APPENDIX I

NETWORK PLANNING

APPNDIX I
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APPENDIX I NETWORK PLANNING

1 TERMINOLOGY

The terminology of transmission and distribution facilities used in this appendix is defined as below and a conceptual layout of a typical water supply system composed of these facilities is shown in Figure I.1.

Raw water main (RWM) : A main pipe constructed for conveying water from a source of supply to a treatment plant.

Transmission main (TM) : Transmission mains consist of components that are designed to convey large amounts of water over great distances, typically between major facilities within the system, for example, between a treatment plant and a service reservoir, a service reservoir and another, or a pumping station to a service reservoir. Individual customers are not served from transmission mains.

Service reservoir (SR): Service reservoirs balance daily fluctuations in demand, and provide security of supply against failure of trunk mains.

Terminal reservoir (TR): In this Study a terminal reservoir is planned, whose functions are to mix and store water from two source systems for conveying to service reservoirs.

Distribution main (DM) : Distribution mains are an intermediate step toward delivering water to the end customers. Distribution mains are smaller in diameter than transmission mains. Frequently, distribution mains are connected to service reservoirs.

Secondary distribution main (SDM): Secondary distribution mains are connected to a distribution main and are smaller than distribution mains in diameter.

Service line (SL): Service lines transmit the water from the distribution mains or secondary mains to the end customers.

Transmission pump (TP): Transmission pumps are used for increasing water pressure within the transmission system.

Distribution pump (DP): Distribution pumps are used for increasing water pressure within the distribution system.

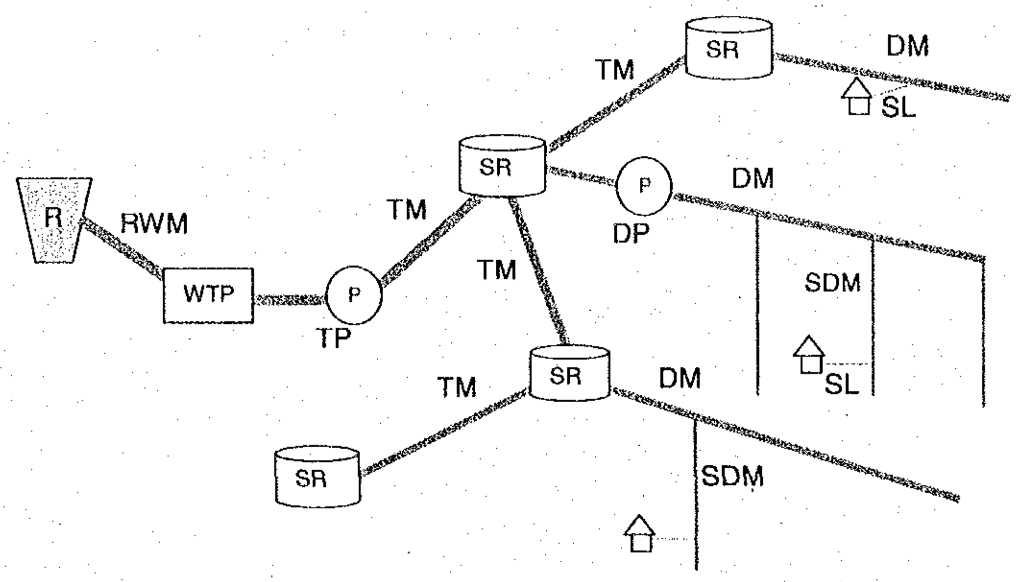


Figure I.1 Conceptual Layout of Typical Water Supply System

2 DESIGN CRITERIA

Design flows and formulas along with the planning and designing conditions used are defined as below.

2.1 DESIGN FLOWS AND FORMULAS

1) Daily average water demand (m^3/day):Qave

Daily average water demand is calculated by dividing annual total water demand by 365 days.

Qave = Annual total water demand / 365 days

2) Daily maximum water demand (m^3/day): Qmax

This demand generally occurs during the hot season, when people consume maximum amount of water.

= Design capacity of water sources, intake, raw water main, treatment plant and transmission system (mains and pumps)

For Yangon City

>> Peak factor = 1.2 of the daily average water demand (Qmax = 1.2 x Qave)
Remarks: For the design capacity of water sources, intakes and raw water mains, water loss generated in water treatment plan shall be added to the daily maximum water demand.

3) Hourly maximum water demand (m^3/day): Qhr

= Design capacity of distribution system (mains and pumps)

For Yangon City

>> Hourly Factor = 1.4 of the average hourly demand in the daily maximum water demand
(Qhr = 1.4 x Qmax)

4) Daily demand profile

= Design capacity of service reservoir

For Yangon City

>> Storage volume = 8-hours demand of hourly average of the daily maximum demand

5) Pressure requirement

A minimum distribution pressure in the mains is 15 m head (1.5 kg/cm^2), which ensures that water is supplied to the second or third floor of house.

6) Pipe friction formula

Hazen-Williams formula is used for analyzing the existing network system and planning and designing the proposed new network system.

$$H = 10.666\, C^{-1.85}\, D^{-4.87}\, Q^{1.85} \cdot L$$

Where: H = head loss due to friction (m)
Q = pipeline flow rate (m^3/sec)
D = pipe diameter (m)
L = distance between section 1 and 2 (m)
C = Hazen-Williams C-factor
Existing pipes: the values estimated from pipe conditions
New pipes: 120 (considering local losses and increase in friction with age by 2020)

7) Network analysis software

Following software is used to analyze the present network system and plan and design future network system.

Info Works WS Ver.3.5, Water Research Center

2.2 PLANNING CONDITIONS

(1) Water Demand

Table I.1 shows summary of planned yearly water demand from 2000 to the target year of 2020 in five-year intervals. The details for water demand estimation are explained in the Chapter 4 PLANNING FUNDAMENTALS.

Table I.1 Summary of Water Demand

	2000	2005	2010	2015	2020
Population	3,887,000	4,403,000	4,955,000	5,541,000	6,159,000
Service Population	1,443,441	2,201,500	2,973,000	3,601,650	4,311,300
Service rate (%)	37	50	60	65	70
Net consumption (m^3/day)	256,306	495,131	733,012	970,730	1,195,456
Leakage ratio (%)	50	45	40	35	25
Average water demand (m^3/day)	512,612	900,238	1,221,687	1,493,443	1,593,541
Maximum water demand (m^3/day)	615,100	1,080,300	1,466,000	1,792,100	1,912,700

For the network analysis of the year 2000 and 2020, water demands by ward or sub-section in a ward are prepared. For small ward the water demand by ward is adopted but for large ward the ward is equally divided into 2 to 6 sections according to the size of the ward and total water demand of the ward is equally distributed into these sections.

(2) Water Source

The existing and proposed water sources for YCDC water supply system are summarized in Table I.2, being categorized into three source systems: reservoir system, Hlaing river system and groundwater system.

Table I.2 Water Sources for YCDC Water Supply System

Name of source	Existing or new	Average intake amount in 2000 (m^3/day)	Planned intake amount (m^3/day)
A. Reservoir			
a) Hlawga reservoir	Existing source	75,000	75,000
b) Gyobyu reservoir	Existing source	118,200	118,200
c) Pyujyi reservoir	Existing source	245,400	245,400
d) Ngamoiyeik reservoir	New source	0	409,000
Sub-total		438,600	847,600
B. Groundwater	Existing and new	43,890	158,500
C. Hlaing river	New source	0	981,500
Total			1,987,600

(3) Water Treatment Plant

All the water of the reservoir system are conveyed from the sources to Hlawga reservoir area and treated in bulk with direct filtration process. On the other hand, Hlaing river water is drawn at Gwandansha and treated with coagulation and filtration process at the site. The treated water is then conveyed to the city area for distribution. Good quality of groundwater is withdrawn, treated with disinfection and injected into distribution system. Groundwater in Hlaingthaya township has high concentration of manganese and iron. This groundwater will be treated with appropriate treatment process and injected into distribution system.

3 PROPOSED TRANSMISSION AND DISTRIBUTION SYSTEM

Four reservoirs, Hlaing river and groundwater are planned as sources of the future city water supply. Groundwater is only a small portion of total amount and will be injected on the site where the water is withdrawn. While reservoir and river sources represent a large amount of water. Since they are located in remote area of the city, it is necessary to convey water to the city area for distribution. Therefore reservoir and river sources are mainly considered when transmission and distribution system is planned.

3.1 TRANSMISSION SYSTEM ALTERNATIVE

(1) Alternatives

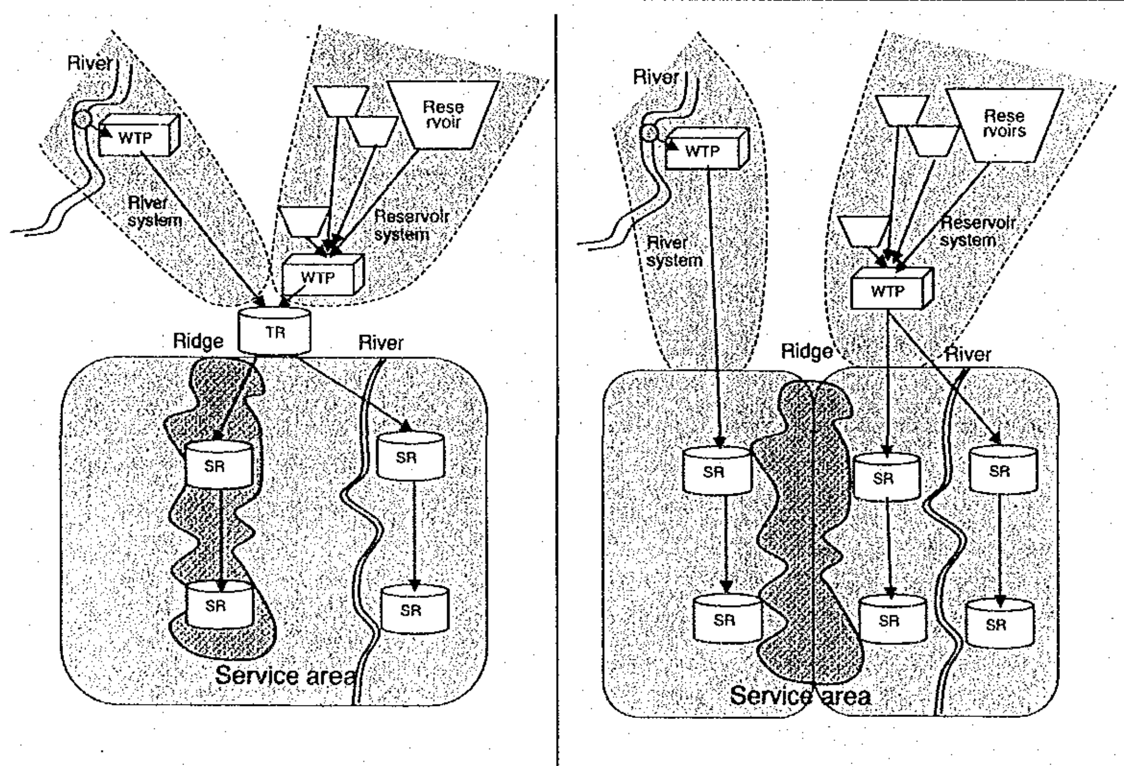
As stated in the planning conditions, reservoir and river water is separately treated in bulk at the riverside or Hlawga reservoir area. These two source systems are called reservoir system and river system respectively. After treatment, both the waters are conveyed to the city area for distribution. Based on these two systems, following two alternatives for the transmission system are formulated.

Alternative A: **Combined System (CS)**

The river system and the reservoir system are combined at a terminal reservoir and both source waters are mixed. The mixed water is then transmitted to service reservoirs by gravity or pumping and distributed from each service reservoir to customers. A conceptual layout of this alternative is shown in Figure I.2 (A). In this transmission system, two major pipelines will be laid along the central ridge of the city and in the eastern city.

Alternative B: **Separate System (SS)**

The river and reservoir systems are separated and each system's water is separately transmitted to service reservoirs of the zones covered by each system by gravity or pumping. Then water is distributed from each service reservoir. A conceptual layout of this alternative is shown in Figure I.2 (B). In this transmission system, the river system covers the western city and the reservoir system covers the eastern city and three major pipelines will be laid in the low land in the western and the eastern city.



(A) Combined System **(B) Separated System**

Figure I.2 Conceptual Layout of Transmission System Alternatives

(2) Comparison of Alternatives

Both alternatives are compared in Table I.3 and many advantages of Combined System is recognized in terms of flexible source management, higher reliability of water supply, less complicated operation and maintenance, and more flexibility in the transitional stage to the new system. Therefore, **Combined System** is proposed for the future water supply system of the Yangon city.

Table I. 3 Comparison of Transmission System Alternatives

Item	Combined System (CS)	Separate System (SS)
Water source management	Flexible operation of source systems. Amount and time of use of water sources can be managed depending on water demand or conditions of water sources. A management plan is necessary.	Rigid operation of source systems. Each source system has fixed distribution zones, which makes the operation rigid.
Water supply reliability	If one of the two source systems has an accident, the other source can supply water evenly to all the city area.	If one of the source systems has an accident, water supply will be suspended in the supply area covered by the accident system.
Operation and maintenance	The number of transmission and distribution pumping stations can be decreased. Most of the water supply zones are covered by gravity flow distribution from service reservoirs. Operation and maintenance can be easy.	More transmission mains and distribution pumping stations than Combined System are required. Most of the water supply zones are covered by pumping and it makes operation and maintenance complicated.
Operation and maintenance costs	If both source systems are managed properly, treatment and transmission costs can be reduced.	The operation and maintenance for separated two systems cost more.
Construction cost		More transmission lines than the combined system are required, which increase the construction costs.
Transitional stage	Without the river system, the reservoir system can transmit water to all the service area.	Without the river system, it is difficult to transmit water to the western parts of the city. So the both systems must be simultaneously constructed to cover all the service areas. A large initial investment is required.

3.2 CONCEPT OF PROPOSED DISTRIBUTION AND TRANSMISSION SYSTEM

(1) Separation of Distribution System from Transmission System

A conceptual layout of the existing network system is shown in Figure I. 3. In the existing water supply system, many off-takes from the transmission mains, typically 6" or 8", particularly along the 56" Gyobyu pipe, are recognized. These off-takes make functions of the transmission and distribution system unclear and the operation and maintenance more complicated. In such system, it is very difficult to monitor and control flow and pressure of water supply system.

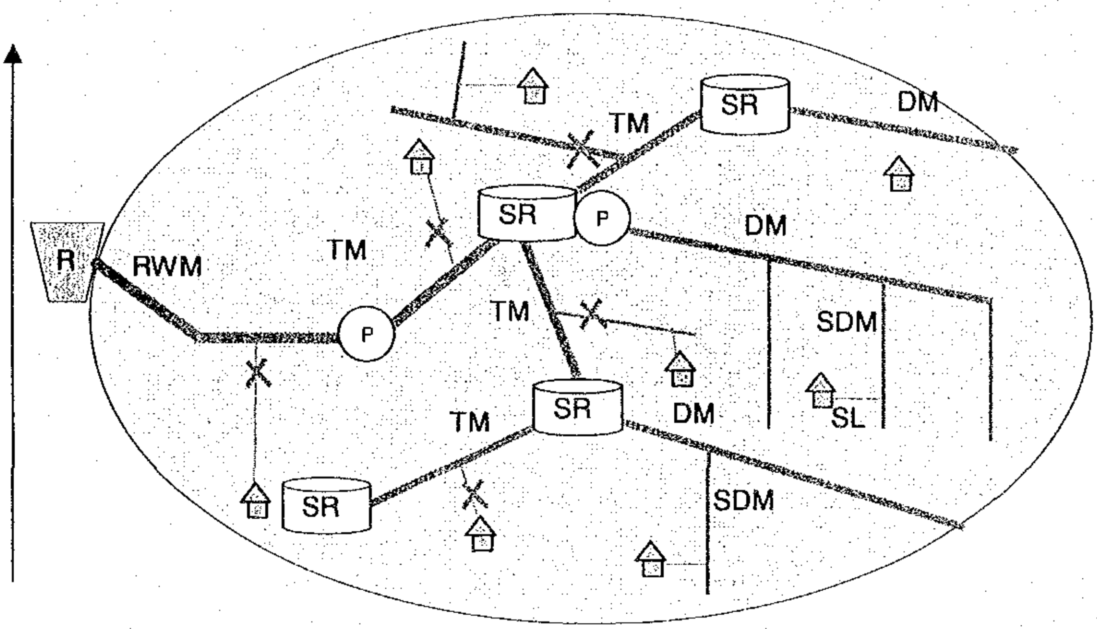


Figure I.3 Conceptual Layout of Existing Water Supply System (Transmission and distribution system are connected.)

The followings are advantages of the system in which distribution system is separated from transmission system.

- Easy monitoring of flow and pressure in transmission system and distribution system.
- Easy and fair allocation of water to each water zone.
- Smaller size of water supply facility and its construction cost.

With the separated system, transmission and distribution systems must be designed with daily maximum and hourly peak water demand, respectively. While without the separated system, all systems should be designed with the hourly peak water demand, which results in larger capacity of water supply facilities.

Because of these advantages, it is proposed that the distribution system is separated from the transmission system. To achieve separation, all off-takes should be disconnected from the transmission mains in future.

(2) Introduction of Zoning System

Once distribution system is separated from transmission system, it is easy and efficient to introduce distribution-zoning system (zoning system). Introduction of a zoning system makes the entire water supply system more efficient and manageable. There are several advantages of zoning system as follows.

- Easy monitoring and control of flow rates and pressure in the zones
- Easy monitoring and control of leakages, and
- Easy operation and maintenance by zone

Generally, as the water supply area becomes larger, the operation and maintenance of the system become more complicated. But even in the large water supply system, introduction of zoning system makes the operation and maintenance efficient and less complicated. In a large water supply system like Yangon city, zoning system should be introduced to manage the system efficiently. Therefore, **Zoning System** is proposed for the future Yangon water supply system. The conceptual layout of separation of distribution from transmission system and zoning system is shown in Figure I. 4.

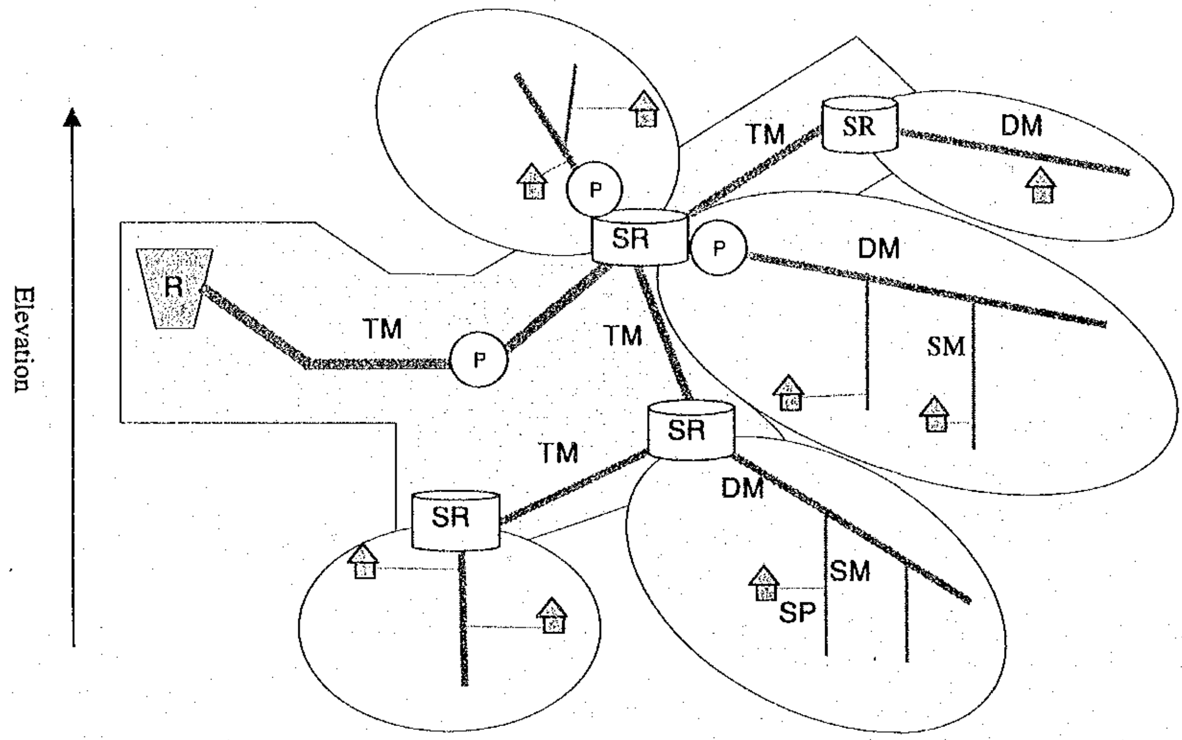


Figure I.4 Conceptual Layout of Proposed Water Supply System (Zoning system and separation of distribution form transmission system)

3.3 ZONING SYSTEM PLAN

(1) Preconditions

A zoning system is introduced to the existing system based on the following conditions.

1) Natural system

When the zoning system is selected, topography and natural system (river lake, etc.) are the most important factor. The city area is divided by three major rivers, Ngamoiyeik Creek, Hlaing River and Yangon River. According to this system, the city area or the water supply area can be divided into three major blocks as shown in Figure I.5. These three blocks are called **Central, East and West Block**, respectively. Other natural systems such as Hlawga reservoir are also considered.

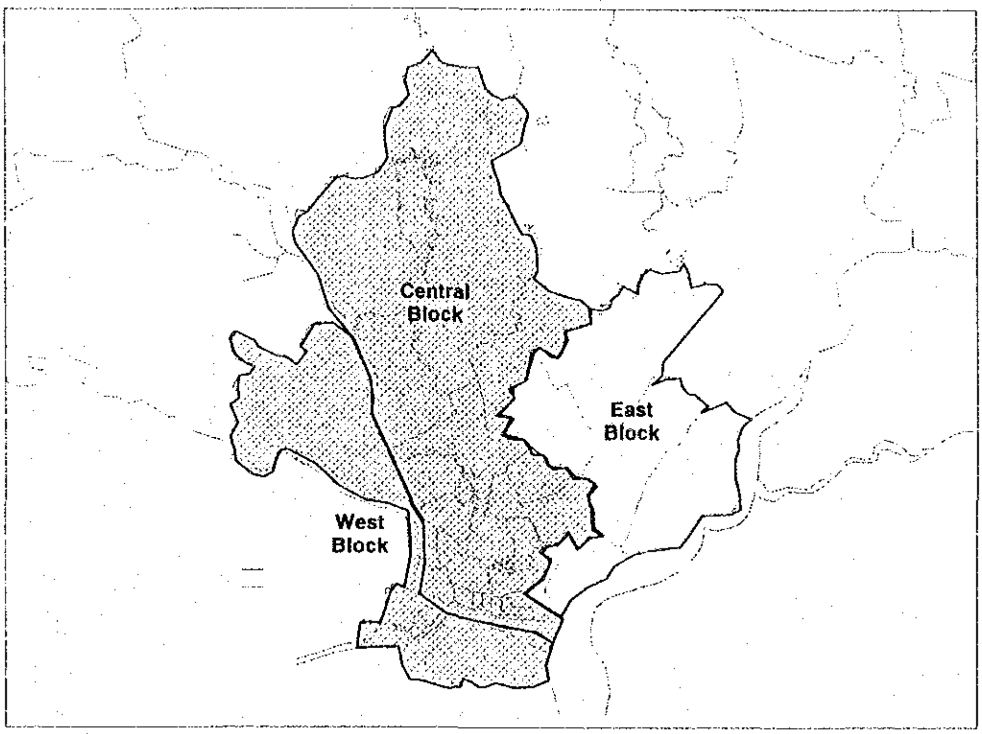


Figure I.5 Water Supply Block System

2) Administrative boundaries

Administratively, it is advantageous that zoning boundaries be the same as township boundaries. So zoning boundaries will be the same as township boundaries as far as possible.

3) Artificial structures

Route and size of roads, streets and railway and location of vacant lands are considered for the routes of pipelines and other water supply facilities such as service reservoir.

4) Land availability

Appropriate land should be available for proposed water supply facilities.

(2) Zoning Concepts

1) Service reservoir

One service reservoir should cover one distribution zone excluding the area covered by existing service reservoirs. The location of service reservoir should be as near to zone center as possible, for both cost and head loss reasons.

2) Terminal reservoir

Terminal reservoir, where the treated water from both the river and reservoir systems is mixed, will be located near the Hlawga No.1 Pumping Station. The elevation of the proposed site should be less than 45 feet to draw the Hlawga reservoir water and Pyugyi reservoir water through Hlawga reservoir by gravity.

3) East block

The elevation of this block ranges from 10 feet (3 m) to 30 feet (9 m). There is no high land from where water can be supplied by gravity flow. In this block, water must be supplied by pumping. Considering township boundaries and the area and extent of the block, it is appropriate that three zones should be established. To convey water to each zone from Terminal Reservoir, a transmission main will be laid along the center of the Block. An analysis may be required whether water should be conveyed from this main or Central Block to the southernmost area, Thaketa and Dawbon.

4) Central block

The elevation of water supply area in this block ranges from 10 feet (3 m) to 120 feet (37 m). To supply water to most of the area in this block by gravity, service reservoirs should be located on the central ridge of the city and a transmission main also should be located along this ridge. To distribute water to the edge of each zone from the ridge, the elevation of service reservoirs should be at least 120 feet (37 m). Only two areas in this Block have this high elevation. One is east of Hlawga reservoir and the other is north of the airport. These two areas are considered for proposed sites of reservoirs.

When zoning is designed in this block, the existing service reservoirs, Kokine, Central and Shwedagon cover a zone of the downtown area and existing transmission mains are used to fill these reservoirs. The total capacity of these three reservoirs is 31 million gallons (MG) (141,500 m^3). The design capacity of service reservoir is 8 hours of maximum water demand so that water demand of 450,000 m^3/day can be covered by the existing reservoirs. A zone will be made for covering this demand in the downtown area. For the rest of the area, it is appropriate that four (4) zones be formulated considering topography and township boundaries of the block.

As stated in planning of East Block, an analysis is required whether water should be conveyed from Central Block or from Eastern Block to the southernmost area in the East Block.

5) West block

The elevation of this block ranges from 10 feet (3 m) to 30 feet (9 m). Most of the West Block is supplied with the groundwater withdrawn in he local areas. Only in Hlaingthaya, groundwater supply will be supplemented by the surface water from the Central Block and a transmission main from the Central Block is required for this township.

(3) Zoning System and Zonal Water Demand

Based on the conditions and concepts stated above, zoning boundaries are delineated as shown in Figure I.6 and zonal water demands in 2010 and 2020 are estimated in Table I.4

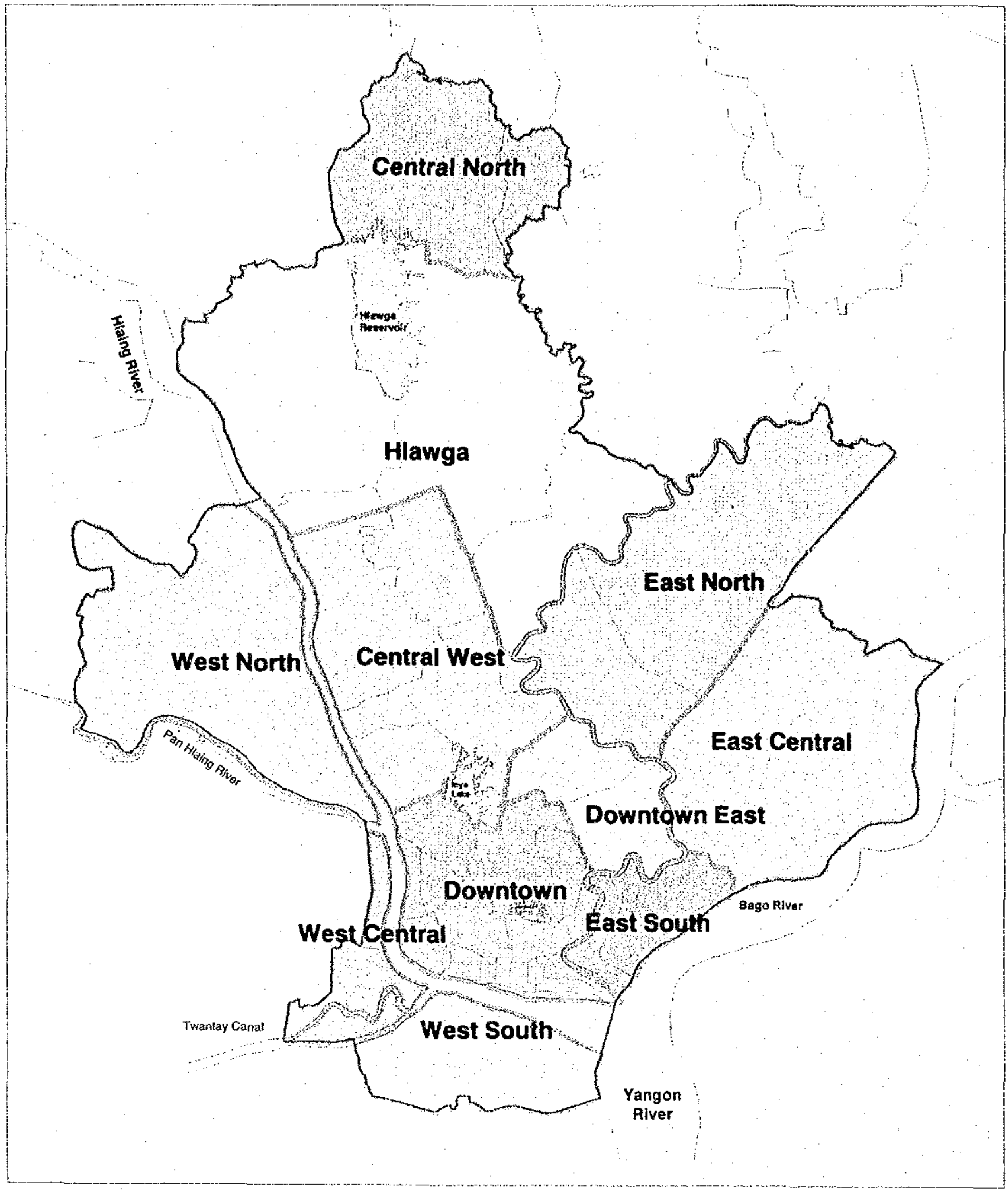


Figure I.6 Distribution Zoning System

Table I.4 Zoning System and Water Demand

Distribution			Water Demand (m^3/day)			
Block	Zone	No.	Average in 2010	Maximum in 2010	Average in 2020	Maximum in 2020
Central	Downtown	1	344,000	413,000	376,000	451,000
	Downtown East	2	167,000	200,000	271,000	326,000
	Central West	3	190,000	228,000	243,000	291,000
	Hlawga	4	195,000	234,000	262,000	325,000
	Central North	5	25,000	30,000	29,000	34,000
East	East South	6	84,000	101,000	121,000	145,000
	East Central	7	95,000	114,000	111,000	133,000
	East North	8	36,000	43,000	52,000	62,000
West	West South	9	11,000	13,000	20,000	25,000
	West Central	10	12,000	14,000	20,000	24,000
	West North	11	63,000	76,000	81,000	97,000
			1,222,000	1,466,000	1,586,000	1,913,000

(4) Water Balance

Considering the groundwater potential, the balances between water sources and water demand in 2001, 2006, 2010, and 2020 are shown in Table I.5(1), 5(2), 5(3), 5(4), respectively. It is not until the Hlaing river development when the water balance is negative, i.e. the available water source amount is less than the water demand.

The balance between water source and zonal water demand in 2001, 2006, 2010 and 2020 is estimated as shown in Figure I.7(1), 7(2), 7(3) and 8(4) respectively.

Table I.5(1) Estimated Water Balance in 2001

Unit: m^3/day

Distribution			Water demand		Water source (est.)	
Block	Zone	No.	Average	Maximum	Ground	Surface
Central	Downtown	1	247,100	296,500	29,400	350,700
	Downtown East	2	80,000	96,000	5,600	
	Central West	3	76,900	92,300	500	
	Hlawga	4	80,800	97,000	1,600	
	Central North	5	14,500	17,300	0	
East	East South	6	10,200	12,200	3,600	
	East Central	7	0	0	900	0
	East North	8	0	0	0	0
West	West South	9	1,800	2,200	2,000	0
	West Central	10	1,300	1,600	0	0
	West North	11	0	0	200	0
			512,600	615,100	43,800	350,700
Available Water Quantity by Source						
Surface water source						
Gyobyu Reservoir						121,300
Pyujyi Reservoir Hlawga Reservoir						229,400
Ngamoeyeik Reservoir						0
Sub-total						350,700
Hlaing river						0
Total						350,700
Groundwater					43,800	
Total						394,500
Daily max (est.)					434,000	

Note: The billed water ratio of April to Sept = 1.1 So the peak factor is assumed 1.1.
. Estimated total flow rate of all reservoir sources in August 2001 = 351

Table I.5(2) Estimated Water Balance in 2006

Unit: m^3/day

Distribution			Water demand		Water source (est.)	
Block	Zone	No.	Average	Maximum	Ground	Surface
Central	Downtown	1	295,600	354,800	48,100	847,000
	Downtown East	2	123,500	148,000	8,000	
	Central West	3	133,500	160,200	900	
	Hlawga	4	137,900	165,500	1,900	
	Central North	5	19,800	23,700	0	
East	East South	6	47,100	56,600	3,100	
	East Central	7	47,500	57,000	800	0
	East North	8	18,000	21,500	0	0
West	West South	9	6,400	7,600	1,700	0
	West Central	10	6,700	7,800	0	0
	West North	11	31,500	38,000	200	0
			867,500	1,040,700	64,700	847,000
Available Water Quantity by Source						
Surface water source						
Gyobyu Reservoir						118,000
Pyujyi Reservoir						245,000
Hlawga Reservoir						75,000
Ngamoeyeik Reservoir						409,000
Sub-total						847,000
Hlaing river						0
Total						847,000
Groundwater					64,700	
Total					911,700	

Note: Peak Factor = 1.2

Table I.5(3) Estimated Water Balance in 2010

Unit: m^3/day

Distribution			Water demand		Water source (est.)	
Block	Zone	No.	Average	Maximum	Ground	Surface
Central	Downtown	1	344,000	413,000	41,400	371,600
	Downtown East	2	167,000	200,000	7,200	192,800
	Central West	3	190,000	228,000	800	227,200
	Hlawga	4	195,000	234,000	1,700	232,300
	Central North	5	25,000	30,000	0	30,000
East	East South	6	84,000	101,000	2,700	98,300
	East Central	7	95,000	114,000	700	113,300
	East North	8	36,000	43,000	0	43,000
West	West South	9	11,000	13,000	1,500	0
	West Central	10	12,000	14,000	0	0
	West North	11	63,000	76,000	75,700	0
			1,222,000	1,466,000	131,700	1,308,500
Available Water Quantity by Source						
Surface water source						
Gyobyu Reservoir						118,000
Pyujyi Reservoir						245,000
Hlawga Reservoir						75,000
Ngamoeyeik Reservoir						409,000
Sub-total						847,000
Hlaing river						470,000
Total						1317,000
Groundwater					131,700	
Total					1,448,700	

Table I.5(4) Estimated Water Balance in 2020

Unit: m^3/day

Distribution			Water demand		Water source (est.)	
Block	Zone	No.	Average	Maximum	Ground	Surface
Central	Downtown	1	376,000	451,000	27,900	423,100
	Downtown East	2	271,000	326,000	4,500	321,500
	Central West	3	243,000	291,000	400	290,600
	Hlawga	4	262,000	325,000	500	324,500
	Central North	5	29,000	34,000	0	34,000
East	East South	6	121,000	145,000	400	144,600
	East Central	7	111,000	133,000	0	133,000
	East North	8	52,000	62,000	0	62,000
West	West South	9	20,000	25,000	24,500	500
	West Central	10	20,000	24,000	17,300	6,700
	West North	11	81,000	97,000	82,500	14,500
			1,586,000	1,913,000	158,000	1,755,000
Available Water Quantity by Source						
Surface water source						
Gyobyu Reservoir						118,000
Pyujyi Reservoir Hlawga Reservoir						245,000 75,000
Ngamoeyeik Reservoir						409,000
Sub-total						847,000
Hlaing river						940,000
Total						1787,000
Groundwater					158,000	
Total					1,945,000	

Figure I.7(1) Estimated Water Balance in 2001 in Daily Average Demand

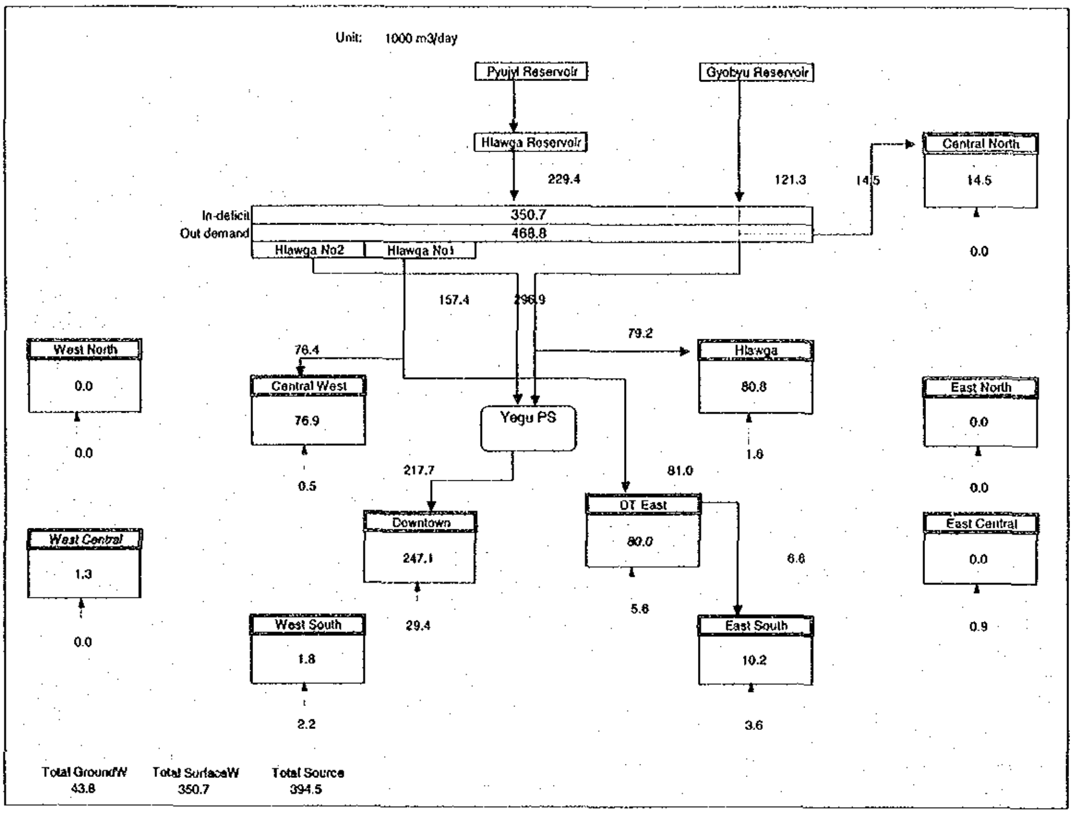


Figure I.7(2) Estimated Water Balance in 2006 in Daily Maximum Demand

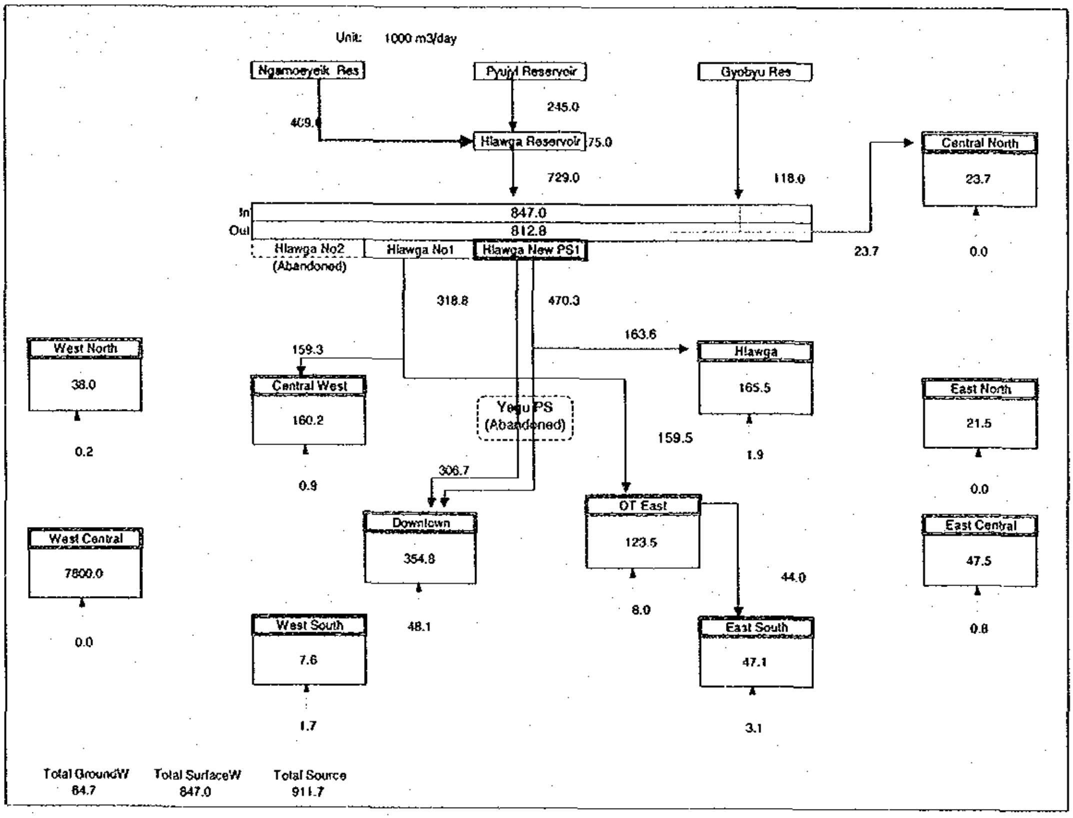


Figure I.7(3) Estimated Water Balance in 2010 in Daily Maximum Demand

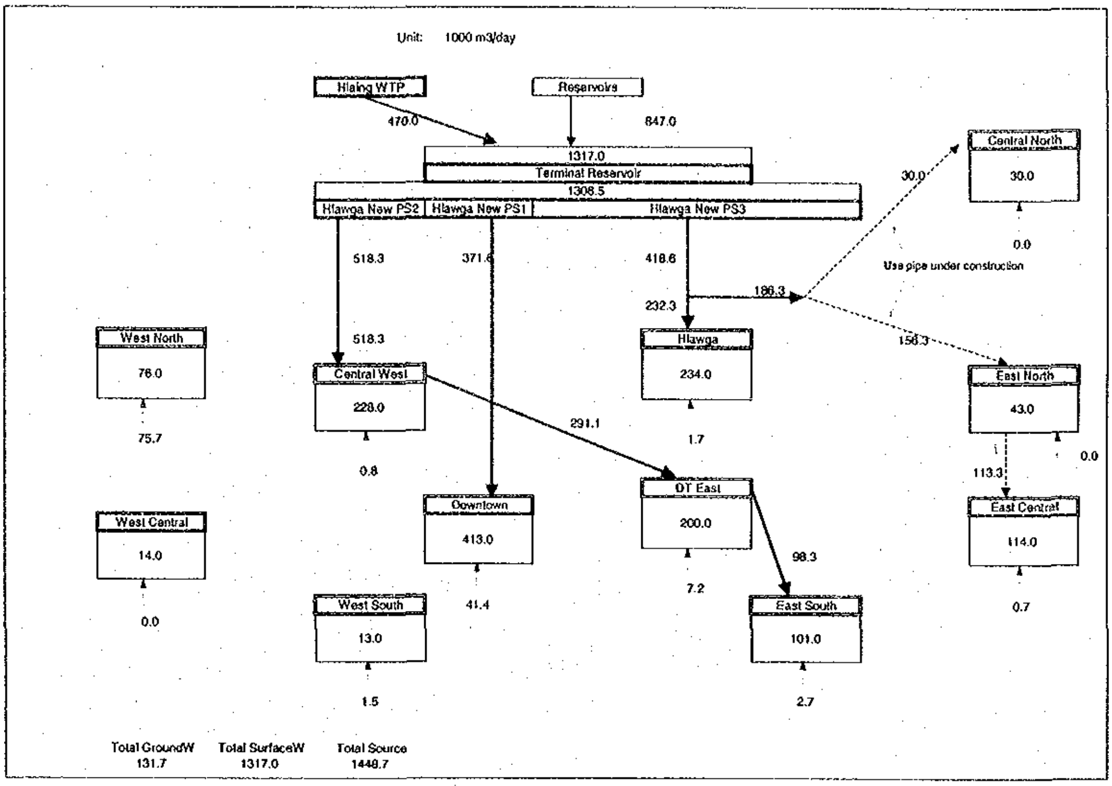
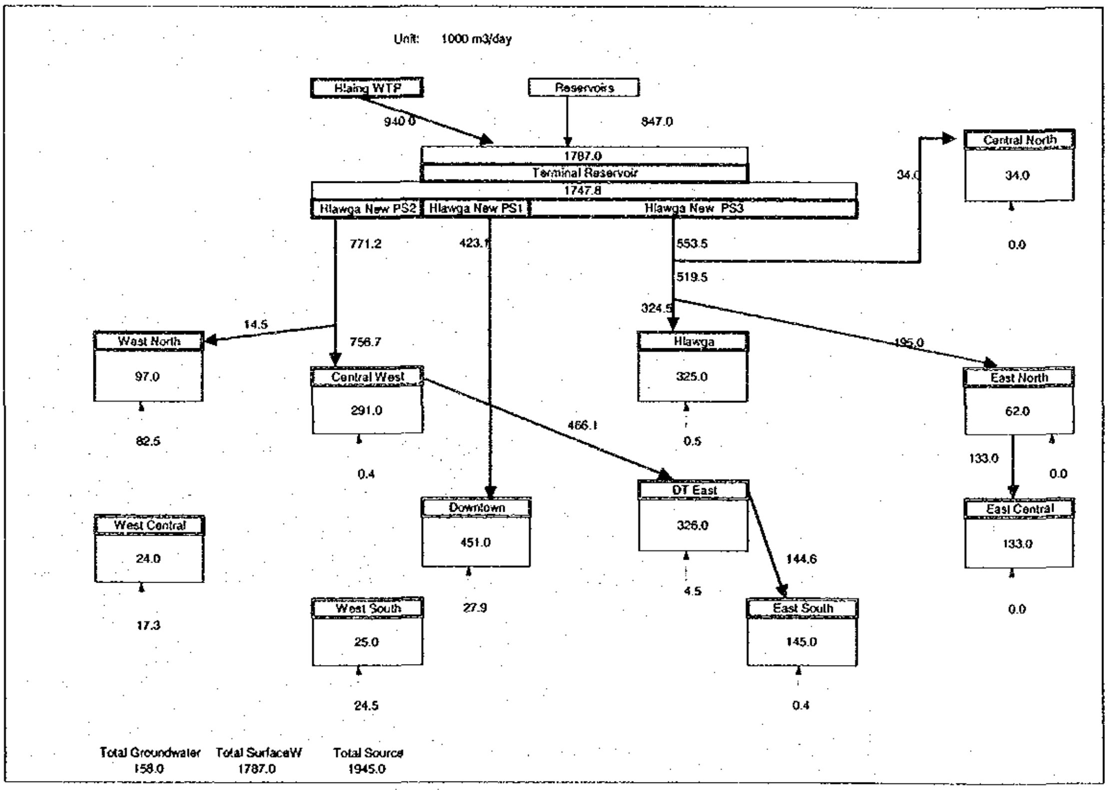


Figure I.7(4) Estimated Water Balance in 2020 in Daily Maximum Demand



4 TRANSMISSION FACILITY PLAN

4.1 OUTLINE OF MAJOR FACILITIES

Based on the topography, land availability for facility and road aliments, the approximate location of service reservoirs and route of transmission mains are proposed as shown in Figure I.8. The more detailed planning of facilities is explained as follows.

4.2 TRANSMISSION MAINS FROM SOURCES TO TERMINAL RESERVOIR

(1) Reservoir System

1) Outline

The raw water of two reservoir systems, Pyugyi and Ngamoeyeik, is conveyed and discharged to Hlawga reservoir and mixed with Hlawga reservoir water. Then, the water of three reservoirs is drawn to Terminal Reservoir. The Hlawga reservoir will play a role of a balancing reservoir between the seasonal source availability and water demand. Gyobyu reservoir water is directly conveyed to Terminal Reservoir by a pipeline.

2) Gyogbyu system

Existing transmission mains and pumps are utilized for conveying the raw water of Gyobyu reservoir to Terminal Reservoir. One additional pump in the existing intake pump station and one connection pipe from the existing pipe to Terminal Reservoir are required.

3) Pyugyi system

Existing transmission mains and pumps are utilized for conveying the raw water of Pyugyi reservoir to Hlawga reservoir and the water of Hlawga reservoir is brought to Terminal Reservoir by gravity. One additional pump in the existing intake pump station is required.

4) Proposed Ngarnoeyeik system

The construction of transmission mains to use Ngamoeyeik reservoir is currently suspended. The constructed part is about one third of the plan, 9 miles of 56-inch pipeline. Based on the use of this pipeline, new transmission mains and a pump station in intake site are added and the water is discharged to the Hlawga reservoir, where the water is drawn to Terminal Reservoir by gravity. The detailed comparisons with alternatives are shown in Annex 1 Design Calculation Sheet.

5) Hlawga system

The raw water of Hlawga reservoir together with Pyugyi and Ngamoeyeik water is drawn at the proposed Hlawaga intake facility to Terminal Reservoir by gravity.

(2) River System

The Hlaing river water is taken by gravity to intake pump station and pump up to proposed Hlaing water treatment plant. The water treatment plant is planned at about 7 km from the intake site. After treatment, the treated water is conveyed to Terminal Reservoir in the south of Hlawga reservoir. The two lines of transmission mains and a pump station are required to convey the treated water from the water treatment plant to Terminal Reservoir. The comparisons with alternatives are shown in Annex 1 Design Calculation Sheet.

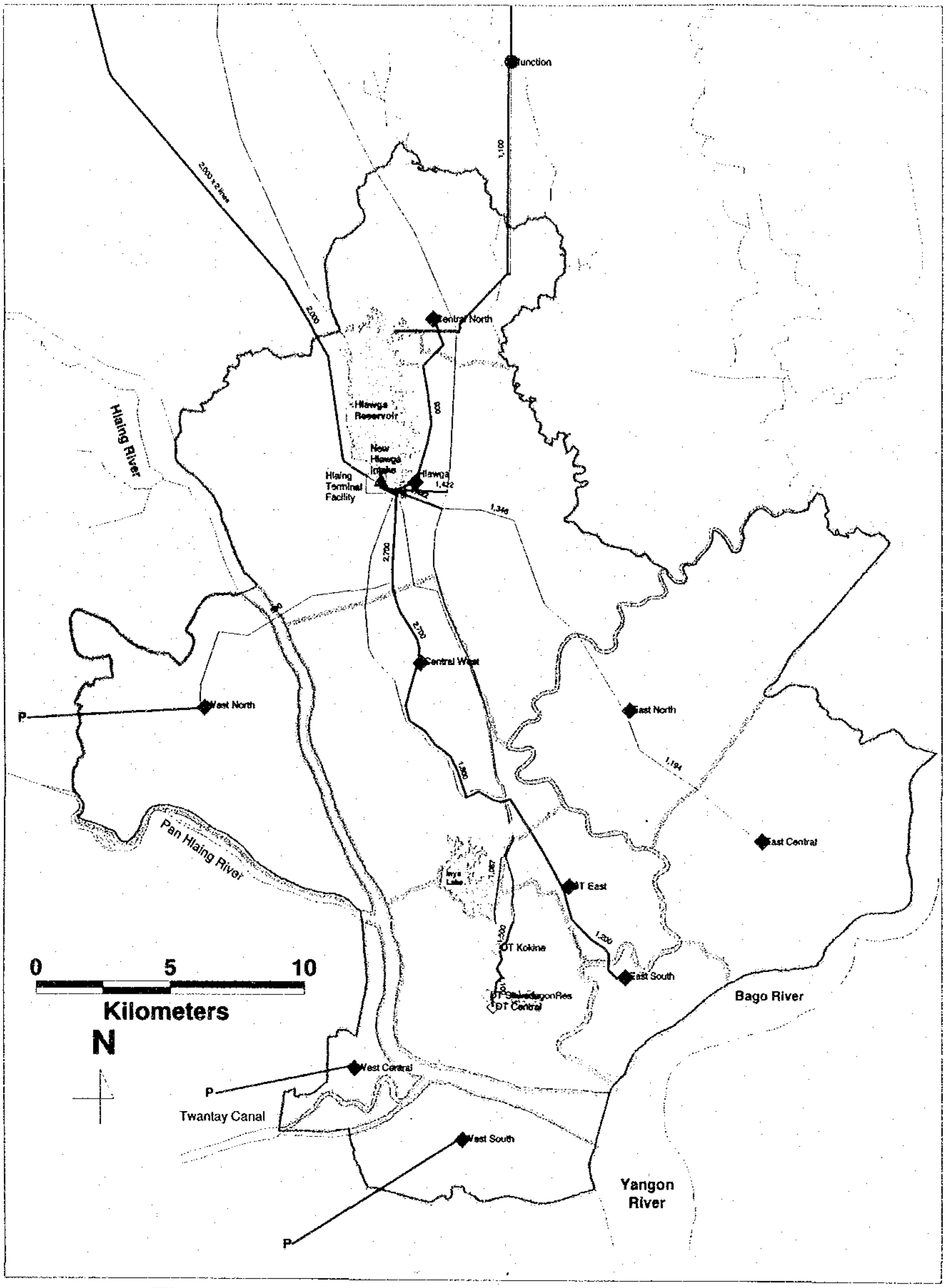


Figure I.8 Proposed Transmission System

(3) Proposed Facility Form Source to Terminal Reservoir

The proposed transmission facilities are summarized in Table I.6.

Table I.6 Proposed Transmission Mains from the Sources to Terminal Reservoir

Route	Lines	Pipe diameter (mm)	Approx distance (m)	Approx pump head (m)	Design flow rate (m^3/day)
A. Reservoir system					
1. Ngamoeyeik reservoir to the existing line	1	1800	30,000		411,000
2. Ngamoeyeik pump station				60	411,000
3. Duplication of existing line	1	1100	13,000		187,000
4. Connection line from Gyobyu pipeline to Terminal Reservoir	1				
B. River system					
1. Intake to water treatment plant	2	2500	7,000	15	1,000,000
2. WTP to Terminal Res.	2	2000	33,000	60	1,000,000

4.3 TRANSMISSION SYSTEM

Figure I.8 showed the proposed transmission system and zoning and Figure I.9(1) and 9(2) show a schematic layout of the planned transmission system in 2020 and 2010 respectively.

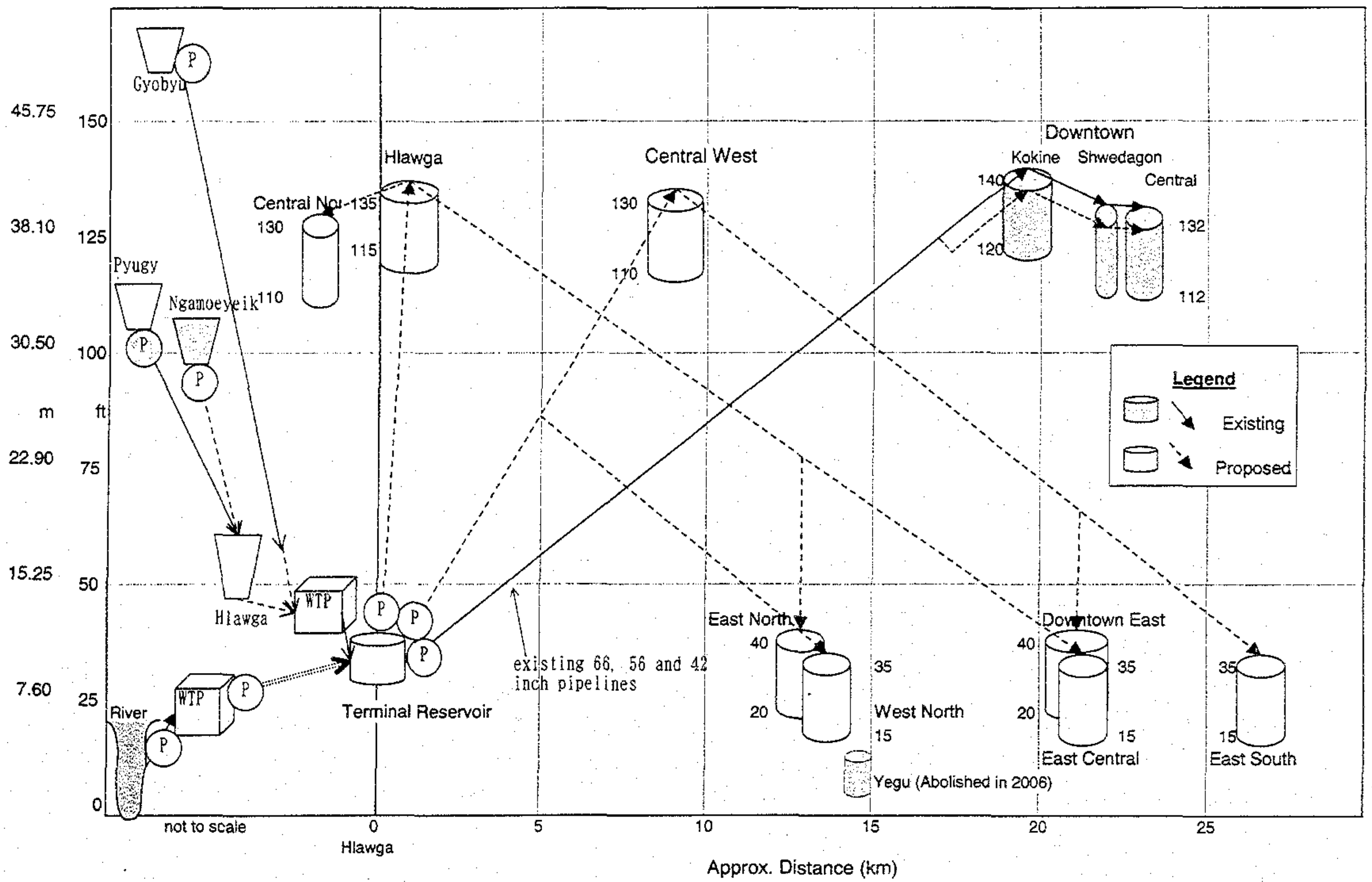


Figure I.9(1) Schematic Layout of Proposed Transmission System in 2020

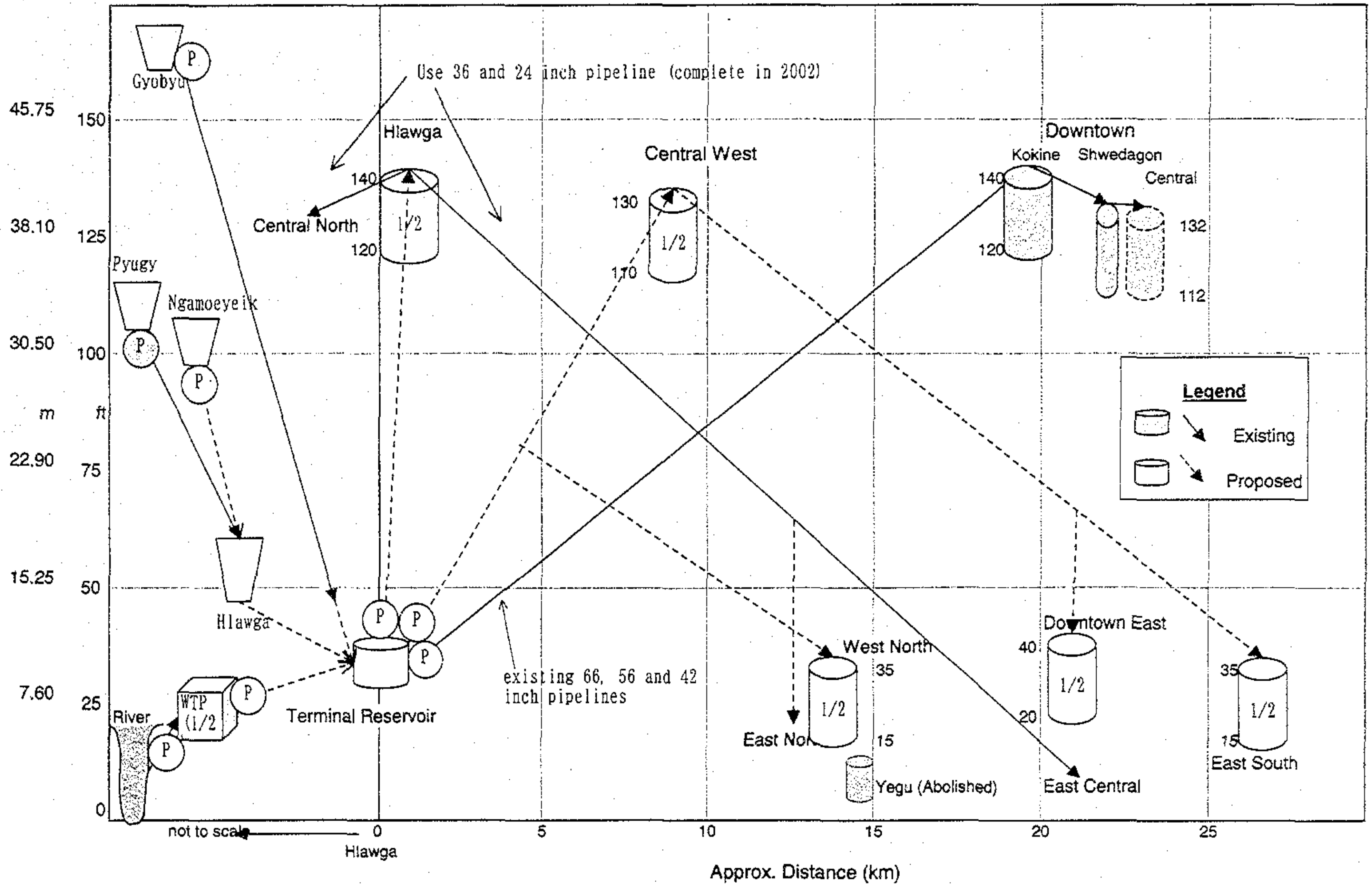


Figure I.9(2) Schematic Layout of Proposed Transmission System in 2010

(1) Terminal Reservoir

Terminal Reservoir is planned to be located southern Hlawga reservoir and designed to store the total mixed water amount of 1,817,000 m^3/day for one hour. The purpose of one-hour storage reservoir is to mix and store water for pumping from Terminal Reservoir to service reservoirs. Terminal Reservoir is designed with 4 m depth. Proposed design of Terminal Reservoir is as below:

- Required volume for one-hour storage: 76,000 m^3
- Proposed capacity: 80,000 m^3
- Required land area: 20,000 m^2

(2) Service Reservoirs

Figure I.8 shows the location of proposed service reservoirs. The capacity of each reservoir is designed in Table I.7 together with distribution method in each zone. Required land area is calculated based on 6 m depth, which is the same depth as the existing reservoirs.

Table I.7 Capacity of Proposed Service Reservoirs

Distri. block	Distribution zone		Maximum water demand in 2020	Required volume	Proposed capacity	Capacity to the max demand	Required land	Distribution method in zone
	Name	No.	m^3/day	m^3	m^3	hours	m^2	
Central	Downtown	1	451,000	150,000	141,500	7.5	24,000	Gravity
	Downtown East	2	326,000	109,000	100,000	7.4	17,000	Pump
	Central West	3	291,000	97,000	100,000	8.2	17,000	Gravity
	Hlawga	4	325,000	108,000	100,000	7.4	17,000	Gravity
	Central North	5	34,000	11,000	10,000	7.1	2,000	Gravity
East	East South	6	145,000	48,000	50,000	8.3	8,000	Pump
	East Central	7	133,000	44,000	50,000	9.0	8,000	Pump
	East North	8	62,000	21,000	20,000	7.7	3,000	Pump
West	West South	9	25,000	8,000	10,000	9.6	2,000	Pump
	West Central	10	24,000	8,000	10,000	10.0	2,000	Pump
	West North	11	97,000	32,000	30,000	7.4	5,000	Pump
	from Central Block	11	(50,000)					
			1,913,000	636,000	621,500	7.8	105,000	

From following service reservoirs water is transmitted to the next service reservoir by gravity. At these service reservoirs, only the water amount necessary for the respective zone is discharged and exposed to atmosphere. The rest of the water amount that us used for the next zone is still kept pressurized in the pipe and transmitted to the next service reservoir by the remaining pressure. By this transmission method, energy loss can be reduced and pumping pressure can be utilized more efficiently.

1) Hlawga
2) Central West
3) Downtown East
4) Kokine

(3) Transmission Mains

Following existing transmission mains will be used as transmission mains in the proposed transmission system and the rest of large diameter mains will be used as distribution mains.

Table I.8 Existing Transmission Mains Used in the Proposed System

No.	Route		Lines	Pipe diameter (mm (inch))	Distance (km)
	From	To			
1	Terminal Res.	Yegu SR	1	1670(66)	16
2	Terminal Res.	Kokine SR	1	1420(56)	19
3	Terminal Res.	Kokine SR	1	1060(42)	19

It was checked whether these transmission mains could convey the necessary amount of water demand in 2020. The result shows insufficient capacity and additional mains are required. In Table I.8, duplicate mains to strengthen the existing transmission mains are planned.

Proposed new transmission mains together with necessary pump head are planned as shown in Table I.9. Detailed calculation and alternative comparisons are shown in Annex 1 Design Calculation Sheet.

The pipeline route in 2020 and 2010 is also shown in Drawings, a supplement material.

Table I.9 Proposed Transmission Mains

Route		Lines	Pipe diameter (mm)	Distance (m)	Pump head (m)	Design flow rate (m^3/day)
From	To					
A. New transmission mains						
Terminal R	Hlawga SR	1	1800	500	38	554,000
Hlawga SR	Central North SR	1	900	6300	-	34,000
Hlawga SR.	East North SR	1	1350	13000	-	195,000
East North SR	East Central SR	1	1200	7300	-	133,000
Terminal R	Branch	1	2200	7500	50	812,000
Branch	Central West SR					762,000
Branch	West North SR	1	700	9800	-	50,000
Central West SR	DT East SR	1	1800	12500	-	471,000
DT East SR	East South SR	1	1200	5000	-	145,000
B. Duplication of existing mains						
Yankin Center Junction	Kokine SR	1	1500	1200	-	251,000
Kokine SR	Central SR	1	1100	2400	-	90,000
C. Connection Line						
Terminal R	Gyobyu line	1				

(4) Pumping Station

From Terminal Reservoir, the treated water is transmitted to each service reservoir by pumping. The design of pumps is shown in this section but in actual planning, the pumps and transmission mains were designed simultaneously to make rational design as a system. Design details are show in Annex 1 Design Calculation Sheet.

There are three exist pumping stations; Hlawga No.1, Hlawga No.2 and Yegu pumping stations. The existing transmission mains together with proposed duplicate mains are used for transmitting the water to the existing reservoirs. In the propsed water supply system, the water is transmitted directly to Kokine reservoir and then Shwedagion and Central without any off-take. In such system, pumping at the only origin, or at Terminal Reservoir, is more efficient solution than using booster pumps at Yegu. Therefore, the Yegu pumping station will be abolished in the new system and the water is pumped up at Terminal Reservoir only.

Existing pumps in Hlawga No.1 pumping station has 62 m head, which is almost the same as proposed necessary head (64m), and can be utilized in the future but when the time to replace will come they shall be replaced with proposed pump capacity. While pumps in Hlawga No.2 pumping station have far less head than the necessary head to transmit water to Kokine reservoir and thus shall be abolished. Table I.10 shows total discharge rate and pump head of proposed pumps.

Table I.10 Proposed Pump Capacity

Pump station	Total discharge rate		Head
	m^3/day	m^3/hour	m
Existing Hlawga No.1	143,000	6,000	62
Proposed additional Hlawga No.1	308,000	12,833	64
Total	451,000	18,833	
Pumps to Hlawga SR	554,000	23,083	38
Pumps to Central West SR	812,000	33,833	50

5 DISTRIBUTION FACILITY

5.1 DISTRIBUTION MAINS

(1) Design Procedure

Following procedure is taken to design the distribution network to meet water demand in 2020.

1. Input the existing networks in Info Works WS.
    a. Pipe data: C-factor, pipe diameter, distance, and location
    b. Pump data: discharge rate, pump head, location, etc.
    c. Service reservoir: location, water levels and capacity
    d. Valve: location and close or open

2. Calibrate the existing network by assigning the water demand in 2000 to the demand points

3. Adjust the network and establish a network model to simulate and design the future system

4. Assign the hourly peak water demand in 2020 to the demand points and make design of the future networks to carry the water demand in 2020 by adding new lines

Data of the calibrated model including proposed distribution mains are attached in Annex 3.

Using the software and the network model, distribution mains more than 200 or 300-inch diameter can be designed due to the accuracy of the demand allocations. Therefore, more than 200 or 300 inch diameter pipes are planned here. The remaining smaller diameter pipes are planned in the section.

(2) Distribution Method

The following Table shows proposed distribution method by zone and pump head if pumping is necessary.

Table I.11 Distribution Method and Pump Head

Block	Distribution zone		Distribution method in zone	Pump head	
	Name	No.		ft	m
Central	Downtown	1	Gravity	-	-
	Downtown East	2	Pump	90	27
	Central West	3	Gravity	-	-
	Hlawga	4	Gravity	-	-
	Central North	5	Gravity	-	-
East	East South	6	Pump	80	24
	East Central	7	Pump	80	24
	East North	8	Pump	90	27
West	West South	9	Pump	80	24
	West Central	10	Pump	-	-
	West North	11	Pump	90	27

(3) Proposed Distribution Mains

Table I.12 shows summary of planned distribution mains and Figure I.10 shows the route of proposed mains. Details of planned distribution mains are shown in Annex 2. The pipeline route in 2020 is also shown in Drawings, a supplement material.

(4) Other Major Equipments

The following equipments will be proposed to construct and monitor the proposed transmission and distribution system.

1) Zoning valves,
2) Zone flow meters and pressure gages, and
3) Flow control valve at service reservoirs.

Table I.12 Proposed Distribution Mains by Zone

No.	Block Name	Total length (m)	Diameter (mm/inch) 200	300	400	500	600	700	800	900	1,000	1,100	1,200	1,300	1,400
			8	12	16	20	24	28	32	36	40	44	48	52	56
1	Downtown	22,553	0	0	0	4,999	3,375	3,346	4,940	73	1,880	0	0	3,295	645
2	Downtown East	34,284	498	0	4,500	6,776	8,666	1,412	7,635	828	942	0	1,163	366	0
3	Central West	52,511	0	0	12,792	5,333	2,365	7,081	7,503	0	7,844	0	4,028	2,207	0
4	Hlawga	56,115	8,369	0	2,027	18,855	2,488	0	2,525	3,325	6,677	3,616	3,084	2,274	2,516
5	Central North	4,356	0	0	2,059	779	0	1,210	0	308	0	0	0	0	0
6	East South	11,512	0	0	1,767	1,734	2,663	810	0	3,220	0	1,028	0	290	0
7	East Central	50,247	10,921	25,656	5,167	1,875	1,222	822	1,890	0	2,694	0	0	0	0
8	East North	27,984	0	8,802	6,818	1,883	7,905	0	0	2,576	0	0	0	0	0
9	West South	1,756	0	501	876	379	0	0	0	0	0	0	0	0	0
10	West Central	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	West North	26,373	0	0	4,965	9,680	0	6,854	1,739	2,871	0	264	0	0	0
	Total	287,691	19,788	34,959	40,971	52,293	28,684	21,535	26,232	13,201	20,037	4,908	8,275	8,432	3,161

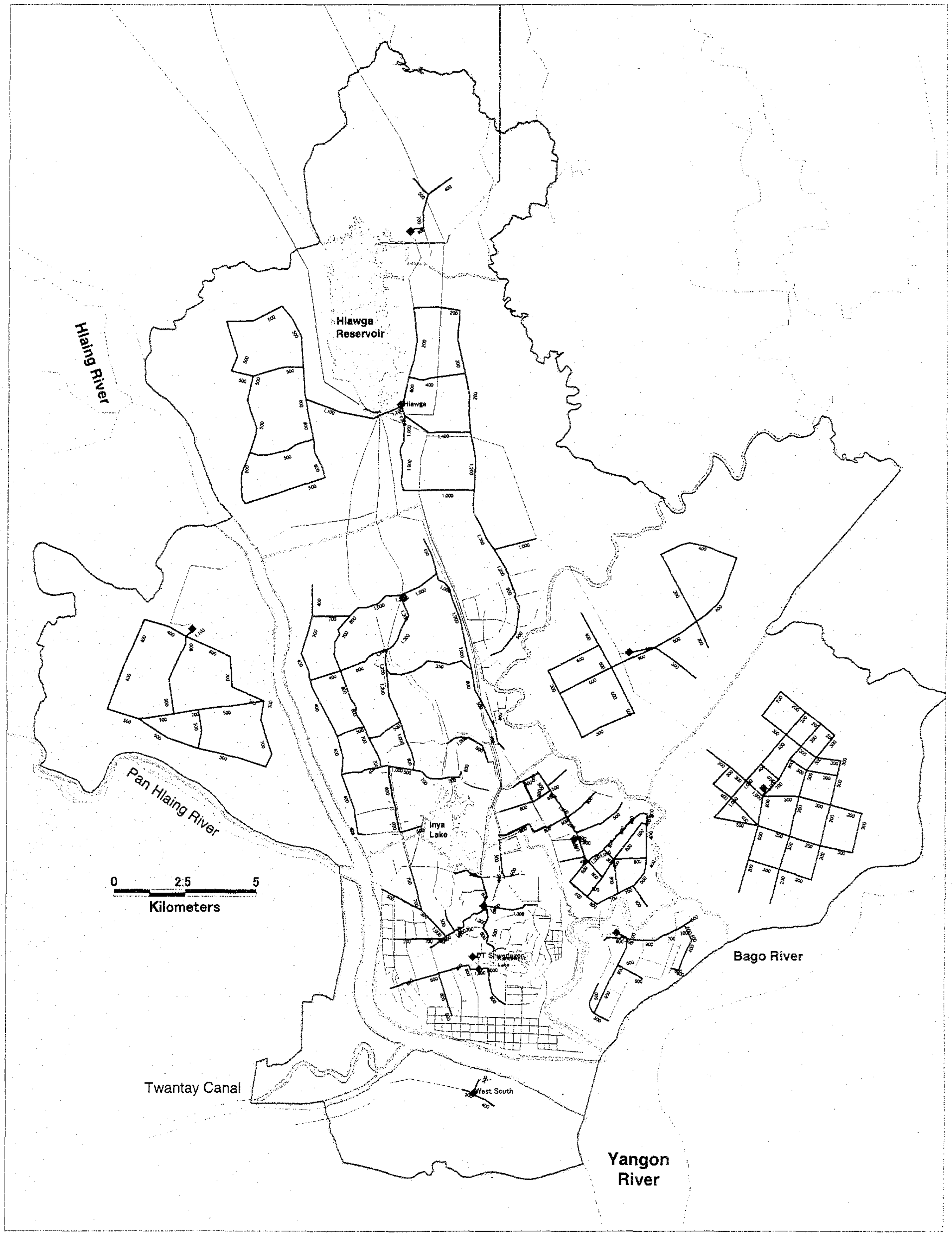


Figure I-10 Route of Proposed Distribution Mains

5.2 DISTRIBUTION NETWORK DEVELOPMENT

(1) Development Strategy

In this section, development of smaller diameter pipes about less than 200 mm and rehabilitation of existing aged pipes are planned The rehabilitation and development plan is formulated based on the data of YCDC piped water supply and the following planning conditions.

1) The plan is formulated by township and later it is assigned to each distribution zone. .
2) The rehabilitation is planned by dividing into the first and second priorities considering the average age of pipes by township
3) The rehabilitation method is replacement considering the very old and deteriorated condition of pipes.
4) When the rehabilitation is planned there are several pipelines that is required with enlargement of pipe diameter to increase the flow capacity. The diameter of enlargement of distribution mains is calculated by network analysis. The plan of these pipes is included in the proposed distribution mains. The diameter of other pipelines to be rehabilitated is the same as the existing ones.
5) Based on the existing distribution pipeline density and the piped water coverage, the townships that require expansion of the network are selected.

The existing water supply information, piped water supply coverage, estimated average pipe age and pipe length, are summarized in Figure I.11 and Table I.13.

Table I.13 summarizes the development strategy considering the above conditions.

Figure I-11 Average Age and Total Pipe Length of Distribution Pipe (< 18 inch) and Pipe Rehabilitation Priority

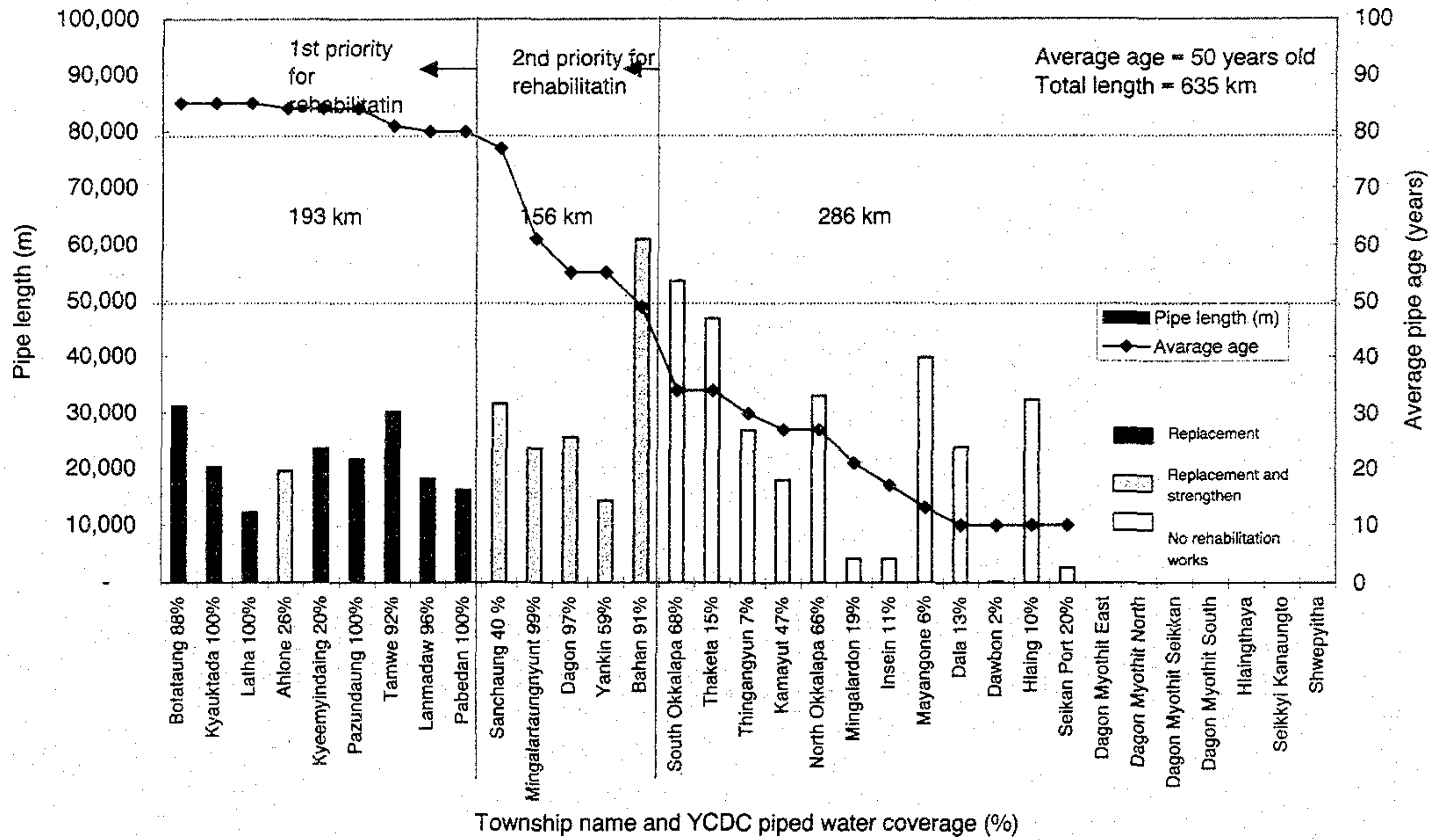


Table I.13 Existing Distribution Network Information and Planning Strategy of Network Rehabilitation and Development

	Township	Dist. zone no	YCDC piped water coverage	Estimated average pipe age	Total pipe length	Strategy of network rehabilitation and expansion				
						Pipe length by average age blanket (m)		Replace. priority	Replace. with enlargement	Service area expansion
			%	years	m	< 80 yrs	50<>80			
1	Ahlone	1	26	84	19,532	19,532		1st	Yes	Yes
2	Bahan	1	91	49	60,909		60,909	2nd	Yes	
3	Botataung	1	88	85	31,228	31,228		1st		
4	Dagon	1	97	55	25,687		25,687	2nd	Yes	
5	Dagon Myothit East	8	0	-	0					Yes
6	Dagon Myothit North	8	0	-	0					Yes
7	Dagon Myothit	7	0	-	0					Yes
8	Dagon Myothit South	7	0	-	0					Yes
9	Dala	9	13	< 10	23,814					Yes
10	Dawbon	6	2	< 10	214					Yes
11	Hlaing	3	10	< 10	32,470					Yes
12	Hlaingthaya	11	0	-	0					Yes
13	Insein	3	11	17	4,194					Yes
14	Kamayut	1	47	27	17,962					Yes
15	Kyauktada	1	100	85	20,214	20,214		1st		
16	Kyeemyindaing	1,10	20	84	23,487	23,487		1st		
17	Lanmadaw	1	96	80	18,158	18,158		1st		
18	Latha	1	100	85	12,135	12,135		1st		
19	Mayangone	3	6	13	39,812					Yes
20	Mingalardon	3,4,5	19	21	4,206					Yes
21	Mingalartaungnyunt	1	99	61	23,643		23,643	2nd	Yes	
22	North Okkalapa	3.4	66	27	33,115					Yes
23	Pabedan	1	100	80	16,150	16,150		1st		
24	Pazundaung	1	100	84	21,663	21,663		1st		
25	Sanchaung	1	40	77	31,697		31,697	2nd	Yes	Yes
26	Seikan Port	1	20	10	2,663					Yes
27	Seikkyi Kanaungto	10	0	-	0					Yes
28	Shwepyitha	4	0	-	0					Yes
29	South Okkalapa	2	68	34	53,528					Yes
30	Tamwe	1	92	81	30,218	30,218		1st		
31	Thaketa	6	15	34	46,879					Yes
32	Thingangyun	2	7	30	26,962					Yes
33	Yankin	1,2	59	55	14,303		14,303	2nd	Yes	Yes
	Total/average		32	50	634,840	193,000	156,000			

Note: The data are as of 2001.

(2) Rehabilitation Plan

1) First Priority

- The first priority works of rehabilitation is set for the townships of which the average pipe age is more than 80 years old.
- These townships are Botataung, Kyauktada, Lanmadaw, Latha, Pabedon, Pazundaung Tamwe, Mingalartaungnyunt Ahlone Sanchaung, and Kyeemyindaing. The total pipe length is 193 km.

2) Second Priority

- The second priority works of rehabilitation is set for the townships of which the average pipe age is more than 50 years old and less than 80 years.
- These townships are Mingalartaungnyunt Dagon, Bahan and Yankin. The total pipe length is 156 km.

(3) Distribution Network Development

The proposed pipe less than diameter 250 mm, which is categorized into secondary or tertiary pipe, is planned based on existing pipe density per service population, which is calculated from the area having about more than 90 % of piped water supply ratio. It is confirmed by network analysis that the existing pipes in the area are enough capacity to distribute the hourly peak water demand in 2020. The existing pipe densities are show in Table I.14. The planned future pipe density is set as follows.

1) Pipe length per service population = 0.4 m
2) Percentage of pipe length by diameter

	diameter					
(mm)	75 mm	100 mm	150 mm	200 mm	250 mm	Total
(%)	7	14	68	5	6	100

The total pipe length is calculated by multiplying 0.4 m by the service population and pipe length by diameter is calculated multiplying the total length by the above each percentage.

The summary of distribution pipe rehabilitation and development plan is shown in Table I.15.

Table I.14 Estimated Pipe Density per Service Population in Higher Piped Water Supply Areas

	Township	Service ratio in 2000	Service Pop in 2000	Pop density	Pipe length less than 20 inch	Pipe length less than 10 inch	Average length per person <20inch	Average length per person <10 inch	Pipe length by diameter (m)						
		%	persons	p/ha	m	m	(m/s. pop)	(m/s. pop)	3	4	6	8	9	10	total
1	Bahan	91	95,114	113	60,909	52,826	0.64	0.56	5,243	11,034	32,339	1,372	2,042	762	52,792
2	Botataung	88	52,653	233	31,228	19,370	0.59	0.37	0	866	17,678	366	448	0	19,358
3	Dagon	97	39,967	90	25,687	22,830	0.64	0.57	1,719	5,257	10,201	0	5,637	0	22,814
4	Kyauktada	100	44,076	717	20,214	15,296	0.46	0.35	2,611	0	11,736	262	676	0	15,285
5	Lanmadow	96	40,597	304	18,158	15,208	0.45	0.37	1,153	958	8,357	0	4,730	0	15,198
6	Latha	100	32,535	421	12,135	9,536	0.37	0.29	959	0	6,706	0	1,865	0	9,530
7	Mingalartaungnyot	99	109,796	228	23,643	15,567	0.22	0.14	0	1,931	12,924	0	0	701	15,556
8	Papeden	100	47,461	659	16,150	10,019	0.34	0.21	0	0	9,022	0	991	0	10,013
9	Pazundaung	100	38,363	399	21,663	17,332	0.56	0.45	198	2,103	14,105	0	0	914	17,320
10	Tamwe	92	128,455	271	30,218	29,227	0.24	0.23	960	7,632	18,596	0	2,019	0	29,207
	Total/average		629,017		260,005	207,210	0.41	0.33	12,843	29,781	141,664	2,000	18,408	2,377	207,073
Adopted total length per service popluation								0.4							
Percentage of pipe by diameter in length								(%)	6	14	68	1	9	1	99
Pipe diameter conversion to mm from inch								(mm)	75	100	150	200	220	250	
Percentage of pipe by diameter in length								(%)	7	14	68	5	0	6	100
Pipe diameter conversion to mm from inch								(mm)	75	100	150	200	250		
Adopted percentage in length								(%)	7	14	68	5	6		100

Note: Although the average length per service population is 0.33 m, 0.4 m/service population is used for the planning because the area used for this calculation is higher density area but the future distribution network development areas are apparently less than the population density or pipe density.

Table I.15 Distribution Network Development Plan by Township

NO.	Township	Zone	Rehabilitation		Rehabilitation	New Installation		Total
			Replace. 1st priority	Replace. 2nd priority		Primary mains	Secondary mains	
1	Ahlone	1	19,500	0	19,500	1,080	18,000	38,580
2	Bahan	1	0	61,000	61,000	7,300	0	68,300
3	Botataung	1	31,000	0	31,000	0	0	31,000
4	Dagon	1	0	25,500	25,500	4,250	0	29,750
5	Dagon Myothit East	8	0	0	0	15,320	17,800	33,120
6	Dagon Myothit North	8	0	0	0	12,660	42,600	55,260
7	Dagon Myothit Seikkan	7	0	0	0	20,430	5,900	26,330
8	Dagon Myothit South	7	0	0	0	18,900	58,600	77,500
9	Dala	9	0	0	0	1,760	20,600	22,360
10	Dawbon	6	0	0	0	1,770	33,700	35,470
11	Hlaing	3	0	0	0	10,280	40,700	50,980
12	Hlaingthaya	11	0	0	0	26,370	64,100	90,470
13	Insein	3	0	0	0	20,850	75,500	96,350
14	Kamayut	1	0	0	0	4,820	24,800	29,620
15	Kyauktada	1	20,000	0	20,000	0	0	20,000
16	Kyeemyindaing	1	23,500	0	23,500	0	0	23,500
	Kyeemyindaing	10	0	0	0	0	17,300	17,300
17	Lanmadaw	1	18,000	0	18,000	350	0	18,350
18	Latha	1	12,000	0	12,000	0	0	12,000
19	Mayangone	3	0	0	0	11,400	65,300	76,700
20	Mingalardon	3	0	0	0	8,960	16,400	25,360
	Mingalardon	4	0	0	0	23,640	27,300	50,940
	Mingalardon	5	0	0	0	4,360	15,300	19,660
21	Mingalartaungnyunt	1	0	23,500	23,500	1,520	0	25,020
22	North Okkalapa	3	0	0	0	150	119,900	120,050
	North Okkalapa	4	0	0	0	0	0	0
23	Pabedan	1	16,000	0	16,000	0	0	16,000
24	Pazundaung	1	21,500	0	21,500	0	0	21,500
25	Sanchaung	1	0	31,500	31,500	2,380	24,800	58,680
26	Seikan Port	1	0	0	0	0	0	0
27	Seikkyi Kanaungto	10	0	0	0	0	6,400	6,400
28	Shwepyitha	4	0	0	0	24,120	55,500	79,620
29	South Okkalapa	2	0	0	0	10,910	63,400	74,310
30	Tamwe	1	30,000	0	30,000	0	0	30,000
31	Thaketa	6	0	0	0	11,510	94,400	105,910
32	Thingangyun	2	0	0	0	19,660	147,600	167,260
33	Yankin	1	0	14,500	14,500	850	11,300	26,650
	Yankin	2	0	0	0	2,350	26,500	28,850
	Total		191,500	156,000	347,500	267,950	1,093,700	1,709,150

5.3 IMPLEMENTATION PLAN

(1) Rehabilitation

The first and second priority works will be implemented for 5 years each from 2004 to 2008and from 2006 to 2010 respectively. The summary of the implementation plan of rehabilitation is tabulated in Table I. 16(1) and 16(2).

(2) Distribution Network

The construction schedule of the proposed primary mains, secondary and tertiary depends on that of transmission mains. Considering it, an implementation schedule of proposed distribution mains are summarized in Table I.17(1) to (4) for distribution mains and Table I.18(1) to (4) for secondary and tertiary mains. The implementation plan of total pipe works including expansion and rehabilitation is summarized in Table I.19(1) and 19(2) and Figure I.12.

Table I-16 (1) Implementation Plan of Rehabilitation by Township

Township	Zone no	YCDC piped water coverage %	Average age yrs	Replace. priority	Replace. with strengthen	Expansion	Pipe length m	Pipe to be replaced (m) < 60 yrs	Pipe to be replaced (m) 50<>60 yrs	1st priority work plan (m) (5 years work) 2004	2005	2006	2007	2008	2009	2010	total	2nd priority work plan (m) (5 years work) 2004	2005	2006	2007	2008	2009	2010	total	Total replacement plan 2004	2005	2006	2007	2008	2009	2010	total
1 Ahlone	1	26	84	1st	Yes	Yes	19,532	19,532		3,900	3,900	3,900	3,900	3,900			19,500			0	0	0	0	0	0	3,900	3,900	3,900	3,900	3,900	0	0	19,500
2 Bahan	1	91	49	2nd	Yes		60,909		60,909	0	0	0	0	0			0			12,200	12,200	12,200	12,200	12,200	61,000	0	0	12,200	12,200	12,200	12,200	12,200	61,000
3 Botataung	1	88	85	1st			31,228	31,228		6,200	6,200	6,200	6,200	6,200			31,000			0	0	0	0	0	0	6,200	6,200	6,200	6,200	6,200	0	0	31,000
4 Dagon	1	87	55	2nd	Yes		25,687		25,687	0	0	0	0	0			0			5,100	5,100	5,100	5,100	5,100	25,500	0	0	5,100	5,100	5,100	5,100	5,100	25,500
5 Dagon Myothit East	8	0				Yes	0			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 Dagon Myothit North	8	0				Yes	0			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 Dagon Myothit Seikkan	7	0				Yes	0			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 Dagon Myothit South	7	0				Yes	0			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 Dala	9	13	10			Yes	23,814			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 Dawbon	6	2	10			Yes	214			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Hlaing	3	10	10			Yes	32,470			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
12 Hlaingthaya	11	0				Yes	0			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 Insein	3	11	17			Yes	4,194			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
14 Kamayut	1	47	27			Yes	17,962			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Kyauktada	1	100	85	1st			20,214	20,214		4,000	4,000	4,000	4,000	4,000			20,000			0	0	0	0	0	0	4,000	4,000	4,000	4,000	4,000	0	0	20,000
16 Kyeemyindaing	1	20	84	1st			23,487	23,487		4,700	4,700	4,700	4,700	4,700			23,500			0	0	0	0	0	0	4,700	4,700	4,700	4,700	4,700	0	0	23,500
	10									0	0	0	0	0			0			0	0	0	0	0	0								0
17 Lanmadaw	1	96	80	1st			18,158	18,158		3,600	3,600	3,600	3,600	3,600			18,000			0	0	0	0	0	0	3,600	3,600	3,600	3,600	3,600	0	0	18,000
18 Latha	1	100	85	1st			12,135	12,135		2,400	2,400	2,400	2,400	2,400			12,000			0	0	0	0	0	0	2,400	2,400	2,400	2,400	2,400	0	0	12,000
19 Mayangone	3	6	13			Yes	39,812			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
20 Mingalardon	3	19	21			Yes	4,206			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4									0	0	0	0	0			0			0	0	0	0	0	0								0
	5									0	0	0	0	0			0			0	0	0	0	0	0								0
21 Mingalartaungnyunt	1	99	61	2nd	Yes		23,643		23,643	0	0	0	0	0			0			4,700	4,700	4,700	4,700	4,700	23,500	0	0	4,700	4,700	4,700	4,700	4,700	23,500
22 North Okkalapa	3	66	27			Yes	33,115			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4									0	0	0	0	0			0			0	0	0	0	0	0								0
23 Pabedan	1	100	80	1st			16,150	16,150		3,200	3,200	3,200	3,200	3,200			16,000			0	0	0	0	0	0	3,200	3,200	3,200	3,200	3,200	0	0	16,000
24 Pazundaung	1	100	84	1st			21,663	21,663		4,300	4,300	4,300	4,300	4,300			21,500			0	0	0	0	0	0	4,300	4,300	4,300	4,300	4,300	0	0	21,500
25 Sanchaung	1	40	77	2nd	Yes	Yes	31,697		31,697	0	0	0	0	0			0			6,300	6,300	6,300	6,300	6,300	31,500	0	0	6,300	6,300	6,300	6,300	6,300	31,500
26 Seikkan Port	1	20	10			Yes	2,663			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
27 Seikkyi Kanaungto	10	0				Yes*	0			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 Shwepyitha	4	0				Yes	0			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 South Okkalapa	2	68	34			Yes	53,528			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Tamwe	1	92	81	1st			30,218	30,218		6,000	6,000	6,000	6,000	6,000			30,000			0	0	0	0	0	0	6,000	6,000	6,000	8,000	6,000	0	0	30,000
31 Thaketa	6	15	34			Yes	46,679			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
32 Thingangyun	2	7	30			Yes	26,962			0	0	0	0	0			0			0	0	0	0	0	0	0	0	0	0	0	0	0	0
33 Yankin	1	59	55	2nd	Yes	Yes	14,303		14,303	0	0	0	0	0			0			2,900	2,900	2,900	2,900	2,900	14,500	0	0	2,900	2,900	2,900	2,900	2,900	14,500
	2																																
Total/average		32	50				834,840	193,000	156,000	38,300	38,300	38,300	38,300	38,300			191,500			31,200	31,200	31,200	31,200	31,200	156,000	39,300	38,300	69,500	69,500	69,500	31,200	31,200	347,500

Township		Pipe replacement length by diameter (m) 75 mm	100 mm	150 mm	200 mm	250 mm	300 mm	350 mm	400 mm	450 mm	Total
1 Ahlone	1	0	2,300	15,400	0	0	500	0	0	1,400	19,600
2 Bahan	1	5,200	11,000	32,300	1,400	2,800	8,100	0	0	0	60,800
3 Botataung	1	0	900	17,700	400	400	11,300	0	0	600	31,300
4 Dagon	1	1,700	5,300	10,200	0	5,600	2,600	300	0	0	25,700
5 Dagon Myothit East	8										
6 Dagon Myothit North	8										
7 Dagon Myothit Seikkan	7										
8 Dagon Myothit South	7										
9 Dala	9										
10 Dawbon	6										
11 Hlaing	3										
12 Hlaingthaya	11										
13 Insein	3										
14 Kamayut	1										
15 Kyauktada	1	2,600	0	11,700	300	700	4,900	0	0	0	20,200
16 Kyeemyindaing	1	0	6,100	15,900	0	1,400	0	0	0	0	23,400
	10										
17 Lanmadaw	1	1,200	1,000	8,400	0	4,700	2,900	0	0	0	18,200
18 Latha	1	1,000	0	6,700	0	1,900	2,600	0	0	0	12,200
19 Mayangone	3										
20 Mingalardon	3										
	4										
	5										
21 Mingalartaungnyunt	1	0	1,900	12,900	0	700	7,100	0	0	900	23,500
22 North Okkalapa	3										
	4										
23 Pabedan	1	0	0	9,000	0	1,000	6,100	0	0	0	16,100
24 Pazundaung	1	200	2,100	14,100	0	900	3,600	0	0	800	21,700
25 Sanchaung	1	0	5,200	21,700	0	4,400	0	0	400	0	31,700
26 Seikkan Port	1										
27 Seikkyi Kanaungto	10										
28 Shwepyitha	4										
29 South Okkalapa	2										
30 Tamwe	1	1,000	7,600	18,600	0	2,000	0	0	0	1,000	30,200
31 Thaketa	6										
32 Thingangyun	2										
33 Yankin	1	1,400	7,400	2,600	300	1,000	1,700	0	0	0	14,300
	2										
Total/average		14,300	50,800	197,100	2,400	27,500	51,400	300	400	4,700	348,900

Table I-16 (2) Implementation Plan of Rehabilitation by Distrubution Zone

Replacement plan by diameter

Distribution Zone Name	No.	Pipe replacement length by diameter (m) 75 mm	100 mm	150 mm	200 mm	250 mm	300 mm	350 mm	400 mm	450 mm	Total
Downtown	1	14,300	50,800	197,100	2,400	27,500	51,400	300	400	4,700	348,900
Downtown East	2	0	0	0	0	0	0	0	0	0	0
Central West	3	0	0	0	0	0	0	0	0	0	0
Hlawga	4	0	0	0	0	0	0	0	0	0	0
Central North	5	0	0	0	0	0	0	0	0	0	0
East South	6	0	0	0	0	0	0	0	0	0	0
East Central	7	0	0	0	0	0	0	0	0	0	0
East North	8	0	0	0	0	0	0	0	0	0	0
West South	9	0	0	0	0	0	0	0	0	0	0
West Central	10	0	0	0	0	0	0	0	0	0	0
West North	11	0	0	0	0	0	0	0	0	0	0
		14,300	50,800	197,100	2,400	27,500	51,400	300	400	4,700	348,900

Yearly replacement plan

Distribution Zone Name	No.	Pipe length to be replaced (m) 2004	2005	2006	2007	2008	2009	2010
Downtown	1	38,300	38,300	69,500	69,500	69,500	31,200	31,200
Downtown East	2	0	0	0	0	0	0	0
Central West	3	0	0	0	0	0	0	0
Hlawga	4	0	0	0	0	0	0	0
Central North	5	0	0	0	0	0	0	0
East South	6	0	0	0	0	0	0	0
East Central	7	0	0	0	0	0	0	0
East North	8	0	0	0	0	0	0	0
West South	9	0	0	0	0	0	0	0
West Central	10	0	0	0	0	0	0	0
West North	11	0	0	0	0	0	0	0
		38,300	38,300	69,500	69,500	69,500	31,200	31,200

Table I-17(1) Yearly Implementation Schedule of Distribution Mains by Township (Primary mains: 300 mm - 1500 mm)

	Township	Zone no.	Construction Start year	End year	Period	Primary mains	Annual average	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
							Yearly construction length (m/year)																	
1	Ahlone	1	2005	2010	6	1,080	180	0	180	180	180	180	180	180	0	0	0	0	0	0	0	0	0	0
2	Bahan	1	2005	2010	6	7,300	1,220	0	1,220	1,220	1,220	1,220	1,220	1,200	0	0	0	0	0	0	0	0	0	0
3	Botataung	1				0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Dagon	1	2005	2010	6	4,250	710	0	710	710	710	710	710	700	0	0	0	0	0	0	0	0	0	0
5	Dagon Myothit East	8	2008	2020	13	15,320	1,180	0	0	0	0	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,160
6	Dagon Myothit North	8	2008	2020	13	12,660	970	0	0	0	0	970	970	970	970	970	970	970	970	970	970	970	970	1,020
7	Dagon Myothit Seikkan	7	2009	2020	12	20,430	1,700	0	0	0	0	0	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,730
8	Dagon Myothit South	7	2009	2020	12	18,900	1,580	0	0	0	0	0	1,580	1,580	1,580	1,580	1,580	1,580	1,580	1,580	1,580	1,580	1,580	1,520
9	Dala	9	2011	2012	2	1,760	880	0	0	0	0	0	0	0	880	880	0	0	0	0	0	0	0	0
10	Dawbon	6	2008	2010	3	1,770	590	0	0	0	0	590	590	590	0	0	0	0	0	0	0	0	0	0
11	Hlaing	3	2006	2020	15	10,260	690	0	0	690	690	690	690	690	690	690	690	690	690	690	690	690	690	620
12	Hlaingthaya	11	2006	2020	15	26,370	1,760	0	0	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,730
13	Insein	3	2006	2020	15	20,850	1,390	0	0	1,390	1,390	1,390	1,390	1,390	1,390	1,390	1,390	1,390	1,390	1,390	1,390	1,390	1,390	1,390
14	Kamayut	1	2005	2010	6	4,820	800	0	800	800	800	800	800	820	0	0	0	0	0	0	0	0	0	0
15	Kyauktada	1				0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Kyeemyindaing	1				0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		10				0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Lanmadaw	1	2005	2005	1	350	350	0	350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	Latha	1				0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Mayangone	3	2006	2020	15	11,400	760	0	0	760	760	760	760	760	760	760	760	760	760	760	760	760	750	760
20	Mingalardon	3	2007	2020	14	8,960	640	0	0	0	640	640	640	640	640	640	640	640	640	640	640	640	640	640
		4	2008	2020	13	23,640	1,820	0	0	0	0	1,820	1,820	1,820	1,820	1,820	1,820	1,820	1,820	1,820	1,820	1,820	1,820	1,800
		5	2011	2013	3	4,360	1,450	0	0	0	0	0	0	0	1,450	1,450	1,460	0	0	0	0	0	0	0
21	Mingalartaungnyunt	1	2005	2010	6	1,520	250	0	250	250	250	250	250	270	0	0	0	0	0	0	0	0	0	
22	North Okkalapa	3	2011	2011	1	150	150	0	0	0	0	0	0	0	150	0	0	0	0	0	0	0	0	0
		4				0																		
23	Pabedan	1				0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	Pazundaung	1				0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	*Sanchaung*	1	2005	2010	6	2,380	400	0	400	400	400	400	400	380	0	0	0	0	0	0	0	0	0	0
26	Seikan Port	1				0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	Seikkyi Kanaungto	10				0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	Shwepyitha	4	2008	2020	13	24,120	1,860	0	0	0	0	1,860	1,860	1,860	1,860	1,860	1,860	1,860	1,860	1,860	1,860	1,860	1,860	1,800
29	South Okkalapa	2	2007	2020	14	10,910	780	0	0	0	780	780	780	780	780	780	780	780	780	780	780	780	780	770
30	Tamwe	1				0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	Thaketa	6	2008	2020	13	11,510	890	0	0	0	0	890	890	890	890	890	890	890	890	890	890	890	890	830
32	Thingangyun	2	2007	2020	14	19,660	1,400	0	0	0	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,460
33	Yankin	1	2006	2006	1	850	850	0	0	850	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		2	2007	2009	3	2,350	780	0	0	0	780	780	790	0	0	0	0	0	0	0	0	0	0	0
	Total					267,950	26,030	0	3,910	9,010	11,760	19,070	22,360	21,560	19,900	19,750	18,880	17,420	17,420	17,420	17,420	17,420	17,420	17,230

267,950
Total is adjusted by this column.

Table I-17(2) Yearly Implementation Schedule of Distribution Mains by Distribution Zone (Primary mains: 300 mm - 1500 mm)

Distribution Zone Name	No.	total	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
			Yearly new secondary main installation plan (m)																
Downtown	1	22,550	0	3,910	4,410	3,560	3,560	3,560	3,550	0	0	0	0	0	0	0	0	0	0
Downtown East	2	32,920	0	0	0	2,960	2,960	2,970	2,180	2180	2180	2180	2180	2180	2180	2180	2180	2180	2230
Central West	3	51,640	0	0	2,840	3,480	3,480	3,480	3,480	3630	3480	3480	3480	3480	3480	3480	3480	3480	3410
Hlawga	4	47,760	0	0	0	0	3,680	3,680	3,680	3680	3680	3680	3680	3680	3680	3680	3680	3680	3600
Central North	5	4,360	0	0	0	0	0	0	0	1450	1450	1460	0	0	0	0	0	0	0
East South	6	13,280	0	0	0	0	1,480	1,480	1,480	890	890	890	890	890	890	890	890	890	830
East Central	*7*	*39,330*	*0*	*0*	*0*	*0*	*0*	*3,280*	*3,280*	*3280*	*3280*	*3280*	*3280*	*3280*	*3280*	*3280*	*3280*	*3280*	*3250*
East North	8	27,980	0	0	0	0	2,150	2,150	2,150	2150	2150	2150	2150	2150	2150	2150	2150	2150	2180
West South	9	1,760	0	0	0	0	0	0	0	880	880	0	0	0	0	0	0	0	0
West Central	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
West North	11	26,370	0	0	1,760	1,760	1,760	1,760	1,760	1760	1760	1760	1760	1760	1760	1750	1760	1760	1730
		267,950	0	3,910	9,010	11,760	19,070	22,360	21,560	19,900	19,750	18,880	17,420	17,420	17,420	17,420	17,420	17,420	17,230

Table I-17(3) Proposed Distribution Mains by Township (Primary mains: 300 mm - 1500 mm)

Township No.	Township Name	Zone	Total length (m)	Dia (mm) 300	350	400	500	600	700	800	900	1,000	1,100	1,200	1,300	1,350	1,400	1,500
1	Ahlone	1	1,080	0	0	0	0	300	0	750	30	0	0	0	0	0	0	0
2	Bahan	1	7,300	0	0	0	2,560	1,810	0	0	0	0	0	0	2,930	0	0	0
3	Botataung	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Dagon	1	4,250	0	0	0	0	1,260	0	2,330	0	660	0	0	0	0	0	0
5	Dagon Myothit East	8	15,320	5,480	0	5,550	0	1,710	0	0	2,580	0	0	0	0	0	0	0
6	Dagon Myothit North	8	12,660	3,320	0	1,270	1,880	6,190	0	0	0	0	0	0	0	0	0	0
7	Dagon Myothit Seikkan	7	20,430	17,940	0	0	0	1,220	0	1,040	0	230	0	0	0	0	0	0
8	Dagon Myothit South	7	18,900	7,720	0	5,170	1,880	0	820	850	0	2,460	0	0	0	0	0	0
9	Dala	9	1,760	500	0	880	380	0	0	0	0	0	0	0	0	0	0	0
10	Dawbon	6	1,770	0	0	0	0	0	0	0	0	1,770	0	0	0	0	0	0
11	Hlaing	3	10,280	0	0	3,810	1,650	2,370	1,370	1,030	0	50	0	0	0	0	0	0
12	Hlaingthaya	11	26,370	0	0	4,970	9,680	0	6,850	1,740	2,870	0	260	0	0	0	0	0
13	Insein	3	20,850	0	0	6,200	2,410	0	3,510	4,420	0	770	0	3,540	0	0	0	0
14	Kamayut	1	4,820	0	0	0	1,630	0	1,610	0	0	1,220	0	0	360	0	0	0
15	Kyauktada	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Kyeemyindaing	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Lanmadaw	1	350	0	0	0	0	0	0	350	0	0	0	0	0	0	0	0
18	Latha	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Mayangone	3	11,400	0	3,360	2,340	1,280	0	2,200	1,910	0	310	0	0	0	0	0	0
20	Mingalardon	3	8,960	0	0	1,320	0	0	0	0	0	4,940	0	490	2,210	0	0	0
		4	23,640	0	0	2,030	0	1,050	0	0	3,330	6,680	2,320	3,080	2,270	0	2,520	360
		5	4,360	0	0	2,060	780	0	1,210	0	310	0	0	0	0	0	0	0
21	Mingalartaungnyunt	1	1,520	0	0	0	0	0	0	1,520	0	0	0	0	0	0	0	0
22	North Okkalapa	3	150	0	0	0	0	0	0	150	0	0	0	0	0	0	0	0
		4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	Pabedan	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	Pazundaung	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	Sanchaung	1	2,380	0	0	0	0	0	1,730	0	0	0	0	0	0	0	650	0
26	Seikan Port	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	Seikkyi Kanaungto	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	Shwepyitha	4	24,120	0	0	0	18,860	1,440	0	2,530	0	0	1,290	0	0	0	0	0
29	South Okkalapa	2	10,910	0	0	0	4,510	1,310	0	2,510	830	0	0	1,160	0	590	0	0
30	Tamwe	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	Thaketa	6	11,510	0	0	1,770	1,730	2,660	810	0	3,220	0	1,030	0	290	0	0	0
32	Thingangyun	2	19,660	0	0	3,630	2,260	6,200	1,410	3,940	0	940	0	0	370	910	0	0
33	Yankin	1	850	0	0	0	810	0	0	0	40	0	0	0	0	0	0	0
		2	2,350	0	0	0	0	1,160	0	1,190	0	0	0	0	0	0	0	0
	Total		267,950	34,960	3,360	41,000	52,300	28,680	21,520	26,260	13,210	20,030	4,900	8,270	8,430	1,500	3,170	360

Table I-17(4) Proposed Distribution Mains by Distribution Zone (Primary mains: 300 mm - 1500 mm)

Distribution Zone Name	No.	Total length (m)	Primary mains new installation plan dy diameter (mm) 300	350	400	500	600	700	800	900	1,000	1,100	1,200	1,300	1,350	1,400	1,500
Downtown	1	22,550	0	0	0	5,000	3,370	3,340	4,950	70	1,880	0	0	3,290	0	650	0
Downtown East	2	32,920	0	0	3,630	6,770	8,670	1,410	7,640	830	940	0	1,160	370	1,500	0	0
Central West	3	51,640	0	3,360	13,670	5,340	2,370	7,080	7,510	0	6,070	0	4,030	2,210	0	0	0
Hlawga	4	47,760	0	0	2,030	18,860	2,490	0	2,530	3,330	6,680	3,610	3,080	2,270	0	2,520	360
Central North	5	4,360	0	0	2,060	780	0	1,210	0	310	0	0	0	0	0	0	0
East South	6	13,280	0	0	1,770	1,730	2,660	810	0	3,220	1,770	1,030	0	290	0	0	0
East Central	7	39,330	25,660	0	5,170	1,880	1,220	820	1,890	0	2,690	0	0	0	0	0	0
East North	8	27,980	8,800	0	6,820	1,880	7,900	0	0	2,580	0	0	0	0	0	0	0
West South	9	1,760	500	0	880	380	0	0	0	0	0	0	0	0	0	0	0
West Central	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
West North	11	26,370	0	0	4,970	9,680	0	6,850	1,740	2,870	0	260	0	0	0	0	0
		267,950	34,960	3,360	41,000	52,300	28,680	21,520	26,260	13,210	20,030	4,900	8,270	8,430	1,500	3,170	360

Table I-18(1) Proposed Distribution Pipe Works by Township (75 mm - 250 mm)

	Township	Zone	YCDC piped water coverage (%)			Planned service population			Service population increase			Average pipe age (>18in.)	Exist. pipe length (>18in.)	Increase of secondary distrib (m)	New pipe installation between 2005 and 2020 by diameter					
			2000	2010	2020	2000	2010	2020	2000 - 2010	2010 - 2020	2000-2020	(years)	(m)	Total	75 mm	100 mm	150 mm	200 mm	250 mm	Total
1	Ahlone	1	26	63	100	12,044	32,256	56,916	20,212	24,660	44,872	64	19,532	18,000	1,300	2,500	12,200	900	1,100	18,000
2	Bahan	1	91	100	100	91,622	104,375	108,789	12,753	4,414	17,167	49	60,909		0	0	0	0	0	0
3	Botataung	1	88	100	100	48,684	59,531	63,930	10,847	4,399	15,246	85	31,228		0	0	0	0	0	0
4	Dagon	1	97	100	100	40,974	44,000	46,009	3,026	2,009	5,035	55	25,687		0	0	0	0	0	0
5	Dagon Myothit East	8	0	30	33	0	28,454	44,400	28,454	15,946	44,400		0	17,800	1,200	2,500	12,100	900	1,100	17,800
6	Dagon Myothit North	8	0	40	43	0	70,088	106,271	70,088	36,183	106,271		0	42,500	3,000	6,000	28,900	2,100	2,600	42,600
7	Dagon Myothit Seikkan	7	0	30	33	0	9,424	14,705	9,424	5,281	14,705		0	5,900	400	800	4,000	300	400	5,900
8	Dagon Myothit South	7	0	40	43	0	96,775	146,736	96,775	49,961	146,736		0	58,700	4,100	8,200	39,900	2,900	3,500	58,600
9	Dala	8	13	30	48	9,954	30,815	61,782	20,861	30,967	51,828	10	23,814	20,700	1,400	2,900	14,100	1,000	1,200	20,600
10	Dawbon	6	2	48	56	1,721	54,377	85,775	52,656	31,398	84,054	10	214	33,700	2,400	4,700	22,900	1,700	2,000	33,700
11	Hlaing	3	10	48	56	18,170	93,523	120,277	75,353	26,754	102,107	10	32,470	40,800	2,900	5,700	27,700	2,000	2,400	40,700
12	Hlaingthaya	11	0	30	33	0	102,692	160,242	102,692	57,550	160,242		0	64,100	4,500	9,000	43,600	3,200	3,800	64,100
13	Insein	3	11	48	56	26,082	149,550	214,503	123,468	64,953	188,421	17	4,194	75,400	5,300	10,600	51,300	3,800	4,500	75,500
14	Kamayut	7	47	73	100	41,022	69,765	103,206	28,743	33,441	62,164	27	17,962	24,600	1,700	3,600	16,900	1,200	1,600	24,600
15	Kyauktada	1	100	100	100	46,405	46,406	46,405	0	0	0	86	20,214		0	0	0	0	0	0
16	Kyeemyindaing	1	20	56	90	18,817	33,973	62,698	15,156	28,725	43,881	84	23,487		0	0	0	0	0	0
		10				0	0	43,569	0	43,569	43,569		0	17,400	1,200	2,400	11,800	900	1,000	17,300
17	Lanmadaw	1	96	100	100	41,311	42,742	42,742	1,431	0	1,431	80	18,158		0	0	0	0	0	0
18	Latha	1	100	100	100	34,254	34,635	35,021	381	386	767	85	12,135		0	0	0	0	0	0
19	Mayangone	3	6	83	100	128,947	198,050	292,237	69,103	94,187	163,290	13	39,812	65,300	4,600	9,100	44,400	3,300	3,900	65,300
20	Mingalardon	3	19	48	56	35,456	116,549	163,440	22,547	18,569	41,146	21	4,206	16,400	1,100	2,300	11,200	800	1,000	16,400
		4							37,493	30,926	68,419			27,400	1,900	3,800	18,600	1,400	1,600	27,300
		5							21,053	17,366	38,419			15,300	1,100	2,100	10,400	800	900	15,300
21	Mingalartaungnyunt	1	99	100	100	114,759	121,830	126,399	7,071	6,569	13,640	61	23,643		0	0	0	0	0	0
22	North Okkalapa	3	66	83	100	200,791	323,855	500,398	15,998	22,951	38,949	27	33,115	15,600	1,100	2,200	10,600	800	900	15,600
		4	66	83	100				107,066	153,592	260,658	27		104,200	7,300	14,600	70,900	5,200	6,300	104,300
23	Pabedan	1	100	100	100	49,969	49,969	49,969	0	0	0	80	18,150		0	0	0	0	0	0
24	Pazundaung	1	100	100	100	40,390	42,014	43,703	1,624	1,689	3,313	84	21,663		0	0	0	0	0	0
25	Sanchaung	1	40	70	100	32,869	61,939	94,895	29,070	32,956	62,026	77	31,697	24,800	1,700	3,500	16,900	1,200	1,500	24,800
26	Seikan Port	1	20	20	28	290	290	407	0	117	117	10	2,663	0	0	0	0	0	0	0
27	Seikkyi Kanaungto	10	0	30	33	0	10,657	16,008	10,657	5,351	16,008		0	6,400	400	900	4,400	300	400	6,400
28	Shwepyitha	4	0	30	33	0	88,869	138,671	88,869	49,802	138,671		0	55,400	3,900	7,800	37,700	2,800	3,300	55,500
29	South Okkalapa	2	68	84	100	157,686	227,459	316,213	69,773	88,754	158,527	34	53,528	63,400	4,400	8,900	43,100	3,200	3,800	63,400
30	Tamwe	1	92	100	100	123,921	145,672	156,906	21,751	11,234	32,985	81	30,218		0	0	0	0	0	0
31	Thaketa	6	15	48	56	41,839	183,476	277,751	141,637	94,275	235,912	34	46,879	94,400	6,600	13,200	64,200	4,700	5,700	94,400
32	Thingangyun	2	7	54	100	18,883	168,260	387,442	149,377	219,182	368,559	30	26,862	147,500	10,300	20,700	100,300	7,400	8,900	147,600
33	Yankin	1	59	79	100	66,581	107,122	160,865	12,024	15,948	27,971	55	14,303	11,200	800	1,600	7,600	600	700	11,300
		2							28,517	37,817	66,333			26,500	1,900	3,700	18,000	1,300	1,600	26,500
	Total			60	70	1,431,397	2,973,000	4,311,300	1,505,950	1,361,909	2,867,859	50	634,840	1,093,700	76,500	153,200	743,700	54,700	65,600	1,093,700

Table I-18(2) Proposed Distribution Pipe Works by Distribution Zone (75 mm - 250 mm)

Distribution Zone					Pipe replacement length by diameter (m)					
Name	No.				75 mm	100 mm	150 mm	200 mm	250 mm	Total
Downtown	1				5,500	11,100	53,600	3,900	4,800	78,900
Downtown East	2				16,600	33,300	161,400	11,900	14,300	237500
Central West	3				15,000	29,900	145,200	10,700	12,700	213500
Hlawga	4				13,100	26,200	127,200	9,400	11,200	187100
Central North	5				1,100	2,100	10,400	800	900	15300
East South	6				9,000	17,900	87,100	6,400	7,700	128100
East Central	7				4,500	9,000	43,900	3,200	3,900	64500
East North	8				4,200	8,500	41,000	3,000	3,700	60400
West South	9				1,400	2,900	14,100	1,000	1,200	20600
West Central	10				1,600	3,300	16,200	1,200	1,400	23700
West North	11				4,500	9,000	43,600	3,200	3,800	64100
					76,500	153,200	743,700	54,700	65,600	1,093,700

Table I-18(3) Yearly Installation Plan of Distribution Pipe by Township (75 mm - 250 mm)

	Township	Zone	Construction Start year	Construction End year	Construction Period	Annual average	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	Ahlone	1	2005	2020	16	1,100	0	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,500
2	Bahan	1																					
3	Botataung	1																					
4	Dagon	1																					
5	Dagon Myothit East	8	2008	2020	13	1,400	0	0	0	0	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,000
6	Dagon Myothit North	8	2008	2020	13	3,300	0	0	0	0	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,000
7	Dagon Myothit Seikkan	7	2009	2020	12	500	0	0	0	0	0	500	500	500	500	500	500	500	500	500	500	500	400
8	Dagon Myothit South	7	2009	2020	12	4,900	0	0	0	0	0	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,700
9	Dala	9	2011	2020	10	2,100	0	0	0	0	0	0	0	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	1,700
10	Dawbon	6	2008	2020	13	2,600	0	0	0	0	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,500
11	Hlaing	3	2006	2020	15	2,700	0	0	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,900
12	Hlaingthaya	11	2007	2020	14	4,600	0	0	0	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,300
13	Insein	3	2006	2020	15	5,000	0	0	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,500
14	Kamayut	1	2005	2020	16	1,600	0	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	800
15	Kyauktada	1																					
16	Kyeemyindaing	1					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		10	2013	2020	8	2,200	0	0	0	0	0	0	0	0	0	2,200	2,200	2,200	2,200	2,200	2,200	2,200	1,900
17	Lanmadaw	1					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	Latha	1					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Mayangone	3	2006	2020	15	4,400	0	0	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	3,700
20	Mingalardon	3	2007	2020	14	1,200	0	0	0	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	800
		4	2008	2020	13	2,100	0	0	0	0	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100
		5	2009	2020	12	1,300	0	0	0	0	0	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,000
21	Mingalartaungnyunt	1					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	North Okkalapa	3	2007	2020	14	1,100	0	0	0	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,300
		4	2007	2020	14	7,400	0	0	0	7,400	7,400	7,400	7,400	7,400	7,400	7,400	7,400	7,400	7,400	7,400	7,400	7,400	8,100
23	Pabedan	1																					
24	Pazundaung	1																					
25	Sanchaung	1	2005	2020	16	1,600	0	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	800
26	Seikan Port	1					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	Seikkyi Kanaungto	10	2013	2020	8	800	0	0	0	0	0	0	0	0	0	800	800	800	800	800	800	800	800
28	Shwepyitha	4	2008	2020	13	4,300	0	0	0	0	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	4,300	3,900
29	South Okkalapa	2	2007	2020	14	4,500	0	0	0	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,900
30	Tamwe	1					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	Thaketa	6	2008	2020	13	7,300	0	0	0	0	7,300	7,300	7,300	7,300	7,300	7,300	7,300	7,300	7,300	7,300	7,300	7,300	6,800
32	Thingangyun	2	2007	2020	14	10,500	0	0	0	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	11,100
33	Yankin	1	2005	2020	16	700	0	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	800
		2	2007	2020	14	1,900	0	0	0	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,800
	Total						0	5,000	17,100	48,300	69,300	76,000	76,000	78,100	78,100	81,100	81,100	81,100	81,100	81,100	81,100	81,100	78,100

Yearly construction length (m/year)

Table I-18(4) Yearly Installation Plan of Distribution Pipe by Distribution Zone (75 mm - 250 mm)

Distribution Zone Name	No.	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	total
Downtown	1	0	5,000	5,000	5,000	5,000	5,000	5,000	5000	5000	5000	5000	5000	5000	5000	5000	5000	3900	78,900
Downtown East	2	0	0	0	16,900	16,900	16,900	16,900	16900	16900	16900	16900	16900	16900	16900	16900	16900	17900	237500
Central West	3	0	0	12,100	14,400	14,400	14,400	14,400	14400	14400	14400	14400	14400	14400	14400	14400	14400	14200	213500
Hlawga	4	0	0	0	7,400	13,800	13,800	13,800	13800	13800	13800	13800	13800	13800	13800	13800	13800	14100	187100
Central North	5	0	0	0	0	0	1,300	1,300	1300	1300	1300	1300	1300	1300	1300	1300	1300	1000	15300
East South	6	0	0	0	0	9,900	9,900	9,900	9900	9900	9900	9900	9900	9900	9900	9900	9900	9300	128100
East Central	7	0	0	0	0	0	5,400	5,400	5400	5400	5400	5400	5400	5400	5400	5400	5400	5100	64500
East North	8	0	0	0	0	4,700	4,700	4,700	4700	4700	4700	4700	4700	4700	4700	4700	4700	4000	60400
West South	9	0	0	0	0	0	0	0	2100	2100	2100	2100	2100	2100	2100	2100	2100	1700	20600
West Central	10	0	0	0	0	0	0	0	0	0	3000	3000	3000	3000	3000	3000	3000	2700	23700
West North	11	0	0	0	4,600	4,600	4,600	4,600	4600	4600	4600	4600	4600	4600	4600	4600	4600	4300	64100
		0	5,000	17,100	48,300	69,300	76,000	76,000	78,100	78,100	81,100	81,100	81,100	81,100	81,100	81,100	81,100	78,100	1,093,700

Yearly new secondary main installation plan (m)

Table I-19(1) Implementation Plan of Total Pipe Works including Expansion and Rehabilitation by Township

NO.	Township	Zone	Rehabilitation: Replace. 1st priority	Rehabilitation: Replace. 2nd priority	Rehabilitation	New Installation: Primary mains	New Installation: Secondary mains	Total	Yearly Pipe Works (m): 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	Ahlone	1	19,500	0	19,500	1,080	18,000	38,580	3,900	5,180	5,180	5,180	5,180	1,280	1,280	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,500
2	Bahan	1	0	61,000	61,000	7,300	0	68,300	0	1,220	13,420	13,420	13,420	13,420	13,400	0	0	0	0	0	0	0	0	0	0
3	Botataung	1	31,000	0	31,000	0	0	31,000	6,200	6,200	6,200	6,200	6,200	0	0	0	0	0	0	0	0	0	0	0	0
4	Dagon	1	0	25,500	25,500	4,250	0	29,750	0	710	5,810	5,810	5,810	5,810	5,800	0	0	0	0	0	0	0	0	0	0
5	Dagon Myothit East	8	0	0	0	15,320	17,800	33,120	0	0	0	0	2,580	2,580	2,580	2,580	2,580	2,580	2,580	2,580	2,590	2,580	2,580	2,580	2,160
6	Dagon Myothit North	8	0	0	0	12,660	42,600	55,260	0	0	0	0	4,270	4,270	4,270	4,270	4,270	4,270	4,270	4,270	4,270	4,270	4,270	4,270	4,020
7	Dagon Myothit Seikkan	7	0	0	0	20,430	5,900	26,330	0	0	0	0	0	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,130
8	Dagon Myothit South	7	0	0	0	18,900	58,600	77,500	0	0	0	0	0	6,480	6,480	6,480	6,480	6,480	6,480	6,480	6,480	6,480	6,480	6,480	6,220
9	Dala	9	0	0	0	1,760	20,600	22,360	0	0	0	0	0	0	0	2,980	2,980	2,100	2,100	2,100	2,100	2,100	2,100	2,100	1,700
10	Dawbon	5	0	0	0	1,770	33,700	35,470	0	0	0	0	3,190	3,190	3,190	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,500
11	Hlaing	3	0	0	0	10,280	40,700	50,980	0	0	3,390	3,390	3,390	3,390	3,390	3,390	3,390	3,390	3,390	3,390	3,390	3,390	3,390	3,390	3,520
12	Hlaingthaya	11	0	0	0	26,370	64,100	90,470	0	0	1,760	6,360	6,360	6,360	6,360	6,360	6,360	6,360	6,360	6,360	6,360	6,360	6,360	6,360	6,030
13	Insein	3	0	0	0	20,850	75,500	96,350	0	0	6,390	6,390	6,390	6,390	6,390	6,390	6,390	6,390	6,390	6,390	6,390	6,390	6,390	6,390	6,890
14	Kamayut	1	0	0	0	4,820	24,800	29,620	0	2,400	2,400	2,400	2,400	2,400	2,420	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,500	1,600	800
15	Kyauktada	1	20,000	0	20,000	0	0	20,000	4,000	4,000	4,000	4,000	4,000	0	0	0	0	0	0	0	0	0	0	0	0
16	Kyeemyindaing (zone 1)	1	23,500	0	23,500	0	0	23,500	4,700	4,700	4,700	4,700	4,700	0	0	0	0	0	0	0	0	0	0	0	0
	Kyeemyindaing (zone 10)	10	0	0	0	0	17,300	17,300	0	0	0	0	0	0	0	0	0	2,200	2,200	2,200	2,200	2,200	2,200	2,200	1,900
17	Lanmadaw	1	18,000	0	18,000	350	0	18,350	3,600	3,950	3,600	3,600	3,600	0	0	0	0	0	0	0	0	0	0	0	0
18	Latha	1	12,000	0	12,000	0	0	12,000	2,400	2,400	2,400	2,400	2,400	0	0	0	0	0	0	0	0	0	0	0	0
19	Mayangone	3	0	0	0	11,400	65,300	76,700	0	0	5,160	5,160	5,160	5,160	5,160	5,160	5,160	5,160	5,160	5,160	5,160	5,160	5,160	5,160	4,460
20	Mingalardon (zone 3)	3	0	0	0	8,960	16,400	25,360	0	0	0	1,840	1,840	1,840	1,840	1,840	1,840	1,840	1,840	1,840	1,840	1,840	1,840	1,840	1,440
	Mingalardon (zone 4)	4	0	0	0	23,640	27,300	50,940	0	0	0	0	3,920	3,920	3,920	3,920	3,920	3,920	3,920	3,920	3,920	3,920	3,920	3,920	3,900
	Mingalardon (zone 5)	5	0	0	0	4,360	15,300	19,660	0	0	0	0	0	1,300	1,300	2,750	2,750	2,760	1,300	1,300	1,300	1,300	1,300	1,300	1,000
21	Mingalartaungnyunt	1	0	23,500	23,500	1,520	0	25,020	0	250	4,950	4,950	4,950	4,950	4,970	0	0	0	0	0	0	0	0	0	0
22	North Okkalapa (zone 3)	3	0	0	0	150	15,600	15,750	0	0	0	1,100	1,100	1,100	1,100	1,250	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,300
	North Okkalapa (zone 4)	4	0	0	0	0	104,300	104,300	0	0	0	7,400	7,400	7,400	7,400	7,400	7,400	7,400	7,400	7,400	7,400	7,400	7,400	7,400	8,100
23	Pabedan	1	16,000	0	16,000	0	0	16,000	3,200	3,200	3,200	3,200	3,200	0	0	0	0	0	0	0	0	0	0	0	0
24	Pazundaung	1	21,500	0	21,500	0	0	21,500	4,300	4,300	4,300	4,300	4,300	0	0	0	0	0	0	0	0	0	0	0	0
25	Sanchaung	1	0	31,500	31,500	2,380	24,800	58,680	0	2,000	8,300	8,300	8,300	8,300	8,280	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	800
26	Seikan Port	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	Seikkyi Kanaungto	10	0	0	0	0	5,400	6,400	0	0	0	0	0	0	0	0	0	800	800	800	800	800	800	800	800
28	Shwepyitha	4	0	0	0	24,120	55,500	79,620	0	0	0	0	6,160	6,160	6,160	6,160	6,160	6,160	6,160	6,160	6,160	6,160	6,160	6,160	5,700
29	South Okkalapa	2	0	0	0	10,910	63,400	74,310	0	0	0	5,280	5,280	5,280	5,280	5,280	5,280	5,280	5,280	5,280	5,280	5,280	5,280	5,280	5,670
30	Tamwe	1	30,000	0	30,000	0	0	30,000	6,000	6,000	6,000	6,000	6,000	0	0	0	0	0	0	0	0	0	0	0	0
31	Thakela	6	0	0	0	11,510	94,400	105,910	0	0	0	0	8,190	8,190	8,190	8,190	8,190	8,190	8,190	8,190	8,190	8,190	8,190	8,190	7,630
32	Thingangyun	2	0	0	0	19,860	147,500	167,260	0	0	0	11,900	11,900	11,900	11,900	11,900	11,900	11,900	11,900	11,900	11,900	11,900	11,900	11,900	12,560
33	Yankin (zone 1)	1	0	14,500	14,500	850	11,300	26,650	0	700	4,450	3,600	3,600	3,600	3,600	700	700	700	700	700	700	700	700	700	800
	Yankin (zone 2)	2	0	0	0	2,350	26,500	28,850	0	0	0	2,680	2,680	2,690	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,800
	Total		191,500	156,000	347,500	267,950	1,093,700	1,709,150	38,300	47,210	95,610	129,560	157,870	129,560	128,760	98,000	97,850	99,980	98,520	98,520	98,520	98,520	98,520	98,520	95,330

Table I-19(2) Implementation Plan of Total Pipe Works including Expansion and Rehabilitation by Distribution Zone

Distribution Zone Name	No.	Yearly distrubution installation plan (m): 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	total
Downtown	1	38,300	47,210	78,910	78,060	78,060	39,760	39,750	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	3,900	448,950
Downtown East	2	0	0	0	19,860	19,860	19,870	19,080	19080	19080	19080	19080	19080	19080	19080	19080	19080	20030	270420
Central West	3	0	0	14,940	17,880	17,880	17,880	17,880	18030	17880	17880	17880	17880	17880	17880	17880	17880	17610	265140
Hlawga	4	0	0	0	7,400	17,480	17,480	17,480	17480	17480	17480	17480	17480	17480	17480	17480	17480	17700	234860
Central North	5	0	0	0	0	0	1,300	1,300	2750	2750	2760	1300	1300	1300	1300	1300	1300	1000	19660
East South	6	0	0	0	0	11,380	11,380	11,380	10790	10790	10790	10790	10790	10790	10790	10790	10790	10130	141380
East Central	7	0	0	0	0	0	8,690	8,690	8680	8680	8680	8680	8680	8680	8680	8680	8680	8350	103830
East North	8	0	0	0	0	6,850	6,850	6,850	6850	6850	6850	6850	6850	6850	6850	6850	6850	6180	88380
West South	9	0	0	0	0	0	0	0	2980	2980	2100	2100	2100	2100	2100	2100	2100	1700	22360
West Central	10	0	0	0	0	0	0	0	0	0	3000	3000	3000	3000	3000	3000	3000	2700	23700
West North	11	0	0	1,760	6,360	6,360	6,360	6,360	6360	6360	6360	6360	6360	6360	6360	6360	6360	6030	90470
		38,300	47,210	95,610	129,560	157,870	129,560	128,760	98,000	97,850	99,980	98,520	98,520	98,520	98,520	98,520	98,520	95,330	1,709,150

Figure I-12 Distribution Network Expansion and Rehabilitation Works (2004-2020)