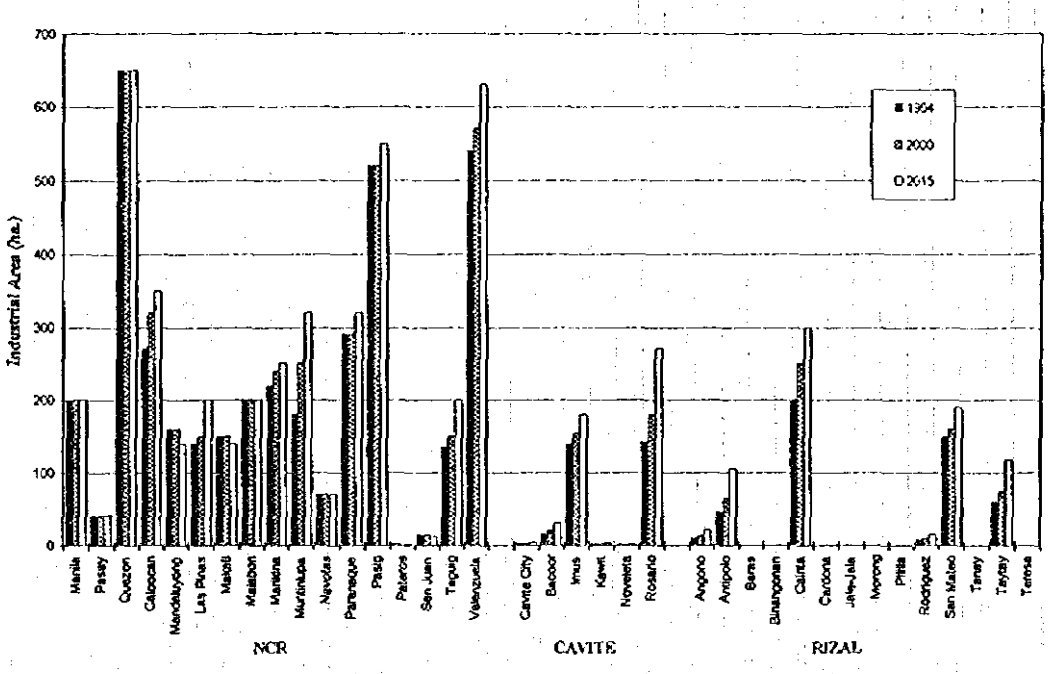


Figure 1.3.6 Industrial Area Projection (1994, 2000 and 2015)

On the other hand, industrial land use in the municipalities located in the intermediate areas (Caloocan North, Valenzuela, Las Piñas, Muntinlupa, all in the NCR) and the outer areas in Cavite and Rizal may increase by the year 2015.

Government efforts to restructure the industry and maintain export growth will have a direct bearing on the development of Cavite and Rizal by utilizing the potential of small firms/cottage industries for development, and thus promote a more equitable distribution of industrial income. Therefore, the emphasis should be on locating industries outside of Metro Manila.

3.4.3 Evaluation of Future Urban Land Use by Development Trends

Urban development forecasts for the Study Area are derived from the results and categorizations outlined in Table 1.3.8. Factors considered are:

- Population growth
- Land conditions
- Physical conditions
- Urban development trends

- Industrial trends
- Development plans, etc.

These factors are graded from 1 to 5 then averaged to give a value which is classified into the following three categories:

Cat.	Evaluation	Development Forecast
A/A'	3.5 or more	High potential for development
B	Between 3 and 3.5	Moderate potential for development
C/C'	Less than 3	Low potential for development

The results are then reclassified according to the expected development of these areas as illustrated in Figure 1.3.7. i.e.:

A: High potential for development: areas where a considerable amount of urban growth is expected.

B: Moderate potential for development: areas where moderate development is expected.

C: Low potential for development: areas located mostly in Rizal province, where low development is expected.

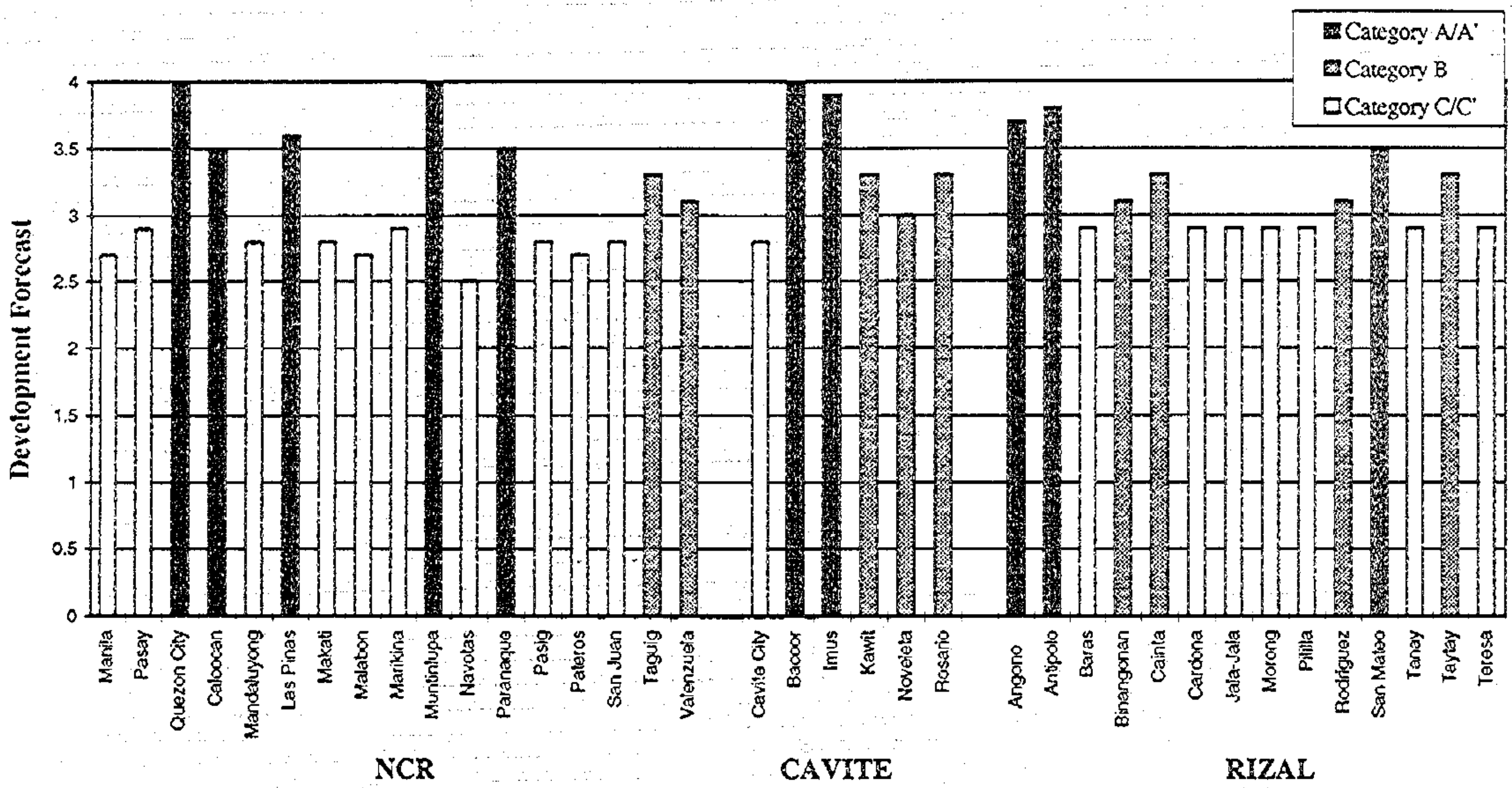
A': Areas located within the consolidated zone, where infilling and intensification of land uses are expected; may be considered as areas with high potential for development.

C': Consolidated zone covered by the main built-up areas where the possibility of high development is low; may be considered to be equal to a low development area.

Table 1.3.8 Urban Development Forecast

City/ Municipality	Land Area (ha)	Population 1990	Population 2015	Increase (1990-2015) (%)	Cat.	Density 2015 per/ha	Cat.	Empl. Opp. & Ind.	Land Availability, Open Area Cat.	Land Availability, Open Area Area (ha)	Land Cost	Physical Conditions Topog.	Physical Conditions Flood Risk	Physical Conditions G.W.	Access	Comm. Time (Dist. from Manila) (km.)	Housing & Subdiv. Dev't Possibility	Gov't Dev't Plans	Evaluation Total	Evaluation Aw.	Evaluation Categ.	Remarks
NCR																						
Manila	3,850	1,601,234	1,719,511	7	1	447	1	5	1	2.2	1	5	4	1	5	3	no	yes	27	2.7	C	Reclamation land project
Pasay	1,760	368,366	517,753	41	1	294	1	5	1	4.1	1	5	4	3	5	3	no	yes	29	2.9	C	Reclamation land project
Quezon City	16,660	1,669,776	2,748,266	65	3	165	3	5	5	11.9	2	5	5	4	5	3	yes		40	4.0	A	and military camp redevelopment
Caloocan	5,580	763,415	1,208,045	58	3	216	1	5	3	13.4	2	5	5	3	5	3	yes		35	3.5	A	
Mandaluyong	1,120	248,143	299,935	21	1	268	1	5	1	1.2	1	5	5	1	5	3	no		28	2.8	C	
Las Pinas	3,270	297,102	770,817	159	5	236	1	3	3	21.4	3	5	5	3	5	3	yes		36	3.6	A	
Makati	1,840	453,170	560,148	24	1	304	1	5	1	0.8	1	5	5	1	5	3	no		28	2.8	C	
Malabon	1,740	280,027	373,140	33	1	214	1	3	1	6.3	3	3	4	3	5	3	no		27	2.7	C	
Marikina	2,280	310,227	516,014	66	3	226	1	3	2	21.4	3	3	3	3	5	3	no		29	2.9	C	
Muntinlupa	3,970	278,411	598,897	115	5	151	3	3	5	29.5	3	5	5	4	5	2	yes	yes	40	4.0	A	
Navotas	1,100	187,479	298,533	59	3	271	1	3	1	7.3	3	3	2	1	5	3	no		25	2.5	C	Reclamation land project
Paranaque	4,020	308,236	602,363	95	3	150	3	3	3	19.9	2	5	5	3	5	3	no	yes	35	3.5	A	
Pasig	3,160	397,679	691,353	74	3	219	1	3	2	16.8	2	3	3	3	5	3	no		28	2.8	C	Reclamation land project
Pateros	185	51,409	66,256	29	3	358	1	2	1	5.4	3	3	3	3	5	3	no		27	2.7	C	
San Juan	620	126,854	153,784	21	1	248	1	3	1	4.8	1	5	5	3	5	3	no		28	2.8	C	
Taytug	4,538	266,637	646,634	143	5	142	3	3	3	5.5	2	3	3	3	5	3	yes	yes	33	3.3	B	
Valenzuela	4,480	340,227	664,336	95	3	148	3	3	2	7.7	2	4	3	3	5	3	?		31	3.1	B	Military camp redevelopment
Reclaimed Land	1,067																					
CAVITE																						
Cavite City	620	91,641	118,105	29	1	190	3	3	1	3.4	3	4	4	3	4	2	no	yes	28	2.8	C	Manila-Cavite Coastal Road
Bacoor	5,240	159,685	361,544	126	5	69	5	3	5	2.4	3	4	4	5	4	2	yes		40	4.0	A	& Reclamation
Imus	9,701	92,125	179,375	95	5	18	5	3	5	1.1	3	4	4	4	4	2	yes		39	3.9	A	
Kawit	1,750	47,755	83,071	74	3	47	5	3	5	1.0	3	2	3	3	4	2	yes		33	3.3	B	
Noveleta	390	20,409	35,329	73	3	91	5	3	2	2.6	3	2	3	3	4	2	yes		30	3.0	B	
Rosario	920	45,405	80,350	77	3	87	5	3	2	2.4	3	4	4	3	4	2	yes	yes	33	3.3	B	Industrial estate (on-going)
RIZAL																						
Angono	2,200	46,014	113,855	147	5	52	5	2	5	2.7	3	3	5	3	4	2	yes		37	3.7	A	
Antipolo	30,610	210,582	609,864	190	5	20	5	3	5	2.0	4	2	5	3	4	2	yes		38	3.8	A	
Baras	2,340	16,880	41,448	146	5	18		1	5	-	5	1	5	3	3	1			29	2.9	C	
Binangonan	7,270	127,561	311,864	144	5	43		1	5	-	5	1	5	5	3	1	yes		31	3.1	B	
Cainta	2,190	126,839	360,125	184	5	164	3	3	3	17.8	3	3	2	3	5	3	yes		33	3.3	B	
Cardona	3,120	32,962	72,013	118	5	23		1	5	-	5	1	5	3	3	1	yes		29	2.9	C	
Jala-Jala	4,930	16,318	35,649	118	5	7		1	5	-	5	1	5	5	1	1			29	2.9	C	
Morong	3,760	32,165	68,660	113	5	18		1	5	-	5	1	5	3	3	1			29	2.9	C	
Pilila	7,390	32,771	71,598	118	5	10		1	5	-	5	1	5	5	1	1			29	2.9	C	
Rodriguez	31,280	67,074	146,684	119	5	5		1	5	-	5	1	5	5	3	1	yes		31	3.1	B	
San Mateo	6,490	82,310	184,616	124	5	28		3	5	0.2	5	3	3	5	4	2	yes		35	3.5	A	
Tanay	24,340	58,410	127,737	119	5	5		1	5	1.0	5	1	5	5	1	1			29	2.9	C	
Taytay	3,364	112,403	245,814	119	5	73	5	3	4	2.1	3	3	2	3	3	2	yes		33	3.3	B	
Teresa	1,860	20,645	45,105	118	5	24		1	5	-	5	1	5	3	3	1			29	2.9	C	
Note				5: +101 3: 51-100 1: 0-50		5: 0-100 3: 101-200 1: +201		5: Good 3: Fair 1: Poor	5: High 3: Medium 1: Low		5: Low 3: Medium 1: High	5: Good 3: Fair 1: Poor	5: Low 3: Medium 1: High	5: Good 3: Fair 1: Poor		5: Near 2: Average 1: Far			A: High development B: Middle development C: Low development			

Figure 1.3.7 Urban Development Forecast



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Based on this development trend analysis, it can be deduced that the fastest growing cities and municipalities are:

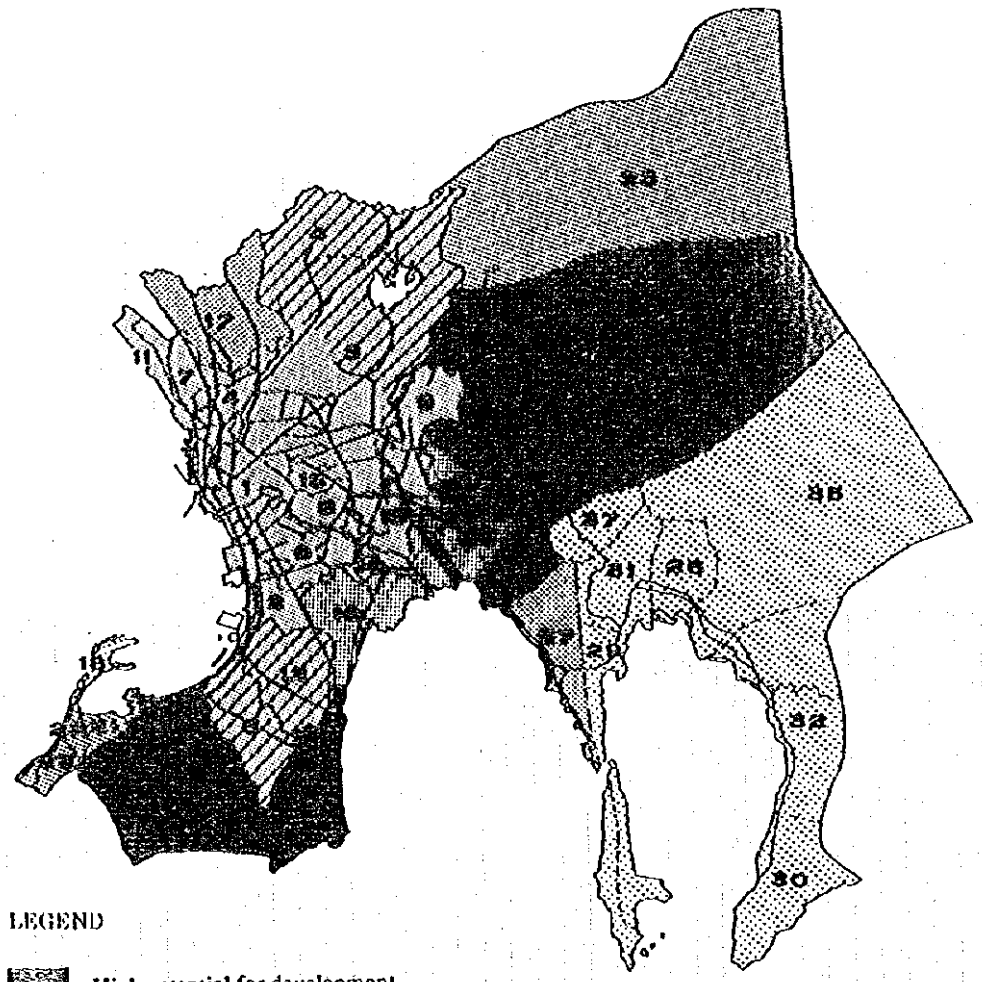
NCR:	Quezon City (northern portion), Caloocan (northern portion), Las Piñas (southern portion), Parañaque, Muntinlupa
Cavite:	Bacoor and Imus
Rizal:	Angono, Antipolo, San Mateo, and portions of Cainta and Taytay

NCR All NCR cities and municipalities are within the consolidated zone. However, development, involving the in-filling and intensification within the consolidated zone and peripheral areas, is expected to occur. Development will include the renovation and redevelopment of large scale mixed-use developments in strategic locations, particularly in the remaining vacant lots and the reverted military camp. Such areas make up category A', and are considered as high development areas.

Cavite The municipalities of Bacoor and Imus in Cavite are rapidly expanding and experiencing the suburbanizing trend of Metro Manila. Encroachment of housing subdivisions and new industries have recently gobbled-up substantial portions of these municipalities. Moreover several districts within the area were observed to be unproductive and considered marginal lands that now are not able to sufficiently support subsistence farmers due to lack of irrigation facilities and the sharp decrease in soil fertility. This type of land can be classified as urbanizable land, suitable for urban development of industrial sites.

Further, the southern areas are being developed into highly urbanized municipalities. Several hectares of land have been allocated for future residential and commercial use, as well as for institutions. These areas constitute primarily the whole municipality of Bacoor and adjacent eastern portion of Imus, where there has been a notable increase in population, and are designated as high density residential areas of the future.

Rizal Extensive areas of residential subdivisions were developed in the municipalities of Cainta, Antipolo, Taytay, San Mateo and a part of Rodriguez. A significant portion of these subdivisions are in areas adjoining the NCR.



LEGEND

A — High potential for development

B — Moderate potential for development

C — Low potential for development

C' — Consolidated zone

A' — In-filling and intensification of landuses within the consolidated zone

CITY/MUNICIPALITY

1. Manila
2. Pasay
3. Quezon
4. Caloocan
5. Las Pinas
6. Makati
7. Malabon
8. Mandaluyong
9. Marikina
10. Muntinlupa
11. Navotas
12. Parenaque
13. Pasig
14. Pateros
15. San Juan
16. Taguig
17. Valenzuela
18. Cavite City
19. Bacoor
20. Imus
21. Kawit
22. Noveleta
23. Rosario
24. Angono
25. Antipolo
26. Baras
27. Binangonan
28. Cainta
29. Cardona
30. Jala-Jala
31. Morong
32. Pillila
33. Rodriguez
34. San Mateo
35. Tanay
36. Taytay
37. Teresa

STUDY AREA

PROVINCIAL BOUNDARY

CITY / MUNICIPALITY BOUNDARY

SCALE

0 2 4 6 8 10km

STUDY ON WATER SUPPLY AND SEWERAGE MASTER PLAN OF METRO MANILA	Figure 1.3.8 URBAN DEVELOPMENT AREAS

The results of the urban development forecast are translated into map form as shown in Figure 1.3.8 indicating the potentials of the areas to be developed: high, moderate, and low development potential.

On the other hand, and as mentioned in the preceding analysis, even though the Figure shows the entire municipalities of Antipolo and Rodriguez as high growth and medium growth areas, only 20 % of their land (western areas) can be theoretically considered as urban, as full development in their eastern parts is not possible due to topographical constraints.

3.4.4 Zoning Plan

Zoning classifies the cities and municipalities in the Study Area by order of priority in terms of urban development growth and water demand by 2015. Therefore, the zoning plan is formulated taking into account the results of the population studies and the development issues and concerns described in the previous sections.

Accordingly, a tentative zoning plan is formulated considering the results of the population study, urban development trends, industrial projection, etc.

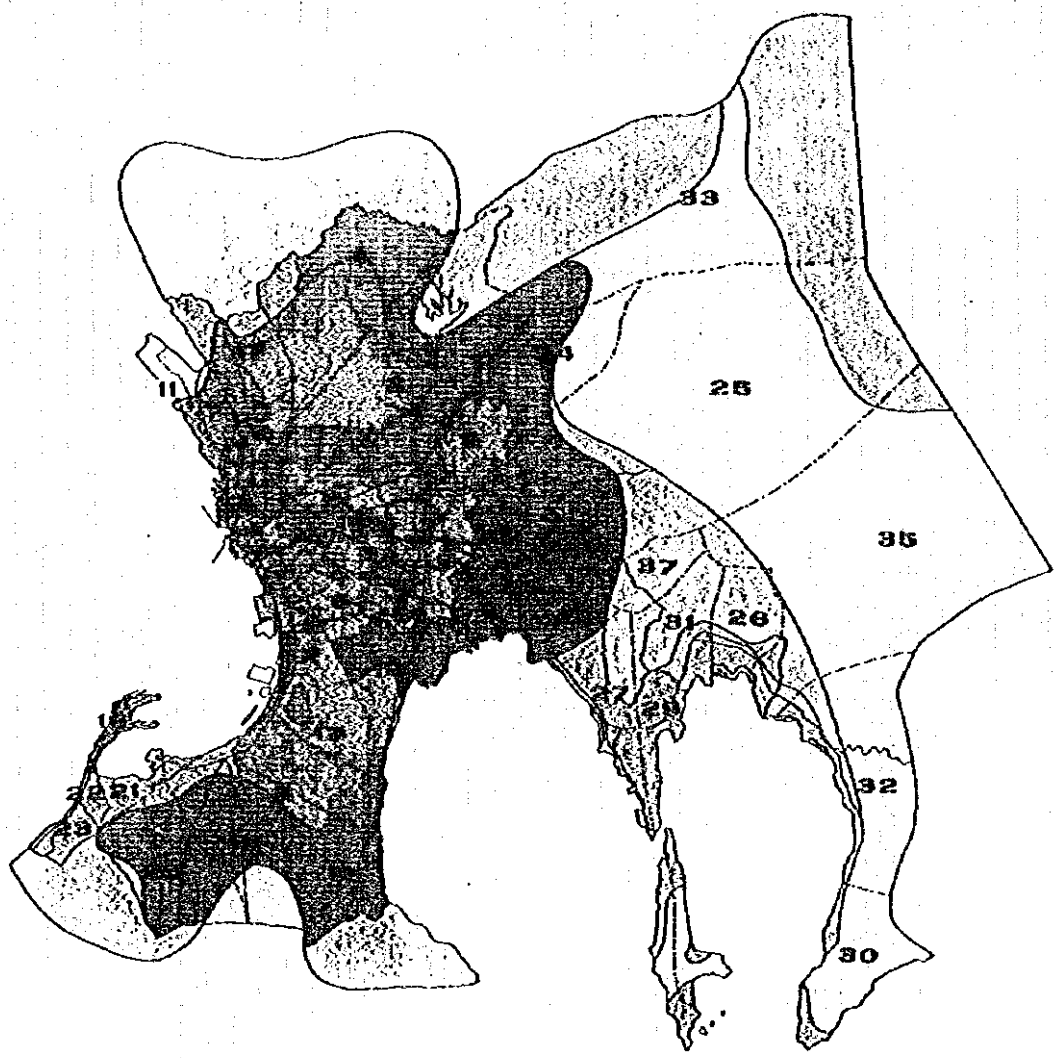
Consequently, the following prioritization of zones was carried out according to the potential of the areas for development:

1. High potential for development
2. Moderate potential for development
3. Consolidated urban zone
4. Future urban expansion zone
5. Agricultural/ forest zone
6. Preservation zone

The land use plan will only focus on the first 3 zones for the target year 2015.

In conclusion, while development policies provide direction for urban growth, metropolitan Manila is a picture of urban sprawl and high density centers (Manila, Makati, etc.) expanding towards the peripheral areas of the metropolis, particularly the south (Bacoor and Imus in Cavite) and the east (Cainta, Antipolo and Angono in Rizal). Future development trends within the NCR forecast the in-filling and intensification of land uses. Portions of Quezon City, northern Caloocan, Parañaque, Las Piñas and Muntinlupa are expected to be fully populated by the target year of 2015.

The zoning plan is shown in Figure 1.3.9 indicating the expansion of urbanization areas within the Study Area.



LEGEND

- High potential for development
- Moderate potential for development
- Consolidated urban area
- Future urban expansion
- Agricultural and forest land
- Preservation area

CITY/MUNICIPALITY

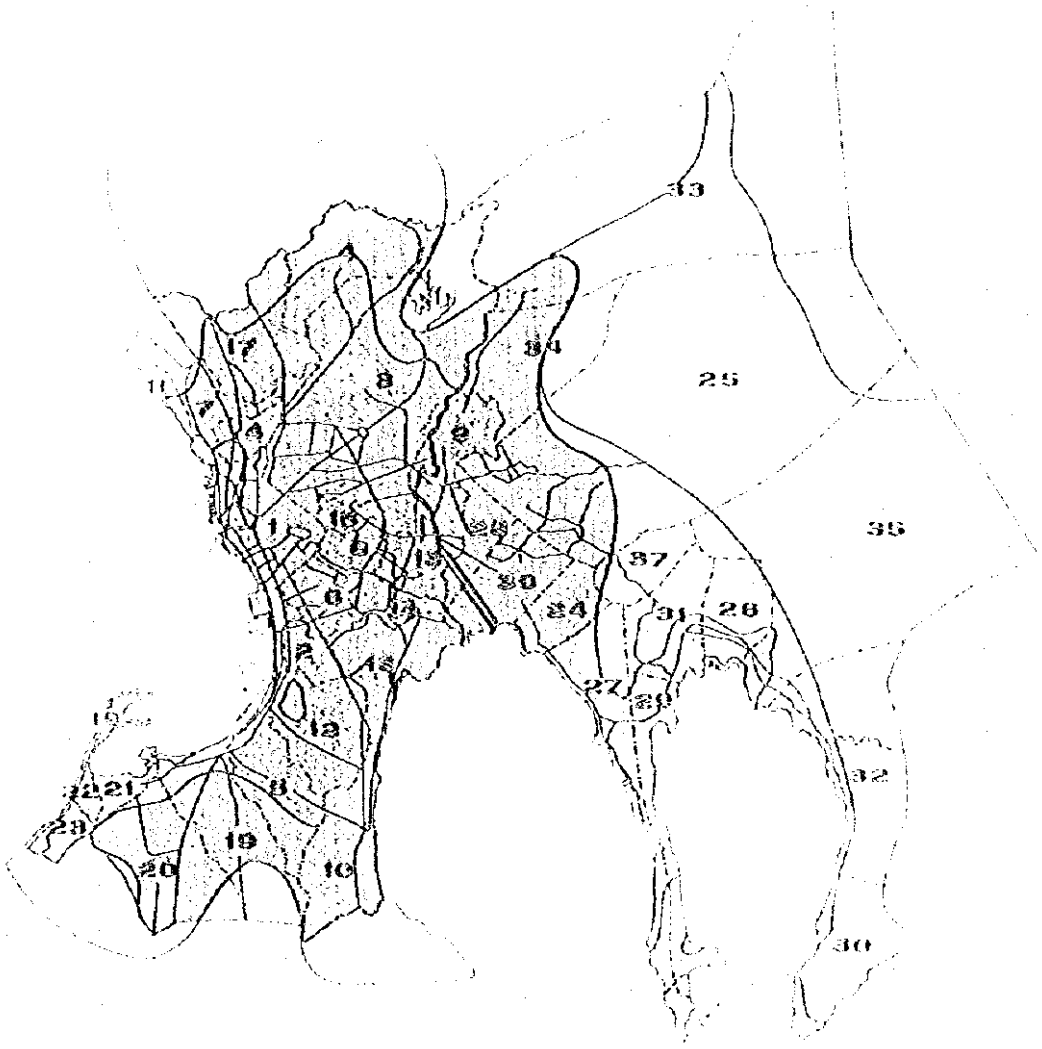
1. Manila
2. Pasay
3. Quezon
4. Caloocan
5. Las Pinas
6. Makati
7. Malabon
8. Mandaluyong
9. Marikina
10. Muntinlupa
11. Navotas
12. Paranaque
13. Pasig
14. Pateros
15. San Juan
16. Taguig
17. Valenzuela
18. Cavite City
19. Bacoor
20. Imus
21. Kawit
22. Noveleta
23. Rosario
24. Angono
25. Antipolo
26. Baras
27. Binangonan
28. Cainta
29. Cardona
30. Jala-Jala
31. Morong
32. Pililla
33. Rodriguez
34. San Mateo
35. Tanay
36. Taytay
37. Teresa

——— STUDY AREA
- - - - PROVINCIAL BOUNDARY
— — — CITY / MUNICIPALITY BOUNDARY

SCALE
0 2 4 6 8 10km

STUDY ON WATER SUPPLY AND SEWERAGE MASTER PLAN OF METRO MANILA

Figure 1.3.9 ZONING PLAN



STUDY ON WATER SUPPLY AND SEWERAGE MASTER PLAN OF METRO MANILA

Figure 1.4.3 ZONING PLAN

3.4.5 Categorization of Fastest Growing Municipalities

To permit the full comprehension and optimum use of the results of the present study, and for comparison between each trend analysis, mainly within the urbanized areas, fastest growing municipalities were categorized and shown in the table below:

Table 1.3.9 Categorization of Fastest Growing Municipalities

Region	Fastest Growing Municipalities in Terms of Population Growth	Fastest Growing Municipalities by Land Development (Urban Land Increase)	Fastest Growing Municipalities in Terms of Industrial Land Growth	Evaluation and Selection of Priority Areas (High Potential Development Areas) (*)	Remarks
NCR	Las Piñas Muntinlupa Taguig Valenzuela Parañaque Caloocan (north)	Las Piñas Muntinlupa Parañaque Taguig Valenzuela Quezon	Muntinlupa Valenzuela Caloocan Las Piñas	Muntinlupa Quezon City (northern portion) Las Piñas Parañaque Caloocan (North) (**)	(*) Showing only the A category (Areas with high potential for development) (**) Taguig, Manila-Cavite Coastal area, and Laguna de Bay Reclamation Area may be included if the proposed development by the government takes effect.
Cavite	Bacoor Imus	Bacoor Imus Rosario	Bacoor Imus Rosario	Bacoor Imus	(*) Showing only the A category (Areas with high potential for development)
Rizal	Antipolo Cainta Angono San Mateo Rodriguez	Antipolo Angono Baras Rodriguez Tanay Binangonan	Cainta Antipolo Taytay San Mateo	Angono Antipolo San Mateo and portions of Cainta and Taytay	(*) Showing only the A category (Areas with high potential for development)

These growing municipalities which are expected to have high potential for development may be considered as the priority areas for development and water supply projects.

Table 1.3.10 shows the entire Study Area by city/municipality, categorized from A to E according to their level of development potential.

While development policies provide the direction for urban growth, Metropolitan Manila gives a picture of urban sprawl and high density formations in major city sectors, extending towards the peripheral areas of the metropolis, particularly the south (Bacoor and Imus in Cavite) and the east (Cainta, Antipolo, Angono in Rizal).

Present development trends see the in-filling and intensification of land uses within the NCR and peripheral areas of the metropolis. This is evidenced by the construction of highly-dense townhouses and condominiums within the mature sections of the urban core adjacent to major

arteries. Development trends in the future will also see the renewal and redevelopment of large scale mixed-used developments in strategic locations of the metropolis, particularly in the remaining open or vacant lots and in the reverted military camp areas.

With pressure from the growing population that is expected to increase by about 45% within the next 20 years, growth in urban sprawls will continue and subsequently spur the development of low-density subdivisions in the peripheral areas of the metropolis.

The concomitant growth of economic and human activities will further trigger increased demand for space and consequently increase land prices. This situation will result in the redevelopment of low-density land uses such as those happening in the Makati, San Juan and Mandaluyong areas.

On the other hand, with the eventual rise in land valuation, market forces have put up investments in the undeveloped portions of Novaliches district in Quezon City, Marikina, Pasig and Alabang. Commercial and residential developments were carried out in Las Piñas, Parañaque and Muntinlupa, municipalities located in the southern part of the metropolis. Improved accessibility and industrial development were the key factors that encouraged urban developments in the latter municipalities. However, these developments brought about problems such as traffic congestion in major thoroughfares and the lack of facilities in telecommunications and infrastructure.

Residential development is moving outward rapidly. Industrial and commercial areas are consolidating along the major roads and rapid development has occurred outside the NCR. Extensive subdivision has occurred adjacent to the Marcos Highway which was constructed in 1980. Extensive areas of residential subdivisions were developed in the municipalities of Cainta, Antipolo, Taytay and San Mateo, all in Rizal. A significant portion of these subdivisions are in areas contiguous with NCR. Most of the subdivisions are supplied with inadequate roads and minimal facilities.

In the past, subdivision development plan was not completely integrated with the plan of the municipalities. This is particularly in terms of road network and traffic circulation. The private road layout in the adjoining subdivisions were not designed to be used as alternative routes for growing municipalities. Thus, what is needed now are alternative distribution systems or secondary local roads to support growth.

Table 1.3.10 Categorization of Areas with Development Potential

Categ.	Classif.	City/Municipality		Remarks
A	High Potential for Development	NCR	Muntinlupa Las Piñas Parañaque Quezon City Caloocan North	Present development trends see the in-filling and intensification of land uses. These cities and municipalities will be fully populated by the target year of 2015. Intensive residential development mixed with fragmented commercial/industrial development is expected in Muntinlupa, such as the Afabang Stock Farm, New Bilibid Prison area, etc.
		Cavite	Bacoor Imus	These municipal areas are rapidly expanding and experiencing the urbanizing trend of Metro Manila.
		Rizal	Antipolo Angono San Mateo Taytay Cainta	The urban growth of these municipalities are very much influenced by the spillover of the NCR residents and the increased number of migrants from rural areas.
B	Moderate Potential for Development	NCR	Taguig Valenzuela	Taguig and Valenzuela belong to the Consolidated Zone. However, medium high growth is expected due to the conversion of existing farm lands to residential use (Valenzuela) and the conversion of military camps into high value residential, commercial and mixed industrial/residential areas, and the Laguna de Bay Reclamation Project (Taguig).
		Cavite	Kawit Noveleta Rosario	These outer area municipalities are expected to absorb the future population growth within and from outside their boundaries.
		Rizal	Binangonan Cainta Rodriguez Taytay	
C	Consolidated Zone	NCR	Manila Pasay Quezon Caloocan Las Piñas Makati Malabon Mandaluyong Navotas Parañaque Pasig Pateros San Juan Taguig Valenzuela	Urban Consolidation Zone where most of the cities/municipalities are occupied by major built-up areas and where the population growth is decreasing or become stationary. Planned renewal in the inner core; to replace the existing low-rise housing units with high-rise dwellings, and to develop the Manila-Cavite Coastal Road and Reclamation Project; is expected.
		Cavite	Cavite City	
D	Future Expansion Zone	Rizal	Antipolo Teresa Binangonan Morong Baras Tanay Pililla	These areas outside the metropolitan complex are expected to absorb a moderate amount of urban growth. The emphasis is seen, however, on urban concentration at selected centers of activity along the major transport routes.
		Cavite	At the south, outside the Study Area	
		Bulacan	Outside the Study Area	
E	Agricultural, Forest Land and Preservation Area	NCR	Quezon City	Preservation areas (where urban development must not be allowed): Novaliches and Marikina watersheds, and portions of municipalities along the Laguna Lake area. Urban expansion such as industrial and residential spaces is being discourage in these areas because of high soil fertility and natural constraints such as steeply sloping terrain and forest reserves.
		Rizal	Rodriguez San Mateo Antipolo Tanay Pililla Jala-Jala	

3.4.6 Conclusion and Recommendations

(1) Conclusion

Population, land use, water use and other related factors provide the basis for planning the MWSS Water Supply and Sewerage System Programs. Population projections for the MWSS Study Area are prepared for the target year 2015 when the population in the service area is forecast to reach 15.7 million.

Other factors, such as future government programs and land uses, may also influence MWSS service areas. Sectoral spending in the MMA in the foreseeable future will sustain the emphasis currently placed on environmental and social services, yet the same trends in infrastructure development will continue. Future land use and zoning plans in the NCR show that migration will veer towards the intermediate and outer areas. Nevertheless, water supply and waste water programs will be phased to accommodate any unpredicted changes in population, land use and government policies by adjusting the time and sequence of later phases.

(2) Recommendations

a) Land Use and Zoning Regulations

At present, there are no land use zoning regulations enforced in Metro Manila and its surroundings. Land use should be regulated under zoning regulations which are usually determined by a regional or municipal agency. These should be strictly enforced with regard to each kind of development and all proposals should be subjected to their stipulations. It is necessary to formulate zoning ordinances so as to encourage desirable developments and to restrict objectionable ones. Not only do zoning regulations control the trend of urban development, they also plan the development of town or settlement areas in different places.

Zoning protects residential areas from the adverse effects of commerce and industry while it also promotes business and industry by the nature of the planned and orderly development that it ensures. It prevents over-crowding of buildings and land, thus facilitating the provision and continued adequacy of water, sewerage, transportation, and other facilities.

The allocation of land for community facilities and services and all future land use shall be governed by zonal plans under the master plan. The zoning regulations and their administration are the major tools in carrying out the land use conditions stated in the master plan.

b) Urban Consolidation Zone

The Urban Consolidation Zone consists of the main built-up areas. It is the densely populated urban area where implementation of the master plan is needed to avoid water shortages, traffic congestion, pollution, and unsanitary environment which results from mixed and uncontrolled land use.

The following are recommended:

- Prevent further expansion
- Implement land use planning and update zoning ordinances
- Improve land subdivision standards
- Prevent the establishment of new heavy industries
- Upgrade urban services.

The improvement, rehabilitation, maintenance of natural drainage courses and existing facilities, particularly water supply, flood control and drainage, and sewerage networks, should be given priority so as to prevent further deterioration of the urban ecosystem.

c) Complementary Urban Satellites

Metropolitan concerns may be mitigated through the development of growth centers outside the metropolis which will act as complementary urban satellites.

An annual increase in the population of NCR will also increase the population in contiguous provinces. New towns and city areas in different parts of the outer areas should be systematically developed to control haphazard urban sprawl, but taking into account advantageous economic conditions, water resources and other related urban amenities.

d) Industrial Areas

As expansion of industrial activities within the NCR, particularly in the suburbs, continue to aggravate traffic conditions and cause environmental problems, it is deemed appropriate, as proposed in the Metropolitan Regional Structure Plan, to develop new economic bases in the southeastern and northwestern regions to serve as centers for relocation of industrial activities from Metro Manila and surrounding towns.

c) Highways

Highway development should be emphasized to assist the development of the economy of the regions which is reliant on the production of goods for export. Thus, a highway network of very high standards should be developed in the future. The highway which leads to special regions, which is also specified in the government policy, should be particularly developed for the quick and scheduled transportation of goods.

The following are recommended:

- Propose to limit the use of private cars by reverting to the use of public transportation. For this, the improvement of the mass transit system is of utmost importance;
- Provide networks of public distributor/collector roads;
- To connect areas that have potential for economic and social development, to develop and open these areas, and solve traffic congestion.

Chapter 4.

Corporate Mission

Chapter 4. Corporate Mission

4.1 Introduction

A corporate mission defines the universal objectives, roles and responsibilities of the enterprise to carry out its business. In order to develop a MWSS Master Plan of which the target year has been set for 2015 and to implement the Master Plan, it is essential to clarify the mission of MWSS from the viewpoints of both public duties and enterprise efficiency. The results of the study on public duties and enterprise efficiency are discussed below.

4.2 Definition of MWSS Corporate Mission

Based on the study conducted by the Study Team on public duties and enterprise efficiency of which details are discussed later in this section, the corporate mission of MWSS is defined in four areas as follows:

(1) Provision of Water

MWSS must insure an uninterrupted adequate supply and equitable distribution of safe potable water at an affordable price in an equitable manner to the people who need this service.

(2) Contribution to Public Health and Safety

MWSS must contribute to public health and safety through the maintenance and improvement of the urban environment and securing of a sanitary environment.

(3) Securing Environmental Conservation

MWSS must secure environmental conservation to preserve the quality of human life and ecological systems and prevent ecological deterioration and pollution.

(4) Efficient Management of Enterprise

MWSS must achieve continuous improvement of operational efficiency by attaining high performance with minimum cost and by maintaining financial soundness.

4.3 Mission in Public Duties

The mission in public duties for MWSS includes provision of water, contribution to public health and safety, and securing environmental conservation. Key issues of public duties are discussed as follows:

(1) Provision of Water to All Customers

MWSS is responsible for providing people with one of the basic necessities of life. MWSS is obliged to provide services to people who need water and can not refuse connection services without sufficient justification. In order to accomplish this duty, MWSS must secure water sources, develop infrastructure, and operate and maintain water supply facilities.

(2) Uninterrupted Water Supply

MWSS must provide uninterrupted water supply to its domestic and other customers through continuous operation and maintenance of facilities and equipment for water production and distribution. MWSS must also stabilize current and future water supply through identifying and securing adequate water sources.

(3) Adequate Amount of Water Supply

MWSS must supply an adequate amount of water to meet various user requirements that fluctuate seasonally. In order to secure an adequate amount of water not only on a short-term basis but also on a long-term basis, MWSS must take long-term measures to meet future water demand through securing water sources and facilities. In addition, specific measures have to be taken to reduce NRW as soon as possible.

(4) Supply of Safe and Potable Water

MWSS must maintain and improve water quality from water sources through a distribution network and finally to faucets of users. In order to insure provision of safe potable water to its customers, MWSS must maintain and improve water quality through extensive research and

development on water quality, improvement of monitoring and testing facilities, and increase of sampling points.

(5) Affordable and Fair Price

A fair tariff for water and sewerage services must be set by MWSS, considering the capacity to pay by different consumers. It is noted that establishing different tariff rates for different types of users does not deviate social equity. At the same time, water rates and sewerage charges should be sufficient to cover operating costs and yield reasonable returns under efficient and effective management of waterworks and sewerage system.

(6) Responsibility for Public Health and Safety

MWSS is responsible for maintaining and improving public health and safety through provision of safe potable water and sewerage services. In order to achieve its duties, MWSS must take a vital role, together with other governmental agencies concerned with urban development to maintain and improve the urban environment, through construction and development of water supply and sewerage facilities that support sustainable water life cycle. MWSS is also responsible for securing a sanitary environment through expansion and maintenance of a sewerage system and enhancement of sanitation programs in its service area including densely populated areas where residents are of a low income level.

(7) Securing Environmental Conservation

MWSS is tasked with securing environmental conservation in developing and maintaining infrastructure in order to preserve the quality of human life and ecological systems, and prevent ecological deterioration and pollution for present and future generations. Areas that require environmental protection include water sources, purification plants, distribution facilities, sewer lines, sewerage treatment facilities, dumping sites of sludge accumulated at treatment plants and waterways where treated waste water is drained.

Environmental Impact Assessment is now often a statutory requirement for any significant industrial or infrastructure development in the major economies and is compulsory for larger third-world projects funded by aid and development agencies.

4.4 Missions in Enterprise Efficiency

The objective of enterprise efficiency is to attain high performance with minimum cost in operations through high productivity of employees, efficient utilization of facilities, and well-planned expansion. Another aspect of enterprise efficiency is to attain full cost recovery through minimum government controls. Key issues of enterprise efficiency are discussed below:

(1) Efficient and Effective Operations

MWSS must improve operational efficiency of existing plants and facilities and reduce operating and maintenance costs. It also requires extensive rehabilitation of existing water supply and distribution systems in areas that exhibit high non-revenue water. In addition, efforts to improve billing and collection efficiency on water and sewerage service charges have to be made through improvement of billing and collection control and management.

(2) Financial Soundness

MWSS must be financially sound in terms of profitability, growth and stability of the enterprise. MWSS must also be operated on a full cost recovery basis and attain an adequate level of self-reliant operations with minimum government subsidy and aid. Capital projects should be at least partially funded by MWSS.

4.5 Corporate Strategy

In order to deal with the key issues discussed above, it is important for MWSS to establish the following strategies for the long-term corporate direction for water supply, sewerage and sanitation operations to fulfill its public duties and enterprise efficiency and to meet the sector targets and consumers' present and future demands:

(1) Securing of Stable Water Supply

- Securing present and future water sources
- Improvement and enhancement of water supply facilities

- Effective use of water
- Aggressive implementation of NRW reduction measures
- Enhancement of R&D for water supply related technology

(2) Improvement of Water Supply Service Level

- Improvement of reliability of water supply
- Improvement of water quality monitoring system
- Maintenance of water quality
- Improvement of water treatment technique
- Increase of service area and connections
- Expansion of water supply through direct pipe system

(3) Enhancement of Operations and Maintenance System

- Improvement of O&M control and monitoring system
- Rehabilitation of deteriorated pipes, appurtenances and facilities
- Development of disaster recovery plan

(4) Development of Sanitary and Safe Urban Environment

- Improvement and enhancement of sewerage and sanitation facilities
- Effective use of sewerage facilities
- Expansion of sewerage service area
- Enhancement of R&D capability on sewerage related technology

(5) Reinforcement of Environment Conservation

- Reinforcement of measures for environment conservation
- Reinforcement of measures for prevention of water pollution
- Conservation of water sources and watersheds
- Reinforcement of reforestation efforts

(6) Revitalizing of MWSS Organization

- Securing qualified personnel and reinforcement of human development function
- Improvement of public relation activities

(7) Strengthening Organizational Infrastructure

- Clarification of corporate policies and direction
- Reallocation of management resources
- Enhancement of corporate planning capability
- Improvement of operational efficiency
- Attainment of financial soundness

Part II

Water Supply

Chapter 1.

Review of Current Operation

Part II Water Supply

Chapter 1. Review of Current Operation

1.1 Water Supply System and Facilities

1.1.1 Raw Water Sources

(1) Surface Water

For its water source, MWSS relies mainly on the Angat River as shown in "Details of the Existing Water Sources", Supporting Report. Presently MWSS draws an annual average of 22 m^3/s (1,900 mld) raw water from the Angat Reservoir through the Auxiliary units of the Hydroelectric Power Plant. The contribution of the intervening watershed upstream of the diversion at Ipo Dam, enables a total constant diversion of 28.5 m^3/s (2,460 mld) for the raw water supply of Metro Manila. The raw water diversion at Ipo Dam represents 97 % of the present total water production of MWSS.

Under the Angat Water Supply Optimization Project (AWSOP) scheme, an additional 15 m^3/s (1,300 mld) discharge was estimated to be available to MWSS by 'the optimized usage' of reservoir releases, i.e., multiple use (power generation-irrigation-water supply) of water release with priority given to water supply. The resolution by the Board of NWRB to grant the MWSS an additional 15 m^3/s was adopted during the Meeting on 2 January 1988. However, it has two restrictions, viz;

1) up to the maximum of 15 m^3/s
2) out of the unutilized grant intended for irrigation

The additional 15 m^3/s water right has been in placed following the conditions attached but MWSS has not been able to benefit from it due to the abnormalities of Regional Climatic Conditions and the irregular withdrawals of water from the Hydroelectric plants. The actual withdrawal of MWSS after Commissioning the auxiliary turbine No. 5 under AWSOP from December 1992 to December 1994 is the minimum 2.26 to maximum 12.25 m^3/s 'AWSOP' water has been taken during this period. A average of water production in 1994 was only 2,896 mld.

(2) Groundwater

In addition to surface water supplied Central Distribution System (CDS), MWSS manages groundwater supply systems which supply water to the areas not connected to CDS. There are 262 MWSS-owned deepwells within the MWSS Service Area (MSA), of which 139 wells are active while 142 wells are inactive or abandoned. Three wells are for 'stand-by' (as of June 1995). Amount of average daily water supply by groundwater varies from approximately 70 to 90 mld. It shares only three percent of MWSS total production.

Aside from MWSS-run wells, it has been reported that there are about 3,000 privately-owned wells in MSA. The present total supply from private groundwater sources in the MWSS service area is about 800 mld.

1.1.2 Raw Water Conveyance Facilities

As described in the previous section, the major water source comes from the Angat and Ipo Dams. These facilities comprise the Angat-Novaliches Water Supply System as shown in Figure 2.1.1.

(1) Ipo Dam to Bicti Headworks

From the Ipo Dam, raw water is channeled by three tunnels to Bicti as shown in Table 2.1.1.

Table 2.1.1 Raw Water Conveyance Facilities, Ipo Dam to Bicti Basins

Description	Specifications	Design Flow Capacity (mld)
Tunnel No. 1 (constructed in 1939)	2.04 m x 2.19 m x L6.4 km (EL+87.6):	760 (200 MGD)
Tunnel No. 2 (constructed in 1969)	3.00 m x 3.00 m (horse shoe) x L6.4 km (EL+88):	1,890 (500 MGD)
Tunnel No. 3 (constructed in 1992)	4.2 m dia.(horse shoe) x L6.4 km (EL+88.1):	2,000 (530 MGD)

(2) Bicti to Novaliches Reservoir and La Mesa Plant

From Bicti Headworks, five aqueducts deliver raw water to the La Mesa Water Treatment Plant and to the Novaliches Reservoir (or La Mesa Dam) for the Balara Water Treatment Plant as shown in Table 2.1.2. There are three junction boxes at the outlet of the aqueducts. Two of the

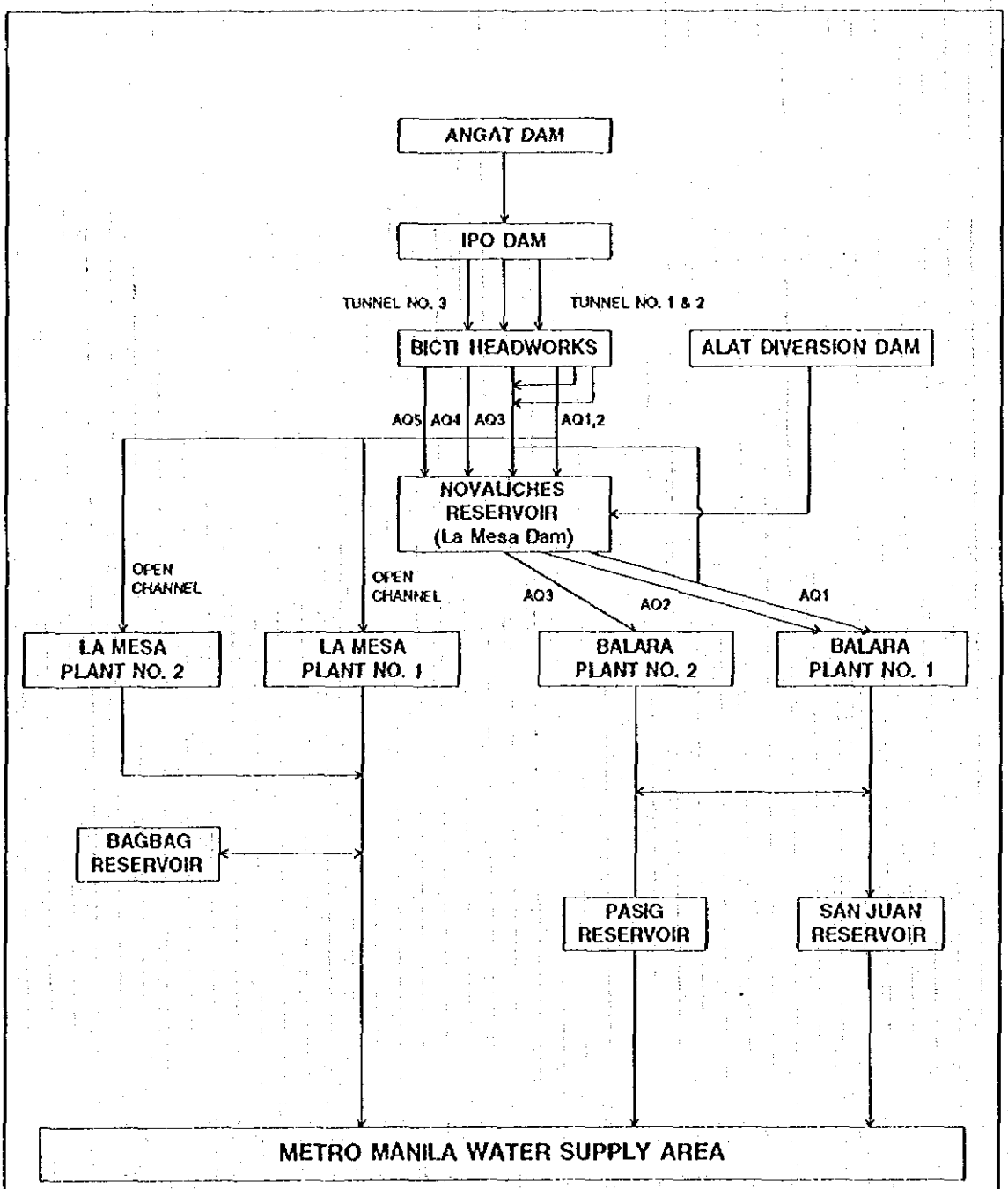


Figure 2.1.1
Angat-Novaliches Water Supply System

junction boxes interconnect with aqueduct Nos. 1, 2 and 3. The third junction box, which is for aqueduct No. 4 and No. 5, is provided with an overflow and diversion weir. Flow is diverted to an open channel and then conveyed to the La Mesa Plant No. 1 and 2.

(3) Novaliches Reservoir to Balara Plant

The Novaliches Reservoir was constructed in 1929 as an artificial impounding reservoir for the Balara Plant. In 1959, the spillway crest as well as the dam and dikes were raised in order to increase the storage capacity to 45.46 million m^3 (10,000 million gallon). The surcharge level is EL. +79.7 and the lowest withdrawable level is EL. +64.

Table 2.1.2 Raw Water Conveyance Facilities, Bicti to Novaliches Reservoir and La Mesa Plant

Description	Specifications	Design Flow Capacity (mld)
Aqueduct No. 1 and No. 2 (constructed in 1939, 1948, respectively)	Siphon : 1.55 m dia. x 2 lines Tunnel : 2.04 m x 2.19 m, L5.1 km	380 (100 MGD each)
Aqueduct No. 3 (constructed in 1969)	Siphon : 2.9m dia. Tunnel : 2.70 m x 2.70 m, L15 km	830 (220 MGD)
Aqueduct No. 4 (constructed in 1983)	Siphon : 3.4m dia. Tunnel : 3.4m dia, L16.5km	1,250 (330 MGD)
Aqueduct No. 5 (constructed in 1992)	Siphon : 3.6m dia. Tunnel : 3.6 m dia, L15.66 km	2,000 (530 MGD)

Raw water is withdrawn the Balara Plant by means of three intake towers. Each intake tower is connected with aqueduct Nos. 1, 2, and 3.. The detailed specifications of the Novaliches-Balara Aqueducts are shown in Table 2.1.3.

Table 2.1.3 Water Conveyance Facilities, Novaliches Reservoir to Balara Plant

Description	Specifications	Design Flow Capacity (mld)
Aqueduct No. 1 and No. 2 (constructed in 1929, 1956, respectively)	Siphon : 1.70 m dia. Tunnel : 1.70 m x 2.03 m, L7.5km	565 (150 MGD each)
Aqueduct No. 3 (constructed in 1968)	Siphon : 2.9 m dia. Tunnel : 2.70 m x 2.90 m, L6.7 km	850 (225 MGD)

1.1.3 Water Treatment Facilities

Water supplied by MWSS to its area of coverage is made potable by treatment in two large water treatment plants -- the Balara and the La Mesa plants. The Balara Plant and the La Mesa Plants have a current design capacity of 1,600 and 1,500 mld respectively, or a total of 3,100 mld. The construction of the La Mesa Water Treatment Plant No.2 commenced in 1991 is about to be completed.

(1) The Balara Plant

The Balara Plant consists of two separate treatment systems: an old plant (Plant No. 1) and a new plant (Plant No. 2), with common use of chemical and chlorine feeding facilities. Both plants were expanded and/or upgraded as shown hereunder.

The Plant No. 1 was originally constructed in 1935 with a design capacity of 190 mld (50 MGD). In 1958, due to increased demand, two accelerator units with capacities of 95 mld (25 MGD) each were expanded to enhance pretreatment process of Plant No. 1. Correspondingly, filtration velocity was doubled to 234 m/d by replacing the filter media and related facilities including the filter rate-of-flow controller. The total capacity of the Plant No. 1 increased to 380 mld (100 MGD).

A part of Plant No. 2 was also constructed in 1958. This was used occasionally as a direct filtration system consisting of only conveyance facility and filter beds. The applied filtration rate was 234 m/d, giving a total plant capacity of 454 mld (120 MGD).

In 1965, pretreatment facilities were added, such as a parshall flume for flow measurement and chemical mixing, mechanical flocculators and six sedimentation basins. New chemical feeding facilities were put in operation in 1967. These facilities have a design capacity of 380 mld (100 MGD).

In 1968, another pretreatment facility, with a design capacity of 380 mld (100 MGD), was further expanded, while eight additional filters were constructed in 1970, completing a total design capacity of 760 mld (200 MGD).

In 1981, Plants No. 1 and No. 2 were upgraded to a capacity of 470 mld (125 MGD) and 1,130 mld (300 MGD), respectively. Mechanical rapid mixers and flocculators and dual media high

rate filtration system were added to Plant No. 1; while a dual media high rate filtration system was added to Plant No. 2. Table 2.1.4 shows the present status of the Balara Plant. Due to the limited operation and maintenance budget, most of the facilities/equipment of the plant have aged or are antiquated. Operating the plant efficiently and effectively is difficult. In 1991, JICA was commissioned to conduct a feasibility study on the "Balara Treatment Plant Rehabilitation" as well as a basic and detailed design from 1993 to 1994, based on the recommendation of the feasibility study. The plant is presently being rehabilitated under the Japanese Grant Aid to restore its design capacity and improve the quality of treated water.

(2) The La Mesa Plant

The La Mesa Water Treatment Plant consists of two separate treatment systems: Plant Nos. 1 and 2. Plant No. 1 was constructed in 1985 under the Manila Water Supply Project II (MWSP II) with a design capacity of 1,500 mld (396 MGD).

Raw water is supplied by aqueduct No. 4 from the Bicti Headworks. Horizontal flow sedimentation and rapid sand filtration systems are utilized in the same manner as in the Balara Plant, where mechanical rapid mixers, flocculators, filters, and chemical feeding facilities are employed. The sludge treatment system, with four basins of sludge lagoon, was utilized for the first time in the Philippines. Detailed design criteria is referred to Table 2.1.5.

In 1994, Plant No. 2 with a design capacity of 900 mld (240 MGD) and adjacent to the existing plant No. 1, was expanded under one package of AWSOP. However, the facilities have not yet been commissioned due to delay in the construction of the final package of AWSOP, which include the construction of an additional distribution network and the La Mesa by-pass aqueduct. The design criteria of the plant is shown in Table 2.1.6.

As of January, 1995, almost all the facilities/equipment are operational except the following; 1) six units of flocculators; 2) No. 12 filter; 3) two units of domestic water supply pumps; 4) three units of chlorine booster pumps; 5) one unit of chlorine evaporator; 6) No. 4 and 5 polymer feeder; and most of the instrumentation equipment.

Table 2.1.4 Design Criteria of the Balara Plant

Description	Units	Plant No. 1		Plant No. 2
Plant Capacity	mld	470(125 MGD)		1,130(300 MGD)
Flush Mixing				
Flush Mixers	Nos.	2(vertical)		N/A
Parshall Flume	Nos.	N/A		2
Flocculation				
Flocculation Basins	Nos.	2		12
Flocculators	Nos.	24(vertical)		36(horizontal)
Detention Time	min.	20		21
Sedimentation				
Sedimentation Basins	Nos.	2		12
Detention Time	min.	137		102
Accelator	tank	2		N/A
Detention Time	min.	48		N/A
Upflow Rate	mm/min.	100		N/A
Filtration				
Filters (dual media type)	Nos.	10		20
Filtration Rate	m/d	288		348
Filtration Area per Filter	m2	162		162
Backwash Rate	m/min.	0.60		0.60
Surface Wash Rate	m/min.	0.20		0.2
Filter Media				
Anthracite				
Effective Size	mm	0.9-1.1		0.9-1.1
Depth	m	0.5		0.4
Sand				
Effective Size	mm	0.45-0.55		0.45-0.55
Depth	m	0.25		0.25
Chemical Feed				
Dosage	mg/l	Min.	Ave.	Max.
Coagulants				
Alum		10	16.34	45
Polyelectrolyte				
Anion		0.03	0.06	0.20
Cation		0.03	0.09	0.20
Disinfection				
Pre-chlorine		-	0.7	3.0
Intermediate chlorination		-	0.5	1.0
Post-chlorination		-	1.15	1.35

With the completion of Plant No. 2, raw water is to be supplied by open channel with a total length of 1.1 km from the Novaliches Reservoir. Mechanical flush mixers are provided in the distribution structure of the plant to mix the reagents (pH adjustment, coagulant, and polymer) and raw water. Eight units of the Pulsator, upflow type of settling facilities are employed as the coagulation, flocculation, and sedimentation processes, while 20 tanks of single media of sand filter, the Aquazur V valuable head, are to be utilized as filtration systems. For the filter washing, the air scoring process, which is being adopted for the first time in MWSS's water treatment facilities will be utilized. Chemicals to be applied are alum, ferric chloride, and PAC for coagulants; caustic soda as a pH adjustment, polymer as a coagulant aid, liquid chlorine and hypochlorite as disinfectants. Hypochloride is to be used for post chlorination only in cases of chlorine shortage.

Table 2.1.5 Design Criteria of the La Mesa Plant No. 1

Description	Units	Capacity		
Plant Capacity	mld	1,500 (396 MGD)		
Flush Mixing				
Vertical Flush Mixers	Nos.	6		
Detention Time	min.			
Flocculation				
Flocculation Basins	Nos.	72		
Detention Time	min.	20		
Sedimentation				
Sedimentation Basins	Nos.	12		
Detention Time	min.	80		
Launder Overflow Rate	mm/min.	5.6		
Filtration				
Filters (dual media type)	Nos.	24		
Filtration Rate	m/d	348		
Filtration Area per Filter	m2	180		
Backwash Rate	m/min.	0.92		
Surface Wash Rate	m/min.	0.16		
Filter Media				
Anthracite	m	0.5		
Sand	m	0.25		
Gravel	m	0.45		
Lagoons	Nos.	4		
Surface Area	m2	60,000		
Chemical Feed				
Dosage	mg/l	Min.	Ave.	Max.
Coagulants				
Alum	mg/l	10	35	70

Table 2.1.5 *Design Criteria of the La Mesa Plant No. 1 (cont'd)*

Ferric Chloride	mg/l	10	25	50
Polymer	mg/l	0.2	1.0	2.0
Coagulant Aid (Polymer)	mg/l	0.025	0.05	0.10
Filter Aid Polymer	mg/l	0.025	0.05	0.10
Sodium Slice Fluoride	mg/l	0.5	0.5	0.75
Disinfection				
Pre-chlorine	mg/l	-	2	5
Intermediate chlorination	mg/l	-	0.5	1
Post-chlorination	mg/l	0.5	0.5	1
pH control (Quick lime)	mg/l	-	10	20

Table 2.1.6 Design Criteria of the La Mesa Plant No. 2

Description	**Units**	**Capacity**		
Plant Capacity	mld	900 (240 MGD)		
Flush Mixer				
Vertical Flush Mixers	Number	4		
Detention Time	sec	84		
Pulsator	No.	8		
Rising Velocity	m/hr	3.9		
Detention Time	min.	78		
Detention Time in Flocculation Zone	min.	71		
Filters				
Filters (dual media type)	No.	20		
Filtration Rate	m/d	280		
Filtration Area per Filter	m2	163		
Backwash Rate	m/min.	0.25		
Air Scoring Rate	m/min	1.0		
Sand Depth	m	1.3		
Sand Size	mm	0.9-1.0		
Chemical Feed				
Coagulants	mg/l	Min.	Ave.	Max.
Alum	mg/l	-	30	67.7
Ferric Chloride	mg/l	-	30	67.7
PAC	mg/l	-	30	67.7
Pre-caustic Soda	mg/l	-	7.6	2.17
Post-caustic Soda	mg/l	-	9.8	11.19
Polymer	mg/l	-	0.05	0.065
Hypochlorite	mg/l		1	
Disinfection	mg/l	0.8	1	1.2
Pre-chlorine	mg/l	-	1	2.1
Post-chlorination	mg/l	-	1	2.1

1.1.4 Distribution Facilities

(1) Reservoirs and Pump Stations

Operating Conditions of Reservoirs and Pump Stations

The MWSS service area has 14 major reservoirs and pump stations as shown in Figure 2.1.2 and as described in Table 2.1.7. These facilities are located in two separate portions of the distribution system - the Balara Plant and the La Mesa Plant portions.

Table 2.1.7 Reservoirs and Pump Stations

Location	Reservoir			Pump Station		Remarks
	Capacity (m^3/d)	HWL	LWL	Pump No. (ml/d x m)	Motor No.(HP)	
Bagbag	100,000x 2 = 200,000	71.00	65.00	N/A	N/A	Used for regulating LP1 production. Water level maintained below overflow level to prevent excessive losses at upstream (Novaliches) area.
Caloocan	19,000	34.40	25.40	3(22 x 45.7) 2(34 x 30)	3(225)) 2(200)	Not operating. Pump station was converted into an office building.
D.Tuazon	19,000	29.20	20.20	1(22 x 45.7) 3(34 x 30)	1(225) 3(200)	Not operating. Reservoir steel dome roofing needs rehabilitation.
Algeciras	38,000	26.80	12.80	5(22 x 45.7) 3(34 x 30)	5(225) 3(200)	Operating. Reservoir and pump station require repair work.
Tondo	19,000	21.83	12.83	3(22 x 47) 2(34 x 30)	3(225) 2(200)	Not operating. Repair works needed for reservoir and pump station.
Balara	19,000	51.65	43.85	7(41 x 64) 1(22 x 58)	7(500) 1(250)	Operating. Used to suffer low suction pressures during peak demand hours.
Cubao	N/A	N/A	N/A	4(25 x 33.8)	4(200)	Operating Has inadequate capacity to meet demand of service area.
San Juan	56,000 94,000	51.40 51.40	43.50 44.70	6(45 x 55) 1(30 x 43)	6(500) 1(250)	Operating. Reservoirs and pump station require rehabilitation works.
Pasig	80,000	48.00	40.29	5(49 x 36)	5(375)	Operating. Pump station capacity needs to be upgraded to meet demand of highly developed service area.
Makati	19,000	32.70	23.70	3(22 x 69) 3(38 x 38.7)	6(300)	Not operating. Water for downstream area passes through pumps with significant head loss.
Fort Bonifacio	30,000	47.55	39.75	4(61 x 29)	4(350)	Operating. Suffers lack of supply and pressure at the suction line.
Ermita	19,000	21.65	12.65	3(23 x 46) 2(34 x 30)	3(225) 2(200)	Operating. Pump station and reservoir require rehabilitation works.
Espiritu	19,000	21.78	12.78	1(22 x 45.7) 3(34 x 30)	1(225) 3(200)	Not operating. Reservoir was repaired but was not used.
Pasay	19,000	22.30	13.30	2(22 x 45.7) 2(34 x 30)	2(225) 2(200)	Operating. Rehabilitation works are not on-going under contract DPS-1.

Notes: 1) LWL is taken as level with the reservoir flooring. 2) The service areas of La Mesa and Balara Treatment Plants are approximations because the internal network pipes are interconnected. 3) Treated water from Balara to San Juan passes through a weir (HWL+57.10 m, floor elev. +52.5 m). Upstream of the weir are the supply lines to Balara pump station and Marikina area.

The treated water from the La Mesa plant goes mainly to the Bagbag Reservoir; while the treated water from the Balara plant goes mainly to the San Juan Reservoir. From these two reservoirs, water is then distributed to the other reservoirs and pump stations.

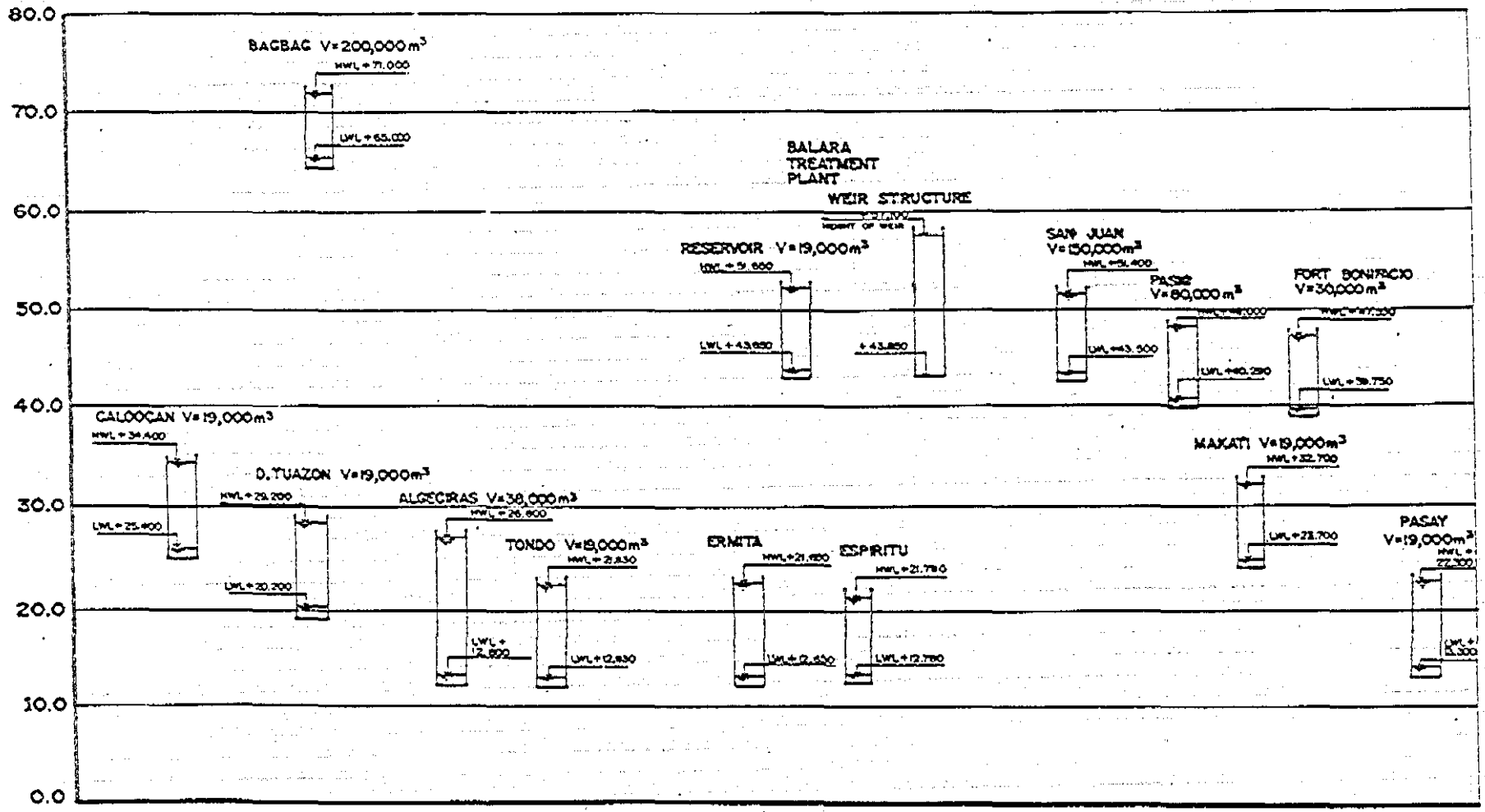


Figure 2.1.2 **Hydraulic Profile**

HOR. SCALE : NOT TO SCALE
VERT. SCALE : 1:500

MWSS DATUM
-10m (MSL)

The operation of the pump stations is presented in Table 2.1.8. The on/off operation of the pumps is done manually, and is performed during peak demand hours in the morning and in the evening.

Table 2.1.8 Operation Conditions of Pump Stations (December, 1994)

Pump Station	Time of Day (hour) 0	2	4	6	8	10	12	14	16	18	20	22	24
Caloocan	Not in Operation												
D. Tuazon	Not in Operation												
Algeciras				2SP							2SP		
Tondo	Not in Operation												
Balara	2BP			5BP			2BP				5BP		
Cubao	2BP						4BP						
San Juan			2SP	6SP						2SP	6SP		
Pasig				3SP						2SP	3SP		2SP
Makati	Not in Operation												
Fort Bonifacio										2BP	3BP		
Ermita				1SP & 1BP									
Espiritu	Not in Operation												
Pasay	2BP			2BP & 1SP			2BP				2BP & 1SP		

Note : SP ; Storage pump, BP ; Booster pump

In the La Mesa Plant portion, only the Algeciras and Ermita pump stations are being used. The other pump stations, constructed before the La Mesa Plant, were decommissioned because of the increased head provided by the La Mesa Plant, which is about 20 m above that of the Balara Plant.

Hourly water level measurements are done manually at most of the reservoirs. The water level data from the Bagbag and San Juan reservoirs are transmitted by radio to the Balara and La

Mesa Plants, respectively, where they are used as basis for controlling the rate of treated water production.

The Fort Bonifacio Reservoir, located within the Balara Plant portion, has a 7 m operating depth. However, water level rises to only about 4 to 5 m above floor level. A similar condition was observed at the Pasig Reservoir. The upper two-thirds of the interior surface of the reservoir wall was observed to be very dry, with no trace of water surface lines, indicating that the water level in this reservoir has not reached the maximum level for some time now.

(2) Distribution Pipes

Of the more than 4,000 km of pipelines, 33 % are PVC, 21 % are ACP, 9 % are CIP, 6 % are SP and the remaining 31 %, due to unavailability of records, are of unknown materials.

In the province of Cavite, PVC and CIP pipes are the commonly used pipes. The PVC and ACP pipes represent 58 % and 18 % of the total pipelines in the province. The ACP pipes used is only 11 % or half of the percentage of the total ACP pipes in the MWSS service area. The ACP pipes in the Rizal province is 33 % of the total pipes in that area, equivalent to 1.5 times the average use of ACP pipes in the entire MWSS service area.

Table 2.1.9 shows that 1050 mm diameter ACP is used for 1,310 m of the pipelines. It also shows that ACP is used mainly for pipelines 600 mm and smaller in diameter than concrete pipes. At present, ACP pipes are usually used for sizes 400 mm and smaller. There is a possibility that the large diameter ACP pipes are actually of reinforced concrete.

PVC pipes are used mostly for sizes 300 mm and smaller. However, record shows that 300 m or 0.4 % of all the PVC pipes used have sizes ranging from 400 to 750 mm. At present, PVC pipes are still planned to be used also for 300 mm and smaller.

Approximately 31 % of the pipelines in the MWSS service area are of unverified materials due to unavailability of records. This percentage needs to be reduced for MWSS to have better pipe accident control and for repair/maintenance management. The pipes have to be checked as to their material, size, condition as well as their strength.

Table 2.1.9 Pipe Lengths by Area and Material

Area	ACP	PVC	CIP	SP	Others	Total
NCR	824,574	1,260,172	347,372	206,319	1,257,362	3,895,799
Manila	54,281	133,674	145,351	18,343	299,858	651,507
Pasay	17,473	60,501	28,950	3,400	20,682	131,006
Quezon	259,901	411,306	81,477	53,124	327,093	1,132,902
Caloocan	38,859	69,811	10,025	7,650	24,912	151,257
Mandaluyong	33,688	35,407	4,965	11,099	58,342	143,501
Las Pinas	36,977	18,793	0	7,170	60,910	123,850
Makati	72,143	76,394	27,404	27,750	98,455	302,146
Malabon	31,457	68,768	9,140	7,215	32,862	149,442
Marikina	53,233	55,739	925	6,465	107,990	224,352
Muntinlupa	47,459	6,562	0	116	0	54,137
Navotas	10,105	35,699	8,125	5,650	4,503	64,082
Paranaque	27,903	49,799	4,254	10,561	40,855	133,372
Pasig	73,538	114,624	15,744	29,076	99,793	332,775
Pateros	210	13,442	0	3,140	940	17,732
San Juan	25,690	24,570	2,417	3,447	71,494	127,618
Taguig	1,460	23,065	2,300	3,533	6,623	36,981
Valenzuela	40,197	62,018	6,295	8,580	2,050	119,140
%	21	33	9	5	32	100
CAVITE	22,018	116,885	35,150	15,756	10,683	200,491
Cavite	4,183	34,389	26,285	4,320	8,555	77,732
Bacoor	13,018	31,422	0	6,260	1,770	52,471
Imus	0	8,944	8,865	0	358	18,167
Kawit	1,898	23,566	0	3,295	0	28,759
Noveleta	0	9,852	0	0	0	9,852
Rosario	2,918	8,713	0	1,880	0	13,551
%	11	58	18	8	5	100
RIZAL	61,792	57,764	14,405	4,414	48,866	187,241
Angono						
Antipolo	35,180	3,559	4,460	0	32,011	75,210
Baras						
Binangonan						
Cainta	9,745	13,623	4,010	1,654	2,525	31,557
Cardona						
Jala-Jala						
Morong						
Pililla						
Rodriguez	1,480	16,885	0	0	0	18,365
San Mateo	0	17,682	4,335	0	3,610	25,627
Tanay						
Taytay	15,387	6,015	1,600	2,760	10,720	36,482
Teresa						
%	33	31	8	2	26	100
Total	908,384	1,434,820	396,927	226,488	1,316,911	4,283,530
%	21	33	9	6	31	100

Note : 1. Unit in meter.
2. Others - Unverified materials due to unavailability of records.

1.2 Water Supply Service Area

The MWSS service area covers the National Capital Region (NCR), Rizal province and part of the province of Cavite. It comprises of eight cities and 29 municipalities.

In the NCR, the areas with low service coverage ratio are the five southern municipalities near Cavite province and one municipality adjacent to Bulacan in the north. The detailed water supply conditions in the NCR are shown in "Present Water Supply Conditions", Supporting Report.

In the province of Cavite, except for Cavite City and Kawit, the service coverage is less than 20 %.

In Rizal province, only the western portions of the municipalities adjacent to the NCR are supplied from MWSS while the rest of the province is yet to be served by MWSS.

1.3 Service Area Population and Served Population

The ten year service area population and served population trend, from 1985 to 1994, are presented in Table 2.1.10.

Served population, including those served by public faucets, has doubled within a ten-year period from 1985 to 1994. Also, the coverage ratio has been increasing from year to year.

At present, 66 % of the people in the service area is served by MWSS. Out of which, 59 % is supplied by house connections and 7 % is supplied indirect connection by public faucets. The unserved population get their supply from private wells or from water vendors.

Table 2.1.10 Service Area Population and Served Population in the Last 10 Years

Year	Service Area Population (x1,000)	Served Population (x1,000)		Coverage	Served Household (number)
		House Connection	Public Faucet	Total Pop. (%)	
85	7,968	3,049	457	3,506	376,359
		38.3	5.7	44.0	(1.00)
86	8,223	3,576	467	4,043	441,522
		43.5	5.7	49.2	(1.17)
87	8,491	3,967	496	4,463	489,792
		46.7	5.8	52.6	(1.30)
88	8,774	4,158	544	4,702	513,342
		47.4	6.2	53.6	(1.36)
89	9,070	4,451	603	5,054	549,464
		49.1	6.6	55.7	(1.46)
90	9,383	4,849	646	5,495	598,664
		51.7	6.9	58.6	(1.59)
91	9,616	5,168	676	5,844	638,003
		53.7	7.0	60.8	(1.70)
92	9,854	5,469	705	6,174	675,227
		55.5	7.2	62.7	(1.79)
93	10,099	5,781	734	6,515	713,676
		57.2	7.3	64.5	(1.90)
94	10,350	6,054	763	6,817	747,376
		58.5	7.4	65.9	(1.99)

Source: Corporate Planning Group
Notes: Underlined years are leap years. Figure in ( ) is the ratio of the distributed water in the year with the amount in 1984.

1.4 Water Quality Control

1.4.1 Drinking Water Standard

The 1993 edition of the Philippine National Standards for Drinking-Water (Philippines) is a revision of the Standards established in 1978, prepared by the Ministry of Health. The Standards is designed to guide waterworks officials, operators of water supply systems, both government and private entities, health and sanitation authorities and the general public in establishing the requirements for safe and potable water. The revisions were undertaken in response to Chapter I, Section 4 of the Code on Sanitation of the Philippines and in consideration of the newly promulgated 1993 WHO Guidelines for Drinking-Water Quality (Second Edition).

The new standards cover requirements for the acceptable values for the determined parameters in measuring water quality. These parameters include the microbiological, physical, chemical and radiological compositions of the water as shown in "Water Quality Standard", Supporting Report. The Standards also delineate values established in conforming with the medical and health implications of the parameters as opposed to values established purely to satisfy aesthetic requirements. In promulgation of the revised standards, more definite and specific requirements for pesticide related parameters and radioactivity were derived. The Standards include standard laboratory and alternative methods for water analysis and sampling methods.

The detailed analytical methods for on the other hand are prescribed in "The Philippine Standard Methods for Air and Water Analysis", 1978, prepared by the Human Settlements Commission: Vol. 1 Bacteriological Examination of Drinking Water (part 1) and Biological Examination of Fresh Water (part 2); Vol. 2 Physical Examination and Chemical Analysis of Water and Wastewater ; and Vol. 3 Air Analysis. Permissible limits on the physical, chemical and radiological aspects of water quality are shown in the Supporting Report.

1.4.2 Process Water Quality Control

The Process Quality Unit (PQU) which is under the control of the Water Sources and Treatment Department is responsible for monitoring water quality from water sources at Angat, Ipo, Bicti, and La Mesa, specifically water quality as it passes through different stages from raw water, treated water (water treated after coagulation and flocculation), influent water (water after

sedimentation), filtered water, and finished water (filtered water after chlorination). Efficiency and effectively of treatment facilities as well as optimization of water treatment chemicals are conducted through daily jar tests.

Items analyzed daily by the PQU are turbidity, pH, iron, alkalinity, bicarbonates, acidity, free CO2, chlorides, and hardness as well as alum and other chemicals used for the Balara and La Mesa Plants before acceptance. Periodically, the PQU examines the raw water sources in the degree of microorganisms like plankton, algae, etc. to determine an application of algecide. Likewise, cross check study on all points of water quality control is conducted in cooperation with three other coordinating laboratories, including the Bureau of Research and Laboratories of DOH, the Manual Health Laboratory, the Central Laboratory of MWSS. Figure 2.2.3 and Figure 2.2.4 show the treatment results on turbidity of the Balara and La Mesa Plants.

1.4.3 Service Water Quality Control

Service water quality control is undertaken by the Central Laboratory Division, the Research and Development Division under the Applied Research and Quality Control Department and cross-checked by the PQU.

A total of 126 samples are currently collected from 12 areas in the MWSS service area.. Out of these samples 17 sampling points in the five groups showed positive results in the bacteriological examination during January to December, 1993; while seven groups reported fully acceptable conditions in supplied water in accordance with the Philippine Drinking Water Quality Standards. The detailed data are shown in Table 2.1.11.

Table 2.1.11 Tap Water Quality in 1994, October

Service Area	No. of Sampling Places	Total No. of Samples	Satisfactory Percent	Residual Chlorine (mg/l)
City of Manila	68	68	100	0.2 - 0.6
Quezon City	24	24	100	0.2 - 0.4
San Juan	6	6	100	0.3 - 0.4
Mandaluyong	4	4	100	0.3 - 0.4
Caloocan City	8	8	100	0.3 - 0.4
Malabon	12	12	100	0.3 - 0.5
Navotas	4	4	100	0.3 - 0.4
Parañaque	5	5	100	0.3 - 0.4
Las Pinas	1	1	100	0.2
Pasay City	8	8	100	0.3 - 0.5
Malikina	11	11	100	0.2 - 0.4
Makati	8	8	100	0.2 - 0.4
Pasig	12	12	100	0.3 - 0.5
Pateros	4	4	100	0.4 - 0.5
Taguig	8	8	100	0.4 - 0.5

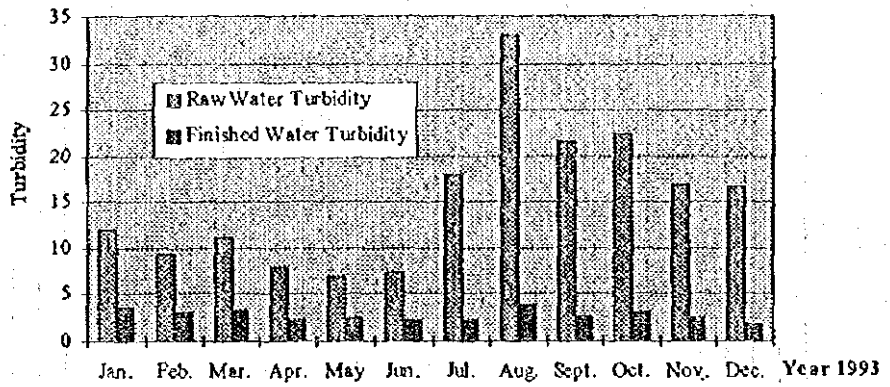


Figure 2.1.3 Balara Plant Turbidity Treatment Result

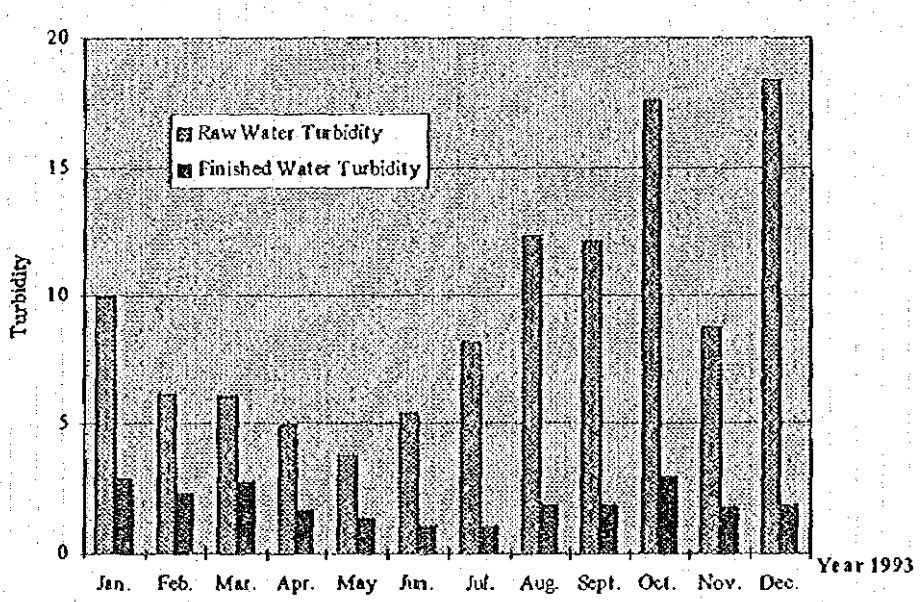


Figure 2.1.4 La Mesa Plant Treatment Result

1.5 Ongoing and Planned Water Supply Projects

To cope with the rapid increase of water demand in the MWSS service area, MWSS is currently undertaking and planning several projects, with funds from international lending institutions such as the International Bank for Reconstruction and Development (IBRD), the Asian Development Bank (ADB), the Overseas Economic Cooperation Fund (OECF), and the Japan International Cooperation Agency (JICA) as shown in Table 2.1.12.

Details are referred to "Ongoing and Planned Water Supply Projects", Supporting Report.

Table 2.1.12 Major Ongoing and Planned Water Supply Projects

	Projects	Brief Description	Implementation Schedule	Performance Indicator	Total Project Cost Estimate (mil. Pesos)
	IBRD Project				
1	Angat Water Supply Optimization Project (AWSOP)	Expansion of served area	1989-1997	Add'l 1,300,000 m^3/day for 360,000 connections	8,811.00
	ADB Projects				
2	Umiray-Angat Transbasin Project (UATP)	Expansion of unserved area	1993-1998	780,000 m^3/d	4,404.59
3	Angat Water Supply Optimization Project Telemetry/Scada Component	Expansion of telemetry system (NRW improvement)	1992-1997	Regulated and rationalized water distribution	391.00
4	Manila South Water Distribution Project (MSWDP)	Expansion to unserved area	1993-1997	300,000 m^3/d	1,578.66
5	Metro Manila Water Distribution Project (MMWDP)	Expansion to unserved area	1986-1994	100,000 new service connections	1,217.83
6	Manila Water Supply Rehabilitation Project II (MWSRP II)	Reduce the NRW in areas not covered by MWSRP I	1989-1995	Rehabilitation of 52 zones and 6 housing subdivisions in Metro Manila	1,756.29
7	Manila North East Water Supply Project (MNEWSP)	Expansion to unserved area	1996-2002	300,000 m^3/d	3,403.17
	JICA Projects				
8	The Project for the Rehabilitation of the Balara Water Treatment Plant	Expansion to unserved area	1992-1996	Restore the current design capacity of 160,000 m^3/d	1,116.31
9	Mini-Project Type Technical Cooperation on the Non-Revenue Water Reduction Project in Metropolitan Manila	NRW Reduction	1995-1996	Improved operations for NRW reduction	
	Local Fund				
10	Fringe Area Water Supply Project (FAWSP)	Expansion of served area	1989-1997	40,000 additional HSC	252.43
11	Locally Funded Project (LFP)	Expansion of served area	Yearly	Improved operations	100.00
	BOT Scheme				
12	Cavite Water Supply Project (CWSP)	Expansion to unserved area	1996-2000	600,000 m^3/day	4,900.00
13	Manila Water Supply Project III (MWSP III)	Expansion to unserved area	1998-2003	1,900,000 m^3/day	34,895.53
14	Metro Manila Groundwater Distribution Project (MMGWDP)	To improve and develop the groundwater supply in Metro Manila, Rizal Province and part of Cavite	1990-1998	33,000 m^3/d by groundwater	317.40
	Others				
15	Rizal Province Water Supply	Expansion to unserved area	1988-1998	48,000 m^3/d	1,091.71
16	NRW Reducing Project	NRW reduction	1994-2000	NRW 30%	14,110.00

Chapter 2.

Mater Plan

Chapter 2. Master Plan

2.1 Water Supply Scheme

2.1.1 Basic Development Concept

The basic principles for the expansion of the water supply scheme of the study areas will be finalized by taking into consideration the projected water demand of priority supply areas. The basic design policy will include the following:

1) Establishment of service area

In addition to the existing service area, any extension will be finalized based on a priority analysis of the said area. Furthermore, the service area must be designed with attention given to its wide expanse; while management efficiency and economy should be the prime considerations in studying the plan of the facility to be constructed.

2) Service level

For the existing service areas, increasing water pressure and the hours of service are the improvements needed to upgrade service levels. For those areas not yet supplied with water service, the object of the completion of a piped water supply is in serving the most number of people within the shortest time frame giving due attention to the areas' social and economic importance as well as its investment efficiency and effectiveness.

3) Supply coverage

Water supply coverage will be determined using a comparison between supply capacity and the goal of the National Sector Plans or any proposed revision on it; and the technical and economic practicability of the proposed project.

4) Service population

Total service population will be computed based on the final service areas, their population projection and supply coverage.

5) Unit consumption rate

Unit consumption rate will be determined at a much higher level, taking into account the required improvement of service levels, as compared to the existing and planned or proposed water supply capacity.

6) Projection of water demand

Water demand of the selected priority areas is computed based on service population and unit consumption rate by categories of water uses; that is, domestic, commercial, and industrial, with total water demand being the sum of the category use and NRW. The projection will incorporate those constraints as development plan and costs.

2.1.2 Service Area

In the NCR, the areas with a low service coverage ratio are the five southern municipalities near Cavite province and one municipality adjacent to Bulacan in the north. In the province of Cavite, except for Cavite City and Kawit, the service coverage is less than 20 %. In Rizal province, only the western portions of the municipalities adjacent to the NCR are supplied by the MWSS water supply system; while the rest of the province is yet to be served by MWSS.

The current water supply conditions in the areas under the MWSS jurisdiction differ from each city and municipality as shown in "Present Water Supply Conditions", Supporting Report. However, the master plan will be very specific about the entire population's having access to a water supply system that provides safe and adequate water supply at reasonable costs by the year 2015. Such water supply system should be one that can be economically and efficiently managed; thus a careful examination of the facility construction plan should be made.

The service area will cover the whole MWSS jurisdiction area, namely; the National Capital Region (NCR), Rizal province and part of the province of Cavite. In its entirety, the service area of the MWSS will be comprised of eight cities and 29 municipalities as listed in Table 2.2.1 Service.

Priority analysis is conducted based on land use planning and water supply scheme, as shown in "Priority Service Area", Supporting Report. Said analysis classifies the urgency of development and allocates to it a weighted distribution amount. It should be stated that water consumption is likely to increase even in such areas not prioritized on the point of view of the priority analysis given. Also, the amount of water being supplied to an area is not directly

proportional to its being a priority for water development. But, the areas given the highest priority to be connected to the existing or new piped system are those with groundwater salinity problems. In analyzing supply amount, water currently consumed will be evaluated. Then, the weighted distribution amount will be derived. This figure considers the amount of unit consumption rate by development potential, water supply capacity, and examination of the facility development plan of its management efficiency.

Table 2.2.1 Service Area and Priority Service Area

National Capital Region (NCR)			
Cities		Municipalities	
Manila✓	MandaluyongO	Las Pinas✓	Paranaque✓
Pasay✓	PasigO	Malabon✓	Pateros✓
Quezon✓	Makati✓	MarikinaO	San JuanO
Caloocan✓		Muntinlupa✓	Taguig✓
		Navotas✓	Valenzuela✓
Cavite Province			
City	Municipalities		
Cavite✓	Bacoor✓	Imus✓	Kawit✓
	Rosario✓	Noveleta✓	
Rizal Province			
City	Municipalities		
N/A	AntipoloO	AngonoO	Morong▲
	Cainta✓	Baras▲	Pililla▲
	RodriguezO	BinangonanO	Tanay▲
	San MateoO	Cardona▲	Teresa▲
	TaytayO	Jala-jala▲	

Notes : Priority is shown by three categories: ✓ ;Top Priority, O; Medium Priority, ▲; Low Priority

2.1.3 Service Level

There are three water supply levels, namely: Level I or point source; Level II or communal faucet system or standposts; and Level III or waterworks system or individual house connection. Generally speaking, Level I is a protected well or spring with no distribution system. Level II is intended for rural areas where houses are clustered densely enough to justify a simple piped distribution system with public standpipes. Level III water supply service, on the other hand, refers to a pipe system with individual house connections. However, these general definitions of water supply service can also include these aspects: supply pressure, supply amount, and convenience to accessing water.

A development gap still exists in the service areas, compared to the NCR, Cavite Province, and Rizal Province. It would be well that this master plan focus on how to extend the Central Distribution System (CDS) toward the farthest reaches of the service areas which have a population of 10 million, and which form the hub of the country. In the long term, Levels I or II would not be a suitable level of service; but a sophisticated water supply system drawing from a surface water source would be more appropriate.

Water supply should be on a 24-hour basis. Intermittent water supply or fluctuation of pressure causes operational problems. It is also one of the causes of unsafe water.

This master plan will discuss three ways of improving water supply service by providing a Level III, 24-hour water supply:

- the reinforcement of the existing Central Distribution System (CDS);
- the possibility of extension from the existing CDS; and,
- the independent distribution areas whose water supply sources will be switched from groundwater to the existing or a newly developed piped water supply system.

Alternative development plans will be made from the financial (the minimum expense), economic (benefits, large and small), technological (particularly, ease of O & M and management), social, and environmental aspects, in relation to the coverage and to reducing NRW.

As to the existing service areas, water service will be improved by increasing water pressure. In the non-supplied areas, completion of a piped water supply will mean serving the most number of people within the shortest time frame giving due attention to the areas' social and economic importance as well as its investment efficiency and effectiveness.

2.1.4 Supply Coverage

The current water supply coverage by city and municipality for domestic water use is summarized in Table 2.2.2. The population to be supplied by direct house connection has increased to approximately six million in 1994, twice as much as the supply level in the last 10 years.

(1) Definition of Supply Coverage

Supply coverage is sometimes defined as the ratio between the supplied population and the population in a limited or defined area, or service area, where a water supply system is available

Table 2.2.2 Present Coverage by City/Municipality

City/ Municipality	Population	House Connection		Public Faucet*1	
		Coverage (%)	Supplied Population	No. of Connections	Supplied Population
NCR					
Manila	1,632,740	87.8	1,434,007	258	123,129
Pasay	394,435	61.5	242,402	176	83,995
Quezon	1,827,511	79.4	1,451,802	317	151,286
Caloocan	852,595	52.6	448,311	125	59,655
Mandaluyong	260,432	77.8	202,571	46	21,953
Las Pinas	360,489	23.8	85,879	41	19,567
Makati	475,427	80.2	381,472	31	14,795
Malabon	297,968	58.1	173,061	45	21,476
Marikina	344,589	82.1	282,765	27	12,886
Muntinlupa	336,145	17.6	59,283	46	21,953
Navotas	206,793	66.2	136,897	61	29,112
Paranaque	351,510	39.4	138,587	31	14,795
Pasig	442,243	73.8	326,198	35	16,704
Pateros	56,177	41.1	23,116	23	10,977
San Juan	132,979	91.6	121,831	10	4,772
Taguig	315,249	13.6	42,898	32	15,272
Valenzuela	392,803	39.7	155,910	40	19,090
Sub Total	8,680,085	65.7	5,706,990	1,344	641,417
CAVITE					
Cavite City	95,990	77.1	73,961	18	8,590
Bacoor	186,141	21.7	40,483	12	5,727
Imus	105,140	8.8	9,267	12	5,727
Kawit	52,941	57.5	30,455	12	5,727
Noveleta	22,581	22.3	5,046	12	5,727
Rosario	50,337	12.9	6,490	12	5,727
Sub Total	513,130	32.3	165,702	78	37,225
RIZAL					
Angono	54,175	0.0	0	0	0
Antipolo	262,776	18.8	49,325	25	11,931
Baras	19,866	0.0	0	0	0
Binangonan	150,126	0.0	0	0	0
Cainta	157,438	21.1	33,162	25	11,931
Cardona	37,113	0.0	0	0	0
Jala-Jala	18,373	0.0	0	0	0
Morong	36,216	0.0	0	0	0
Pililla	38,898	0.0	0	0	0
Rodriguez	75,522	26.3	19,849	14	6,681
San Mateo	92,712	42.1	39,032	27	12,886
Tanay	65,766	0.0	0	0	0
Taytay	126,559	31.6	39,941	25	11,931
Teresa	23,245	0.0	0	0	0
Sub Total	1,158,785	15.6	181,309	116	55,360
TOTAL	10,352,000	58.5	6,054,001	1,538	734,002

Source : Based on the data from CORPLAN (*1 is data in 1994 and others are data in 1993), the JICA Study Team computed through the survey.

at the moment. However, in this case, it is the ratio between the supplied population using direct house connections through the central distribution system (CDS) or equivalent system which will be expanded in the future and the total population within the MWSS jurisdiction area.

The served population which utilizes public faucets, private wells, ambulant vendors, or undetermined sources is excluded from the supply coverage; however, the current supply coverage data of MWSS includes the water supplied by CDS and MWSS deep wells.

(2) Planned Supply Coverage

As of 1994, 59 % of the total population in the Study Area had access to CDS. The service area coverage included 66 % in NCR, 32 % in Cavite Province, and 16 % in Rizal Province.

In preparing the target supply coverage, two plans, which are currently provided as shown in Table 2.2.3, are considered. The first plan is the Medium Term Philippine Development Plan (1993-1998), which aims to increase coverage up to 71 % by the target year of 1998. The second is envisioned in the MWSS strategic plan which was realigned by MWSS in support of President Ramos' bid to transform the Philippines into a newly industrialized country by the year 2000.

MWSS revised MTPDP in "MWSS' Toward Philippines 2000 (1994~2000)" which follows the MTPDP in its policy and strategy with revisions in the coverage and served population in reflection to the latest population data and feasibility studies. However, there are still so many technical constraints in the MWSS plan to fulfill the target in the year 2000. For example, considerable delay in the provision of distribution pipe lines and water source augmentation, as well as considerably high NRW level, in addition to other institutional, managerial, and financial constraints.

Table 2.2.3 Present Supply Coverage and its Sector Plans

Supply Coverage	Target Year	Rate	Served Population[1)]
Supply Coverage in 1994	N/A	59(66)%[2)]	6,054
MTPDP[3)]	1998	71 %	9,100
MWSS[4)]	2000	90 %	12,600

Notes :
1) Unit in thousand.
2) 59% includes only direct house connections; if portion of public faucet is added, coverage is 66% or served population is 6.8 million.
3) MTPDP refers to "The Medium Term Philippine Development Plan (1993-1998)"
4) MWSS data from "Toward Philippines 2000 (1994-2000)" prepared by MWSS.

(3) Applied Supply Coverage

In targeting the year 2015, the two scenarios are shown in proposing a useful plan which provides a realistic guideline for the expansion of water supply service in the study area.

<Scenario 1>

This scenario complies with the MWSS Plan which sets the target coverage level of 90 % by the year 2000. Scenario 1 holds that toward the master plan target year of 2015, 100 % coverage is substantially achieved, which is also targeted by the MWSS plan; namely 95 % coverage by the CDS will be set as a target level. The remaining 5 % is composed of those people dependent on the public faucet provided by MWSS, private wells whose residents are located in depopulated areas and those with difficult access to the CDS. A staged target level is then utilized as shown in Table 2.2.4, taking into consideration the current state of coverage, schedule of planned or project implementation, and the priority of each city/municipality. That is not necessarily proportionally allocated by year.

<Scenario 2>

Scenario 2 is based on a pessimistic view of the MWSS plan in respect to the implementation schedule, taking into consideration delays in development of water source and the expansion of distribution network as water demand increases. Under this scenario, the coverage of 90 % is delayed from the year of 2000 to the master plan target year of 2015. Allocation of coverage in each year will be set in the same manner as Scenario 1 as shown in Table 2.2.4. The supply coverage in year 2000, which is MWSS' target year, is proposed to be 67 %.

Allocation of the supply coverage to each city/municipality will still be based on priority.

Table 2.2.4 Supply Coverage (%)

Year	1994	1995	2000	2005	2010	2015
Scenario 1	58	63	90	91	93	95
Scenario 2	58	60	67	74	83	90

2.1.5 Served Population

There are two categories of served population, namely: 1) direct house connection by the CDS and 2) indirect house connection by public faucets. Served population by direct house

connection is derived by multiplying population and coverage in each planned year. The population supplied by public faucet is assumed to be 50 % of the unserved population by the direct house connections in the target year 2015. These relations are shown below:

Total served population = Served population by direct house connection + 0.5 x Unserved population by direct house connection

In 1985, the number of blighted areas was 402 and its inhabitants were approximately two million or 28 % of the total population in the study area. In 1990, the number of blighted areas was sharply increased to 578 and its inhabitants were approximately 2.5 million or 31 % of the total population. These figures could not be ignored for the water demand projection because the corporate mission of MWSS calls for the efficient provision of an adequate supply of potable water for the entire population. This would be an effective measure to reduce illegal use or pilferage of water and possibly contribute to the reduction of the current high NRW level.

Furthermore, the data listed in Table 2.2.5 shows that not all inhabitants are necessarily demanding for direct water supply due to the relatively expensive water tariff according to the survey conducted by the Team as shown in "Survey Needs of Residents/Enterprises", Supporting Report. Therefore, it is assumed that public faucets will still be utilized in the target year 2015 by half of the unsupplied population.

Table 2.2.5 Willingness to Connect to MWSS

	Yes	If charge is not expensive	Undecided	With own connection
Low Income	25(48%)	18(35%)	8(15%)	1(2%)
Middle Income	21(37%)	33(59%)	0(0%)	2(4%)
High Income	29(85%)	2(6%)	1(3%)	2(6%)

Notes: Low Income (Less than P5,000/month), Middle Income (P5,001 ~ P8,000/month), High Income (higher than P8,001/month)

(1) Served Population by House Connection

As discussed in the previous Part I, a population projection is made as basis for estimating the future water demand in the service area. The Team reviewed the analysis of past trends of 1970, 1980 and the latest census data of 1990, which were given by NSO, as well as the present and future physical, socio-economic, and development trend factors which affect future population growth rate. Thus, population projections by area is given in Table 2.2.6.

Table 2.2.6 Population Projection (x 1,000)

Year	NCR	Cavite Province	Rizal Province	Total
1994	8,680	513	1,157	10,350
1995	9,024	537	1,255	10,787
2000	10,012	618	1,523	12,152
2005	10,891	697	1,797	13,385
2010	11,701	777	2,118	14,595
2015	12,436	858	2,435	15,729

Source : JICA Study Team and NSO

By the target year of 2015, the population in the whole study area is projected to be 15.7 million or 1.5 times of the current population level. Total increase of population will be 5,379,000, composed of 3,756,000 (70 %) in NCR, 345,000 (6 %) in Cavite, and 1,278,000 (24 %) in Rizal, respectively.

Applying Scenarios 1 and 2 concerning supply coverage and the projected population, population supplied is shown in Table 2.2.7.

Table 2.2.7 Served Population(x 1,000)

Year	1994	1995	2000	2005	2010	2015
Population	10,350	10,787	12,152	13,385	14,595	15,729
Scenario 1						
Served population	6,054	6,811	10,911	12,229	13,580	14,927
Coverage (%)	58	63	90	91	93	95
Scenario 2						
Served population	6,054	6,444	8,139	9,839	12,065	14,199
Coverage (%)	58	60	67	74	83	90

(2) Served Population by Public Faucet

Coverage by public faucet is proportionally reduced from the current level of 7.4 % to 2.5 % linearly for the target year in Scenario 1 and 5 % in Scenario 2, respectively, as follows:

Table 2.2.8 Scenario 1 - Served Population by Public Faucet (x 1,000)

Year	1994	1995	2000	2005	2010	2015
Population (a)	10,350	10,787	12,152	13,385	14,595	15,729
Coverage by house connection (%)	58	63	90	91	93	95
Coverage by public faucet (b %)	7.4	7.2	6.0	4.8	3.7	2.5
Population utilized public faucet (c)=(a)x(b)	763	777	729	642	540	393

Table 2.2.9 Scenario 2 - Served Population by Public Faucet (x 1,000)

Year	1994	1995	2000	2005	2010	2015
Population(a)	10,350	10,787	12,152	13,385	14,595	15,729
Coverage by house connection (%)	58	60	67	74	83	90
Coverage by public faucet(b %)	7.4	7.3	6.7	6.1	5.6	5.0
Population utilized public faucet (c)=(a)x(b)	763	787	814	816	817	786

(3) Total Served Population

Table 2.2.10 summarizes the total served population by scenario.

Table 2.2.10 Total Served Population Projection

	Population (x 1,000)	Served population(upper, population; lower, %)					
		Scenario 1			Scenario 2		
		House	Public	Total	House	Public	Total
1994	10,350	6,054	763	6,817	6,054	763	6,817
		58	7.4	65.9	58	7.4	65.9
1995	10,787	6,811	777	7,588	6,449	787	7,236
		63	7.2	70.3	60	7.3	67.3
2000	12,152	10,911	729	11,640	8,139	814	8,953
		90	6.0	95.8	67	6.7	73.7
2005	13,385	12,229	642	12,871	9,839	816	10,655
		91	4.8	96.2	74	6.1	79.6
2010	14,595	13,580	540	14,120	12,065	817	12,882
		93	3.7	96.7	83	5.6	88.3
2015	15,729	14,927	393	15,320	14,199	786	14,985
		95	2.5	97.4	90	5.0	95.3

2.1.6 NRW Reduction

Table 2.2.11 presents the details of distributed water in 1993. The current NRW, which MWSS defines as a ratio of unbilled water against the total distributed water amount, hit 57.43 %, composed of 22.34 % of effectively used NRW and 35.09 % of lost water, further specified as leaks, unauthorized use and metering errors.

To cope with the current high level of NRW, MWSS set the target to reduce the NRW to 30 % by year 2000.

Table 2.2.11 Details of Distributed Water

	Revenue Water 42.57%	Billed Water		42.57%
Distributed Water 100%	NRW 57.43%	NRW, but Effectively Used 22.34%	Under Registration of Meter	8.24%
			Malfunctioning of Meters	
			Improper Meters	0.21%
			Improper Size	0.41%
			Tampered meters	3.49%
			Illegal Use	
			Illegal Connections	6.05%
			Illegal Drawings	1.76%
			Operational Use	
			Flushing and Disinfection	0.98%
			Fire Fighting	1.20%
		Lost 35.09%	Leakage/Breakage	20.90%
			Unspecified Losses	14.19%

Source: MWSS Operational Report Oct.- Dec. 1993

To be able to reduce the NRW to 30 %, the following measures should be undertaken systematically or simultaneously:

- Controlling unauthorized use of water
- Improving metering efficiency
- Reducing leakage
- Improving institutional aspects

Of course, a permanent reduction in leakage losses can only be achieved through the prevention of leakage occurrence. This implies pipeline renewal before the end of its useful life. The main thrust of leakage reduction must therefore be:

- Pipe replacement/renovation to renew old and defective distribution components
- Research and development of new pipe materials, workmanship and technologies which will lengthen the useful life of the distribution facilities.

To achieve the above, it will take some time, with continuous effort, and budgetary support. The maintenance cost for pipe renovation must be increased drastically for the next years. From our experiences in major cities in Japan, only one percent could be achieved in reducing NRW in the past several decades. In Bangkok, Thailand, the Metropolitan Waterworks Authority could decrease its water loss by 44 % to 29 % in 26 years, which is 1.7 % achievement by year. Hence, two scenarios will be applied for this master plan, as discussed below:

<Scenario 1>

Scenario 1 is based on the MWSS plan. NRW will be reduced to 30 % in 2000, then, 20 % in 2015. Effective NRW and ineffective NRW is assumed to be 10 % and 5 %, respectively in 2015. Reduction of the NRW ratio will be done continuously at the same rate every year up to the target year of 2015.

Table 2.2.12 Scenario 1- NRW Reducing Plan

Year		1993	1995	2000	2005	2010	2015
RW	(%)	42.57	50.04	70.0	73.3	76.7	80.0
NRW	Effective (%)	22.34	18.8	10.0	8.3	6.7	5.0
	Ineffective (%)	35.09	30.8	20.0	18.4	16.6	15.0
	Total (%)	57.43	49.6	30.0	26.7	23.3	20.0

<Scenario 2>

Assuming that replacement of the existing pipings will be delayed due to various constraints as discussed in the previous section, NRW in 2015 is set at 30 %, composed of 25 % of ineffective and 5 % of effective. This scenario stresses that the MWSS target will be achieved at the same level, about 30 % in view of reducing ineffective NRW lost through leakage/breakage and/or unspecified losses. The reduction of the NRW ratio is done continuously at the same rate every year up to the target year of 2015 in the same manner as Scenario 1.

Table 2.2.13 Scenario 2-NRW Reducing Plan

Year		1993	1995	2000	2005	2010	2015
RW	(%)	42.57	45.1	51.3	57.5	63.8	70.0
NRW	Effective (%)	22.34	20.8	16.8	12.9	8.9	5.0
	Ineffective (%)	35.09	34.1	31.9	29.6	27.3	25.0
	Total (%)	57.43	54.9	48.7	42.5	36.2	30.0

2.2 Water Demand Projection

2.2.1 General

Water demand projection serves as the fundamental basis for preparing the master plan. The projection is largely dependent on the past trend which forecasts the future from past experience. Furthermore, the water demand used for this Study will incorporate the following constraints in order to present a practical estimate:

- Construction costs and affordability of water tarrif
- Implementation schedule

The water demand projection will be based on the revenue water amount which is known in the past water use trends. Classification by use is categorized into domestic, commercial, and industrial. In addition to this classification, the estimated NRW will be summed up for the total water demand.

Table 2.2.14 Distribution Trend in the Last 10 Years

Year	Distribution (ml/y) (mld)		Revenue Water (ml/y) (mld)		NRW RW (%)
1985	769,098 2,107	(1.00)	302,601 829	(1.00)	60.7 39.3
86	874,076 2,395	(1.14)	310,811 852	(1.03)	64.4 35.6
87	834,762 2,287	(1.09)	336,495 922	(1.11)	59.7 40.3
88	849,341 2,321	(1.10)	359,449 982	(1.19)	57.7 42.3
89	888,051 2,433	(1.15)	375,855 1,030	(1.24)	57.7 42.3
90	909,127 2,491	(1.18)	384,666 1,054	(1.27)	57.7 42.3
91	900,094 2,466	(1.17)	386,486 1,059	(1.28)	57.1 42.9
92	851,591 2,327	(1.11)	383,584 1,048	(1.27)	55.0 45.0
93	932,758 2,556	(1.21)	397,307 1,089	(1.31)	57.4 42.6
94	1,009,600 2,766	(1.31)	418,940 1,148	(1.38)	58.5 41.5

Source: MWSS Annual Report
Notes : Underlined year are leap years.
Figures in ( ) are the ratio of distributed water in the year with the amount in 1984.

Table 2.2.14 presents the trend of total water distribution for a 10-year period, from 1985 to 1994. The general trend is a yearly increase in the water distributed, with a total increase of

about 30 % in the last 10 years; although there was a decrease in 1991 and 1992. The distributed water is divided into non-revenue water (NRW), about 60 %, and billed water, about 40 %. This trend has been the same for years, as in the last ten years.

2.2.2 Domestic Water Demand

(1) Unit Consumption Rate

a) Unit Consumption Rate of House Connection

Table 2.2.15 presents the domestic water demand trend by house connection in the last 10 years, based on records of individual domestic connections.

Table 2.2.15 Domestic Water Demand Trend by House Connection

Year	Distribution (ml/y) (mld)		Year	Distribution (ml/y) (mld)	
1985	181,989	(1.00)	1990	243,982	(1.34)
	499			668	
86	194,149	(1.07)	91	252,462	(1.39)
	532			692	
87	217,262	(1.19)	92	255,484	(1.40)
	595			698	
88	223,494	(1.23)	93	266,734	(1.46)
	611			731	
89	234,707	(1.29)	94	281,100	(1.54)
	643			770	

Source : FCBD
Notes : Underlined years are leap years.
Figures in ( ) are the ratio of distributed water in the year with the amount in 1985.

There is an increased trend in domestic water use as a result of population increase and the expansion of the distribution network. Domestic water use in the future will also increase as population increases, and as the ratio of water supply coverage also expands.

From a survey conducted in 1990, the domestic water supply from private wells was 379 mld which is about 57 % of the total MWSS domestic water supply.

Table 2.2.16 summarizes the per capita domestic use in the last 10 years. There is a decreased trend in the per capita domestic use of about 20 %. This decreasing trend is attributable to the slow rate of installing additional lines which sorely lags behind the population growth, and to the

reduced distribution system pressures which were resorted to prevent excessive leaks and breakages of the old watermains.

Table 2.2.16 Unit Consumption Rate Trend

Year	Rate (l/capita)	Year	Rate (l/capita)
1985	164	1990	133
86	149	91	134
87	150	92	128
88	147	93	126
89	144	94	127

The average household size, the ratio of household to number of connections, and the average monthly consumption per connection are determined based on a survey of 1,823 households which was made by a branch office. The average daily per capita consumption was then estimated, assuming that a 1/2 inch service connection is used for households. These figures are presented in Table 2.2.17.

Average daily consumption ratio shows distinctly three levels, namely: 1) less than 110 l/capita/day; 2) between 110~140 l/capita/day; and 3) more than 140 l/capita/day as shown in Table 2.2.17.

Table 2.2.17 Domestic Water Demand by Branch Office

Branch Office	Average Household Size	Ratio of Household to Number of Connections	Average Monthly Consumption/Connect (m^3/month)	Average Daily Cons. per Capita (l/capita/day), Consumption Level
1. Tondo	5.49	1.36	24	107, 1)
2. Malate	5.91	1.43	31	122, 2)
3. Caloocan	5.53	1.32	32	146, 3)
5. Sta. Cruz	6.19	1.30	30	124, 2)
7. Sampaloc	5.95	1.71	32	105, 1)
8. Pasay	5.16	1.66	32	125, 2)
9. Sta. Mesa	5.48	1.35	31	140, 3)
10. Pasig	5.94	1.35	30	125, 2)
11. Cubao	5.86	1.51	35	132, 2)
12. Makati	5.76	1.45	37	148, 3)
13. España	5.67	1.35	37	161, 3)
14. Cavite	5.07	1.46	24	108, 1)
16. Novaliches	5.91	1.28	29	128, 2)
17. Balara	5.87	1.57	36	130, 2)
18. Marikina	5.66	1.34	32	141, 3)
19. Las Piñas	5.06	1.29	23	117, 1)
20. Parañaque	5.15	1.00	31	201, 3)
21. Navotas	5.05	1.38	26	124, 2)

Source : CORPLAN (six monthly report : large meters and NRW analysis)

In the unit consumption rate projection, assumptions are set up as listed below:

- the per capita consumption trend will continue to be the same as the current trend by branch office;
- even per capita of the low consumption areas will be raised to 160 l/capita, the same level as indicated in 1985, to resume the water consumption level;
- the present high consumption area with a per capita of 200 l/capita will be decreased as the coverage will be expanded. Meanwhile, per capita consumption rate will be raised to 200 l/capita level due to living standard improvement;
- the intermediate area between the low and high consumption areas will be set at 180 to 190 l/capita;
- areawise priority will be given;
- unit consumption rate will increase proportionally.

Table 2.2.18 presents the classification of domestic per capita consumption by each branch office in the target year of 2015.

Table 2.2.18 Per Capita Domestic Consumption in 2015

Classification	Branch Office and No.	Year 2015 l/capita/day
Low Consumption Area	1-Tondo, 7-Sampaloc, 14-Cavite	160
Intermediate Consumption Area	2-Malate, 5-Sta. Cruz, 8-Pasay, 10-Pasig, 11-Cubao, 16-Novaliches, 17-Balara, 19-Las Pinas, 21-Navotas	180 to 190
High Consumption Area	3-Caloocan, 9-Sta. Mesa, 12-Makati, 13-Espana, 18-Marikina, 20-Paranaque	200

Note : Refer to Table 2.2.17 for the numbering of each branch office.

Unit consumption rate by branch office was further broken down into city/municipality basis by means of average area-weighted ratio according to the MWSS branch boundary map. Based on the unit consumption level in 1994, the unit consumption in the target year 2015 was computed in five consumption levels, 160, 180, 185, 190, and 200 l/capita/day. Table 2.2.19 presents a summary of improvement of domestic water unit consumption rate by city/municipality.

b) Unit Consumption Rate of Public Faucet

Water from public faucets are either billed or are free of charge. Table 2.2.20 presents the number of billed public faucets from 1984 to 1993.

Table 2.2.19 Domestic Water Unit Consumption Rate by City/Municipality

City/ Municipality	Year 1994	1995	2000	2005	2010	2015
NCR						
Manila	116	119	134	150	165	180
Pasay	121	124	138	152	166	180
Quezon	128	131	144	158	171	185
Caloocan	132	135	149	162	176	190
Mandaluyong	135	138	154	169	185	200
Las Piñas	146	148	159	169	180	190
Makati	141	144	158	172	186	200
Malabon	131	134	148	162	176	190
Marikina	135	138	154	169	185	200
Muntinlupa	121	124	138	152	166	180
Navotas	120	123	137	151	166	180
Parañaque	190	190	193	195	198	200
Pasig	122	125	139	152	166	180
Pateros	143	146	159	173	186	200
San Juan	135	138	154	169	185	200
Taguig	143	146	159	173	186	200
Valenzuela	120	123	137	151	166	180
CAVITE						
Cavite City	104	107	120	133	147	160
Bacoor	104	107	120	133	147	160
Imus	104	107	120	133	147	160
Kawit	104	107	120	133	147	160
Noveleta	104	107	120	133	147	160
Rosario	104	107	120	133	147	160
RIZAL						
Angono	-	107	120	133	147	160
Antipolo	121	124	138	152	166	180
Baras	-	107	120	133	147	160
Binangonan	-	107	120	133	147	160
Cainta	121	124	138	152	166	180
Cardona	-	107	120	133	147	160
Jala-Jala	-	107	120	133	147	160
Morong	-	107	120	133	147	160
Pililla	-	107	120	133	147	160
Rodriguez	136	139	154	170	185	180
San Mateo	136	139	154	170	185	180
Tanay	-	107	120	133	147	160
Taytay	121	124	138	152	166	180
Teresa	-	107	120	133	147	160

The number of faucets has increased proportionately with the increase of the service area population and the population using these public faucets fluctuated between 5.7 % and 7.3 % of the service area population.

Per capita consumption is being reduced due to the increase of population per public faucet and the lack of water pressure. In the same manner as house connection, the decreasing trend will be attributable to the slow rate in the expansion of water supply system.

The convenience provided by having individual connections for each household is preferable over that of public faucets. But providing individual connections to the low income group is difficult at present, thus, public faucets are still needed. Therefore, per capita consumption rate is assumed to be 30 l per capita in 2015, which is the same level as in 1985.

Table 2.2.20 Public Faucet

Year	Number of Faucets	Billed Faucets (%)	Water Supply (ml/y) (mld)	Served Households h.h./faucet	Per capita consumption (l/capita/d)
1984	940	388 41.3	1,124.436 3.072	18,913 49	32
85	940	409 43.5	1,141.270 3.127	20,562 50	30
86	960 (1.02)	483 50.3	1,100.733 3.016	23,437 49	25
87	1,020 (1.09)	329 32.3	951.167 2.606	17,200 52	30
88	1,120 (1.19)	407 36.3	1,172.770 3.204	22,232 55	28
89	1,240 (1.32)	473 38.1	1,513.238 4.146	25,433 54	32
90	1,380 (1.47)	516 37.4	1,55.103 4.255	31,651 61	26
91	1,390 (1.48)	624 44.9	1,687.736 4.624	38,590 62	23
92	1,470 (1.56)	647 44.0	1,855.311 5.069	40,795 63	24
93	1,540 (1.64)	685 44.4	1,944.680 5.328	43,768 64	24

Source: CORPLAN
Note: The amount of water and the number of households indicated are limited only to billed faucets. Figures in ( ) are ratios of the number of faucets of any year with that for 1984. Consumption/cap = a / (No. of served Household x Household size)x 1,000. Household size = 5.1.

(2) Domestic Water Demand

A total domestic water demand combining the house connections and public faucets is obtained by scenario as shown in Table 2.2.21.

Table 2.2.21 Domestic Water Demand (Unit: mld)

Year	1994	1995	2000	2005	2010	2015
<Scenario 1>						
House Conn.	769.467	886.832	1,573.5252	1,928.360	2,322.886	2,744.637
Public Faucet	22.890	23.310	1.870	19.260	16.200	11.790
Total	792.357	910.142	1,595.395	1,947.620	2,339.086	2,756.427
<Scenario 2>						
House Conn.	769.467	839.096	1,176.263	1,560.540	2,065.037	2,611.224
Public Faucet	22.890	23.610	24.420	24.480	24.510	23.580
Total	792.357	862.706	1,200.683	1,585.020	2,089.547	2,634.804

2.2.3 Commercial Water Demand

The trend of MWSS water supply for commercial use in the last 10 years is presented in Table 2.2.22.

The commercial water use slightly decreased in the 1980's, but later on, the trend was reversed and is expected to continue increasing in the future. Unlike water for industrial use which is dependent on private wells, water for commercial use is more dependent on MWSS. Also, the population growth is projected to increase by 1.6 times of current levels in the target year of 2015. For the projection of commercial water use, therefore, time series trend analysis was adopted and the following trend analysis formula, a yearly average of increase ratio, was applied. This method is often utilized for a developing area which keeps the same increase ratio for a considerably long term.

$y = y_0(1+r)^x$ where, y : consumption after x-year from the reference year
y_0 : consumption of the reference year
r : yearly average increase ratio
x : number of years after the reference year

A survey made in 1990 revealed that water supplied from private wells for commercial use was about 107 mld. Further, saline intrusion to the ground water has become a serious problem in Metro Manila. Therefore, 50 % of the private wells consumption affected by salinity problems is assumed to convert or connect to the MWSS CDS systems by the year 2000. After the year 2005, 50 % of the all private well consumption is further added to convert or connect to the MWSS CDS systems.

Table 2.2.22 Commercial Water Use Trend

Year	Consumption (ml/y) (mld)		Year	Consumption (ml/y) (mld)	
1985	104,840	(1.00)	1990	113,850	(1.09)
	287			312	
86	100,790	(0.96)	91	107,940	(1.03)
	276			296	
87	101,760	(0.97)	92	102,630	(0.98)
	279			280	
88	112,810	(1.08)	93	105,770	(1.01)
	308			290	
89	114,760	(1.09)	94	111,780	(1.07)
	314			306	

Source: Corporate Planning
Notes : Underlined years are leap years.
Figures in ( ) are the ratio of supplied water for the year with the amount in 1985.

Table 2.3.23 summarizes the commercial water demand projection of the selected years.

Table 2.2.23 Commercial Water Demand Projection

Year	Trend Analysis (mld)	For ground water convert (mld)	Total (mld)
1995	308.2	-	308.2
2000	319.4	30	349.4
2005	330.9	54	384.9
2010	342.9	54	396.9
2015	355.4	54	409.4

2.2.4 Industrial Water Demand

Table 2.2.24 presents the trend for the last 10 years of water supplied by MWSS for industrial use.

The trend of the MWSS water supply for industrial use increased during the latter part of the 1980's, but leveled off in the 1990's, attributable to industries being dependent more on private wells. For industrial water, the formula utilized is the exponential curve trend analysis. This formula can be used for ordinal cities with moderate development.

$y = y_0 + Ax^a$ where, y : consumption after x-year from the reference year
y_0: consumption of the reference year
x : number of years after the reference year
a, A : constants

Table 2.2.24 Industrial Water Use Trend

Year	Consumption (ml/y) (mld)		Year	Consumption (ml/y) (mld)	
1985	14,450	(1.00)	1990	25,800	(1.79)
	40			71	
86	14,520	(1.00)	91	25,230	(1.75)
	40			69	
87	16,270	(1.13)	92	24,320	(1.68)
	45			66	
88	20,900	(1.45)	93	24,500	(1.70)
	57			67	
89	25,280	(1.75)	94	26,060	(1.80)
	69			71	

Source: Corporate Planning
Notes : Underlined years are leap years.
Figures in ( ) are ratios of the supplied water for the year with the amount for 1985.

Industrial water use, which used 355 mld from groundwater in 1990, will increase due to economic growth brought about by the population growth, projected to be increased by 1.6 times of the current level in 2015, in the same manner as commercial water use. Likewise, since saline

intrusion to the ground water sources has become a serious problem in Metro Manila, it can be assumed that 50 % consumption of the private wells with salinity problems will be converted or be connected to the MWSS CDS systems by the year 2000. After the year 2005, 50 % of the total private well consumption will be assumed to be converted or be connected to the MWSS CDS systems as same manner as commercial water use.

Table 2.3.25 summarizes the industrial water use demand of the selected years.

Table 2.2.25 Industrial Water Use Projection

Year	Trend Analysis (mld)	For ground water conversion (mld)	Total (mld)
1995	75.8	-	75.8
2000	84.9	88.4	173.3
2005	92.1	174.0	266.1
2010	98.2	174.0	272.2
2015	103.5	174.0	277.5

2.2.5 Total Water Demand

(1) Peak Factor

a) Peak Day Demand Factor

Table 2.2.26 and Table 2.2.27 present the monthly water supply from the treatment plants in 1993 and 1994. The monthly variation of distributed water is small. In both years, the minimum supply occurred in April when the distributed water was 9 % below average in 1993, and 5 % below average in 1994.

The distributed water peaked during the months of January 1993 and September 1994, reaching 9 % above the average in 1993 and 4 % above the average in 1994.

Table 2.2.26 Monthly Water Distribution Trend in 1993

Mon.	Balara No. 1 ml/mo.	Balara No. 2 ml/mo.	La Mesa ml/mo.	Total ml/mo	Daily Ave. mld	Peak Factor
1	13,920.3	33,606.5	43,523.1	90,449.9	2,917.7	1.09
2	12,981.4	28,531.4	33,526.6	75,039.4	2,680.0	1.01
3	14,264.0	28,816.6	34,116.3	77,196.9	2,573.2	0.97
4	13,354.9	28,751.0	32,953.5	75,059.4	2,421.3	0.91
5	12,936.7	32,356.0	39,012.5	84,305.2	2,719.5	1.02
6	11,074.2	29,309.0	37,393.6	77,776.8	2,592.6	0.97
7	12,593.4	29,944.5	38,605.2	81,143.1	2,617.5	0.98
8	13,810.5	31,789.3	37,276.1	82,875.9	2,673.4	1.00
9	13,881.6	28,908.7	37,206.2	79,996.5	2,666.6	1.00
10	14,408.0	31,217.6	38,823.6	84,449.2	2,724.2	1.02
11	12,901.2	29,343.6	36,871.2	79,116.0	2,637.2	0.99
12	14,612.1	31,963.6	38,982.0	85,557.7	2,759.9	1.04
	160,738.3	363,937.8	448,289.9	972,966.0	2,655.7	1.00

Source: WSTD (Water Sources and Treatment Department)
Note : Factor shown is the ratio of the distributed water with the average value.

Table 2.2.27 Monthly Distributed Water in 1994

Mon.	Balara No. 1 ml/mo.	Balara No. 2 ml/mo.	La Mesa ml/mo.	Total ml/mo.	Daily Ave. mld	Peak Factor
1	14,287.8	33,962.6	40,086.3	88,336.7	2,849.6	0.98
2	12,631.6	29,384.8	37,333.9	79,350.3	2,833.9	0.98
3	14,234.2	32,424.2	41,718.3	88,376.7	2,850.9	0.98
4	14,049.8	30,757.8	38,067.3	82,874.9	2,762.5	0.95
5	16,179.3	31,158.1	40,994.0	88,331.4	2,849.4	0.98
6	15,399.2	31,821.7	40,584.2	87,805.1	2,926.8	1.01
7	16,038.8	32,662.2	42,868.4	91,569.4	2,953.9	1.02
8	15,932.5	33,514.5	43,449.3	92,896.3	2,996.7	1.03
9	15,001.4	33,176.2	42,357.7	90,535.3	3,017.8	1.04
10	15,895.5	33,602.3	40,619.9	90,117.7	2,907.0	1.00
11	15,900.2	31,863.4	39,449.6	87,213.2	2,907.1	1.00
12	6,591.4	14,427.3	16,500.4	37,519.1	2,886.1	1.00
	172,141.7	368,755.1	464.029.3	1,004,926.1	2,896.0	1.00

Source: WSTD (Water Sources and Treatment Department)
Note : Data for December covers 13 days only.

Table 2.2.28 Max. Min. Distributed Water in 1993

	Balara No. 1	Balara No. 2	La Mesa	Total
Max. (mld)	554.5	1,148	1,521.7	3,132.3
Date	Nov. 9	Jan. 12	Jan. 15	Jan. 16
Min. (mld)	282.9	846.9	943.1	2,244.3
Date	Jul. 27	Jul. 27	Apr. 13	Apr. 13

Source: WSTD (Water Sources and Treatment Department)

Table 2.2.29 Max. Min. Distributed Water in 1994

	Balara No. 1	Balara No. 2	La Mesa	Total
Max. (mld)	572.9	1,165.5	1,515.2	3,098.8
Date	Jun. 24	Jan. 10	Aug. 22	Aug. 22
Min. (mld)	402.0	954.3	1,138.5	2,643.6
Date	Feb. 22	May 27	Jan. 23	Jan. 23

Source: WSTD (Water Sources and Treatment Department)

Table 2.2.30 presents a average daily production, maximum daily production, and maximum day demand factor from 1987 to 1994.

Table 2.2.30 Maximum Day Demand Factor

Year	1987	1988	1989	1990	1991	1992	1993	1994
① Average	2,286.8	2,327.6	2,354.0	2,402.4	2,374.6	2,449.7	2,665.7	2,896.0
② Maximum	2,454.3	2,470.6	2,584.9	2,709.1	2,709.1	3,003.1	3,132.3	3,098.8
Date	Feb. 14	Jun. 29	Sep. 25	Oct. 6	Sep. 22	Dec. 9	Jan. 16	Aug. 22
Factor ②/①	1.07	1.06	1.10	1.13	1.14	1.23	1.18	1.07

Note: Unit in mld.

Maximum day demand factor varies from 1.06 to 1.23, with the average at 1.12. Therefore, 1.25, *the maximum rounded number in the last 8 years, will be applied for the maximum day* demand factor. Loading ratio is computed to be 0.80.

b) Peak Hour Demand Factor

Based on the same assumption of the Angat Water Supply Optimization Project, 1.75 will be applied for the Peak hour demand factor.

In general, peak hour demand factor varies from 1.3 to 2.0 of the daily maximum water demand, depending upon the scale of the planned area. Large cities apply a lower factor; while a higher factor is applied for small scale cities. This master plan will adopt a 1.75 peak factor as the daily average water demand. It will be computed that the actual peak hour demand factor against the daily maximum water demand is 1.75/1.25=1.4, which is a reasonable level for a large city. If the lowest level 1.3 will be applied, the daily maximum water demand is computed to be 1.3 x 1.25=1.625.

(2) Total Water Demand Projection

Summarizing the above study, the two scenarios in targeting water supply coverage and the other two scenarios in reducing NRW by the target year of 2015, provides us with four alternatives, which is shown in Table 2.2.31. Table 2.2.32 and Table 2.2.33 show water demand projection in each five year period for 20 years up to the target year 2015.

Table 2.2.31 Comparison of Coverage and NRW Alternatives

Alternatives	Supply Coverage		NRW Reduction	
	Year 2000	Year 2015	Year 2000	Year 2015
Alt. 1	90%	95%	30%	20%
Alt. 2	90%	95%	48%	30%
Alt. 3	67%	90%	30%	20%
Alt. 4	67%	90%	48%	30%

Each alternative is characterized as shown below:

Alternative 1 fully complies with the MWSS strategy. However, the Team judged that it may not be accomplished without difficulties on the following issues:

- 90 % of coverage in year 2000 provides 10.911 million people or 1.8 times of the present served population. This could be achieved with a large expansion of the distribution network which physically takes more than five years.

- NRW is reduced by 27 % (5.4 % per year) to 30 % in only five years that needs huge investigation and construction efforts, which could possibly result in a traffic crisis due to necessary excavation for pipe renovation/repair works.

Alternative 2 has the same constraints in supply coverage, while NRW reduction goes down to 30 % in the target year 2015, a reduction of 1.35 % every year.

Alternative 3 has the same constraints in NRW reduction of 27 % reduction.

Alternative 4 is most practical combination of scenarios that follows the national sector plans.

- Supply coverage of 67 % in the year 2000 is achievable, on condition that the on-going AWSOP and UATP projects will be accomplished by the year 2000. It planned to increase served population to almost 2.5 million people.
- Supply coverage of 90 % can be highly regarded as having the same goal as the national sector plan, which promotes a more sustainable and integrated development program in proportion to the increase of population.
- A permanent reduction in leakage losses can only be achieved through the prevention of leakage occurrence. This implies pipeline renewal before the end of its useful life. This is a time consuming job. So, 30 % NRW, which could be said to be the allowable level, will be set as a target level for the year 2015.

As a conclusion, Alternative 1 is the most practical recommendation for the master plan as it fulfills the national sector plans. The following analysis regarding the development plan will be based on the conditions assumed in Alternative 4. Thus, the water demand will be increased from 2,765 mld in 1995 to 4,746 mld in 2015 on a daily average basis and from 3,456 mld in 1995 to 5,932 mld in 2015 on a daily maximum basis. Supply coverage will be 67 % in 2000 and 90 % in 2015; while NRW ratio will be reduced from 49 % in 2000 to 30 % in 2015.

The particulars of water demand projection are summarized in "Particulars of Water Demand Projection", Supporting Report.

Table 2.2.32 Water Demand Projection, Alt. 1 and Alt. 2

Alt. 1 Water Demand Projection

Year		1994	1995	2000	2005	2010	2015
Projected Population (a)		10,350,000	10,787,000	12,152,000	13,385,000	14,595,000	15,729,000
Population to be Supplied	Direct Supply (b)	6,054,000	6,811,000	10,911,000	12,229,000	13,580,000	14,927,000
	Public Faucet (c)	763,000	755,000	608,000	562,000	482,000	393,000
Total Population to be Supplied (b+c)		6,817,000	7,566,000	11,519,000	12,791,000	14,062,000	15,320,000
Supply Coverage (b/a)*		58%	63%	90%	91%	93%	95%
Revenue Water (m3/d)	Domestic (Direct) (d)	769,467	886,832	1,573,525	1,928,360	2,322,686	2,744,637
	Domestic (Public Faucet) (e)	22,890	23,310	21,870	19,260	16,200	11,790
	Sub Total (d)+(e)	792,357	910,142	1,595,395	1,947,620	2,339,086	2,756,427
	Commercial (f)	306,000	308,200	349,400	384,900	396,900	409,400
	Industrial (g)	71,000	75,800	173,300	266,100	272,200	277,500
	Total (h)=(d)+(e)+(f)+(g)	1,169,357	1,294,142	2,118,095	2,598,620	3,008,186	3,443,327
RW (%) (i)		42%	50%	70%	73%	77%	80%
NRW(%) =1-(i)		58%	50%	30%	27%	23%	20%
NRW (m3/d) (j)=(h)x(1-i)/(i)		1,641,597	1,273,600	907,755	948,564	913,830	860,832
Daily Average Water Demand (k)=(h)+(j)		2,810,954	2,567,742	3,025,850	3,545,184	3,922,016	4,304,159
Daily Maximum Water Demand (k)x1.25		3,513,693	3,209,678	3,782,313	4,431,480	4,902,520	5,380,199

Notes : 1. Coverage involves only the direct water supply to house connections, but not involves indirect water supply by public faucet.

2. Supply coverage 90% and NRW 30% in 2000 are set according to the MWSS strategy.

Alt. 2 Water Demand Projection

Year		1994	1995	2000	2005	2010	2015
Projected Population (a)		10,350,000	10,787,000	12,152,000	13,385,000	14,595,000	15,729,000
Population to be Supplied	Direct Supply (b)	6,054,000	6,811,000	10,911,000	12,229,000	13,580,000	14,927,000
	Public Faucet (c)	763,000	755,000	608,000	562,000	482,000	393,000
Total Population to be Supplied (b+c)		6,817,000	7,566,000	11,519,000	12,791,000	14,062,000	15,320,000
Supply Coverage (b/a)*		58%	63%	90%	91%	93%	95%
Revenue Water (m3/d)	Domestic (Direct) (d)	769,467	886,832	1,573,525	1,928,360	2,322,686	2,744,637
	Domestic (Public Faucet) (e)	22,890	23,310	21,870	19,260	16,200	11,790
	Sub Total (d)+(e)	792,357	910,142	1,595,395	1,947,620	2,339,086	2,756,427
	Commercial (f)	306,000	308,200	349,400	384,900	396,900	409,400
	Industrial (g)	71,000	75,800	173,300	266,100	272,200	277,500
	Total (h)=(d)+(e)+(f)+(g)	1,169,357	1,294,142	2,118,095	2,598,620	3,008,186	3,443,327
RW (%) (i)		42%	45%	51%	58%	64%	70%
NRW(%) =1-(i)		58%	55%	49%	43%	36%	30%
NRW (m3/d) (j)=(h)x(1-i)/(i)		1,641,597	1,575,352	2,010,745	1,920,719	1,706,839	1,475,712
Daily Average Water Demand (k)=(h)+(j)		2,810,954	2,869,494	4,128,840	4,519,339	4,715,025	4,919,039
Daily Maximum Water Demand (k)x1.25		3,513,693	3,586,868	5,161,050	5,649,174	5,893,781	6,148,799

Notes : 1. Coverage involves only the direct water supply to house connections, but not involves indirect water supply by public faucet.

2. Supply coverage 90% in 2000 is set according to the MWSS strategy, while NRW 30% in 2015 is modified from the MWSS strategy, 30% in 2000 by the JICA Study Team.

Table 2.2.33 Water Demand Projection, Alt. 3 and Alt. 4

Alt. 3 Water Demand Projection

Year		1994	1995	2000	2005	2010	2015
Projected Population (a)		10,350,000	10,787,000	12,152,000	13,385,000	14,595,000	15,729,000
Population to be Supplied	Direct Supply (b)	6,054,000	6,449,000	8,139,000	9,839,000	12,065,000	14,199,000
	Public Faucet (c)	763,000	787,000	814,000	816,000	817,000	786,000
Total Population to be Supplied (b+c)		6,817,000	7,236,000	8,953,000	10,655,000	12,882,000	14,985,000
Supply Coverage (b/a)*		58%	60%	67%	74%	83%	90%
Revenue Water (m3/d)	Domestic (Direct) (d)	769,467	839,096	1,176,253	1,560,540	2,065,037	2,611,224
	Domestic (Public Faucet) (e)	22,890	23,610	24,420	24,480	24,510	23,580
	Sub Total (d)+(e)	792,357	862,706	1,200,673	1,585,020	2,089,547	2,634,804
	Commercial (f)	308,000	308,200	349,400	384,900	396,900	409,400
	Industrial (g)	71,000	75,800	173,300	268,100	272,200	277,500
	Total (h)=(d)+(e)+(f)+(g)	1,169,357	1,246,706	1,723,373	2,238,020	2,758,647	3,321,704
RW (%) (i)		42%	50%	70%	73%	77%	80%
NRW(%) =1-(i)		58%	50%	30%	27%	23%	20%
NRW (m3/d) (j)=(h)x(1-i)/(i)		1,641,597	1,226,917	738,588	814,485	838,024	830,426
Daily Average Water Demand (k)=(h)+(j)		2,810,954	2,473,623	2,461,961	3,050,505	3,596,671	4,152,130
Daily Maximum Water Demand (k)x1.25		3,513,693	3,092,029	3,077,451	3,813,131	4,495,839	5,190,163

Notes : 1. Coverage involves only the direct water supply to house connections, but not involves indirect water supply by public faucet.

2. Supply coverage 90% in 2015 is modified by the JICA Study Team from the MWSS Strategy, 80% in 2000, while NRW 30% in 2000 are set according to the MWSS strategy.

Alt. 4 Water Demand Projection

Year		1994	1995	2000	2005	2010	2015
Projected Population (a)		10,350,000	10,787,000	12,152,000	13,385,000	14,595,000	15,729,000
Population to be Supplied	Direct Supply (b)	6,054,000	6,449,000	8,139,000	9,839,000	12,065,000	14,199,000
	Public Faucet (c)	763,000	787,000	814,000	816,000	817,000	786,000
Total Population to be Supplied (b+c)		6,817,000	7,236,000	8,953,000	10,655,000	12,882,000	14,985,000
Supply Coverage (b/a)*		58%	60%	67%	74%	83%	90%
Revenue Water (m3/d)	Domestic (Direct) (d)	769,467	839,096	1,176,253	1,560,540	2,065,037	2,611,224
	Domestic (Public Faucet) (e)	22,890	23,610	24,420	24,480	24,510	23,580
	Sub Total (d)+(e)	792,357	862,706	1,200,673	1,585,020	2,089,547	2,634,804
	Commercial (f)	308,000	308,200	349,400	384,900	396,900	409,400
	Industrial (g)	71,000	75,800	173,300	268,100	272,200	277,500
	Total (h)=(d)+(e)+(f)+(g)	1,169,357	1,246,706	1,723,373	2,238,020	2,758,647	3,321,704
RW (%) (i)		42%	45%	51%	58%	64%	70%
NRW(%) =1-(i)		58%	55%	49%	43%	36%	30%
NRW (m3/d) (j)=(h)x(1-i)/(i)		1,641,597	1,517,609	1,638,029	1,652,710	1,565,251	1,423,587
Daily Average Water Demand (k)=(h)+(j)		2,810,954	2,764,315	3,359,402	3,888,730	4,323,898	4,745,291
Daily Maximum Water Demand (k)x1.25		3,513,693	3,455,394	4,199,253	4,860,913	5,404,873	5,931,614

Notes : 1. Coverage involves only the direct water supply to house connections, but not involves indirect water supply by public faucet.

2. Supply coverage 90% and NRW 30% in 2000 are modified by the JICA Study Team from the MWSS Strategy which targets supply coverage to be 90% and NRW to be 30% in 2000, respectively.

2.2.6 Water Supply Basic Indicators

As a conclusion to the foregoing discussion, Table 2.2.34 summarizes the overall water supply indicators during the period 1995 to 2015 by five years.

Table 2.2.34 Water Supply Basic Indicators

Description	1995	2000	2005	2010	2015
Projected Population (million)	10.787	12.152	13.385	14.595	15.729
Supply Coverage (%)	60	67	74	83	90
Served Population (million)	6.449	8.139	9.839	12.065	14.199
Ave. Unit Consumption Rate(l/capita/d)*	193	211	226	230	234
NRW (%)	55	49	43	36	30
Daily Ave. Water Demand (mld)	2,765	3,360	3,889	4,324	4,746
Daily Max. Water Demand (mld)	3,456	4,200	4,861	5,405	5,932

Note: Ave. unit consumption rate shows the ratio revenue water amount and served population, including domestic water, commercial, and industrial uses.

2.3 Development Plan

2.3.1 General

According to the city planning study discussed in the chapter 3 Project Framework, Part I, the development policies provide direction for urban growth in the study area. Metropolitan Manila is pictured by urban sprawl and high density centers especially in Manila and Makati cities, expanding towards the peripheral areas of the metropolis, particularly toward the south like Bacoor and Imus in Cavite province, and toward the east like Cainta, Antipolo, and Angono in Rizal province.

By the target year of 2015, the population is projected to increase to be approximately 15.8 million and water demand will approach to 6,000 mld on a daily maximum basis with a supply coverage 90 %, or approximately double of the present water supply capacity.

To cope with the urbanization of the study area, a long-term development plan for water supply is being proposed. This will help promote the sound growth of the cities/municipalities. The water development plan, as a general rule, will follow the vision set under the national sector plan, which is the provision of safe and adequate water supply and sanitation services.

To be realized, therefore, in the 20-year water supply development plan, which is from 1996-2015, are the following:

- Acquisition of future water sources
- Expansion of new water supply facilities
- Augmentation/Expansion of distribution network
- Optimization of the existing water supply system
- NRW reduction

(1) Acquisition of Future Water Sources

To supply new water demand, it is absolutely necessary that additional water sources be developed in an economic and technically safe manner. Waterworks, the "Life Line" of cities, has a responsibility to supply water at all times, even during disasters and droughts. Additional

water sources, particularly surface water, should be secured this early knowing the problem on existing groundwater sources. This will result in guaranteeing a back-up water supply system to the sole existing "Angat Novaliches Water Supply System," especially in emergency cases. The availability of new water sources is discussed in detail in the following section, Potential Water Sources.

(2) Expansion of New Water Supply Facilities

This includes the construction of a new water supply system, and such facilities as raw water intake, water treatment, distribution tanks, and the development of the new water sources. The water produced from the new facilities will be brought to low pressure areas, or to those with inadequate supply, and to areas presently unserved with water.

The new system will also be a back-up system of the "Angat-Novaliches Water Supply System" as it will augment present supply and optimize the operation and maintenance of the systems.

(3) Augmentation/Expansion of Distribution Network

The additional water supply will be distributed to the existing service areas. It will provide relief to current water supply problems such as saline intrusion to the groundwater sources and inadequate water supply. The existing and expanded network's interconnection is a must.

Furthermore, the presently unsupplied areas should be serviced, in addition to the existing service areas. The service area must be designed with attention given to its wide expanse; while management efficiency and economy should be the prime considerations in studying the plan of the facility to be constructed.

(4) Optimization of the Existing Water Supply System

The existing water supply system is composed of Angat Dam, Ipo Dam, Balara TP 1 and 2, La Mesa TP 1 and 2. Since 1935, or the last 60 years, the distribution network has had very few operation and maintenance works. Many of the facilities/equipment are already damaged and go without proper maintenance works, except for the Balara TP which is undergoing rehabilitation through a grant aid scheme from the Government of Japan. Before optimization or rehabilitation works are made, a review focusing on the facilities and equipment that are non-functioning and deteriorated should be made.

The optimization work should also be coordinated with the existing "Angat-Novaliches Water Supply System" and the expanded water supply systems being proposed. The same can be said about the combination of the existing and proposed distribution tanks and the distribution network.

(5) NRW Reduction

NRW reduction is one of more important issues in the water supply development. The master plan targets the level of the NRW reduction to be set at 30 % by the target year 2015.

2.3.2 Potential Water Sources

(1) Existing Sources

a) Angat River

For its water source, MWSS relies mainly on the Angat River. A total of the intervening watershed upstream of the diversion at Ipo Dam provides 28.5 cms (2,460 mld) for the raw water supply of Metro Manila.

b) Groundwater

In addition to surface-water-supplied Central Distribution System (CDS), MWSS manages groundwater supply systems which provide potable water to the areas not connected to CDS. Annual production of groundwater in the last ten years and the status of MWSS deepwells are tabulated in Supporting Report. Amount of average daily water supply by groundwater varies from approximately 70 mld to 90 mld, covering only 3 % of total water supply of MWSS .

Aside from MWSS-run wells, it has been reported that there are about 3,000 privately-owned wells in MSA. The total volume pumped out from these wells is estimated at about 800 mld per annum. This over exploitation of groundwater mainly for industrial use by the firms located along the coastal area causes saline water intrusion into the groundwater aquifer as analyzed in a study on the groundwater development in Metro Manila conducted by JICA during the period from August 1990 to March 1992 (MMGWDP).

Therefore, this Study regards the groundwater sources as a supplemental source. By the year 2000, 50 % of the groundwater consumption in the coartal area suffering from saline intrusioin

is assumed to be convert to the MWSS system. Furthermore, after the year 2005, 50 % of total groundwater consumption even without salinity problems is assumed to convert to the public water supply system by MWSS.

(2) On-going Augmentation of Source: AWSOP and UATP

Under the Water Supply, Sewerage and Sanitation Master Plan (1988-2000), MWSS has initiated a major water supply and distribution development program to address the existing inadequacies of water supply for Metropolitan Manila and its environs. As the first stage of the development program, MWSS has undertaken the Angat Water Supply Optimization Project (AWSOP) in 1989. AWSOP aims to increase the water supply capacity of MWSS by 15 cms (1,300 mld) once the project is completed in 1996.

The resolution to grant MWSS an additional 15 cms was adopted during the NWRB Board Meeting in January, 1988. This 15 cms will be produced by 'the optimized usage' of the reservoir release, i.e. multiple use (power generation-irrigation-water supply) of water release with priority given to water supply.

However, this additional grant has two restrictions from the beginning, viz.:

- up to the maximum of 15 cms,
- out of the unutilized grant intended for irrigation.

Operational records of withdrawals of additional raw water from the Angat Reservoir during the period from July 1992 to May 1994 revealed that only about 7 cms were actually withdrawn. While it will still take some time by further analysis to get the final volume of dependable additional yield which would be produced by AWSOP, there are indications that the 15 cms as initially intended cannot be produced, unless some rearrangement/reallocation is made of 'multiple use' of Angat Reservoir between NPC, NIA and MWSS.

In the meantime, the Umiray-Angat Transbasin project (UATP) was conceived by MWSS as the second stage of its development program. The primary objective of the project is to augment the treated water supply capacity of MWSS by 9 cms (780 mld) through diversion of Umiray river flow into the Angat reservoir by 1998. The MWSS will be able to increase the water supply by utilizing the diverted water of 15.7 cms from the Umiray River into the Angat reservoir. This

increased water supply coupled with the improvement of the operational performance of MWSS, would result to the secondary objective of minimizing the excessive extractions of groundwater caused mostly by the activities of private firms, which has significant environmental implications in the MSA.

Thus, it is assumed that the Angat-Novaliches Water Supply System currently provides 2,896 mld in a yearly average basis as shown in 1994 data. In addition, it is concluded through a series of discussion with MWSS that AWSOP could supply 100 mld in 1998 and 70 mld in 1999 by AWSOP and 400 mld in 1999 and 500 mld in 2000 by UATP.

(3) Proposed Augmentation of Source:

a) Kaliwa River (Third Manila Water Supply Project: MWSP III)

After World War II, many studies on future supply sources were conducted. The prefeasibility and feasibility studies for the Third Manila Water Supply Project III (MWSP III) carried out in 1978 and 1979, respectively, identified the Kaliwa river as the most promising source among other proposed sources.

In the feasibility study, the project was conceived as a multi-purpose development that will provide an average yield of 1,950 mld (23 cms) of water supply and hydropower generation. This was conceived as the first stage of an integrated development of the Kaliwa and Kanan River Basins, with the Kanan River Basin providing an additional yield of about 3,200 mld (38 cms).

The Water Permit to use water (23 cms) from the Kaliwa River was granted by NWRC (now NWRB) on August 30, 1979, for the purpose of water supply for Metro Manila and incidental power generation. Subsequently, the Water Permit to use water (38 cms) from the Kanan River was granted on April 22, 1981, for 'Municipal Use (Domestic)'.

Soon after the completion of the feasibility study, MWSS proceeded with the detailed design and preparation of tender documents for the diversion tunnel and the construction of the proposed Laiban Dam at Sitio Laiban, Tanay, Rizal. Construction work of the tunnel was started in November, 1982, and completed in December, 1984. However, economic and political circumstances were not so favorable for MWSP III so that the Dam and other construction works could not be continued.

Meanwhile, according to the demand projection beyond the year 2001, it has been revealed that the next substantial augmentation of water source is urgently needed. Accordingly, the Kaliwa River development project has been revived. Fortunately, MWSS has continued relocation work for the proposed Laiban Dam and its impounding area, even after deferment of its construction. MWSS now intends to review and update the feasibility study conducted some fifteen years ago.

Considering the lack of alternative sources, the Kaliwa River is presently the most suitable source on which MWSS could depend for future water supply. The reasons are:

- Satisfactory and stable yield would be expected;
- It could meet the demand for several years after 2015 (the Study target year);
- Satisfactory water quality - there are no harmful substances nor waste water discharges in the basin, now and in the future;
- When its development is integrated with the Kanan River basin, the joint project will be a permanent supply source;
- The elevation of the proposed treatment plant (Pantay) and distribution reservoir (Cogeo) is more favorable due to 'supply by gravity';
- Due to the location of the basin and the treatment plant, it is much easier to increase the supply capacity in the east bank of Marikina River (Rizal), the southernmost parts of NCR (Parañaque, Las Piñas and Muntinlupa) and the service areas in Cavite Province;
- A dual water source system is essential for a megapolis like Metro Manila, especially in cases of unexpected emergencies.

b) Kanan River

Kanan River, as mentioned in the previous section, would provide additional amount of water after the Kaliwa River Expansion Project. While the Master Plan Study considered only the requirements up to the year 2015, the Study Team also reviewed the potentials of the Kanan River as the most promising source to assure the water supply for Metro Manila for the years ahead.

Incidentally, the National Power Corporation (NAPOCOR) revealed a plan to develop the Kanan River Basin for the 112 MW Kanan B1 Hydropower Plant as an intermediate measure prior to full-scale augmentation of hydropower generation for the Luzon grid. Accordingly, NPC has asked MWSS repeatedly since early 1995 about MWSS' plans of using the Kanan River as a future water supply source, presumably for the years after 2006 particularly when and how these plans will be implemented.

Generally speaking, intangible assets like "water rights", when allowed by the owner (rights holder) to be used temporarily by others would be very difficult to be reverted to the rightful owners. NPC plans to operate the Kanan B1 HEP by availing temporarily of MWSS water rights until NPC recovers all its investment which would be, at the earliest, in the year 2035. Faced with these realities, it would be best for MWSS to keep its water rights over the use of Kanan river water for the post-Kaliwa supply source and not to temporarily lend its use to NPC.

c) Laguna Lake

Several studies have been conducted on Laguna Lake since early 1970s. Aside from the limited volume that could be extracted for water supply, the water quality makes it not desirable for source of public water supply. Most of the houses and factories located in the watershed surrounding the lake discharge their wastewater into the lake without treatment. There is no basin-wide sewerage system where untreated wastewater is diverted and treated before being discharged into the lake. Only a few wastewater treatment facilities have been constructed by environment-conscious private firms in recent years. In addition, various fish culture runs along the lake coast.

MWSS planned two projects which rely on the use of Laguna Lake water. One is the Cavite Water Supply Project (CWSP), and another is the Rizal Province Water Supply Improvement Project (RPWSIP). As of August 1995, both projects are still in their feasibility study stages.

[CWSP]

CWSP was planned to improve the worsening water supply and to meet the increasing demand in Cavite City and the municipalities of Kawit, Noveleta, Imus and Rosario, all requiring 300 mld, with Laguna Lake as the water source. For intake facilities, it is planned to use the existing pump station (located at Putatay, Muntinlupa) presently owned and operated by NIA. The pump

station initially was planned under the Second Laguna de Bay Irrigation Project to supply 900 mld of water for irrigating the stretch of farm lands in the municipalities of Bacoor, Noveleta, Imus and Kawit. In the meantime, this area was rapidly urbanized, so that a considerable amount of the 900 mld would be unnecessary for irrigation purposes.

Therefore, MWSS now plan CWSP, to supply domestic water for Cavite Cavite City and other municipalities mentioned above, by diverting 300 mld out of 900 mld of water initially intended for irrigation. This amount to be diverted was increased to 600 mld recently, because another 300 mld might be unnecessary again since the urbanization of this area has been accelerated beyond original expectations.

Meanwhile, MWSS is conducting Manila South Water Distribution Project (MSWDP) with the 300 mld of supply source from an allotment coming out of AWSOP water. Due to the delay of the distribution phase of AWSOP, however, the situation of water supply in the project area of MSWDP (Bacoor, Las Piñas, Muntinlupa and Parañaque) has been worsening year after year, so that instead of using Laguna Lake Water for AWSOP, the water will be used to improve the supply for the MSWDP Project.

Thus, the expected total amount of water supply from Laguna Lake will be 600 mld, corresponding to the amount of 600 mld unutilized irrigation water out of 900 mld of water for Second Laguna de Bay Irrigation Project.

[RPWSIP]

RPWSIP covers nine municipalities which have been included as the MWSS service area (MSA) by virtue of BP 799 in 1984. Out of 9 municipalities, 7 municipalities will be supplied by groundwater (for Phase II), because they are not yet highly urbanized. For the other two municipalities, i.e. Angono and Taytay, the use of Laguna Lake for 48 mld of water (for Phase I) was decided during the early planning stage.

Concept for Use of Laguna Lake Water as Supply Source is as follows:

- Since water quality condition of Laguna de Bay is 'hypereutrophic', which will likely worsen for some time before it is restored to desirable quality through massive water pollution prevention measures.