	143
Amount (P million)		*124.84*	*111.32*	*146.12*	*183.27*
MWSI					
o Vacuum Tankers					
5 m3		12	11	9	15
10 m3		40	82	62	74
Amount (P million)		*53.04*	*96.22*	*73.38*	*91.50*
Sub-total (Tankers)		**177.88**	**207.54**	**219.50**	**274.77**
Total		**226.90**	**354.60**	**382.90**	**528.04**

Note:
1. O & M per 10 m^3 vacuum tanker (PhP/tanker/yr) = 1.05 million
2. O & M per 5 m^3 vacuum tanker (PhP/tanker/yr) = 0.92 million
3. Vacuum tankers are those operating during the period which includes the current as well as those purchased in the previous period.
4. O & M of SpTP (PhP/m^3) = 0.082 million
5. Two trips/day/vacuum tanker
6. Only 90 % of vacuum tankers are assumed to be purchased by concessionaire, rest by private contractors

Appendix to Chapter 10

1. Introduction

1.1 General

This Annex to Chapter 10 Sewerage Master Plan for Metro Manila to 2025 presents the details of the planning and preliminary engineering undertaken in the development of the Sewerage Master Plan (SMP) for Metro Manila. The sewerage plans for the planning horizons were developed for the delineated drainage catchments in the city or municipality where sewerage coverages up to 2021 are specified by contractual agreements between MWSS and its two concessionaires. Beyond 2021, sewerage coverage is prioritized for densely populated areas, environment protection and prime residential areas currently suffering from constrained water supply that will be environment protection, serviced by the potential Laiban dam development.

1.2 Bases of Sewerage Planning

Sewerage planning for Metro Manila was based on the following:

- Contractual sewerage coverage specified by the Concession Agreements until 2021 and rate rebasings approved by the MWSS-Regulatory Office (MWSS-RO);
- Preliminary engineering criteria as set by planning and design guidelines of the MWSS, MWSI and MWCI;
- Wastewater (residential and commercial) projections for each of the city / municipality, where contractual sewerage coverages are specified;
- Identification of critical areas (i.e. pollution “hot spots”) not covered by the Concessionaires contractual sewerage coverage that need to be urgently addressed between 2021 and 2025; and
- Longer-term strategy for sewerage coverage beyond the Master Plan period of 2025.

The above bases for sewerage planning are described in detail in SAP #8.

Planning Horizon - The planning horizon adopted for the Sewerage Master Plan (SMP) is 20 years beginning 2005, with SMPs formulated for the time horizons of 2010, 2015, 2020, and 2025. The 25-year concession agreement for water and sewerage services in the MWSS service area started in August 1997. Minimum targets for water, sanitation and sewerage coverages are specified in the concession agreement every five years beginning in 1997, i.e. 2001, 2006, 2011, 2016 and 2021.

Sewerage Coverage Targets - These targets were specified for the East and West Zones service areas in the 1997 concession agreements; but were revised in the rate rebasing determination by the MWSS-RO in 2002/2003 for the two concessionaires. These revised coverages are presented in **Table 1-1** wherein the sewerage coverage targets are expressed as the percentages of water served population. Sewerage coverage for the planning horizons for this study were interpolated from these rates rebased values as planning years did not match. Beyond 2021, sewerage coverage focused on selected densely populated areas and developed or up-scale population centers (with high capacity to pay), whose current water supply will be significantly improved by the development of new water sources in the future.

Planning and Design Guidelines / SewerCAD – The planning and design guidelines of MWSI[1] were used in the sewerage master planning, with appropriate modifications as presented in East Concession Area Master Plan Update, 2005. The planning and design criteria cover: peak factors, minimum/maximum velocity calculation, minimum pipe size, minimum slopes, manhole size and spacing, minimum / maximum depth of pipe cover, pumps & pumping stations hydraulics, etc. Many of these parameters are built-in the hydraulic software model SewerCAD©.

SewerCAD©. is a design and analysis tool for planning and implementing sewerage systems, for developing and computing sanitary (sewage flow) loads, and to dynamically simulate the hydraulic response of the entire system including gravity collection and pressure force mains.

For the hydraulic simulation, SewerCAD©. utilizes the basic principles of conservation of mass and conservation of energy.

The SewerCAD©. interface allows for the integration of CAD for a more accurate and convenient representation of the sewer system. Required inputs are pipe lengths, pipe materials, infiltration, minimum / maximum slopes, minimum / maximum velocities, and ground cover. Manhole data includes ground elevation and sewage flow loading. SewerCAD©. assess the aforementioned conditions to design the initial system.

The pipe, hydraulic & energy gradient profiles, and ground profiles can be conveniently viewed to assess a change in the input parameters.

SewerCAD©. generates reports for the gravity and pressure pipes, manholes, pumps and wet wells. The optimized design includes the pipe sizes, slopes and invert elevations, and manhole depth.

File output of the SewerCAD©. is convertible to a spreadsheet format to facilitate further spreadsheet calculations like cost estimation or for graphics presentations.

Projections of Sewage Flows – The projection of sewage flows for the planning horizons was made using the water supply projections that consisted of domestic, commercial and industrial demands. The sewage flow was calculated as the 80% of the sum of domestic and commercial water use. The industrial wastewater is not included.

The total sewage flow to a facility is the sewage flow calculated above plus infiltration, estimated at 7.5 m^3/ha of catchment area.

Critical Pollution Areas – These “hotspot” areas are the densely populated areas of over 250 persons/ha, like Pateros, Taguig, Las Piñas, etc. and subject to poor drainage due to topographic conditions and prone to flooding like the lake or bay coastal plains.

[1] *MWSI Project Management Project – Planning and Design Guidelines for Water Supply and Sewerage Systems (1999):*

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Table 1-1 Sewerage Coverage Targets for the East and West Zones

City / Municipality	Percent Sewerage Coverages***							
	2006	2010*	2011	2015*	2016	2020*	2021	
West Zone	RR	interpolated	RR	interpolated	RR	interpolated	RR	SMP 2025
Manila (92%)	55	68	71	76	77	82	83	91
Quezon City (63%)	0	0	0	0	0	0	0	11
Makati (12%)	-	-	-	-	-	-	-	-
Pasay	0	0	0	0	0	13	16	25
Caloocan	3	2	2	2	2	26	32	38
Las Piñas	0	0	0	0	0	0	0	25
Malabon	2	2	2	2	2	31	38	38
Muntinlupa	0	35	44	54	57	55	54	61
Navotas	3	3	3	3	3	29	36	36
Parañaque	0	0	0	0	0	0	0	20
Valenzuela	0	0	0		0	19	24	24
East Zone								
Manila (8%)	-	-	-	-	-	-	-	-
Quezon City (37%)	13	19	20	17	16	17	17	17
Makati (88%)	40	38	38	28	28	24	23	23
Mandaluyong**	1	3	4	9	10	14	15	15
Marikina	0	0	0	0	0	0	0	19
Pasig**	9	10	10	12	12	14	14	44
Pateros	0	0	0	0	0	0	0	100
San Juan	0	0	0	14	18	36	41	59
Taguig**	5	21	25	26	26	21	20	51
Cainta**	0			5		5		5
Taytay**	0	0		5		5		5

* Interpolated sewerage coverage from the 2002/2003 Rate Rebasing by MWSS-RO
** Includes coverages by MTSP and existing systems
*** Coverage target expressed as percentage of the water-served population
\- no target indicated

1.3 Catchment Areas

Using topographic maps of Metro Manila covering the East and West Zone service areas of the MWSS, thirty-one (31) drainage catchments proposed for sewerage were delineated as shown in **Figure 1.1** and listed in **Table 1.2**.

These catchments were grouped into four Metro Manila regions, namely: West, North, Central and East.

The proposed sewerage systems are essentially gravity systems, with the treatment plant located at the low zone of the catchment area. The sewerage system may cover more than one drainage catchments, e.g. in an area with relatively flat terrain, where dirty water can be pumped over catchment divides. In a rolling or highly irregular terrain, a sewerage catchment may also involve several small sewerage systems to avoid excessive pumping over the sub-catchments.

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Table 1.2 -The 31 Sewerage Catchments and Areas in the MWSS Service Area

Catchment Area / Name	Catchment No. / Name	Area, ha.	Existing sewered Areas, ha	2005 Sewered Area (%)
I West Metro Manila Region				
(a) South Manila Area	1 **W-1 Muntinlupa**	3,949	850	22%
	2 **W-2 Las Pinas**	3,928	-	-
	3 **W-3 Paranaque**	3,648	-	-
	4 **W-4 Pasay - NAIA**	1,657	-	-
	5 **W-5 South Manila**	1,167	-	-
(b) Manila Area	6 **W-6 Pandacan**	500	500	100%
	7 **W-7 Central-Manila**	713	713	100%
	8 **W-8 Central-North**	1,715	1,492	87%
	9 **W-9 Sampaloc**	654	-	-
	10 **W-10 Balut**	140	79	56%
II North Metro Manila Region				
(c) Calo-Mala (Dagat-dagatan) Area	11 **W-11 Dagat-Dagat**	520	520	100%
	12 **W-12 Caloocan**	717	-	-
	13 **W-13 Malabon-Tullahan**	989	-	-
(d) Caloocan Novaliches Area	14 **W-18 Caloocan B**	4,084	-	-
(e) Navotas-Malabon-Valenzuela Area	15 **W-16 Navotas**	3,130	-	-
	16 **W-17 Valenzuela**	2,835	-	-
III Central Metro Manila Region				
(f) QC Novaliches-QC North Area	17 **W-14 QC Novaliches**	2,027	-	-
	18 **W-19 Malabon**	1,489	-	-
(g) Quezon West & Central Area	19 **W-15 Quezon West**	1,079	-	-
	20 **EW-1 Quezon Central**	1,502	466	31%
(h) QC North & East Area	21 **EW-2 Quezon North**	3,329	265	8%
	22 **EW-3 Quezon East**	2,432	67	3%
IV East Metro Manila Region				
(i) Pasig-Taytay Area	23 **E-1 Taguig****	1,875	656	35%
	24 **E-2 Makati**	2,322	819	35%
	25 **E-3 Pateros****	1,495	661	44%
	26 **E-7 Taytay**	2,835	-	0%
(j) QC South-SanJuan-Manda-Pasig Area	27 **E-4 Bonifacio**	249	249	100%
	28 **E-5 Pasig****	3,294	439	13%
	29 **E-6 Manda-San Juan**	1,036	32	3%
	30 **E-8 QC South**	2,074	381	18%
(k) Marikina-Cainta Area	31 **E-9 Cainta-Marikina**	5,817	37	1%
** With planned sewerage coverage by MTSP	TOTAL	63,197	8,226	13%
	Metro Manila	59,674	8,226	14%

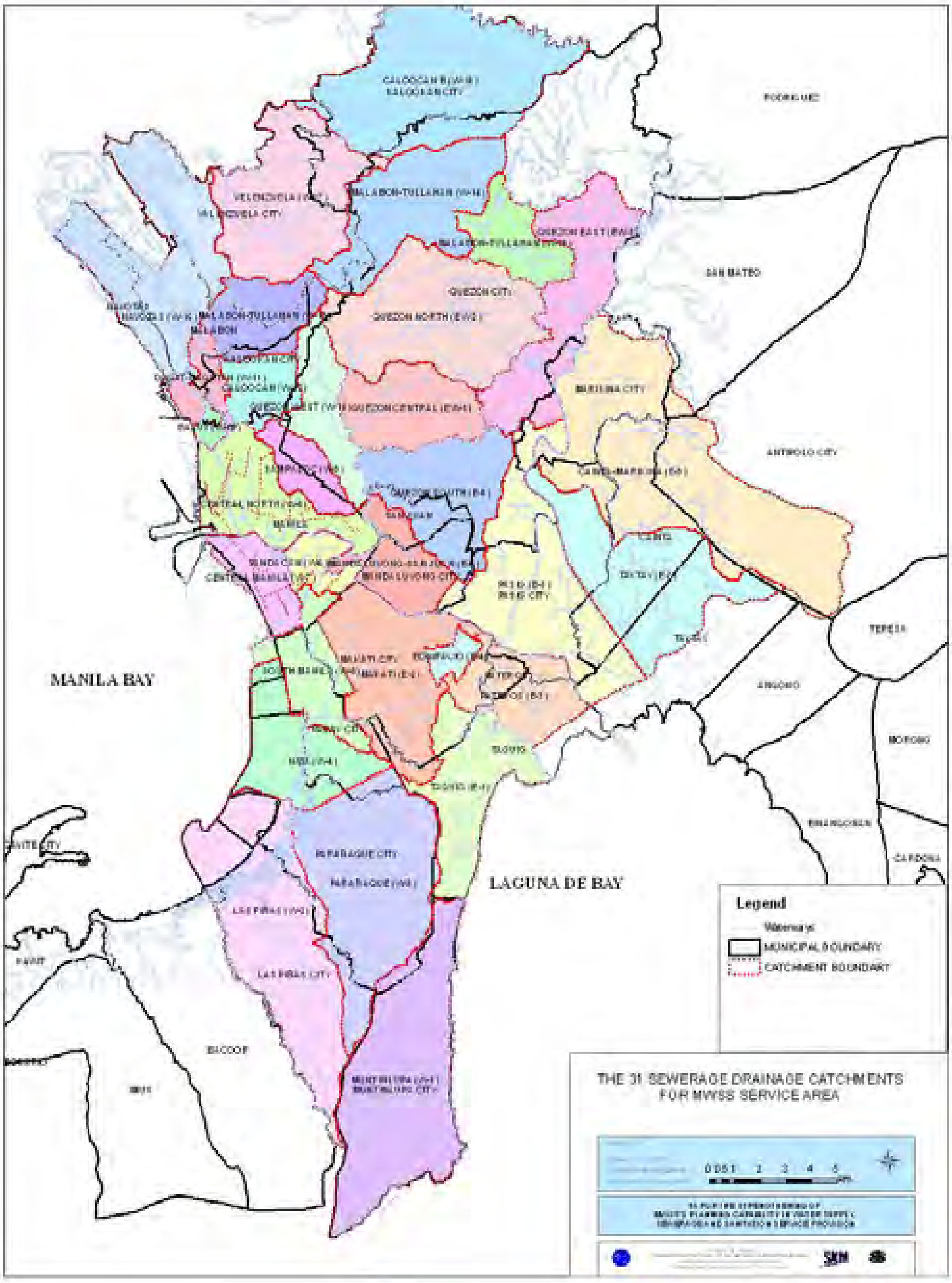

Figure 1-1 The 31 Sewerage/Drainage Catchments in the MWSS Service Area

2. West Metro Manila Region

The West Metro Manila region for sewerage covers the cities of Manila, Pasay, Paranaque, Las Pinas and Muntinlupa, all in the West Zone concession area. In these five cities, there are ten delineated drainage catchments with total area of 18,070 ha or about 30% of the NCR area. In 2005, the population in these five cities is about 3.4 million (32% of the NCR population) and projected to increase to 3.6 million in 2015. Manila and Pasay cities are densely populated with densities of 389 and 197 person/ha, respectively, in 2005 but are projected to decrease in the next decades. Paranaque, Las Piñas and Muntinlupa have population densities ranging from 108 to 228 people/ha.

The contiguous cities of Parañaque, Las Piñas and Muntinlupa have generally similar land use plans of dominantly residential development (62%), commercial (20%) and open space (19%). Among these four cities, Parañaque has a large industrial area of 530 ha (12% of the city area).

2.1 South Manila Area Catchment (W-1 to W-6)

The South Manila Area sewerage systems cover the cities of Muntinlupa, Parañaque, Las Piñas and Pasay, or five delineated catchments with a total area of 14,348 ha. The Muntinlupa, Las Piñas and Parañaque catchments are each over 3,600 hectares, mainly residential and commercial development with a number of industrial zones.

Topography is rolling at the upper areas of the catchments, with well-defined drainage patterns. Towards the lake or bay shores, the rolling topography flattens out. Except for the Muntinlupa catchment that drains to the freshwater Laguna de Bay, all systems drain westward to Manila Bay.

At present, except for Pasay, potable water supply is constrained in this area. By 2015, sufficient water could be available from a potential Laiban Dam development. This increased availability of water will have an adverse environmental impact in terms of the increased generated sewage. Sewerage systems should be established, particularly in Las Piñas and Parañaque, currently suffering from constrained water supply. Contractual sewerage coverage is not required in these areas within the concession period. The 2025 time horizon has provided sewerage coverage for Las Piñas and Parañaque.

2.1.1 Muntinlupa Sewerage System (W-1)

The proposed Muntinlupa sewerage system will service Muntinlupa, a Laguna de Bay coastal city with a current population of 415,098.

2.1.1.1 Catchment Description

Topography and Drainage – The 3,950ha Catchment W-1 covers the whole city and a small portion of Parañaque. The catchment terrain is hilly at the south and west portions, and becomes rolling and flat towards the lakeshores. Elevations at the hills vary from 30 to 60 m above mean seal level, while the flatlands at the lakeshore are at 2 to 6 m levels. Some five major creeks drain storm run-offs in north easterly pattern towards the Laguna Lake.

Land Use – The city landuse is predominantly residential and commercial, respectively at 59% and 30%. Open space is small at 7%, and minimal for industry and institution.

The catchment is traversed by the South Luzon Expressway, enabling convenient access to Manila, thus the many residential subdivisions. Most of the residential developments are by private developers and several by the government housing agencies and owned by the middle to high income groups. Standard storm sewer systems and septic tanks are installed.

STP Site - The proposed STP site shown in photo at right is located at San Guillermo St., Alabang, at the south river mouth bank of the Alabang River. The present open lot is private owned. Additional land requirement maybe met by land reclamation at the lakeshore. STP effluent maybe discharged to the river or via an outfall to the Lake.

2.1.1.2 Sewerage Options

Sewerage coverage targets for Muntinlupa were specified in the Concession Agreements for as early as 2001, and increasing towards the end of the concession period in 2021. The early targets for sewerage are justified by the need to protect the freshwater Laguna Lake, considered as a source of potable water for Metro Manila. In 2005, the existing sewerage system operated by a private entity covers 850 hectares or about 22% of the catchment area.

Two sewerage options are proposed for Muntinlupa namely: Option A: Continue operation of the Ayala Alabang and Filinvest Alabang private STPs and build a new STP to service other areas; and Option B: decommission the existing two STPs and build a centralized single STP at the proposed lakeshore site.

Reticulation for the new sewerage areas is by combined drainage and STED, the latter to be used at the lakeshore residential settlements and the former at the residential subdivisions where orderly storm drainage systems exist. The existing private sewerage at Alabang utilizes separate systems.

Sewerage development: In 2010, the proposed Muntinlupa sewerage system has a target coverage of 35%. The private Ayala Alabang and Filinvest Sewerage systems already cover the 22%. The 13% deficit in coverage will be met by a new reticulation / trunk sewer system and a new STP with adequate capacity until 2020.

In 2015, the Muntinlupa system will be expanded by an additional coverage of 19%; the trunkline will be extended to convey flows from the additional reticulation areas. The new Bilibid Prison's vast property, that is being be considered for urban renewal under the proposed Metro Manila Urban Services for the Poor Project, forms part of the Muntinlupa System and is incorporated in 2015. In 2020, an additional 1% coverage will be made, with expansion of reticulation works and expansion of the 2010 STP. In 2025, another 7%

additional coverage will be made. Only reticulation work will be installed with no expansion of existing 2020 STP.

Sewerage Layout – The sewerage layout is shown in **Figure 2.1**. Expansion of the service area as well as the trunks extensions are shown for each of the planning horizon of 2010, 2015, 2020 and 2025.

SewerCAD Modelling – Hydraulic analysis of the trunk sewer was made using the SewerCAD© software. Inputs to the model like sewage flows (reticulation flow from each sub-catchment) at nodes, ground and pipe elevations at the nodes, lift stations, etc, are presented in **Annex 2.1.1** Muntinlupa Sewerage System.

2.1.1.3 Recommended Option and Cost

The recommended option for the development of the Muntinlupa Sewerage system is shown in **Figure 2.1** with the summary of facilities and costs presented in **Table 2.1.**

A total capital investment of P 5.215 B is required for the full development of the proposed Muntinlupa sewerage system that would meet the specified sewerage coverages under the concession agreement to 2021. An estimated population of 198,000 would be benefited from the sewerage development by 2025.

Table 2.1 Summary of Facilities and Costs for the proposed Muntinlupa Sewerage System

Muntinlupa Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	1,494	500	40	170	**2,204**
	Incremental Sewage Flow (STP Capacity) (Mld):	40	0	20	0	**60**
	Increment trunk sewers total length (m), (∅250mm - ∅1200mm)	3,735	16,034	0	0	**19,769**
	Required STP Area (ha)	2.01	0	1.04	0	**3.05**
	* includes existing sewered 850 ha					
	Costs in P million					
	STP Land Cost	402	0	208	0	**610**
	STP Incremental Cost:	1,408	0	499	0	**1,907**
	Sewer Trunks Cost:	117	305	0	0	**422**
	Reticulation Cost :	998	900	72	306	**2,276**
	Total	2,925	1,205	779	306	**5,215**

Figure 2.1 Proposed Muntinlupa Sewerage System

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2.1.2 Pasay Sewerage System (W-4 part)

Pasay City, with a land area of 1,805 ha, is bordered by Manila, Makati, Parañaque and Manila Bay respectively at the north, east, south and west sides. Large tract of land has been reclaimed at the bay shore area and these lands are being developed for high-rise residential, shopping malls and mix-use. Land use for Pasay is similar to adjoining Manila, which is predominantly residential.

In 2005, Pasay City has a population of 355,122. Like its neighbour Manila, population is projected to decrease to 342,295 in 2005 and much less to 314,760 in 2025. Population density in 2005 is 187 people/ha.

2.1.2.1 Catchment Description

The 1,657-ha W-4 catchment covers a greater part of the City. Topography is generally flat with elevations varying from 2 to 6 m above MSL. A large part of the City is low-lying reclaimed salt beds. A tributary to the Parañaque River that traverses the catchment provides the main drainage way for the upper portion of the catchments. A pump station for flood control is installed at the downstream end of Maricaban Creek.

Except for the new land development at the new reclaimed land at the bay shore, the catchment is dominated by old dense residential neighborhood and commercial establishments along the main road. This dense settlement area is covered by the proposed sewerage system.

STP Site – The proposed STP site (refer to photo at right) will be located at the vicinity of Roxas Blvd corner NAIA Road, a reclaimed vacant lot at present. Effluent discharge will be directed to the nearby creek leading to Manila Bay. Vicinity development at the proposed STP site consists of commercial and residential highrises.

2.1.2.2 Sewerage Options

Sewerage development: Sewerage coverage of 16% of the population by 2021 is specified by the concession agreement. The proposed sewerage system satisfies this coverage requirement. The City is 100% covered by the water supply system of the West Zone concessionaire.

In 2020, the proposed Pasay sewerage system will cover 13% of the City or an area of 230 ha. A new STP, trunk lines and reticulation works will be installed as shown in **Figure 2.2**. By 2025, the Pasay sewerage system will be expanded to 25% or a total reticulation area of 655 ha. New trunk lines, reticulation works will be installed and the STP expanded to a total 42 MLD.

Sewerage Option / Layout – The sewerage option with STED reticulation suits the non-uniform dense residential neighbourhood with relatively poor drainage systems. The sewerage layout is shown in **Figure 2.2**.

SewerCAD Modelling – Hydraulic analysis of the trunk sewer was made using the SewerCAD software. Inputs to the model like sewage flows (reticulation flow from each sub-catchment) at nodes, ground and pipe elevations at the nodes, pipe lengths, pipe materials, etc, are presented in **Annex 2.1.2** Pasay Sewerage System.

2.1.2.3 Recommended Option and Cost

The recommended option for the proposed Pasay Sewerage system is shown in **Figure 2.2** with the summary of facilities and costs shown in **Table 2.2**

Table 2.2 Summary of Facilities and Costs for the proposed Pasay Sewerage System

Pasay Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	0	0	230	425	**655**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	15	27	**42**
	Increment trunk sewers total length (m), (∅375mm - ∅1350mm)	0	0	3,325	4,433	**7,758**
	Required STP Area (ha)	0	0	0.79	1.44	**2.23**
	* includes existing sewered 750 ha					
	Costs in P million					
	STP Land Cost	0	0	198	360	**558**
	STP Incremental Cost:	0	0	380	684	**1,065**
	Sewer Trunks Cost:	0	0	112	496	**608**
	Reticulation Cost :	0	0	414	765	**1179**
	Total	0	0	1,104	2,305	**3,409**

2.1.3 Las Piñas Sewerage System (W-2 part)

Las Pinas City, with a land area of 3,299 ha, is bordered by Parañaque, Muntinlupa, Bacoor and Manila Bay at the north, east, south and west sides respectively. At its bayshore, a large land reclamation started in the late 1990s but is now on-hold.

In 2005, Las Piñas City has a population of 559,481 and a density of 1,696 people/ha. Population is projected to 754,286 in 2015 and population density of 2,941 people/ha in 2025.

2.1.3.1 Catchment Description (W-2)

Catchment W-2 with an area of 3,928 ha covers the City and beyond. The proposed Las Piñas sewerage system of 1,249 ha in 2025 will cover about 38% of the city area.

The elongated catchment has a rolling terrain at its south east end and becomes flatter northwest towards the bay. Elevations at the rolling areas range from 20 to 40 m, while the flatlands are at elevation 2 to 10 m. The Las Piñas River traversing the catchment provides the main drainage way towards Manila Bay.

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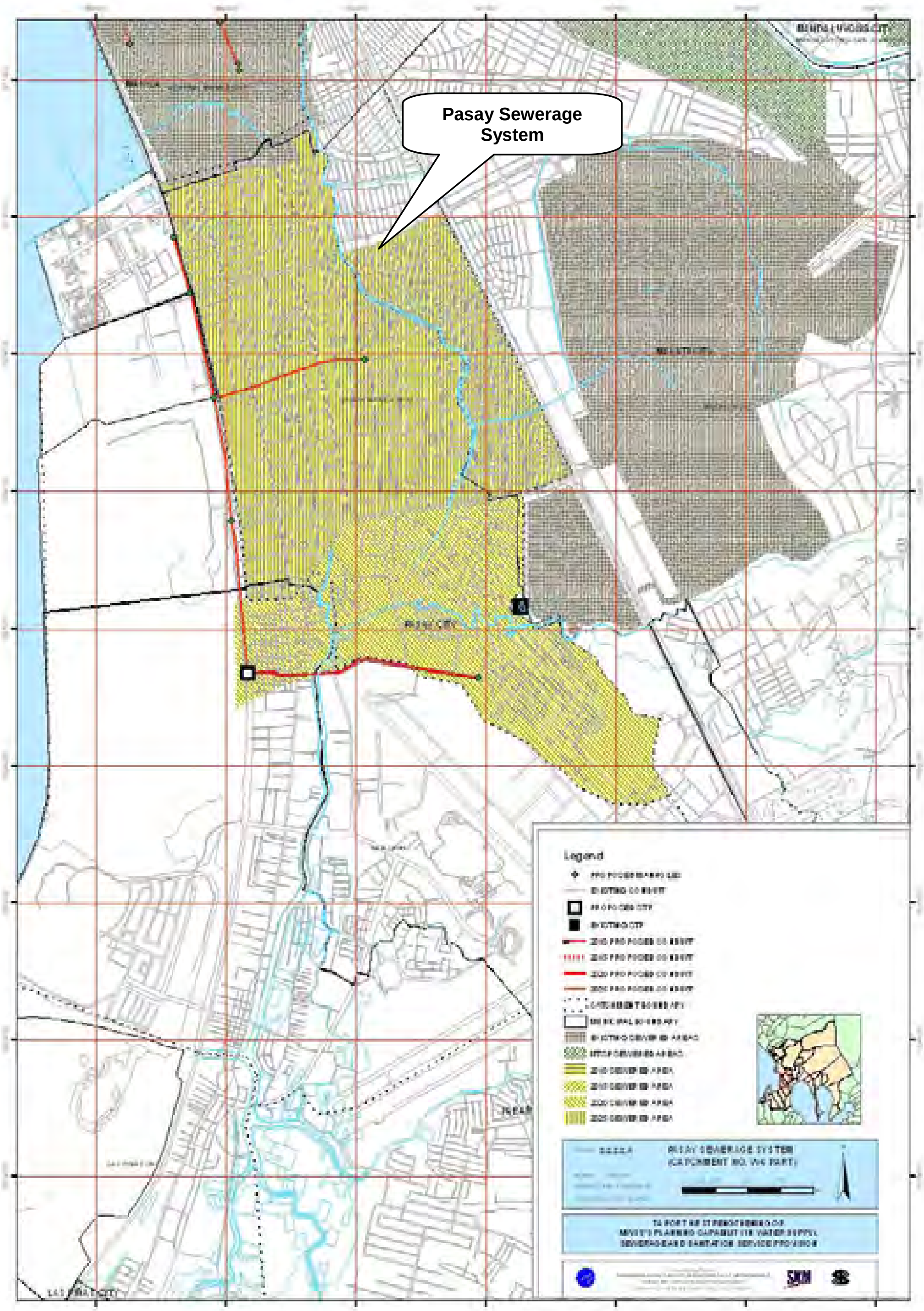

Landuse for Las Piñas or essentially the catchment is 62% residential, 16% commercial, 17% open space and the rest is industrial and commercial. Due to proximity to Manila and good road access with other areas, there are large number of residential subdivisions of middle to high income groups.

STP Site – The proposed STP site is planned for location at Alabang-Zapote Road, at a large vacant lot besides the Uniwide Sales Metromall, Las Piñas (refer to photo at right). Effluent discharge will be directly into a nearby tributary creek to the Las Pinas River draining to Manila Bay. The proposed STP is surrounded by a commercial area, and a large open land partly occupied by informal settlers along the creek.

2.1.3.2 Sewerage Options

Description – No sewerage coverage is required for Las Piñas during the concession period. Due to dense population, Las Piñas sewerage system will only start in year 2025 with a coverage area of 25%. The proposed sewerage system is STED reticulation system with trunks conveyance. A new STP, trunk lines, and reticulation works will be constructed as shown in **Figure 2.3.**

Sewerage Option / Layout – The sewerage option with STED reticulation is proposed for the sewerage system. The initial sewerage area covers a dense population with the sewerage layout is shown in **Figure 2.3**.

SewerCAD Modelling – Hydraulic analysis of the trunk sewer was made using the SewerCAD software. Inputs to the model like sewage flows (reticulation flow from each sub-catchment) at nodes, ground and pipe elevations at the nodes, pipe lengths, pipe materials, etc, are presented in **Annex 2.1.3** Las Piñas Sewerage System.

2.1.3.3 Recommended Option and Cost

The recommended option for the Las Piñas Sewerage system is shown in **Figure 2.3** with the summary of facilities and costs presented in **Table 2.3.**

Table 2.3 Summary of Facilities and Costs for the proposed Las Pinas Sewerage System

Las Pinas Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	0	0	0	1249	**1,249**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	0	80	**80**
	Increment trunk sewers total length (m), (∅300mm - ∅900mm)	0	0	0	4,807	**4,807**
	Required STP Area (ha)	0	0	0	5.5	**5.5**
	Costs in P million					
	STP Land Cost	0	0	0	550	**550**
	STP Incremental Cost:	0	0	0	1,918	**1,918**
	Sewer Trunks Cost:	0	0	0	179	**179**
	Reticulation Cost :	0	0	0	1,919	**1,919**
	Total	0	0	0	4,566	**4,566**

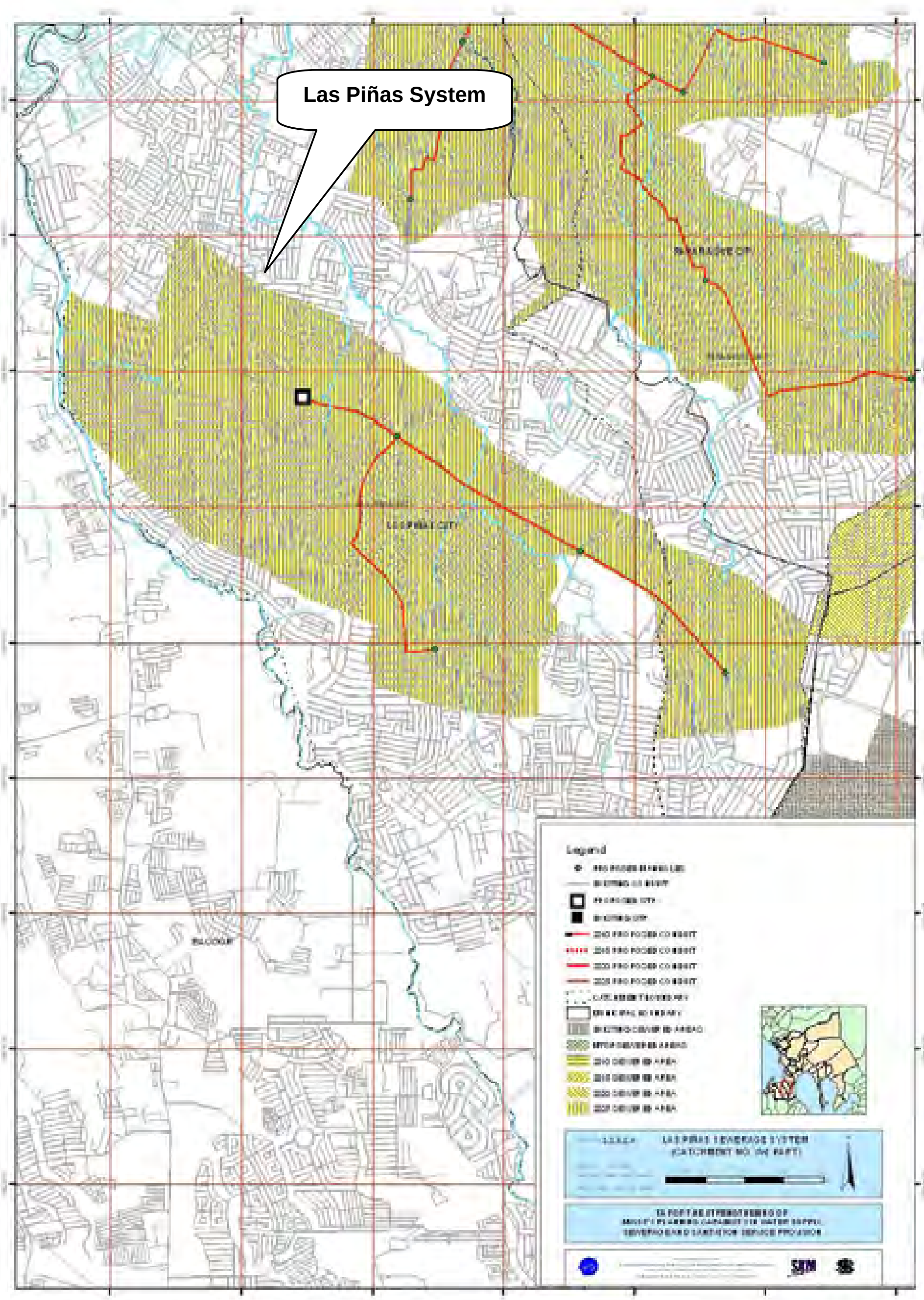

Figure 2.3 Proposed Las Piñas Sewerage System

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2.1.4 Parañaque Sewerage System (W-3 part)

Parañaque City has a large land area of 4,657 ha, and is near Manila separated only by Pasay and Makati cities. Manila Bay forms its west border where land reclamation and development exist.

In 2005, Parañaque City has a population of 498,242 and a density of 97 people/ha. Population is projected to 588,518 in 2015 and a population density of 142 people/ha in 2025.

No sewerage coverage is required up to the end of the concession period in 2021. However, with sufficient water supply from the Laiban Dam development and the upper-income communities opting for an improved environment by a sewerage system, it is planned to provide sewerage coverage for the area by 2025.

2.1.4.1 Catchment Description

Catchment W-3 with an area of 3,648 ha covers about 78% of the City area. The proposed Parañaque sewerage system of 961 ha in 2025 will cover about 20% of the city area.

The large catchment reaches Muntinlupa in the east and has a rolling terrain at the east portion and gradually flattens towards the Bay. Elevations at the rolling areas range from 12 to 24 m. while the flatlands are at elevation 2 to 10 m. The Parañaque River traversing the catchment provides the main drainage way towards Manila Bay

Landuse at the catchment is essentially similar to P Parañaque which is 67% residential, 12% commercial, 11% industrial and 8% open space and the rest institutional. Due to proximity to Manila and good accessibility provided by major roads like the South Luzon Expressway and Coastal Road Tollway, a large number of residential subdivisions ranging from mass housing to high income have been developed in the catchment.

STP Site – The STP site is proposed at a present vacant lot at Sucat Road corner Bernabe St., Bernabe Subdivision, Parañaque (see photo at right). Effluent discharge will be directly into the nearby tributary creek leading to Manila Bay. Surroundings of the proposed STP are mix-use of commercial and residential areas.

2.1.4.2 Sewerage Options

Description – Parañaque sewerage system will only start in year 2025 with a coverage area of 20 percent. The proposed system for Parañaque is STED reticulation. A new STP, trunk lines, and reticulation works will be constructed as shown **in Figure 2.4**.

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Sewerage Option / Layout – The sewerage option with STED reticulation is proposed for the sewerage system. The initial sewerage area covers a dense population. The sewerage layout is shown in **Figure 2.4.**

SewerCAD© Modelling – Hydraulic analysis of the trunk sewer was made using the SewerCAD© software. Inputs to the model like sewage flows (reticulation flow from each sub-catchment) at nodes, ground and pipe elevations at the nodes, pipe lengths, pipe materials, etc, are presented in **Annex 2.1.4** Parañaque Sewerage System.

2.1.4.3 Recommended Option and Cost

The recommended option for the Parañaque Sewerage system is shown in **Figure 2.4** with the summary of facilities and costs presented in **Table 2.4**

Table 2.4 Summary of Facilities and Costs for the proposed Parañaque Sewerage System

Paranaque Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	0	0	0	961	**961**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	0	32	**32**
	Increment trunk sewers total length (m), (∅375mm - ∅750mm)	0	0	0	9,408	**9,408**
	Required STP Area (ha)				1.68	**1.68**
	Costs in P million					
	STP Land Cost	0	0	0	168	**168**
	STP Incremental Cost:	0	0	0	789	**789**
	Sewer Trunks Cost:	0	0	0	251	**251**
	Reticulation Cost :	0	0	0	1,352	**1,352**
	Total	0	0	0	2,559	**2,559**

2.2 Manila Area Catchments (W-8, W-9 &W-10)

Manila with an area of 4,046 ha is covered by three drainage catchments and is served by the existing Manila Central Sewerage System, except the eastern portion (Catchment W-9) with an area of 654 ha.

Manila is the most densely populated city of Metro Manila. In 2005, its population is 1,572,788 and a density of 391 people/ha. Population is projected to decline in the future and is estimated at 1,498,308 in 2015 and a population density of 337 people/ha in 2025.

Due to the dense population and the need for improved environment, sewerage coverage is a priority of Manila with 83% coverage in 2021.

2.2.1 Manila East Sewerage System (W-9)

Landuse at the east part of Manila covered by catchment W-9 is considered to be similar to the general land use of the city which predominantly commercial (26%) and residential (16%). Parañaque

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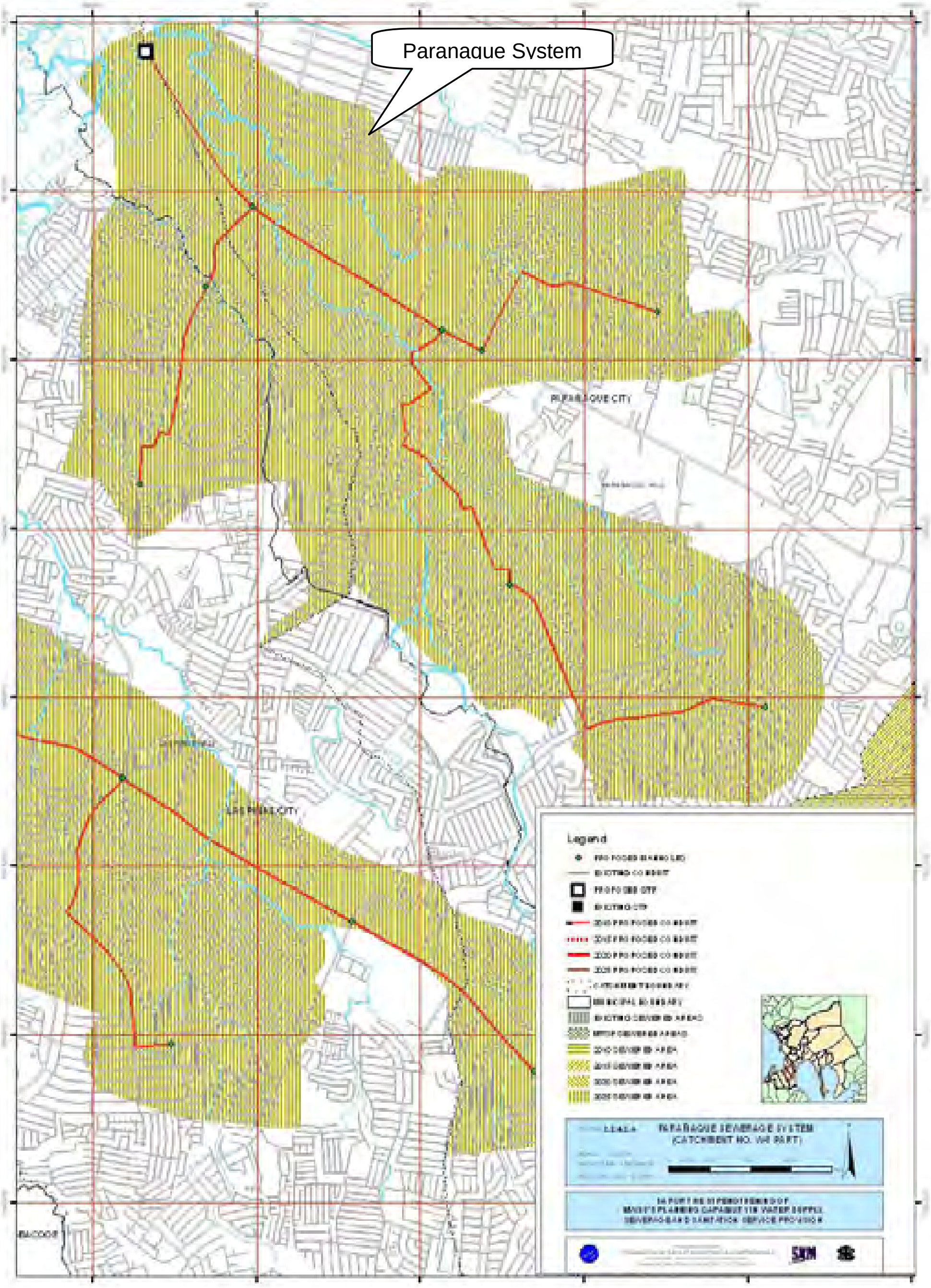

Figure 2.4 Proposed Paranaque Sewerage System

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2.2.1.1 Catchment Description

Catchment W-9 with an area of 654 ha covers a small 16% of the City area. The proposed Manila East (or Sampaloc) sewerage system of 399 ha in 2025 will cover about 60% of the catchment, resulting to an overall 91% sewerage coverage for Manila.

Terrain in the oblong-shape catchment varies from slightly rolling at the south to flat towards the west northwest. Elevations range from 6 to 10m. Covered storm sewer served as the main drainage ways.

STP Site – The proposed STP site (shown in photo at right) is nearby the Manila North Cemetery western portion along 3289 Rizal Avenue Extension, Sta. Cruz, Manila. Effluent discharge will be directly into the nearby creek leading to Manila Bay. Vicinity land uses to the STP site consist of mix-use of commercial, residential and institutional areas.

2.2.1.2 Sewerage Options

Description – The proposed Manila east sewerage system consists of a trunk main with STED reticulation. Combined drainage was not recommended due to poor storm drainage system and the high cost of a separate system like the MCSS was a disadvantage.

In 2015 Manila East sewerage system will cover 76% of the catchment area. A new STP with a capacity of 30 MLD adequate until 2020 is proposed. Trunk lines and reticulation works will be installed/constructed as shown in **Figure 2.5**.

In 2020 the sewerage system will be expanded to 82% coverage with a new trunk line and reticulation works. A small expansion in the reticulation area, resulting to 83% coverage, will be made in 2025.

SewerCAD© Modelling – Hydraulic analysis of the trunk sewer was made using the SewerCAD© software. Inputs to the model like sewage flows (reticulation flow from each sub-catchment) at nodes, ground and pipe elevations at the nodes, pipe lengths, pipe materials, etc, are presented in **Annex 2.1.5** Manila East Sewerage System.

2.2.1.3 Recommended Option and Cost

The recommended option for the proposed Manila East Sewerage system is shown in **Figure 2.5** with the summary of facilities and costs provided in **Table 2.5**

Table 2.5 Summary of Facilities and Costs for the proposed Manila East Sewerage System

Manila East Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	0	80	172	147	**399**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	30	0	32	**62**
	Increment trunk sewers total length (m), (∅900mm - ∅1200mm)	0	972	1,741	1,743	**4,456**
	Required STP Area (ha)	0	1.53	0	1.68	**3.21**
	Costs in P million					
	STP Land Cost	0	428	0	470	**899**
	STP Incremental Cost:	0	732	0	789	**1,521**
	Sewer Trunks Cost:	0	36	61	79	**176**
	Reticulation Cost :	0	144	310	265	**718**
	Total	0	1,340	370	1,603	**3,314**

2.3 Summary of Facilities and Costs

The summary of the sewerage facilities and costs for the West Metro Manila Region is presented in **Table 2.6.** Sewerage services envisaged a total coverage of 1,494 ha in 2010 in addition to existing systems, with continuing expansion up to 2025 when the total coverage becomes 5,468 ha with 5 decentralized STPs with a total capacity of 276 MLD. The five sewerage systems will benefit about 476,600 residents in the West Metro Manila Region.

Table 2.6 Summary for West Metro Manila Region Sewerage

	CATCHMENT	2010	2015	2020	2025	Total
SUMMARY: West Metro Manila Sewerage						
	Selected Option Costs in P million					
	(1) STP Area & Land Cost					
	(a) Required STP Area (ha)	2.01	1.53	1.83	10.30	15.67
	(b) STP Land Cost	402	428	406	1,548	2,784
	(2) STP Cost	1,408	732	880	4,179	7,199
	(3) Sewer Trunks Costs	117	341	172	1,005	1,636
	(4) Reticulation Costs	998	1,044	796	4,606	7,444
	(a)Conventional	0	0	0	0	0
	(b)Combined	323	0	0	659	982
	(c)STED	675	1,044	796	3,947	6,462
	(d) Existing Storm sewer Rehab	0	0	0	0	0
	Total	***2,925***	***2,545***	***2,253***	***11,339***	**19,063**
	Summary of Facilities					
	(1) Trunk Main, (m),(∅250mm -∅1350mm)	7,235	11,342	5,066	20,391	44,034
	(2) Reticulation, (ha.)					
	(a)Conventional	850	0	0	0	850
	(b)Combined	269	0	0	549	818
	(c)STED	375	580	442	2,403	3,800
	(d) Existing Storm sewer Rehab	0	0	0	0	0
	Total sewered area (ha.)	*1,494*	*580*	*442*	*2,952*	**5,468**
	(3) UASB-SBR Capacity, (Mld)	40	30	35	171	276

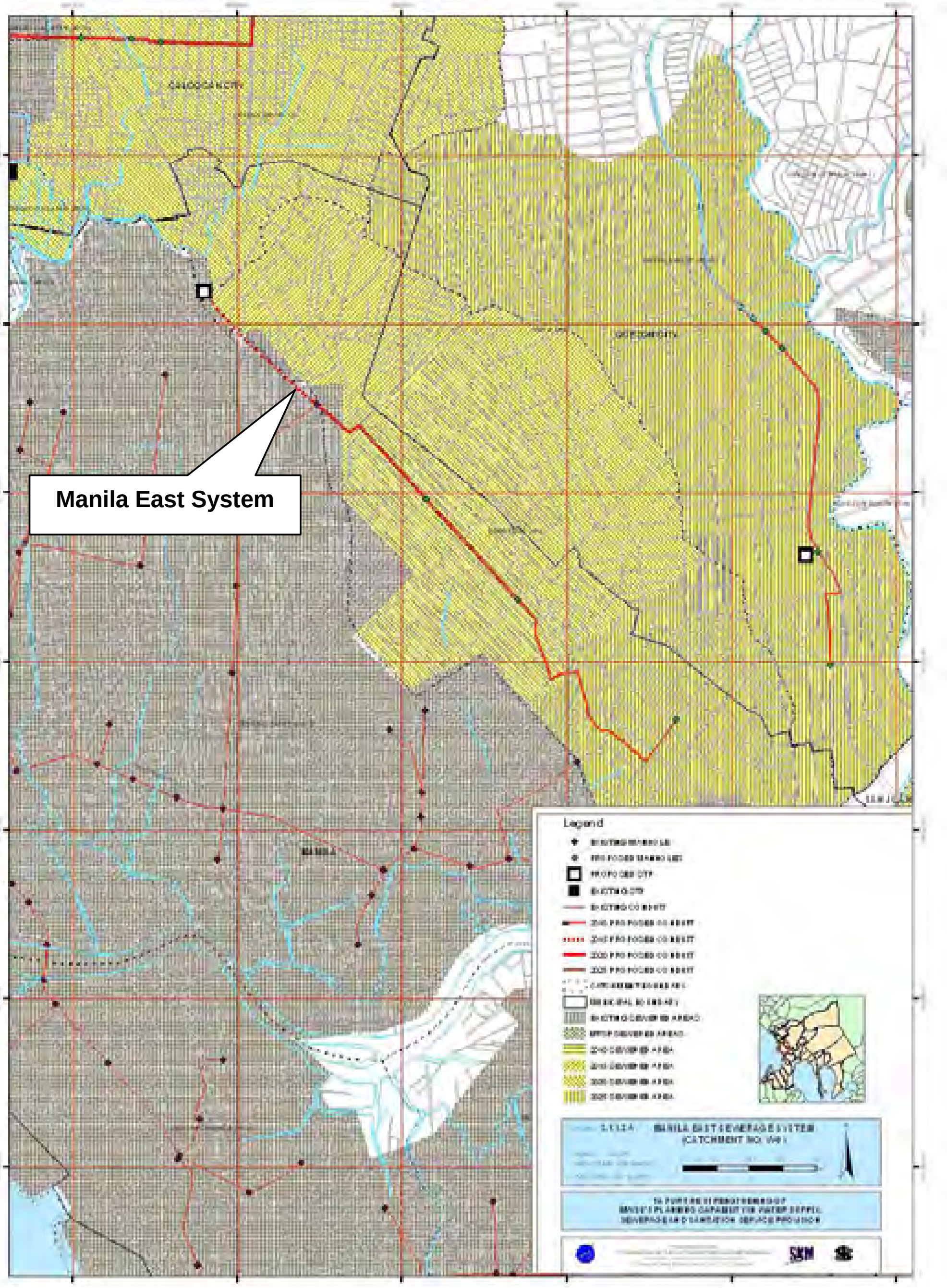

Figure 2.5 Proposed Manila East Sewerage System

3. North Metro Manila Region

The North Metro Manila region for sewerage covers the cities of Caloocan, Navotas, Malabon and Valenzuela, all in the West Zone concession area. In these four cities, there are six delineated drainage catchments with total area of 13,317 ha, which extend beyond the four-city boundaries.

These four cities cover about 19% of the NCR, with a total population of 2.42 million in 2005 or 23% of the NCR population. A declining population growth rate (about 2% in 2005 to less than 1% in 2025) is estimated for these four cities except Malabon whose population will decrease from 330,508 in 2005 to 264,608 in 2025.

These contiguous cities have generally similar land use plans with large industrial areas of 20% to 30% and predominantly residential of 40% to 70%. Except for the detached Caloocan North area, these cities are located in the flat lands.

3.1 Caloocan-Malabon (Dagat-dagatan) Catchments (W-11, W-12 & W-13)

These three catchments with a total area of 2,225 ha cover major portions of the cities of Caloocan, Navotas and Malabon. The existing Dagat-dagatan sewerage system serving a land reclamation / housing development by NHA is located within these catchments, including the new Smokey Mountain re-development and bayshore land reclamation projects.

Caloocan (south), Malabon and Navotas are contiguous cities with a total area of about 3,990 ha. Population is dense in the vicinities of the industrial areas.

3.1.1 Caloocan (Dagat-dagatan) - South Malabon Sewerage System (W-12 Caloocan & W-13 Malabon)

3.1.1.1 Catchment Description

Catchments W-12 and W-13 with an area of 1,706 ha cover the border areas of Malabon and Caloocan. The proposed 1,692 ha sewerage system will essentially cover these two catchments.

Terrain in these contiguous catchments is flat with elevations varying from 2 to 20 m. Drainage is provided by several creeks / esteros traversing the catchments. The area is essentially build-up with commercial, residential and mix-use use development. Due to the proximity to sea ports, many industries have located in the area.

STP Site – It is envisioned that by 2020, the existing sewage treatment lagoons in the 10-hectare Dagat-dagatan site (partly shown at right photo) will have been upgraded to more intensive compact treatment systems, providing land space for other treatment plants like the UASB- SBR STP for the proposed

Caloocan-South Malabon sewerage system.

The effluent of the STP will be discharged to Estero de Maypajo. At present, informal communities surround the Dagat-dagatan treatment ponds as well as the new Dagat-dagatan Septage Treatment Plant.

3.1.1.2 Sewerage Options

Description – The proposed sewerage coverage covers the 2020 expansion for the Dagat-dagatan system. Current sewerage is composed of conventional separate system. Because of this, and the fact that the area is prone to a flooding, the expansion was to follow the same type of system. STED was determined to be more economical than the conventional system but will greatly depend on the condition of the septic tanks located at the expansion areas.

The recommended trunkmains and service pipes shall be completed by 2020 to include the sewerage targets for the 2003 Rate Rebasing.

Sewerage Option / Layout – The sewerage option with STED reticulation is proposed for the sewerage system. The sewerage layout is shown in **Figure 3.1.**

SewerCAD Modelling – Hydraulic analysis of the trunk sewer was made using the SewerCAD software. Inputs to the model like sewage flows (reticulation flow from each sub-catchment) at nodes, ground and pipe elevations at the nodes, pipe lengths, pipe materials, etc, are presented in **Annex 3.1.1** Caloocan-South Malabon Sewerage System.

3.1.1.3 Recommended Option and Cost

The recommended option for the Dagat-dagatan – South Malabon Sewerage system is shown in **Figure 3.1** with the summary of facilities and costs shown in **Table 3.1.**

Table 3.1 Summary of Facilities and Costs for the proposed Caloocan – South Malabon Sewerage System

Dagat-dagatan-South Malabon Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	0	0	1,692	0	**1,692**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	93	0	**93**
	Increment trunk sewers total length (m), (∅600mm - ∅1350mm)	0	0	6,686	0	**6,686**
	Required STP Area (ha)	0	0	4.72	0	**4.72**
	Costs in P million					
	STP Land Cost	0	0	472	0	**472**
	STP Incremental Cost:	0	0	2,107	0	**2,107**
	Sewer Trunks Cost:	0	0	226	0	**226**
	Reticulation Cost :	0	0	2,061	0	**2,061**
	Total	0	0	4,866	0	**4,866**

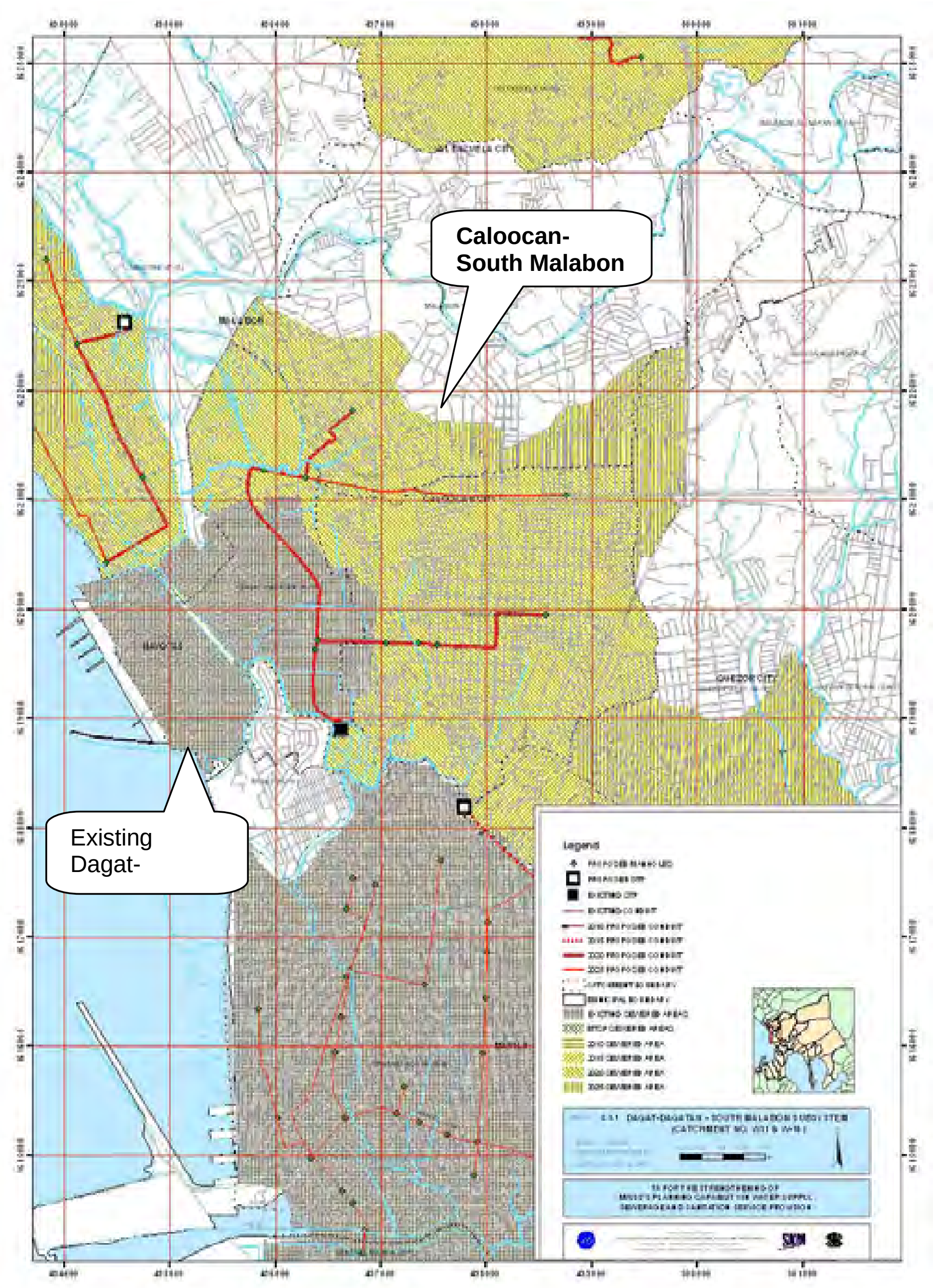

Figure 3.1 Proposed Caloocan (Dagat-dagatan) – South Malabon Sewerage System

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3.2 QC Novaliches & QC North Catchments (W-14 & W-19)

These catchments lie in Quezon City and there are no specified sewerage coverage targets. There are large residential subdivisions and a rapidly growing commercial development. Septage services will be provided in these areas.

3.3 Navotas-Malabon-Valenzuela Catchments (W-13, W-16, W-17 & W-18)

These four drainage catchments cover the cities of Navotas, part of Malabon and the west portion of Valenzuela with a total area of 6,700 ha. In 2005, the population of Navotas and Malabon are respectively 245,524 and 330,538 or equivalent densities of 228 and 210 people/ha. Malabon is projected to decline in population with an estimated density of 168 people/ha in 2025; but Navotas will increase its density by 21%.

Land uses in the catchments are considered similar to the city-wide uses which are dominantly residential (37% to 70%) and industrial (21% to 35%). Particularly for Navotas and Malabon, their proximity to sea ports has made them ideal for the location of industries.

3.3.1 Navotas Sewerage System (W-16 part)

The proposed Navotas sewerage system will cover Navotas and the west part of Malabon.

3.3.1.1 Catchment Description

The 3,130-ha Catchment W-16 covers Navotas, part of Malabon and part of Valenzuela. Due to the flat terrain, two sewerage systems are planned in this catchment: the Navotas system and the Valenzuela system, the former services Navotas and Malabon, while the latter system services Valenzuela and also part Malabon.

The terrain is mainly flatlands with meandering rivers affected by tidewater. Spots of land are at Elevation 2 m, and a major portion of the land is below the 2 m level.

The proposed sewerage system will service the residential areas and commercial establishments built along the roadways.

STP Site – The proposed STP site for the Navotas system is located at Kaunlaran St. in Malabon. The required area is less than a hectare. The proposed site is near a low-cost Pag-ibig housing project where a Material Recovery Facility (MRF) is also located. The site is nearby the Dampalit River which is will be the receiver of the proposed STP effluent.

The general vicinity of the site is composed of residential communities with other developments being industrial for Navotas and agricultural for

Malabon. The proposed STP site is shown in photo at right.

3.3.1.2 Sewerage Options

Description - The 2021 targets for the rate rebasing are to be met with the proposed options for 2020. The options presented are for the use of conventional and STED systems. This can be attributed to the fact that the area is low-lying and highly prone to flooding.

The layout of the trunkmains for both options shall remain the same. Works are projected to be completed by 2020 to satisfy the 2021 Rate Rebasing sewerage targets.

Sewerage Option / Layout – The sewerage option with STED reticulation is proposed for the sewerage system. The sewerage layout is shown in **Figure 3.2.**

SewerCAD© Modelling – Hydraulic analysis of the trunk sewer was made using the SewerCAD© software. Inputs to the model like sewage flows (reticulation flow from each sub-catchment) at nodes, ground and pipe elevations at the nodes, pipe lengths, pipe materials, etc, are presented in **Annex 3.3.1** Navotas Sewerage System.

3.3.1.3 Recommended Option and Cost

The recommended option for the Navotas Sewerage system is shown in **Figure 3.2** with the summary of facilities and costs presented in **Table 3.2**

Table 3.2 Summary of Facilities and Costs for the proposed Navotas Sewerage System

Navotas Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	0	0	425	0	**425**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	17	0	**17**
	Increment trunk sewers total length (m), (∅250mm - ∅900mm)	0	0	3,109	0	**3,109**
	Required STP Area (ha)	0	0	0.95	0	**0.95**
	Costs in P million					
	STP Land Cost	0	0	95	0	**95**
	STP Incremental Cost:	0	0	424	0	**424**
	Sewer Trunks Cost:	0	0	109	0	**109**
	Reticulation Cost :	0	0	765	0	**765**
	Total	0	0	1,393	0	**1,393**

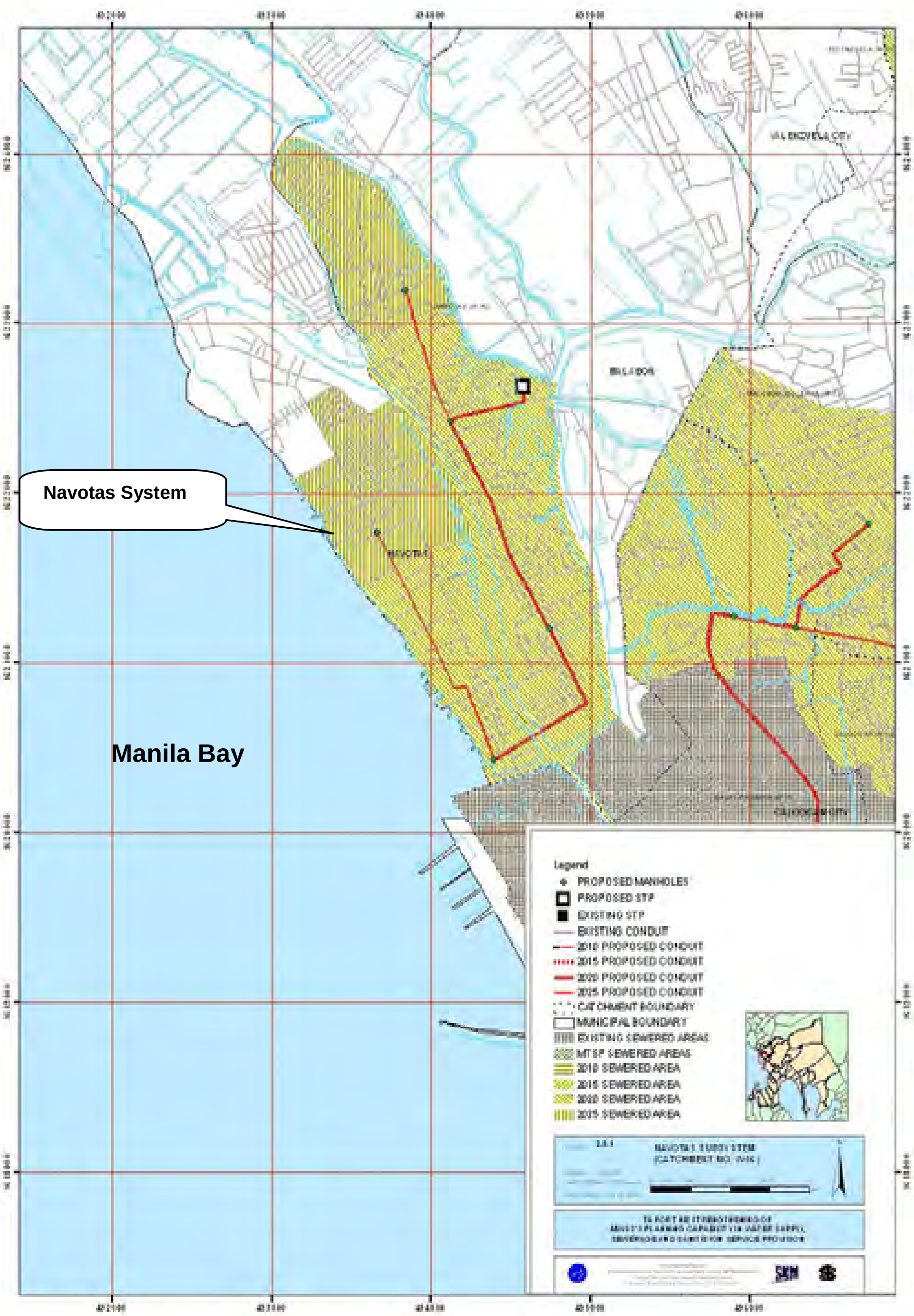

Figure 3.2 Proposed Navotas Sewerage System

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3.3.2 Valenzuela Sewerage System (W-17 part)

3.3.2.1 Catchment Description

The 2,835-ha Catchment W-17 lies mainly in Valenzuela City, but also encroaches the west portion of Caloocan North. The proposed Valenzuela sewerage system covers 1,011 ha within the catchment and services mainly Valenzuela. Extension of the trunk mains in the future will cover the Caloocan North area. The proposed sewerage system covers about 23% of the city area.

Topography of the catchment is a rolling terrain at the east portion (elevations 16-32 m) to near flat at the west and mid sections with elevations 10 to 14 m. A system of creeks and tributaries provides efficient drainage leading to the Meycauayan River.

STP Site – The STP site for the Valenzuela system is located along Maysan Road in Bahayang Pag-asa Subdivision, Valenzuela. The required area for the STP was estimated to be 1.68 ha. A creek runs adjacent to the site which can receive the STP effluent.

Industries surround the nearby vicinity of the site although residential communities are numerous in the service area.

3.3.2.2 Sewerage Options

Description –STED reticulation was considered mainly because drainage has not been fully developed in these areas. Combined system was ruled out due to numerous industries found within the area.

The proposed 2020 system shall accommodate the 2021 targets set by the 2003 Rate Rebasing.

Sewerage Option / Layout – The sewerage option with STED reticulation is proposed for the sewerage system. The sewerage layout is shown in **Figure 3.3.**

SewerCAD Modelling – Hydraulic analysis of the trunk sewer was made using the SewerCAD software. Inputs to the model like sewage flows (reticulation flow from each sub-catchment) at nodes, ground and pipe elevations at the nodes, pipe lengths, pipe materials, etc, are presented in **Annex 3.3.2** Valenzuela Sewerage System.

3.3.2.3 Recommended Option and Cost

The recommended option for the proposed Valenzuela Sewerage system is shown in **Figure 3.3** with the summary of facilities and costs shown in **Table 3.3.**

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Table 3.3 Summary of Facilities and Costs for the proposed Valenzuela Sewerage System

Valenzuela Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	0	0	1,011	0	**1,011**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	32	0	**32**
	Increment trunk sewers total length (m), (∅250mm - ∅900mm)	0	0	7,960	0	**7,960**
	Required STP Area (ha)	0	0	1.68	0	**1.68**
	Costs in P million					
	STP Land Cost	0	0	168	0	**168**
	STP Incremental Cost:	0	0	770	0	**770**
	Sewer Trunks Cost:	0	0	247	0	**247**
	Reticulation Cost :	0	0	1,820	0	**1,820**
	Total	0	0	3,005	0	**3,005**

3.3.3 Caloocan North Sewerage System (W-18 west part)

3.3.3.1 Catchment Description

The 4,084-ha Catchment W-18 lies in Caloocan North area, and has several sub-catchments drained by creeks that are tributary to the Meycauayan River. The proposed sewerage system covers 629 ha or 15% of Catchment W-18. Topography is highly rolling to undulating terrain with elevation from 28 to 60 m.

STP Site – The proposed STP site for the Caloocan North system is located along Iba-Bagbaguin Road at the border of Caloocan and Meycuayan, Bulacan. The required area of 1.88 ha can be accommodated by the site. The site is bounded by two creeks which is ideal for disposal of the plant's effluent. The proposed site is located on a fairly flat terrain.

Industrial areas are located within the vicinity of the site. Numerous housing development projects can also be found within the same vicinity as well as the general catchment area of the system.

3.3.3.2 Sewerage Options

Description – A STED reticulation systems was considered mainly because drainage has not been fully developed in these areas. The undesirable color of liquid flows in the creeks observed during the visit is evident that combined sewerage is not possible due to industrial plant effluents.

As with the other nearby systems, the proposed 2020 system will accommodate the specified coverage targets in 2021.

Sewerage Option / Layout – The sewerage option with STED reticulation is proposed for the system. The sewerage layout is shown in **Figure 3.4.**

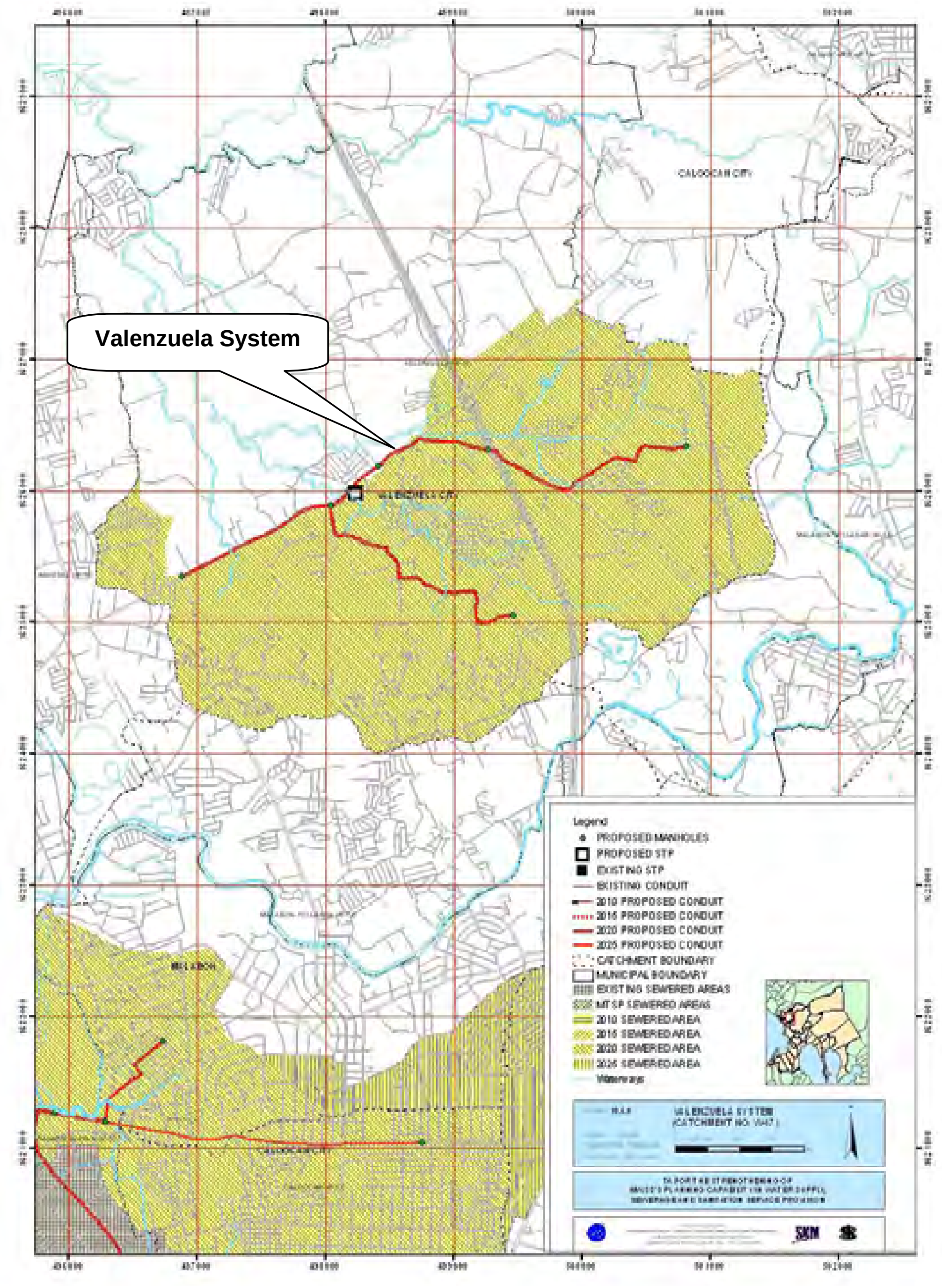

Figure 3.3 Proposed Valenzuela Sewerage System

SewerCAD© Modelling – Hydraulic analysis of the trunk sewer was made using the SewerCAD© software. Inputs to the model like sewage flows (reticulation flow from each sub-catchment) at nodes, ground and pipe elevations at the nodes, pipe lengths, pipe materials, etc, are presented in **Annex 3.3.3** Caloocan North Sewerage System.

3.3.3.3 Recommended Option and Cost

The recommended option for the Caloocan North Sewerage system is shown in **Figure 3.4** with the summary of facilities and costs shown in **Table 3.4.**

Table 3.4 Summary of Facilities and Costs for the proposed Caloocan North Sewerage System

Caloocan North Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Incremental Sewerage Coverage (Reticulation) (ha):	0	0	629	0	**629**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	36	0	**36**
	Increment trunk sewers total length (m), (∅375mm -∅750mm)	0	0	7,819	0	**7,819**
	Required STP Area (ha)			1.88		**1.88**
	Costs in P million					
	STP Land Cost	0	0	188	0	**188**
	STP Incremental Cost:	0	0	860	0	**860**
	Sewer Trunks Cost:	0	0	157	0	**157**
	Reticulation Cost :	0	0	1,131	0	**1,131**
	Total	0	0	2,337	0	**2,337**
Central Metro Manila Sewerage		**2010**	**2015**	**2020**	**2025**	**Total**

3.4 Summary of Facilities and Costs

The summary of the sewerage facilities and costs for the North Metro Manila region is presented in **Table 3.5.** Sewerage services envisaged a total coverage of 3,957 ha, starting in 2020 with 4 STPs at a total capacity of 178 MLD benefiting an estimated 986,700 residents. The total capital investment was estimated at P 11.6 B, including acquisition of about 9 hectares of land for the STP sites.

No further expansion of the sewerage services is recommended as other areas will be served by sanitation services.

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Table 3.5 Summary for North Metro Manila Region Sewerage

	CATCHMENT	2010	2015	2020	2025	Total
SUMMARY:North Metro Manila Sewerage						
	Selected Option Costs in P million					
	(1) STP Area & Land Cost					
	(a) Required STP Area (ha)	0	0	9.23	0	9.23
	(b) STP Land Cost	0	0	923	0	923
	(2) STP Cost	0	0	4,161	0	4,161
	(3) Sewer Trunks Costs	0	0	740	0	740
	(4) Reticulation Costs	0	0	5,778	0	5,778
	(a)Conventional	0	0	0	0	0
	(b)Combined	0	0	0	0	0
	(c)STED	0	0	5,778	0	5,778
	(d) Existing Storm sewer Rehab	0	0	0	0	0
	Total	0	0	11,602	0	**11,602**
	Summary of Facilities					
	(1) Trunk Main, (m),(∅250mm -∅1350mm)	0	0	25,574	0	25,574
	(2) Reticulation Areas, (ha.)*includes existing sewered 750ha.					
	(a)Conventional	0	0	390	0	390
	(b)Combined	0	0	0	0	0
	(c)STED	0	0	3,367	0	3,367
	(d) Existing Storm sewer Rehab	0	0	0	0	0
	Total sewered area (ha.)	*0*	*0*	*3,757*	*0*	**3,757**
	(3) UASB-SBR Capacity, (Mld)	0	0	178	0	178

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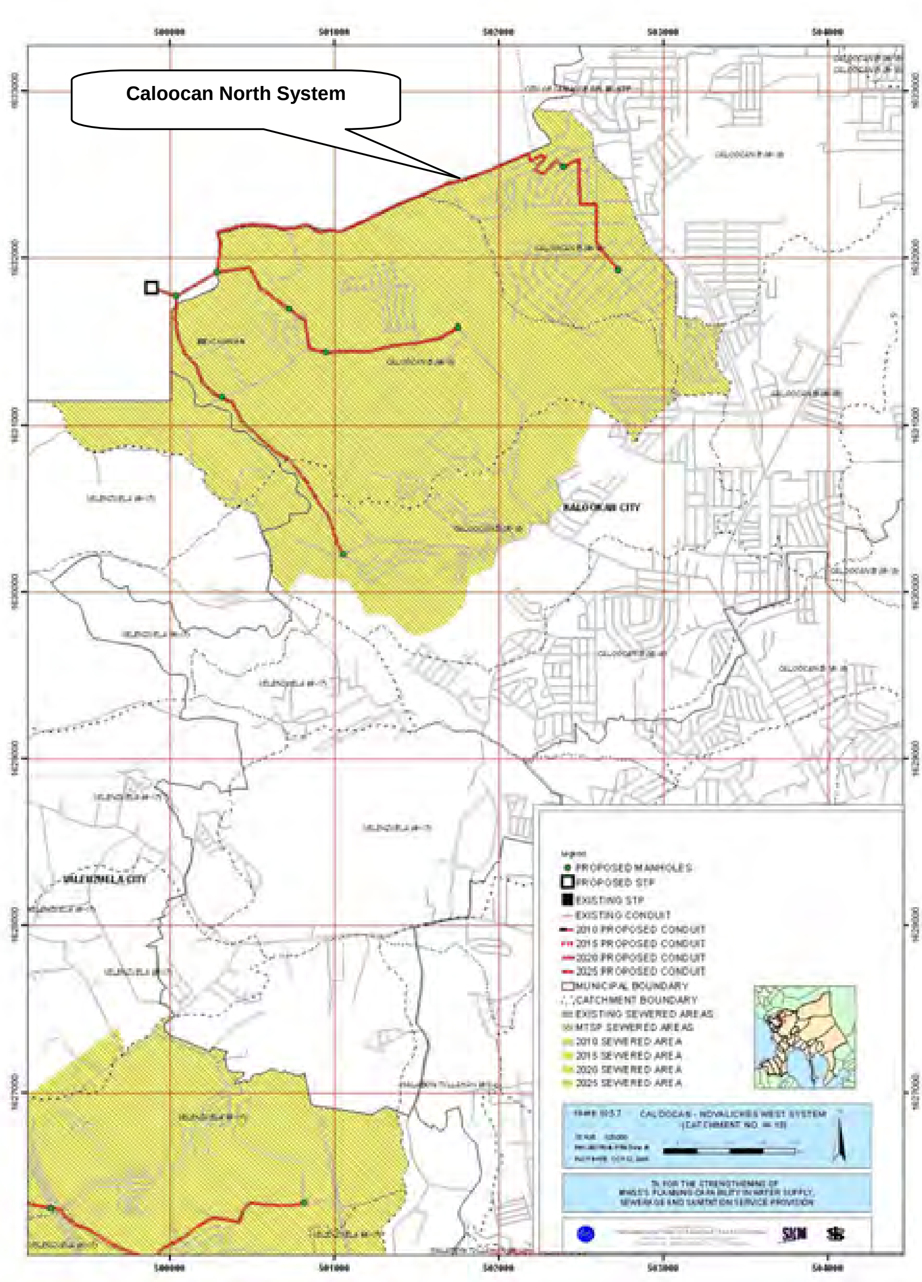

Figure 3.4 Proposed Caloocan North Sewerage System

4. Central Metro Manila Region

The Central Metro Manila region for sewerage covers the major part of Quezon City, the municipality of San Juan, and the cities of Mandaluyong, Pasig and Makati, all in the East Zone concession area, except for southwest portion of Quezon City. In this region, there are 6 delineated catchments with a total area of 11,857 ha or about 53% of the total cities/municipality area. In these catchment, about 1,840 ha is already served by several large (e.eg. Makati, Bonifacio) systems and numerous community sewerage systems.

In 2005, the population in these four cities and one municipality is 3.44 million (33% of the NCR population) and projected to increase to 3.71 million in 2015. At present, San Juan and Mandaluyong are densely populated respectively at 200 and 263 people/ha. San Juan and Makati populations are projected to have negative growth rates.

Land use in this region is dominantly residential and commercial (ranging from 60% to 90% for each city/municipality). Large areas in Quezon and Makati cities are institutional and quite large area for open spaces. San Juan with its small area of 595 ha, is mainly residential and commercial landuse.

4.1 QC North & East Catchments (EW-2 & EW-3)

These two large catchments with a total 5,760 hectares covers the north and east part of Quezon City of rolling to hilly terrain. A good drainage system exists. Most of the area is residential development, with large open areas.

In the QC North area, there are small sewerage systems, including the University of the Philippines sewerage system. No sewerage coverage is required during the Concession period and these catchments were not covered by the proposed SMP.

4.2 QC West & Central Catchments (W-15 & EW-1)

These two catchments in Quezon City have an area of 2,581 ha straddling the borders of the East – West concession zones. At QC West (catchment W-15), there exists no sewerage systems, while at QC Central (catchment EW-1) a number of community sewerage systems are operating. Sewerage coverage is proposed for QC West area during the 2025 planning horizon.

4.2.1 QC West Sewerage System (W-15)

This catchment has an area of 1,079 hectares, located at the northwest corner of Quezon City. It is bordered in the west by an un-sewered catchment of the large Manila Central Sewerage System.

Terrain in this elongated catchment is relatively flat with elevations varying from 16 m in the north to 8 m in the south. The uniform grid system of roads and drainage, and zoned residential blocks and commercial establishments indicate a well planned development ideal for combined sewerage.

4.2.1.1 Catchment Description

The proposed QC West sewerage system of 541 ha planned for 2025 will cover about 50% of the catchment, and contributes to the overall sewerage coverage for Quezon City.

The proposed sewerage system covers a predominantly residential area with scattered commercial establishments along the major roads. Storm drainage consists of open canals and covered drains. Improved and lined canals convey run-off to a tributary to the San Juan River.

STP Site – The proposed STP site (photo at right) is located in the PCSO compound along E. Rodriguez Sr. Avenue corner G. Araneta Avenue. Effluent can be discharged to the nearby San Juan River. About 1 ha area is needed for the recommended UASB-SBR treatment facility.

The vicinity of the site is a mix of residential, commercial and institutional uses.

4.2.1.2 Sewerage Options

The sewerage options for the QC West system differ only as to the use of STED or combined drainage or both types of reticulation. A combined drainage covers a larger area than STED reticulation due to the use of the built-up drainage systems like lined canals.

The layout of the two options varies due to the additional catchment area of the combined system option. The combined drainage option utilizes the lined canal traversing the entire W-15 catchment. Although the cost per hectare is less, the capital investment for the additional area is greater than using the recommended STED system.

SewerCAD© Modelling – Hydraulic analysis of the trunk sewer was made using the SewerCAD© software. Inputs to the model like sewage flows (reticulation flow from each sub-catchment) at nodes, ground and pipe elevations at the nodes, pipe lengths, pipe materials, etc, are presented in **Annex 4.2.1** Quezon City West Sewerage System.

4.2.1.3 Recommended Option and Costs

The recommended option for the proposed Quezon City West Sewerage system is shown in **Figure 4.1,** with the summary of facilities and costs shown in **Table 4.1.**

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Table 4.1 Summary of Facilities and Costs for the proposed QC West Sewerage System

QC West Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Sewerage Coverage (Reticulation) (ha):	0	0	0	541	**541**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	0	32	**32**
	Increment trunk sewers total length (m), (∅250mm - ∅900mm)	0	0	0	3,259	**4,235**
	Required STP Area (ha)	0	0	0	1.68	**1.68**
	Costs in P million					
	Required STP Area (ha)	0	0	0	1.68	**1.68**
	STP Land Cost	0	0	0	336	**336**
	STP Incremental Cost:	0	0	0	770	**770**
	Sewer Trunks Cost:	0	0	0	103	**103**
	Reticulation Cost :	0	0	0	974	**974**
	Total	0	0	0	2,182	**2,182**

4.3 QC South - San Juan – Mandaluyong - Pasig West Catchments (E-5, E-6 & E-8)

With an area of 7,758 ha, these three catchments in the East Zone cover the south part of Quezon City, the municipality of San Juan, and cities of Pasig and Mandaluyong. The catchment is predominantly residential and commercial development.

There exist a number of small sewerage systems, like those at Mandaluyong and Pasig cities. The large commercial establishments located in the area are required to install treatment plants for their generated wastewater.

Early sewerage coverage is specified for Pasig and San Juan, i.e. 2010 and 2015, respectively, but none for the south part of Quezon City.

4.3.1 San Juan Sewerage Systems (E-6 & E-8)

The town of San Juan straddles catchment E-6 and E-8; two small systems are proposed in order to meet the required sewerage coverage specified in the concession agreement.

San Juan is a small town of 595 ha with a population density of 200 people/ha in 2005 and is projected to decline to 186 people/ha in 2025. Present land use is 60% residential, 17% commercial, 15% open space, and minimal industry and institution.

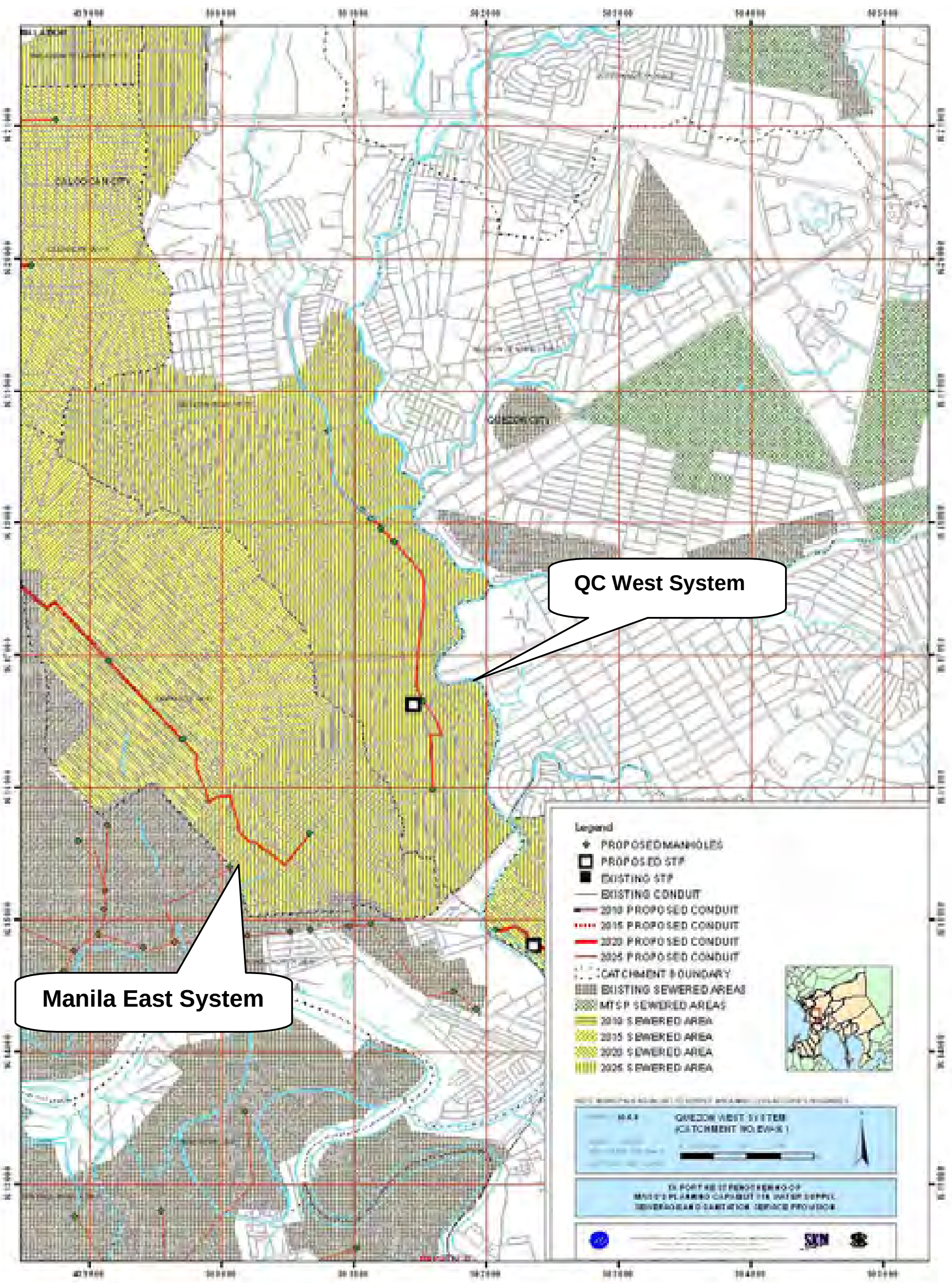

Figure 4.1 Proposed QC West Sewerage System

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4.3.1.1 Catchment Description

The catchments are slightly undulating terrain, and within are located well-planned residential development provided with good drainage along paved roads. Commercial establishments abound along the main roads. Drainage canals traversing the area have been improved.

Sewerage for San Juan is required starting 2015 with a coverage of 63 ha and expands to 327 ha by 2025. Sewerage systems to be located in two separate catchments are proposed.

STP Site - The San Juan STP sites are located at F. Manalo corner Valenzuela St., San Perfecto and at Ortigas Avenue beside the lot corner Xavier Street for catchments E-6 (south) and E-8 (north), respectively.

The proposed STP site for the south catchment is a private property which is a warehouse (shown in photo at right). Although availability for the site is uncertain, an adjacent warehouse showed for sale or lease sign. About 3,500 m^2 is needed for the proposed STP. The site is ideal as it is besides a drainage canal leading to San Juan River.

The site for the San Juan north catchment will service the up-scale areas of Greenhills. Currently, the proposed site is vacant. About 5,500 m^2 is required for the recommended STP. Discharge can be directed to the lined drainage canal (see photo at right) besides the site leading to San Juan River.

4.3.1.2 Sewerage Options

Options – STED and combined drainage systems were considered for the south (E-6) catchment. The drainage condition of the area can be used to the advantage of the combined drainage system because the required drainage rehabilitation needs less capital. The development plan for the system should be in place by 2020 and expanded in 2025.

Development for the options for the north (E-8) catchment should be on-line by 2015. Continuous expansion is required until 2025, together with the sewerage development in E-6, will have a 59% coverage area. Although the combined drainage system yielded a lower capital cost, the larger STP requires a larger lot size, which cannot be accommodated in the proposed site. Because of this constraint, the STED system was recommended to be more suitable in confining the service area.

Sewerage Layout - The layout of the south (E-6) catchment is heavily dependent on the drainage pipes along F. Manalo St. as it is the backbone of the system. For the San Juan

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E-8 catchment, trunkmains for the STED reticulation follow the alignment of the existing lined canal.

SewerCAD© Modelling – Hydraulic analysis of the trunk sewer was made using the SewerCAD© software. Inputs to the model like sewage flows (reticulation flow from each sub-catchment) at nodes, ground and pipe elevations at the nodes, lift stations, etc, are presented in **Annex 4.3.1** San Juan Sewerage System.

4.3.1.3 Recommended Option and Cost

The recommended option for the proposed San Juan Sewerage system is shown in **Figure 4.2** with the summary of the facilities and costs presented in **Table 4.2.**

Table 4.2 Summary of Facilities and Costs for the proposed San Juan Sewerage System

San Juan Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Sewerage Coverage (Reticulation) (ha):	0	63	129	135	**327**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	5	11	0	**16**
	Increment trunk sewers total length (m), (∅200mm - ∅450mm)	0	1,933	1,680	1,600	**5,213**
	Required STP Area (ha)	0	0.35	0.55	0	**0.9**
	Costs in P million					
	Required STP Area (ha)	0	0.35	0.55	0	**0.9**
	STP Land Cost	0	70	110	0	**180**
	STP Incremental Cost:	0	135	295	0	**430**
	Sewer Trunks Cost:	0	21	5	3	**29**
	Reticulation Cost :	0	113	92	151	**356**
	Total	0	339	502	154	**995**

4.3.2 Pasig Sewerage System (E-5 west part)

Catchment E-5 of 3,294-ha covers most part of Pasig City at both sides of the Pasig River. The catchment extends southward to the Lake along the Mangahan floodway. The proposed sewerage covers the north part of the catchment at the west side of the Pasig River. This part of the City is a densely developed area of residential settlements and commercial establishments including some factories.

4.3.2.1 Catchment Description

Topography and Drainage – Topography of Pasig City west of the River is multi-level flatlands with steep slopes at transitions from the higher flatlands (about elevation 50) to the flat areas bordering the river (elevation 10 m.). Lined canals and creeks leading to the Pasig River provide effective drainage of the catchment.

Sewerage is proposed in this area of mainly residential neighborhood with a number of shopping malls and commercial centers, the latter usually provided with wastewater treatment facilities.

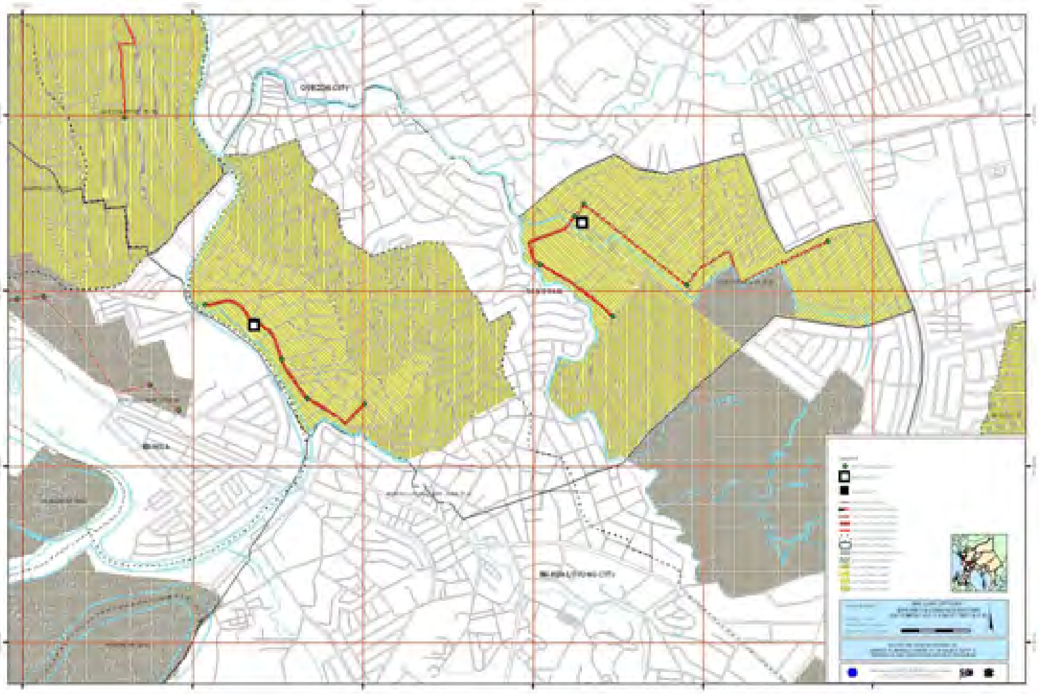

Figure 4.2 Proposed San Juan Sewerage System

STP Site - The General Milling Compound along C-5 Road (refer to photo at right) was found to be more than adequate for the required 2.53 ha area for the STP. The area was formerly an industrial zone which was sequestered by the government in the late 1980s. To date no other development has been done in the area.

The STP effluent can be directed to the Marikina River which bounds the property to the east. The area is surrounded by residential, commercial and the existing industrial development.

4.3.2.2 Sewerage Options

Conventional, STED and combined drainage systems were costed and the latter prevailed as the least costly. The presence of a lined canal leading to Marikina River can be intercepted and treated. The utilization of the combined drainage can service a larger area due to the good drainage conditions in the catchment.

SewerCAD© Modelling – Hydraulic analysis of the trunk sewer was made using the SewerCAD© software. Inputs to the model like sewage flows (reticulation flow from each sub-catchment) at nodes, ground and pipe elevations at the nodes, lift stations, etc, are presented in **Annex 4.3.2** Pasig Sewerage System.

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4.3.2.3 Recommended Option and Cost

The recommended option for the proposed Pasig Sewerage system is shown in **Figure 4.3** with the summary of facilities and costs shown in **Table 4.3.**

Table 4.3 Summary of Facilities and Costs for the proposed Pasig Sewerage System

Pasig Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Sewerage Coverage (Reticulation) (ha):	119	61	61	328	**569**
	Incremental Sewage Flow (STP Capacity) (Mld):	8	1	4	22	**35**
	Increment trunk sewers total length (m), (∅200mm - ∅600mm)	0	1,143	1,742	5,362	**8,247**
	Required STP Area (ha)	0.45	0	0.9	1.19	**2.54**
	* excludes existing sewered 27 ha					
	Costs in P million					
	STP Land Cost	63	0	126	167	**356**
	STP Incremental Cost:	210	0	400	540	**1,151**
	Sewer Trunks Cost:	0	24	14	110	**147**
	Reticulation Cost :	77	40	40	213	**370**
	Total	350	63	579	1030	**2023**

4.4 Summary of Facilities and Costs

The summary of the sewerage facilities and costs for the Central Metro Manila Region is presented in **Table 4.4.** Sewerage services envisaged a total coverage of 119 ha in 2010 in addition to existing systems, with continuing expansion up to 2025 when the total coverage becomes 1,437 ha with four decentralized STPs with a total capacity of 83 MLD. The four sewerage systems will benefit about 743,000 residents in the Central Metro Manila Region with a corresponding estimated capital investment of P 5.20 B including land acquisition.

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Table 4.4 Summary for Central Metro Manila Region Sewerage

CATCHMENT	2010	2015	2020	2025	Total
SUMMARY: Central Manila Region Sewerage					
Selected Option Costs in P million					
(1) STP Area & Land Cost					
(a) Required STP Area (ha)	0.45	0.35	1.45	2.87	5.12
(b) STP Land Cost	63	70	236	503	872
(2) STP Cost	210	135	695	1,310	2,350
(3) Sewer Trunks Costs	0	45	19	215	279
(4) Reticulation Costs	77	153	131	1,338	1,700
(a)Conventional	0	0	0	0	0
(b)Combined	0	0	0	203	203
(c)STED	0	113	54	1,073	1,240
(d) Existing Storm sewer Rehab	77	40	77	62	257
Total	*350*	*403*	*1,081*	*3,366*	**5,200**
Summary of Facilities					
(1) Trunk Main, (m),(∅200mm -∅900mm)	0	3,076	3,422	10,221	16,719
(2) Reticulation Areas, (ha.)*includes existing sewered 27ha					
(a)Conventional	0	0	0	0	0
(b)Combined	0	0	0	312	312
(c)STED	0	63	71	596	730
(d) Existing Storm sewer Rehab	119	61	119	96	395
Total sewered area (ha.)	*119*	*124*	*190*	*1,004*	**1,437**
(3) UASB-SBR Capacity, (Mld)	8	6	15	54	83

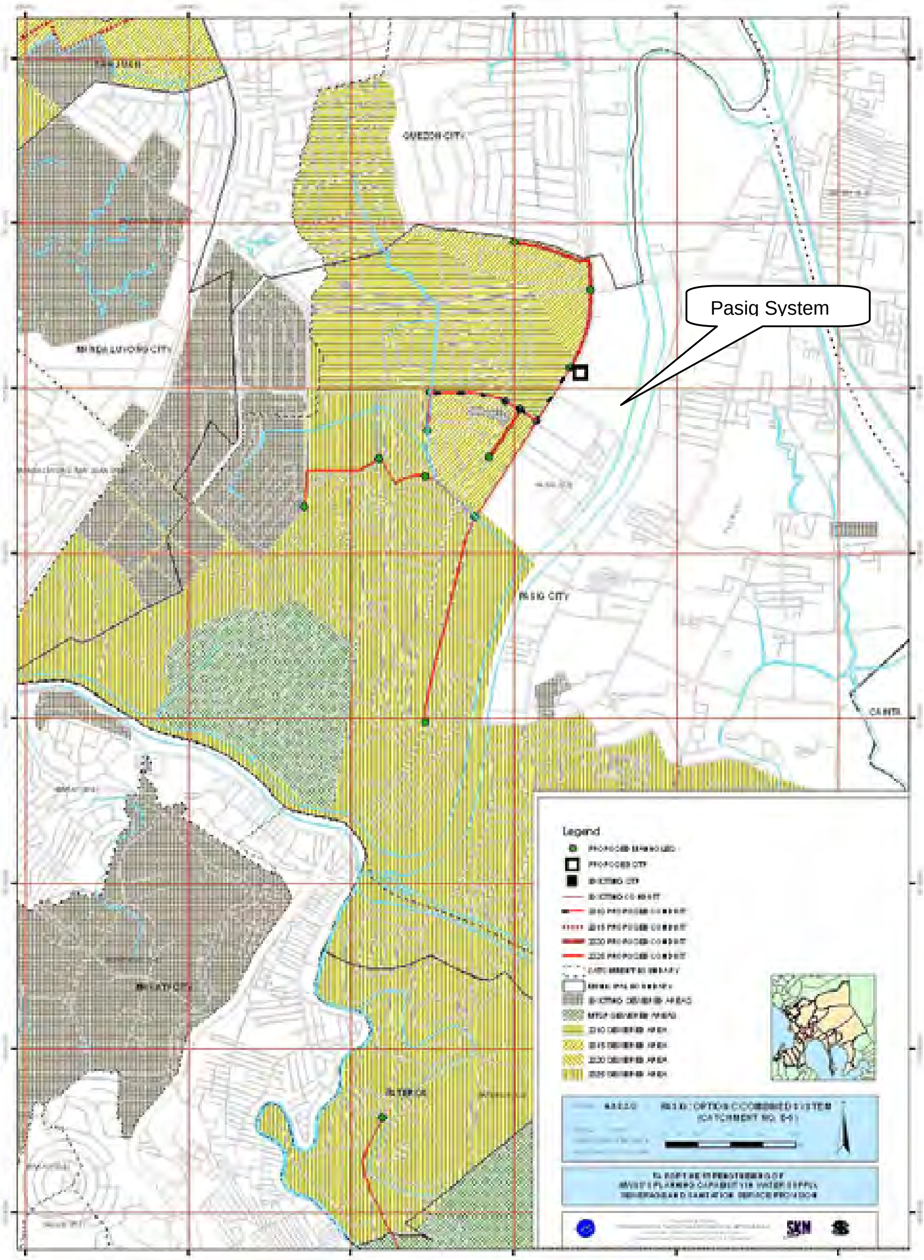

Figure 4.3 Proposed Pasig Sewerage System

5. East Metro Manila Region

The East Metro Manila area proposed for sewerage covers Marikina, Cainta, Taytay, Taguig and Pateros, all in the East Zone concession area. In this area, there are five delineated catchments with a total area of 15,990 ha essentially covering these five cities municipalities. The Marikina-Cainta catchment even extends to adjoining Antipolo City.

In 2005, the population in these five is 1.43 million (14% of the NCR population) and projected to increase to 1.858 million in 2015. Taguig and Pateros are densely populated (over 200 people/ha), while Taytay and Cainta have low densities of 72 to 98 people/ha in 2005.

5.1 Marikina-Cainta Catchment (E-9)

The Marikina-Cainta catchment has a large area of 5,817 ha and covers essentially the whole of Marikina City, the northern half of Cainta, and parts of Antipolo and Pasig City. In the catchment, settlement is dense at the Marikina and Pasig portions but sparse at Cainta and Antipolo.

There exists no sewerage system in the catchment, except the few small community systems in the NHA housing development in Cainta. No sewerage coverage is required by the concession agreement for this area. However, due to the need to reduce pollution of the Marikina River, the upstream portion of the Pasig River, sewerage coverage is recommended.

5.1.1 Marikina Sewerage System (E-9 west part)

The proposed Marikina system will cover an area in Marikina which is at the west part of Catchment E-9.

5.1.1.1 Catchment Description

The proposed Marikina sewerage system will serve a 320-ha strip (about 15% of the city area) of dense residential settlement along the east bank of the Marikina river. Elevations vary from 10 m to 14. The trunk mains will be laid parallel the east river bank.

STP Site – The proposed STP site is located at the bank of Marikina River along A. Bonifacio Avenue. At present the proposed location is an open space. Effluent from the STP will be directly discharged to the river.

Surroundings of the proposed STP locaton are a residential area in eastern part and Marikina River in western part as shown in the photo at right.

5.1.1.2 Sewerage Options

Sewerage Layout – The proposed Marikina sewerage system is planned to be operational in 2025 with a coverage of 19% of the population. STED reticulation is considered most suited to the development in the catchment. The proposed system layout is shown in **Figure 5.1**.

SewerCAD© Modelling – Hydraulic analysis of the trunk sewer was made using the SewerCAD© software. Inputs to the model like sewage flows (reticulation flow from each sub-catchment) at nodes, ground and pipe elevations at the nodes, lift stations, etc, are presented in **Annex 5.1.1** Marikina Sewerage System.

5.1.1.3 Recommended Option and Cost

The recommended option for the proposed Marikina Sewerage system is shown in **Figure 5.1** with the summary of facilities and costs presented in **Table 5.1.**

Table 5.1 Summary of Facilities and Costs for the proposed Marikina Sewerage System

Marikina Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Sewerage Coverage (Reticulation) (ha):	0	0	0	320	**320**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	0	17	**17**
	Increment trunk sewers total length (m), (∅300mm - ∅900mm)	0	0	0	3,200	**3,200**
	Required STP Area (ha)				0.95	**0.95**
	Costs in P million					
	STP Land Cost				95	**95**
	STP Incremental Cost:	0	0	0	437	**437**
	Sewer Trunks Cost:	0	0	0	108	**108**
	Reticulation Cost :	0	0	0	384	**384**
	Total	0	0	0	1,024	**1,024**

5.2 Pasig – Taytay Catchments (E-5)

The 3,294-ha catchment E-5 is bounded in the east by the Mangahan Floodway and in the west by the Napindan River. It covers Pasig City and the west borders of Cainta and Taytay.

Pasig City has an area of 3,101 ha and is traversed about midway by the Pasig River. Settlement is dense in the area west of the Pasig River and a sewerage system is proposed for this area to improve the environment.

The south part of the catchment bordering the Laguna de Bay is covered by the MTSP project. The proposed Pasig sewerage system will expand the MTSP system northward to cover the City east of the Pasig River.

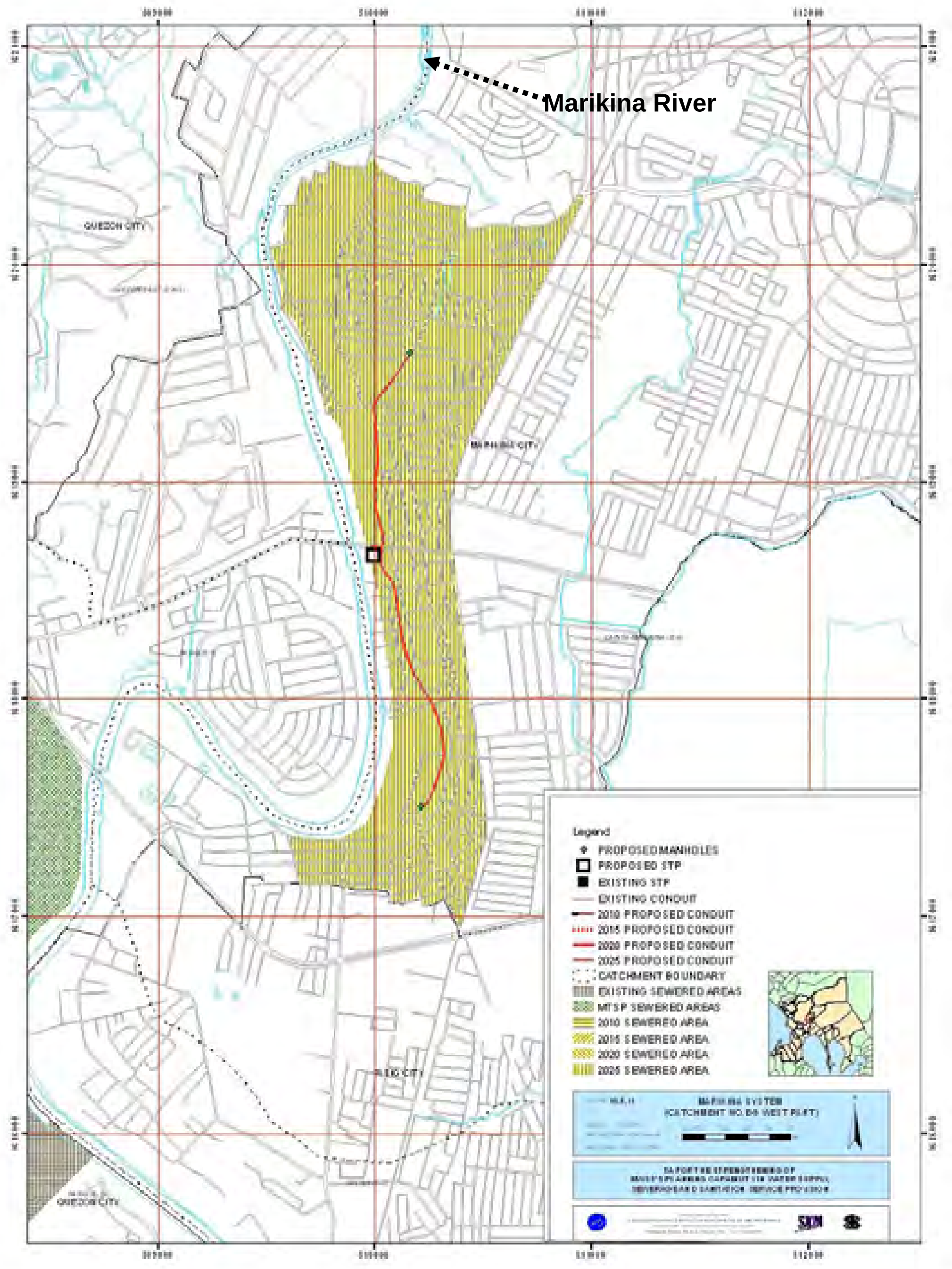

Figure 5.1 Proposed Marikina Sewerage System

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5.2.1 Pasig East – Taytay West Sewerage System (E-5)

The proposed Pasig East-Taytay sewerage system covers the portion of Pasig east of the Pasig River and extends south to the MTSP site at the lake shore.

5.2.1.1 Catchment Description

At catchment E-5, the planned MTSP covers 441 ha along the lakeshore. An expansion is proposed in 2025 to cover 375 ha area of Pasig East. Present land use is predominantly residential with large open spaces for development.

SewerCAD© Modelling – Hydraulic analysis of the trunk sewer was made using the SewerCAD© software. Inputs to the model like sewage flows (reticulation flow from each sub-catchment) at nodes, ground and pipe elevations at the nodes, lift stations, etc, are presented in **Annex 5.2.1** Pasig East-Taytay Sewerage System.

STP Site - The Department of Public Works and Highways (DPWH) retention lagoons was proposed to be converted by MWCI to aerated lagoons/oxidation ditch through the MTSP project. At present, the area in Hon. Sandoval Avenue is being developed with a dike at the shores of Laguna Lake. The addition of a UASB-SBR plant for the expanded service areas shall require 1.68 ha which is available in the area.

The vicinity of the site is the Laguna Lake, residential and some industrial areas. Location of the STP site for the proposed lagoons/treatment facility is shown in photo at right.

5.2.1.2 Sewerage Options

The expansion of the MTSP areas is planned for 2025. For sewerage the MTSP uses a combined drainage system. This study confirmed that the use of the combined drainage system was the least cost option.

SewerCAD© Modelling – Hydraulic analysis of the trunk sewer was made using the SewerCAD© software. Inputs to the model like sewage flows (reticulation flow from each sub-catchment) at nodes, ground and pipe elevations at the nodes, lift stations, etc, are presented in **Annex 5.2.1** Pasig East – Taytay Sewerage System Sewerage System.

5.2.1.3 Recommended Option and Cost

The recommended option for the proposed Pasig East – Taytay Sewerage system is shown in **Figure 5.2** with the summary of facilities and costs presented in **Table 5.2.**

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Table 5.2 Summary of Facilities and Costs for the proposed Pasig East - Taytay Sewerage System

Pasig East-Taytay Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Sewerage Coverage (Reticulation) (ha):	0	0	0	375	**375**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	0	32	**32**
	Increment trunk sewers total length (m), ∅250mm - ∅1350mm)	0	0	0	5,490	**5,490**
	Required STP Area (ha)	0	0	0	1.68	**1.68**
	Costs in P million					
	STP Land Cost	0	0	0	84	**84**
	STP Incremental Cost:	0	0	0	770	**770**
	Sewer Trunks Cost:	0	0	0	212	**212**
	Reticulation Cost :	0	0	0	248	**248**
	Total	0	0	0	1,313	**1,313**

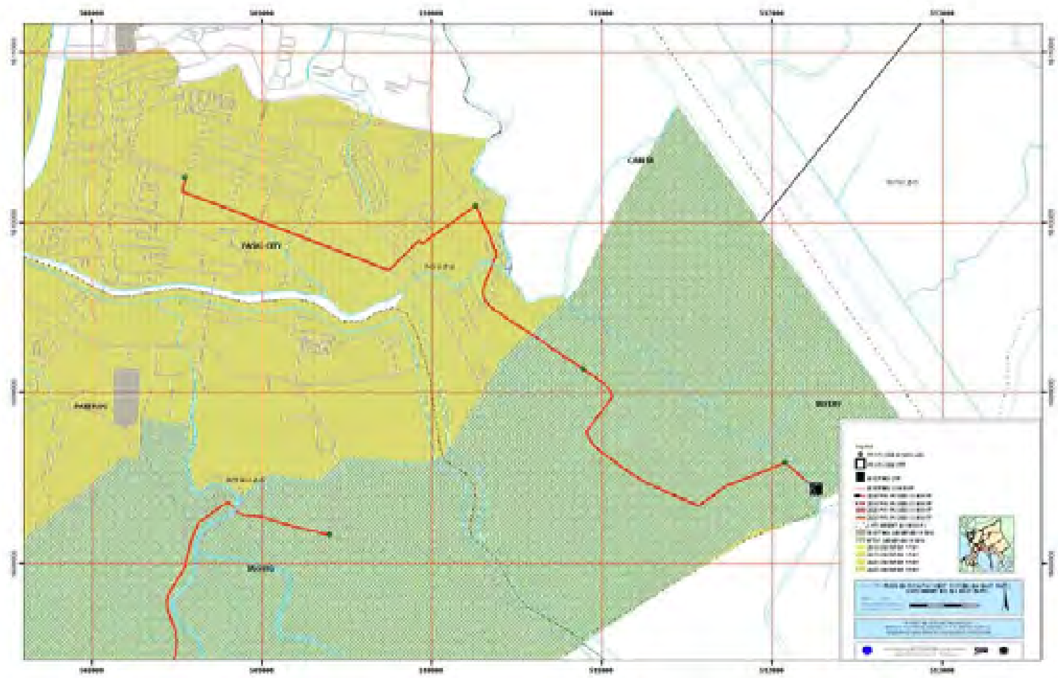

Figure 5.2 Proposed Pasig East - Taytay Sewerage System

5.3 Taguig-Pateros Catchments (E-1 & E-3)

The adjoining catchments E-1 and E-3 (total area of 3,370 ha) cover Taguig City, Pateros town and partly Makati City. Pateros with an area of 185 ha is the smallest town in Metro Manila but is densely populated (311 people/ha in 2005). Taguig City along the coast of Laguna de Bay has an area of 2,752 ha, with a quite dense population of 201 people/ha in 2005. Population in Pateros is projected to decline in the future, while settlements will increase in Taguig due to its large open spaces.

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5.3.1 Taguig-Pateros Sewerage System (E-1 & E-3)

The proposed Taguig-Pateros system is an expansion of the planned MTSP sewerage with an additional 400 ha that will provide full coverage of Pateros town and the portion of Pasig City west of the Napindan River. Including the 1,317-ha MTSP sewerage, the expanded system will cover 1,717 ha by 2025.

5.3.1.1 Catchment Description

The terrain is relatively flat in these catchments with elevations of 4 m in the inland town of Pateros and decreases to 1 m or less at the lakeshores of Taguig. A major part of Taguig is subject to inundation by high lake levels during the wet season. The DPWH is implementing a system of flood protection dykes at the low-lying areas. With improved drainage and flood protection, the large open areas are expected to be developed.

STP Site - The Labasan MTSP site near Tipas River in Taguig also has adequate area for the addition of the UASB-SBR treatment facility for the planned sewerage expansion covering Pateros. It is also part of the DPWH retention ponds to be converted into treatment lagoons/oxidation ditch for treatment prior to discharge to Laguna Lake.

Although the immediate vicinity of the site is presently free of any development, nearby areas include residential and industrial land uses. Location of the STP site for the proposed lagoons/treatment facility is shown in photo at right.

5.3.1.2 Sewerage Options

The options presented for the Taguig expansion are to be operational in 2025. As with the Taytay system, the recommended sewage system is combined drainage. Conventional and STED systems were evaluated as well and the combined system still came up as the least costly option.

SewerCAD© Modelling – Hydraulic analysis of the trunk sewer was made using the SewerCAD© software. Inputs to the model like sewage flows (reticulation flow from each sub-catchment) at nodes, ground and pipe elevations at the nodes, lift stations, etc, are presented in **Annex 5.3.1** Taguig-Pateros Sewerage System.

5.3.1.3 Recommended Option and Cost

The recommended option for the proposed Pasig East – Taytay Sewerage system is shown in **Figure 5.3** with the summary of facilities and costs shown in **Table 5.3.**

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Table 5.3 Summary of Facilities and Costs for the proposed Taguig-Pateros Sewerage System

Taguig-Pateros Sewerage System		2010	2015	2020	2025	Total
	Summary of Facilities					
	Sewerage Coverage (Reticulation) (ha):	0	0	0	400	**400**
	Incremental Sewage Flow (STP Capacity) (Mld):	0	0	0	26	**26**
	Increment trunk sewers total length (m), (∅900mm - ∅1350mm)	0	0	0	4,890	**4,890**
	Required STP Area (ha)	0	0	0	1.39	**1.39**
	Costs in P million					
	STP Land Cost	0	0	0	278	**278**
	STP Incremental Cost:	0	0	0	633	**633**
	Sewer Trunks Cost:	0	0	0	174	**174**
	Reticulation Cost :	0	0	0	450	**450**
	Total	0	0	0	1,535	**1,535**

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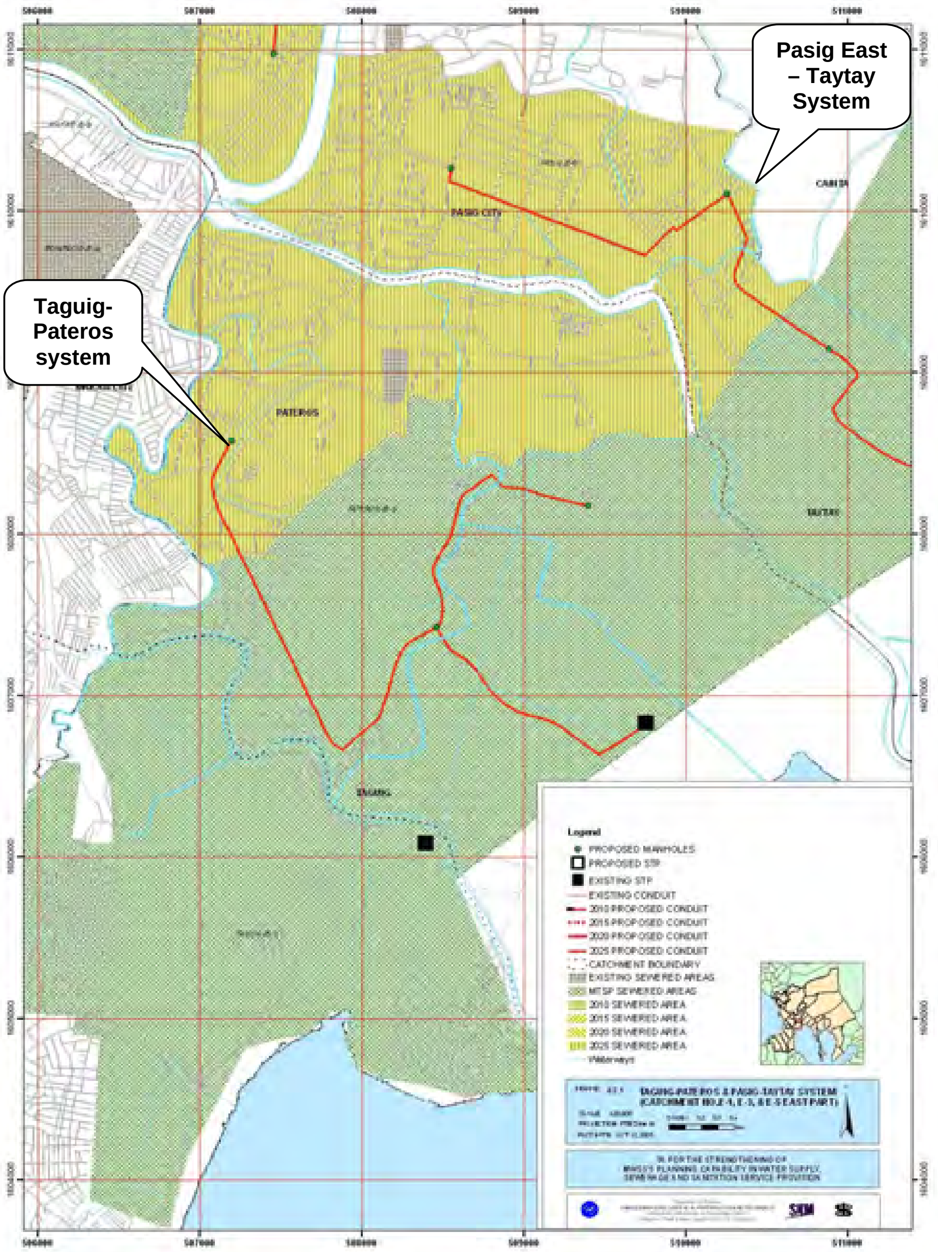

Figure 5.3 Proposed Taguig-Pateros Sewerage System

5.4 Summary of Facilities and Costs

The summary of the sewerage facilities and costs for the East Metro Manila region is presented in **Table 5.4.** Sewerage services are mainly for the 2025 planning horizon, as there is no required sewerage coverage by the concession agreement in this region prior to 2021. Sewerage coverage envisaged an additional 1,095 ha in 2025 excluding the 1,756 ha served by the MTSP. For the region, three new STPs are proposed, including the upgrade of the two MTSP STPs. The expanded sewerage will benefit an estimated 494,000 residents in the area. The total capital investment was estimated at P 3.87 B including land acquisition for the STP sites and their expansion.

Table 5.4 Summary of Facilities and Costs for the East Metro Manila Region Sewerage

	CATCHMENT	2010	2015	2020	2025	Total
SUMMARY: East Metro Manila Sewerage						
	Selected Option Costs in P million					
	(1) STP Area & Land Cost					
	(a) Required STP Area (ha)	0.00	0.00	0.00	4.02	4.02
	(b) STP Land Cost	0	0	0	457	457
	(2) STP Cost	0	0	0	1,840	1,840
	(3) Sewer Trunks Costs	0	0	0	494	494
	(4) Reticulation Costs	0	0	0	1,082	1,082
	(a)Conventional	0	0	0	0	0
	(b)Combined	0	0	0	834	834
	(c)STED	0	0	0	0	0
	(d) Existing Storm sewer Rehab	0	0	0	248	248
	Total	*0*	*0*	*0*	*3,872*	**3,872**
	Summary of Facilities					
	(1) Trunk Main Areas, (m),(∅250mm -∅1350mm)	0	0	0	13,580	13,580
	(2) Reticulation Areas, (ha.):*includes existing sewered 1,781ha.					
	(a)Conventional	0	0	0	0	0
	(b)Combined	0	0	0	720	720
	(c)STED	0	0	0	0	0
	(d) Existing Storm sewer Rehab	0	0	0	375	375
	Total sewered area (ha.)	*0*	*0*	*0*	*1095*	**1095**
	(3) UASB-SBR Capacity, (Mld)	0	0	0	75	75
	a.Conventional	0	0	0	0	0
	b.Combined	0	0	0	43	43
	c.STED	0	0	0	0	0
	d.Drainage Rehabilitation	0	0	0	32	32
	Total(MLd):	*0*	*0*	*0*	*75*	**75**

Chapter 10 Annex

Annex 3.1.1

Caloocan (Dagat-dagatan) Sewerage System

Chapter 10 Annex

Annex 3.3.1

Navotas Sewerage System

Chapter 10 Annex

Annex 3.3.2

Valenzuela Sewerage System

Chapter 10 Annex

Annex 3.3.3

Caloocan North Sewerage System

Chapter 10 Annex

Annex 4.2.1

QC West Sewerage System

Chapter 10 Annex

Annex 4.3.1

San Juan Sewerage System

Chapter 10 Annex

Annex 4.3.2

Pasig Sewerage System

Chapter 10 Annex

Annex 5.1.1

Marikina Sewerage System

Chapter 10 Annex

Annex 5.2.1

Pasig East – Taytay West Sewerage System

Chapter 10 Annex

Annex 5.3.1

Taguig – Pateros Sewerage System

Appendix to Chapter 12

Chapter 12 Annex

Annex 12-1
Financial Analysis of Sanitation Services

East Zone - Unit Cost Analysis of Septage Treatment (Php/m^3)

Component	Capacity	Cost	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2035	Discounted Cost
			YEAR																				
CAPITAL COST																							
Septage Treatment Plant (Incl. land)																							
Rizal Treatment Plant	800 m^3/day	973.00	-	-	-	-	-	-	-	973.00	-	-	-	-	-	-	-	-	-	-	-	-	
Implementation										100%													
Rizal Extension Treatment Plant	700 m^3/day	941.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	941.00	-	-	
Implementation																				100%			
CAPITAL COST		1,914.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	973.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	941.0	0.0	0.0	599.46
CAPITAL COST (incl. contingencies)		2,488.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,264.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,223.3	0.0	0.0	779.30
SLUDGE DISPOSAL											9.7	9.7	9.7	9.7	9.7	12.9	12.9	12.9	12.9	12.9	16.1	16.1	104.25
OPERATING & MAINTENANCE COST											65.6	65.6	65.6	65.6	65.6	65.6	65.6	65.6	65.6	131.2	131.2	131.2	731.72
FINANCIAL BENEFITS																							
Capacity (MCM)																							
Rizal Treatment Plant	800		-	-	-						0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	
Rizal Extension	800		-	-	-																0.292	0.292	
Total Capacity (MCM)			-	-	-	-	-	-	-	-	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.292	0.584	0.584	1.43

Unit Cost of Septage Treatment(Php/M^3)	Base Cost	Base Cost Plus Contingencies
	1006.08	1132.13

2.12

East Zone - Unit Cost Analysis of Septage Collection (Php/m^3)

Component	Capacity	Cost	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2035	Discounted Cost
			YEAR																				
CAPITAL COST																							
Vacuum Tankers	5 m^3																						
Cost		131.04	-	-	-	-	-	-	-	-	-	-	-	-	112.84	-	-	-	-	18.20	-	-	
Implementation															86%					14%			
Vacuum Tankers	10 m^3																						
Cost		649.60	-	-	-	-	-	-	-	8.96	-	-	-	-	492.80	-	-	-	-	147.84	-	-	
Implementation										1%					76%					23%			
CAPITAL COST		780.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0	0.0	0.0	0.0	0.0	605.6	0.0	0.0	0.0	0.0	166.0	0.0	0.0	199.38
CAPITAL COST (incl. contingencies)		1,014.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.6	0.0	0.0	0.0	0.0	787.3	0.0	0.0	0.0	0.0	215.9	0.0	0.0	259.20
OPERATING & MAINTENANCE COST			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	2.1	2.1	2.1	120.5	120.5	120.5	120.5	120.5	120.5	153.5	35.1	273.71
FINANCIAL BENEFITS																							
Capacity (MCM)																							
Vacuum Tankers (5 m3)	0		-	-	-	-	-	-	-	-	-	-	-	-	-								
Vacuum Tankers (5 m3)	0										-	-	-	-	-	-	-	-	-	-			
Vacuum Tankers (5 m3)	31															0.11	0.11	0.11	0.11	0.11	0.11		
Vacuum Tankers (5 m3)	5																				0.02	0.02	
Vacuum Tankers (10 m3)	0					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Vacuum Tankers (10 m3)	2										0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01			
Vacuum Tankers (10 m3)	110															0.80	0.80	0.80	0.80	0.80	0.80		
Vacuum Tankers (10 m3)	33		-	-	-																0.24	0.24	
Total Capacity (MCM)			-	-	-	-	-	-	-	-	0.0	0.0	0.0	0.0	0.0	0.9	0.9	0.9	0.9	0.9	1.2	0.3	1.85

Unit Cost of Septage Collection (Php/m^3)	Base Cost (Php'm)	With Contingencies (Php'm)
	256.07	288.45

0.54

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West Zone - Unit Cost Analysis of Septage Treatment (Php/m^3)

Component	Capacity	Cost	YEAR 2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2035	Discounted Cost
CAPITAL COST																							
Septage Treatment Plant (Incl. land)																							
Dagat-dagatan Treatment Plant	400 m^3/day	470.40	-	-	470.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Implementation					100%																		
Dagat-dagatan Extension 1	200 m^3/day	235.20	-	-	-	-	-	-	-	235.20	-	-	-	-	-	-	-	-	-	-	-	-	
Implementation										100%													
Dagat-dagatan Extension 2	200 m^3/day	235.20	-	-	-	-	-	-	-	-	-	-	-	-	235.20	-	-	-	-	-	-	-	
Implementation															100%								
Dagat-dagatan Extension 3	200 m^3/day	235.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	235.20	-	-	
Implementation																				100%			
Paranaque/Las Pinas	200 m^3/day	630.40	-	-	630.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Implementation					100%																		
Paranaque/Las Pinas	300 m^3/day	235.20	-	-	-	-	-	-	-	156.80	-	-	-	-	-	-	-	-	-	78.40	-	-	
Implementation										67%										33%			
CAPITAL COST		**2,041.6**	**0.0**	**0.0**	**470.4**	**0.0**	**0.0**	**0.0**	**0.0**	**392.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**78.4**	**0.0**	**0.0**	**540.44**
CAPITAL COST (incl. contingencies)		**1,223.0**	**0.0**	**0.0**	**611.5**	**0.0**	**0.0**	**0.0**	**0.0**	**509.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**101.9**	**0.0**	**0.0**	**702.57**
SLUDGE DISPOSAL						**6.3**	**6.3**	**6.3**	**6.3**	**6.3**	**8.4**	**8.4**	**8.4**	**8.4**	**8.4**	**6.4**	**6.4**	**6.4**	**6.4**	**6.4**	**8.1**	**8.1**	**63.42**
OPERATING & MAINTENANCE COST			**0.0**	**0.0**	**0.0**	**77.1**	**77.1**	**77.1**	**77.1**	**77.1**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**121.0**	**121.0**	**121.0**	**121.0**	**121.0**	**142.9**	**142.9**	**671.54**
FINANCIAL BENEFITS																							
Capacity (MCM)																							
Dagat-dagatan Treatment Plant	400		-	-	-	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	0.146	
Dagat-dagatan Extension 1	200		-	-	-	-	-	-	-	-	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	
Dagat-dagatan Extension 2	200															0.073	0.073	0.073	0.073	0.073	0.073	0.073	
Dagat-dagatan Extension 3	200																				0.073	0.073	
Paranaque/ Las Pinas	200					0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	
Paranaque/ Las Pinas Extension	300		-	-	-						0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.110	0.110	0.110	0.110	
Total Capacity (MCM)			-	**-**	**-**	**0.219**	**0.219**	**0.219**	**0.219**	**0.219**	**0.365**	**0.365**	**0.365**	**0.365**	**0.365**	**0.438**	**0.438**	**0.438**	**0.475**	**0.475**	**0.548**	**0.548**	**2.29**

Unit Cost of Septage Treatment(Php/M^3)	Base Cost	Base Cost Plus Contingencies	
	557.74	628.65	1.18

West Zone - Unit Cost Analysis of Septage Collection (Php/m^3)

Component	Capacity	Cost	YEAR 2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2035	Discounted Cost
CAPITAL COST																							
Vacuum Tankers	5 m^3																						
Cost		94.64	-	-	21.84	-	-	-	-	18.20	-	-	-	-	14.56	-	-	-	-	40.04	-	-	
Implementation					23%					19%					15%					42%			
Vacuum Tankers	10 m^3																						
Cost		698.88	-	-	179.20	-	-	-	-	188.16	-	-	-	-	89.60	-	-	-	-	241.92	-	-	
Implementation					26%					27%					13%					35%			
CAPITAL COST		**793.5**	**0.0**	**0.0**	**201.0**	**0.0**	**0.0**	**0.0**	**0.0**	**206.4**	**0.0**	**0.0**	**0.0**	**0.0**	**104.2**	**0.0**	**0.0**	**0.0**	**0.0**	**282.0**	**0.0**	**0.0**	**319.21**
CAPITAL COST (incl. contingencies)		**1,031.6**	**0.0**	**0.0**	**261.4**	**0.0**	**0.0**	**0.0**	**0.0**	**268.3**	**0.0**	**0.0**	**0.0**	**0.0**	**135.4**	**0.0**	**0.0**	**0.0**	**0.0**	**366.5**	**0.0**	**0.0**	**414.97**
OPERATING & MAINTENANCE COST			**0.0**	**0.0**	**0.0**	**42.6**	**42.6**	**42.6**	**42.6**	**42.6**	**87.1**	**87.1**	**87.1**	**87.1**	**87.1**	**65.9**	**65.9**	**65.9**	**65.9**	**65.9**	**79.1**	**57.7**	**410.66**
FINANCIAL BENEFITS																							
Capacity (MCM)																							
Vacuum Tankers (5 m3)	6		-	-	-	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02								
Vacuum Tankers (5 m3)	5										0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02			
Vacuum Tankers (5 m3)	4															0.01	0.01	0.01	0.01	0.01	0.01		
Vacuum Tankers (5 m3)	11																				0.04	0.04	
Vacuum Tankers (10 m3)	40					0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29								
Vacuum Tankers (10 m3)	42										0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31			
Vacuum Tankers (10 m3)	20															0.15	0.15	0.15	0.15	0.15	0.15		
Vacuum Tankers (10 m3)	54		-	-	-																0.39	0.39	
Total Capacity (MCM)			**-**	**-**	**-**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.6**	**0.4**	**3.03**

Unit Cost of Septage Collection (Php/m^3)	Base Cost (Php'm)	With Contingencies (Php'm)	
	240.64	272.21	0.51

Sanitation Financial Evaluation - East Zone
(in Php'mil., 2005 prices)

Year	Capital Costs	Operating & Maintenance Cost	Revenue from Households	Revenue from Private Tankers	Net Income	Sensitivity Analysis		
						Cost + 10%	Revenue - 10%	Cost +10% Rev -10%
2007	-	-	-	-	-	-	-	-
2008	-	-	-	-	-	-	-	-
2009	-	-	-	-	-	-	-	-
2010	-	-	-	-	-	-	-	-
2011	-	-	-	-	-	-	-	-
2012	-	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-	-
2014	1,277	-	-	-	(1,277)	(1,404)	(1,277)	(1,404)
2015	-	68	381	42	355	306	275	268
2016	-	68	381	42	355	306	275	268
2017	-	68	381	42	355	306	275	268
2018	-	68	381	42	355	306	275	268
2019	787	186	381	42	(551)	(690)	(631)	(728)
2020	-	186	714	42	570	509	457	438
2021	-	186	714	42	570	509	457	438
2022	-	186	714	42	570	509	457	438
2023	-	186	714	42	570	509	457	438
2024	1,439	252	714	42	(935)	(1,146)	(1,048)	(1,217)
2025	-	285	1,178	83	977	865	776	747
2026	-	285	1,178	83	977	865	776	747
2027	-	285	1,178	83	977	865	776	747
2028	-	285	1,178	83	977	865	776	747
2029	-	285	1,178	83	977	865	776	747
2030	-	166	845	83	762	662	594	577
2031	-	166	845	83	762	662	594	577
2032	-	166	845	83	762	662	594	577
2033	-	166	845	83	762	662	594	577
2034	-	166	845	83	762	662	594	577
2035	-	166	845	83	762	662	594	577
FIRR					**26.34%**	**20.19%**	**19.87%**	**16.88%**
NPV					**$1,065.94**	**$697.81**	**$611.59**	**$447.21**

Sanitation Financial Evaluation - West Zone
(in Php'mil., 2005 prices)

Year	Capital Costs	Operating & Maintenance Cost	Revenue from Households	Revenue from Private Tankers	Net Income	Sensitivity Analysis		
						Cost + 10%	Revenue - 10%	Cost +10% Rev -10%
2007	-	-	-	-	-	-	-	-
2008	-	-	-	-	-	-	-	-
2009	873	-	-	-	(873)	(960)	(873)	(960)
2010	-	120	213	14	108	82	72	60
2011	-	120	213	14	108	82	72	60
2012	-	120	213	14	108	82	72	60
2013	-	120	213	14	108	82	72	60
2014	778	120	213	14	(670)	(774)	(705)	(795)
2015	-	192	388	23	219	177	157	138
2016	-	192	388	23	219	177	157	138
2017	-	192	388	23	219	177	157	138
2018	-	192	388	23	219	177	157	138
2019	135	192	388	23	84	28	22	(11)
2020	-	187	387	28	228	182	162	143
2021	-	187	387	28	228	182	162	143
2022	-	187	387	28	228	182	162	143
2023	-	187	408	30	252	203	181	162
2024	468	187	408	30	(217)	(313)	(288)	(353)
2025	-	222	481	35	294	237	211	188
2026	-	222	481	35	294	237	211	188
2027	-	222	481	35	294	237	211	188
2028	-	222	481	35	294	237	211	188
2029	-	222	481	35	294	237	211	188
2030	-	201	436	35	271	215	192	172
2031	-	201	436	35	271	215	192	172
2032	-	201	436	35	271	215	192	172
2033	-	201	436	35	271	215	192	172
2034	-	201	436	35	271	215	192	172
2035	-	201	436	201	436	215	192	172
FIRR					**11.85%**	**7.21%**	**6.93%**	**4.28%**
NPV					**$115.88**	**($259.98)**	**($255.98)**	**($475.95)**

Chapter 12 Annex

Annex 12-2
Financial Analysis of Sewerage Facilities

EAST CONCESSION AREA - Unit Cost Analysis of Proposed Sewerage Facilities

Component	Average Capacity (MLD)	Cost (Php'mil)	YEAR 2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2045	Discounted Cost
CAPITAL COST																							
Phase 1	**8**																						
Land Acquisition		**63.0**	63.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Sewerage Treatment Plant		**210.0**	52.5	52.5	52.5	52.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Trunk Sewer Pipe		**-**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Reticulation		**77.0**	19.3	19.3	19.3	19.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Sub-Total Cost		**350.0**	**134.8**	**71.8**	**71.8**	**71.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**282.5**
Implementation			39%	21%	21%	21%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Phase 2	**5**																						
Land Acquisition		**70.0**	-	-	-	-	-	-	-	70.0	-	-	-	-	-	-	-	-	-	-	-	-	
Sewerage Treatment Plant		**135.0**	-	-	-	-	-	-	-	-	135.0	-	-	-	-	-	-	-	-	-	-	-	
Trunk Sewer Pipe		**45.0**	-	-	-	-	-	-	-	22.5	22.5	-	-	-	-	-	-	-	-	-	-	-	
Reticulation		**153.0**	-	-	-	-	-	-	-	76.5	76.5	-	-	-	-	-	-	-	-	-	-	-	
Sub-Total Cost		**403.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**169.0**	**234.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**172.6**
Implementation			0%	0%	0%	0%	0%	0%	0%	42%	58%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Phase 3	**27**																						
Land Acquisition		**236.0**	-	-	-	-	-	-	-	-	-	-	236.0	-	-	-	-	-	-	-	-	-	
Sewerage Treatment Plant		**695.0**	-	-	-	-	-	-	-	-	-	-	-	208.5	243.3	243.3	-	-	-	-	-	-	
Trunk Sewer Pipe		**19.0**	-	-	-	-	-	-	-	-	-	-	-	-	9.5	9.5	-	-	-	-	-	-	
Reticulation		**131.0**	-	-	-	-	-	-	-	-	-	-	-	39.3	45.9	45.9	-	-	-	-	-	-	
Sub-Total Cost		**1,081.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**236.0**	**247.8**	**298.6**	**298.6**	**-**	**-**	**-**	**-**	**-**	**-**	**312.3**
Implementation			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	22%	23%	28%	28%	0%	0%	0%	0%	0%	0%	
Phase 4	**95**																						
Land Acquisition		**624.0**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	624.0	-	-	-	-	-	
Sewerage Treatment Plant		**2,380.0**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	476.0	476.0	476.0	476.0	476.0	-	
Trunk Sewer Pipe		**606.0**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	121.2	121.2	121.2	121.2	121.2	-	
Reticulation		**1,309.0**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	261.8	261.8	261.8	261.8	261.8	-	
Sub-Total Cost		**4,919.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1,483.0**	**859.0**	**859.0**	**859.0**	**859.0**	**-**	**948.2**
Implementation			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	30%	17%	17%	17%	17%	0%	
Total Capital Costs (All Stages)	**135**	**6,753.0**	**134.8**	**71.8**	**71.8**	**71.8**	**0.0**	**0.0**	**0.0**	**169.0**	**234.0**	**0.0**	**236.0**	**247.8**	**298.6**	**298.6**	**1,483.0**	**859.0**	**859.0**	**859.0**	**859.0**	**0.0**	**1,715.69**
OPERATING & MAINTENANCE COST																							
Phase 1	24		-	-	-	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	
Phase 2	16		-	-	-	-	-	-	-	-	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	
Phase 3	72		-	-	-	-	-	-	-	-	-	-	-	-	-	72.5	72.5	72.5	72.5	72.5	72.5	72.5	
Phase 4	137		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	137.3	137.3	
Reticulation			-	0.1	0.3	0.4	0.6	0.6	0.6	0.6	1.2	1.7	1.7	1.7	2.0	2.4	2.7	4.7	6.6	8.6	10.6	12.5	
Total O&M (All Stages)			**-**	**0.1**	**0.3**	**23.9**	**24.1**	**24.1**	**24.1**	**24.1**	**40.4**	**40.9**	**40.9**	**40.9**	**41.2**	**114.0**	**114.4**	**116.3**	**118.3**	**120.3**	**259.6**	**261.5**	**627.8**
FINANCIAL BENEFITS																							
Capacity (MCM)																							
Phase 1			-	-	-	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	
Phase 2			-	-	-	-	-	-	-	-	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	
Phase 3			-	-	-	-	-	-	-	-	-	-	-	-	-	9.9	9.9	9.9	9.9	9.9	9.9	9.9	
Phase 4			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	34.7	34.7	
Total Capacity (MCM)			**-**	**-**	**-**	**2.9**	**2.9**	**2.9**	**2.9**	**2.9**	**4.7**	**4.7**	**4.7**	**4.7**	**4.7**	**14.6**	**14.6**	**14.6**	**14.6**	**14.6**	**49.3**	**49.3**	**101.2**

	Base Cost	With Contingencies	
Unit Cost of Investment / O&M (Php/M^3)	**23.16**	**28.25**	**22.60**
Unit Cost of Investment (Php/M^3)	**16.96**	**22.04**	**17.63**
Unit Cost of O&M (Php/M^3)	**6.20**	**6.20**	**4.96**

SKM

WEST CONCESSION AREA - Unit Cost Analysis of Proposed Sewerage Facilities

Component	Average Capacity (MLD)	Cost (Php'mil)	YEAR 2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2045	Discounted Cost
CAPITAL COST																							
Phase 1	**40**																						
Land Acquisition		**402.0**	402.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Sewerage Treatment Plant		**1,408.0**	352.0	352.0	352.0	352.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Trunk Sewer Pipe		**117.0**	29.3	29.3	29.3	29.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Reticulation		**998.0**	249.5	249.5	249.5	249.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Sub-Total Cost		**2,925.0**	**1,032.8**	**630.8**	**630.8**	**630.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2,346.3**
Implementation			35%	22%	22%	22%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Phase 2	**30**																						
Land Acquisition		**428.0**	-	-	-	-	-	428.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Sewerage Treatment Plant		**732.0**	-	-	-	-	-	-	219.6	256.2	256.2	-	-	-	-	-	-	-	-	-	-	-	
Trunk Sewer Pipe		**341.0**	-	-	-	-	68.2	68.2	68.2	68.2	68.2	-	-	-	-	-	-	-	-	-	-	-	
Reticulation		**1,044.0**	-	-	-	-	208.8	208.8	208.8	208.8	208.8	-	-	-	-	-	-	-	-	-	-	-	
Sub-Total Cost		**2,545.0**	**-**	**-**	**-**	**-**	**277.0**	**705.0**	**496.6**	**533.2**	**533.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1,267.2**
Implementation			0%	0%	0%	0%	11%	28%	20%	21%	21%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Phase 3	**183**																						
Land Acquisition		**1,329.0**	-	-	-	-	-	-	-	-	-	923.0	406.0	-	-	-	-	-	-	-	-	-	
Sewerage Treatment Plant		**5,041.0**	-	-	-	-	-	-	-	-	-	832.2	1,052.2	1,052.2	1,052.2	1,052.2	-	-	-	-	-	-	
Trunk Sewer Pipe		**912.0**	-	-	-	-	-	-	-	-	-	148.0	148.0	199.6	208.2	208.2	-	-	-	-	-	-	
Reticulation		**6,574.0**	-	-	-	-	-	-	-	-	-	1,314.8	1,314.8	1,314.8	1,314.8	1,314.8	-	-	-	-	-	-	
Sub-Total Cost		**13,856.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3,218.0**	**2,921.0**	**2,566.6**	**2,575.2**	**2,575.2**	**-**	**-**	**-**	**-**	**-**	**-**	**4,319.2**
Implementation			0%	0%	0%	0%	0%	0%	0%	0%	0%	23%	21%	19%	19%	19%	0%	0%	0%	0%	0%	0%	
Phase 4	**205**																						
Land Acquisition		**1,884.0**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,548.0	336.0	-	-	-	-	
Sewerage Treatment Plant		**4,949.0**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	835.8	835.8	1,220.8	1,220.8	835.8	-	
Trunk Sewer Pipe		**1,108.0**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	201.0	201.0	252.5	252.5	201.0	-	
Reticulation		**5,580.0**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	921.2	1,213.4	1,262.1	1,262.1	921.2	-	
Sub-Total Cost		**13,521.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3,506.0**	**2,586.2**	**2,735.4**	**2,735.4**	**1,958.0**	**-**	**2,594.4**
Implementation			0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	26%	19%	20%	20%	14%	0%	
Total Capital Costs (All Stages)	**458**	**32,847.0**	**1,032.8**	**630.8**	**630.8**	**630.8**	**277.0**	**705.0**	**496.6**	**533.2**	**533.2**	**3,218.0**	**2,921.0**	**2,566.6**	**2,575.2**	**2,575.2**	**3,506.0**	**2,586.2**	**2,735.4**	**2,735.4**	**1,958.0**	**0.0**	**10,527.14**
Total Capital Costs (With Cont.)		**42,701.1**	**1,342.6**	**820.0**	**820.0**	**820.0**	**360.1**	**916.5**	**645.6**	**693.2**	**693.2**	**4,183.4**	**3,797.3**	**3,336.6**	**3,347.8**	**3,347.8**	**4,557.8**	**3,362.1**	**3,556.0**	**3,556.0**	**2,545.4**	**0.0**	**13,685.28**
OPERATING & MAINTENANCE COST																							
Phase 1	**93**		-	-	-	93.2	93.2	93.2	93.2	93.2	93.2	93.2	93.2	93.2	93.2	93.2	93.2	93.2	93.2	93.2	93.2	93.2	
Phase 2	**73**		-	-	-	-	-	-	-	-	72.9	72.9	72.9	72.9	72.9	72.9	72.9	72.9	72.9	72.9	72.9	72.9	
Phase 3	**409**		-	-	-	-	-	-	-	-	-	-	-	-	-	409.5	409.5	409.5	409.5	409.5	409.5	409.5	
Phase 4	**444**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	444.5	444.5	
Reticulation			-	1.9	3.7	5.6	7.5	9.1	10.6	12.2	13.7	15.3	25.2	35.0	44.9	54.8	64.6	71.5	80.6	90.1	99.6	106.5	
Total O&M (All Stages)			**-**	**1.9**	**3.7**	**98.8**	**100.7**	**102.3**	**103.8**	**105.4**	**179.8**	**181.4**	**191.2**	**201.1**	**211.0**	**630.3**	**640.2**	**647.1**	**656.2**	**665.6**	**1,119.6**	**1,126.5**	**2,879.0**
FINANCIAL BENEFITS																							
Capacity (MCM)																							
Phase 1			-	-	-	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	
Phase 2			-	-	-	-	-	-	-	-	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	
Phase 3			-	-	-	-	-	-	-	-	-	-	-	-	-	66.8	66.8	66.8	66.8	66.8	66.8	66.8	
Phase 4			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	74.8	74.8	
Total Capacity (MCM)			**-**	**-**	**-**	**14.6**	**14.6**	**14.6**	**14.6**	**14.6**	**25.6**	**25.6**	**25.6**	**25.6**	**25.6**	**92.3**	**92.3**	**92.3**	**92.3**	**92.3**	**167.2**	**167.2**	**416.8**

Unit Cost (Php/m³)	Base Cost	With Contingencies	
Unit Cost of Investment / O&M	32.16	39.74	31.79
Unit Cost of Investment	25.26	32.83	26.27
Unit Cost of O&M	6.91	6.91	5.53

SKM

Sewerage Financial Evaluation - East Zone

(in Php'mil., 2005 prices)

Year	Capital Costs	Operating & Maintenance Cost	Revenues	Net Income	Sensitivity Analysis		
					Cost + 10%	Revenue - 10%	Cost +10% Rev -10%
2007	175	-	-	(175)	(193)	(175)	(193)
2008	93	0	-	(93)	(103)	(93)	(103)
2009	93	0	-	(94)	(103)	(94)	(103)
2010	93	24	82	(35)	(46)	(43)	(55)
2011	-	24	82	58	56	50	48
2012	-	24	82	58	56	50	48
2013	-	24	82	58	56	50	48
2014	220	24	82	(161)	(186)	(170)	(194)
2015	304	40	134	(211)	(245)	(224)	(258)
2016	-	41	134	93	89	80	76
2017	307	41	134	(214)	(248)	(227)	(262)
2018	322	41	134	(229)	(265)	(242)	(279)
2019	388	41	134	(295)	(338)	(309)	(352)
2020	388	114	412	(90)	(140)	(131)	(181)
2021	1,928	114	412	(1,630)	(1,834)	(1,671)	(1,875)
2022	1,117	116	412	(821)	(944)	(862)	(985)
2023	1,117	118	412	(823)	(946)	(864)	(987)
2024	1,117	120	412	(825)	(948)	(866)	(989)
2025	1,117	260	1,392	16	(122)	(124)	(261)
2026	-	262	1,392	1,130	1,104	991	965
2027	-	262	1,392	1,130	1,104	991	965
2028	-	262	1,392	1,130	1,104	991	965
2029	-	262	1,392	1,130	1,104	991	965
2030	-	262	1,392	1,130	1,104	991	965
2031	-	262	1,392	1,130	1,104	991	965
2032	-	262	1,392	1,130	1,104	991	965
2033	-	262	1,392	1,130	1,104	991	965
2034	-	262	1,392	1,130	1,104	991	965
2035	-	262	1,392	1,130	1,104	991	965
2036	-	262	1,392	1,130	1,104	991	965
2037	-	262	1,392	1,130	1,104	991	965
2038	-	262	1,392	1,130	1,104	991	965
2039	-	262	1,392	1,130	1,104	991	965
2040	-	262	1,392	1,130	1,104	991	965
2041	-	262	1,392	1,130	1,104	991	965
2042	-	262	1,392	1,130	1,104	991	965
2043	-	262	1,392	1,130	1,104	991	965
2044	-	262	1,392	1,130	1,104	991	965
2045	-	262	1,392	1,130	1,104	991	965
FIRR				**10.40%**	**8.96%**	**8.81%**	**7.43%**
NPV	-	-		**($0.00)**	**($285.82)**	**($285.82)**	**($571.64)**

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Sewerage Financial Evaluation - West Zone

(in Php'mil., 2005 prices)

Year	Capital Costs	Operating & Maintenance Cost	Revenues	Net Income	Sensitivity Analysis		
					Cost + 10%	Revenue - 10%	Cost +10% Rev -10%
2007	1,343	-	-	(1,343)	(1,477)	(1,343)	(1,477)
2008	820	2	-	(822)	(904)	(822)	(904)
2009	820	4	-	(824)	(906)	(824)	(906)
2010	820	99	580	(339)	(430)	(397)	(488)
2011	360	101	580	119	73	61	15
2012	917	102	580	(439)	(540)	(497)	(598)
2013	646	104	580	(169)	(244)	(227)	(302)
2014	693	105	580	(218)	(298)	(276)	(356)
2015	693	180	1,015	142	55	41	(46)
2016	4,183	181	1,015	(3,349)	(3,786)	(3,451)	(3,887)
2017	3,797	191	1,015	(2,973)	(3,372)	(3,075)	(3,474)
2018	3,337	201	1,015	(2,522)	(2,876)	(2,624)	(2,978)
2019	3,348	211	1,015	(2,543)	(2,899)	(2,645)	(3,001)
2020	3,348	630	3,670	(308)	(706)	(675)	(1,073)
2021	4,558	640	3,670	(1,528)	(2,048)	(1,895)	(2,415)
2022	3,362	647	3,670	(339)	(740)	(706)	(1,107)
2023	3,556	656	3,670	(542)	(964)	(909)	(1,331)
2024	3,556	666	3,670	(552)	(974)	(919)	(1,341)
2025	2,545	1,120	6,643	2,978	2,612	2,314	1,948
2026	-	1,126	6,643	5,517	5,404	4,853	4,740
2027	-	1,126	6,643	5,517	5,404	4,853	4,740
2028	-	1,126	6,643	5,517	5,404	4,853	4,740
2029	-	1,126	6,643	5,517	5,404	4,853	4,740
2030	-	1,126	6,643	5,517	5,404	4,853	4,740
2031	-	1,126	6,643	5,517	5,404	4,853	4,740
2032	-	1,126	6,643	5,517	5,404	4,853	4,740
2033	-	1,126	6,643	5,517	5,404	4,853	4,740
2034	-	1,126	6,643	5,517	5,404	4,853	4,740
2035	-	1,126	6,643	5,517	5,404	4,853	4,740
2036	-	1,126	6,643	5,517	5,404	4,853	4,740
2037	-	1,126	6,643	5,517	5,404	4,853	4,740
2038	-	1,126	6,643	5,517	5,404	4,853	4,740
2039	-	1,126	6,643	5,517	5,404	4,853	4,740
2040	-	1,126	6,643	5,517	5,404	4,853	4,740
2041	-	1,126	6,643	5,517	5,404	4,853	4,740
2042	-	1,126	6,643	5,517	5,404	4,853	4,740
2043	-	1,126	6,643	5,517	5,404	4,853	4,740
2044	-	1,126	6,643	5,517	5,404	4,853	4,740
2045	-	1,126	6,643	5,517	5,404	4,853	4,740
FIRR				**10.40%**	**9.12%**	**8.98%**	**7.75%**
NPV	-	-		**($0.00)**	**($1,656.43)**	**($1,656.43)**	**($3,312.86)**

Chapter 12 Annex

Annex 12-3
Economic Analysis of Sanitation Services Option

PARAMETER VALUES FOR SANITATION SERVICES OPTION

Parameter	*Unit*	Concession Area		Both Areas	*Notes*
		East	West		
Cost estimates					
Exchange rate	*Php/$*			56	
Planning contingency	*%*			30%	*As % of Base Cost*
Taxes and duties	*%*				*As % of Base Cost*
Foreign costs				33%	
Local costs				10%	
Capital	*%*				
Foreign costs				65%	*As % of Base Cost*
Unskilled labour				40%	*As % of Local Cost*
O&M	*%*				
Foreign costs				30%	
Unskilled labour				50%	
Shadow prices					
Exchange rate				1.2	
Wage rate				0.6	
SpTP capacity	*m3/day*				
- incremental					*SSMP Annex 9C (24 Nov 05)*
2010		0	600		
2015		800	1000		
2020		800	1200		
2025		1600	1500		
- total					
2010		2000	900		*Spreadsheet*
2015		2800	1200		
2020		2800	1500		
2025		3600	1800		
Additional tankers purchased	*no.*				*SSMP Annex 9B (24 Nov 05)*
- 5m³					
2010		0	6		
2015		0	5		
2020		31	4		
2025		5	11		
- 10m³					
2010		0	40		
2015		2	42		
2020		110	20		
2025		33	54		
Tankers in use	*no.*				*SSMP Annex 9C (24 Nov 05)*
- 5m³					
2010		17	11		
2015		16	11		
2020		31	9		
2025		36	15		
- 10m³					
2010		104	40		
2015		92	82		
2020		112	62		
2025		143	74		
Master Plan capex					*SSMP Page xix*
SpTP capacity	*Php mill*				
2010		0	946	946	
2015		973	470	1443	
2020		0	235	235	
2025		941	353	1294	
Additional tankers	*Php mill*				
2010		0	201	201	
2015		9	206	215	
2020		606	104	710	
2025		166	282	448	
Unit cost of tanker	*$*				
5m³				65,000	
10m³				80,000	

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Master Plan opex					*SSMP Annex 9B & 9C*
SpTPs	*%*			7%	*(24 Nov 05)*
Tankers		26%	25%		*Incl 2.1% & 1.0% for cost of sludge disposal*
WTP measure					
Sanitation charge WTP rate	*Php/m3*	2.45	2.76		*SAP12 Table 5.3 (incorporates those not willing to pay)*
Water consumed	*m3/mth*	51	51		
WTP for improved service	*Php*	8,397	9,452		*PV factor of* 5.6 *(at 2% real over 6 years)*
% expressing WTP	*%*	55%	86%		*SAP12 Table 5.1*
H'holds per toilet		1.03	1.07		*WTP Survey Report Fig.V-1*
Septic tanks desludged/day	*no.*				
- incremental					*Assumes 2 trips/day and 10% handled by private contractors*
2010		0	109		
2015		103	263		
2020		131	192		
2025		258	245		
Septage treatment					
- incremental	*m3/day*				
2010		0	545		*Assumes average tank size of* $5m^3$ *(SSMP p.9-6)*
2015		514	1,313		
2020		656	958		
2025		1,288	1,223		
- available capacity					
2010		200	90		*Assumes 10% of total capacity available for private contractors*
2015		280	120		
2020		280	150		
2025		360	180		
Average incremental cost	*Php/m3*	556	779		*SpTP capacity only. Reduced by 10% to reflect revenue value.*
Improved environment					
Housing payment	*Php/mth*			3,697	*WTP Survey Report p.IV-4*
House market value	*Php*			931,644	*PV factor of 21 (at 2.5% real over 30 years)*
Housing market rates of return	%/yr				*In real terms*
Capital growth				2.5%	
Rental				2.5%	
Property value differential	%				
Sewerage				3.0%	*Applied over catchment area*
Sanitation				1.0%	*Applied to no. of h'holds*
Improved health					
Medical expenses	*Php/mth*			3,186	*WTP Survey Report p.IV-4*
% on env'tl sanitation diseases	*%*			25%	*Refer SSMP Page 2-11 & 12*
Health impact	*%*				*Reduced incidence*
Sewerage				33%	*Refer SSMP Page 2-13*
Sanitation				17%	*Assumes effectiveness is half that of improved sewerage*

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CALCULATION OF EIRR FOR SANITATION OPTION, WEST CONCESSION AREA
(Php million in 2005 prices)

Year	Economic Costs		Economic Benefits				Net Economic Benefits
	Capital Cost	O & M Cost	WTP	SpTP Capacity	Environ-mental	Health	
2005	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0
2009	587	0	0	0	0	0	-587
2010	587	0	0	0	0	0	-587
2011	0	78	329	21	1	8	282
2012	0	78	329	21	1	8	282
2013	0	78	329	21	1	8	282
2014	0	78	329	21	1	8	282
2015	692	78	329	21	1	8	-410
2016	0	172	793	28	4	19	671
2017	0	172	793	28	4	19	671
2018	0	172	793	28	4	19	671
2019	0	172	793	28	4	19	671
2020	347	172	793	28	4	19	324
2021	0	210	579	35	3	14	420
2022	0	210	579	35	3	14	420
2023	0	210	579	35	3	14	420
2024	325	210	579	35	3	14	96
2025	325	210	579	35	3	14	96
2026	0	272	739	42	4	17	531
2027	0	272	739	42	4	17	531
2028	0	272	739	42	4	17	531
2029	0	272	739	42	5	17	531
2030	0	272	739	42	5	17	531
2031	0	272	739	42	5	17	531
2032	0	272	739	42	5	17	531
2033	0	272	739	42	5	17	531
2034	0	272	739	42	5	17	532
2035	0	272	739	42	5	17	532
2036	0	272	739	42	5	17	532
2037	0	272	739	42	6	17	532
2038	0	272	739	42	6	17	532
2039	0	272	739	42	6	17	532
2040	0	272	739	42	6	17	532
2041	0	272	739	42	6	17	533
2042	0	272	739	42	6	17	533
2043	0	272	739	42	7	17	533
2044	0	272	739	42	7	17	533
2045	0	272	739	42	7	17	533
PV at 12%	1064	708	2548	131	13	60	980

EIRR	**24%**

CALCULATION OF EIRR FOR SANITATION OPTION, BOTH CONCESSION AREAS
(Php million in 2005 prices)

Year	Economic Costs		Economic Benefits				Net Economic Benefits
	Capital Cost	O & M Cost	WTP	SpTP Capacity	Environ-mental	Health	
2005	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0
2009	587	0	0	0	0	0	-587
2010	587	0	0	0	0	0	-587
2011	0	78	329	21	1	8	282
2012	0	78	329	21	1	8	282
2013	0	78	329	21	1	8	282
2014	502	78	329	21	1	8	-221
2015	1195	78	329	21	1	8	-913
2016	0	225	1061	75	8	41	960
2017	0	225	1061	75	8	41	960
2018	0	225	1061	75	8	41	960
2019	0	225	1061	75	9	41	960
2020	967	225	1061	75	9	41	-7
2021	0	269	920	82	9	42	784
2022	0	269	920	82	10	42	784
2023	0	269	920	82	10	42	785
2024	891	269	920	82	10	42	-107
2025	891	269	920	82	10	42	-106
2026	0	412	1409	102	18	74	1191
2027	0	412	1409	102	19	74	1191
2028	0	412	1409	102	19	74	1191
2029	0	412	1409	102	20	74	1192
2030	0	412	1409	102	20	74	1192
2031	0	412	1409	102	21	74	1193
2032	0	412	1409	102	21	74	1193
2033	0	412	1409	102	22	74	1194
2034	0	412	1409	102	22	74	1195
2035	0	412	1409	102	23	74	1195
2036	0	412	1409	102	23	74	1196
2037	0	412	1409	102	24	74	1196
2038	0	412	1409	102	25	74	1197
2039	0	412	1409	102	25	74	1197
2040	0	412	1409	102	26	74	1198
2041	0	412	1409	102	27	74	1199
2042	0	412	1409	102	27	74	1199
2043	0	412	1409	102	28	74	1200
2044	0	412	1409	102	29	74	1201
2045	0	412	1409	102	29	74	1202
PV at 12%	1644	916	3601	263	35	149	1487

EIRR	**24%**

Chapter 12 Annex

Annex 12-4
Economic Analysis of Sewerage Facilities Option

SKM

PARAMETER VALUES FOR SEWERAGE SERVICES OPTION

Parameter		Unit	Concession Area East	Concession Area West	Both Areas	Notes
Cost estimates						
Exchange rate		*Php/$*			56	
Planning contingency		*%*			30%	*As % of Base Cost*
Taxes and duties		*%*				*As % of Base Cost*
Foreign costs					33%	
Local costs					10%	
Capital		*%*				
Foreign costs					30%	*As % of Base Cost*
Unskilled labour					40%	*As % of Local Cost*
O&M		*%*				
Foreign costs					30%	
Unskilled labour					50%	
Shadow prices						
Foreign exchange					1.1	
Unskilled labour					0.6	
Land					1	
Master Plan capex						*'Master Plan costs'*
STP land		*Php mill*				
	2010		63	402	465	
	2015		60	428	488	
	2020		256	1329	1585	
	2025		804	1884	2688	
STP		*Php mill*				
	2010		210	1408	1618	
	2015		135	732	867	
	2020		695	5041	5736	
	2025		2780	4949	7729	
Trunk main		*Php mill*				
	2010		0	117	117	
	2015		45	341	386	
	2020		19	912	931	
	2025		709	1108	1817	
Reticulation		*Php mill*				
	2010		77	998	1075	
	2015		153	1044	1197	
	2020		131	6574	6705	
	2025		2284	5580	7864	
Master Plan capex in existing sewered areas						*Includes MTSP areas*
STP						
	2010		0%	0%		
	2015		0%	0%		
	2020		0%	52%		
	2025		50%	0%		
Trunk main		*%*				
	2010		0%	0%		
	2015		0%	0%		
	2020		0%	0%		
	2025		0%	0%		

Master Plan opex	*%*				
STP				10%	*SSMP Figures 10.21 & 10.22*
Trunk main				7%	
Reticulation				3%	
WTP measure					
Sewerage charge WTP rate	*Php/m3*	2.45	3.51		*SAP12 Table 5.3 (incorporates*
Water consumed	*m3/mth*	51	51		*those not willing to pay)*
WTP for improved system	*Php*	8,397	12,029		*PV factor of 5.6 (at 2% real*
					over 6 years)
% expressing WTP	*%*	68%	85%		*SAP12 Table 5.1*
Improved environment					
Housing payment	*Php/mth*			3,697	*WTP Survey Report p.IV-4*
House market value	*Php*			931,644	*PV factor of 21 (at 2.5% real*
					over 30 years)
Housing market rates of return	%/yr				*In real terms*
Capital growth				2.5%	
Rental				2.5%	
Property value differential	%				
Sewerage				3.0%	*Applied over catchment area*
Sanitation				1.0%	*Applied to no. of h'holds*
Improved health					
Medical expenses	*Php/mth*			3,186	*WTP Survey Report p.IV-4*
% on env'tl sanitation diseases	*%*			25%	*Refer SSMP Page 2-11 & 12*
Health impact	*%*				*Reduced incidence*
Sewerage				33%	*Refer SSMP Page 2-13*
Sanitation				17%	*Assumes effectiveness is*
					half that of improved sewerage

CALCULATION OF EIRR FOR SEWERAGE OPTION, EAST CONCESSION AREA
(Php million in 2005 prices)

Year	Economic Costs			Economic Benefits			Net Economic Benefits
	Capital						
	Land	Constr^n	O & M	WTP	Environ-mental	Health	
2005	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0
2007	82	0	0	0	0	0	-82
2008	0	93	0	0	0	0	-93
2009	0	93	0	0	0	0	-93
2010	0	93	0	0	0	0	-93
2011	0	0	22	466	14	56	515
2012	0	0	22	466	14	56	515
2013	0	0	22	466	14	56	515
2014	0	22	22	466	14	56	493
2015	78	303	22	466	14	56	134
2016	0	0	42	574	17	69	618
2017	333	0	42	574	17	69	285
2018	0	226	42	574	17	69	392
2019	0	290	42	574	17	69	328
2020	0	308	42	574	17	69	310
2021	1045	855	112	768	23	92	-1129
2022	0	855	112	768	23	92	-84
2023	0	855	112	768	23	92	-84
2024	0	855	112	768	23	92	-84
2025	0	855	112	768	23	92	-84
2026	0	0	355	1420	43	171	1279
2027	0	0	355	1420	43	171	1279
2028	0	0	355	1420	43	171	1279
2029	0	0	355	1420	43	171	1279
2030	0	0	355	1420	43	171	1279
2031	0	0	355	1420	43	171	1279
2032	0	0	355	1420	43	171	1279
2033	0	0	355	1420	43	171	1279
2034	0	0	355	1420	43	171	1279
2035	0	0	355	1420	43	171	1279
2036	0	0	355	1420	43	171	1279
2037	0	0	355	1420	43	171	1279
2038	0	0	355	1420	43	171	1279
2039	0	0	355	1420	43	171	1279
2040	0	0	355	1420	43	171	1279
2041	0	0	355	1420	43	171	1279
2042	0	0	355	1420	43	171	1279
2043	0	0	355	1420	43	171	1279
2044	0	0	355	1420	43	171	1279
2045	0	0	355	1420	43	171	1279
PV at 12%	346	1015	443	3226	97	388	1907

EIRR	**33%**

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CALCULATION OF EIRR FOR SEWERAGE OPTION, WEST CONCESSION AREA
(Php million in 2005 prices)

Year	Economic Costs			Economic Benefits			Net
	Capital				Environ-		Economic
	Land	Constr^n	O & M	WTP	mental	Health	Benefits
2005	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0
2007	523	0	0	0	0	0	-523
2008	0	820	0	0	0	0	-820
2009	0	820	0	0	0	0	-820
2010	0	820	0	0	0	0	-820
2011	0	270	169	1589	16	63	1229
2012	556	270	169	1589	16	63	672
2013	0	508	169	1589	16	63	991
2014	0	508	169	1589	16	63	991
2015	0	508	169	1589	16	63	991
2016	570	1932	290	1854	18	73	-847
2017	1158	1932	290	1854	18	73	-1434
2018	0	1932	290	1854	18	73	-277
2019	0	1932	290	1854	18	73	-277
2020	0	1932	290	1854	18	73	-277
2021	2278	2270	764	4141	41	163	-967
2022	0	2270	764	4141	41	163	1311
2023	171	2270	764	4141	41	163	1139
2024	0	2270	764	4141	41	163	1311
2025	0	2270	764	4141	41	163	1311
2026	0	0	1461	8088	80	318	7025
2027	0	0	1461	8088	80	318	7025
2028	0	0	1461	8088	80	318	7025
2029	0	0	1461	8088	80	318	7025
2030	0	0	1461	8088	80	318	7025
2031	0	0	1461	8088	80	318	7025
2032	0	0	1461	8088	80	318	7025
2033	0	0	1461	8088	80	318	7025
2034	0	0	1461	8088	80	318	7025
2035	0	0	1461	8088	80	318	7025
2036	0	0	1461	8088	80	318	7025
2037	0	0	1461	8088	80	318	7025
2038	0	0	1461	8088	80	318	7025
2039	0	0	1461	8088	80	318	7025
2040	0	0	1461	8088	80	318	7025
2041	0	0	1461	8088	80	318	7025
2042	0	0	1461	8088	80	318	7025
2043	0	0	1461	8088	80	318	7025
2044	0	0	1461	8088	80	318	7025
2045	0	0	1461	8088	80	318	7025
PV at 12%	1523	6120	2316	14393	142	566	5142

EIRR	**22%**

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CALCULATION OF EIRR FOR SEWERAGE OPTION, BOTH CONCESSION AREAS
(Php million in 2005 prices)

Year	Economic Costs			Economic Benefits			Net Economic Benefits
	Capital						
	Land	Constr^n	O & M	WTP	Environ-mental	Health	
2005	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0
2007	605	0	0	0	0	0	-605
2008	0	914	0	0	0	0	-914
2009	0	914	0	0	0	0	-914
2010	0	914	0	0	0	0	-914
2011	0	270	191	2056	30	119	1743
2012	556	270	191	2056	30	119	1187
2013	0	508	191	2056	30	119	1505
2014	0	530	191	2056	30	119	1483
2015	78	811	191	2056	30	119	1124
2016	570	1932	332	2428	36	142	-229
2017	1490	1932	332	2428	36	142	-1149
2018	0	2158	332	2428	36	142	115
2019	0	2222	332	2428	36	142	52
2020	0	2241	332	2428	36	142	33
2021	3323	3125	876	4909	64	255	-2096
2022	0	3125	876	4909	64	255	1227
2023	171	3125	876	4909	64	255	1056
2024	0	3125	876	4909	64	255	1227
2025	0	3125	876	4909	64	255	1227
2026	0	0	1816	9508	123	489	8304
2027	0	0	1816	9508	123	489	8304
2028	0	0	1816	9508	123	489	8304
2029	0	0	1816	9508	123	489	8304
2030	0	0	1816	9508	123	489	8304
2031	0	0	1816	9508	123	489	8304
2032	0	0	1816	9508	123	489	8304
2033	0	0	1816	9508	123	489	8304
2034	0	0	1816	9508	123	489	8304
2035	0	0	1816	9508	123	489	8304
2036	0	0	1816	9508	123	489	8304
2037	0	0	1816	9508	123	489	8304
2038	0	0	1816	9508	123	489	8304
2039	0	0	1816	9508	123	489	8304
2040	0	0	1816	9508	123	489	8304
2041	0	0	1816	9508	123	489	8304
2042	0	0	1816	9508	123	489	8304
2043	0	0	1816	9508	123	489	8304
2044	0	0	1816	9508	123	489	8304
2045	0	0	1816	9508	123	489	8304
PV at 12%	1869	7134	2758	17619	239	954	7049

EIRR	**26%**