3.5 EXISTING WATER SUPPLY SYSTEM

3.5.1 *Existing Facilities*

Figure 3.22 shows the outline of the existing water supply system for Yangon City. Three Reservoirs are supplying water to the City through transmission pipes.

(1) Gyobyu Reservoir

1) Reservoir

Built in 1940, Gyobyu reservoir has a catchment area of 32.9 km^2 (12.7 sq.mile) and water surface area of 7.25 km^2 (2.8 sq.mile) at full water level. Total capacity is approximately 75.5 million m^3 (16,600 million gallon). The spill way is also equipped and the crest level is +65.5 m (215 ft) above mean sea level. Water is withdrawn from the intake tower and it has three intake ports to cope with water level fluctuation:

1st Intake Port	+61.3 m (201 ft)
2nd Intake Port	+54.9 m (180 ft)
3rd Intake Port	+42.1 m (138 ft)

When the water level is low, especially during the dry season, a valve installed in the steel transmission, diameter 1,400 mm (56 inch), will be closed and instead water from Phugyi Reservoir will be injected via an inter-connection, shown in Figure 3.16, until the water level in Gyobyu Reservoir recovers.

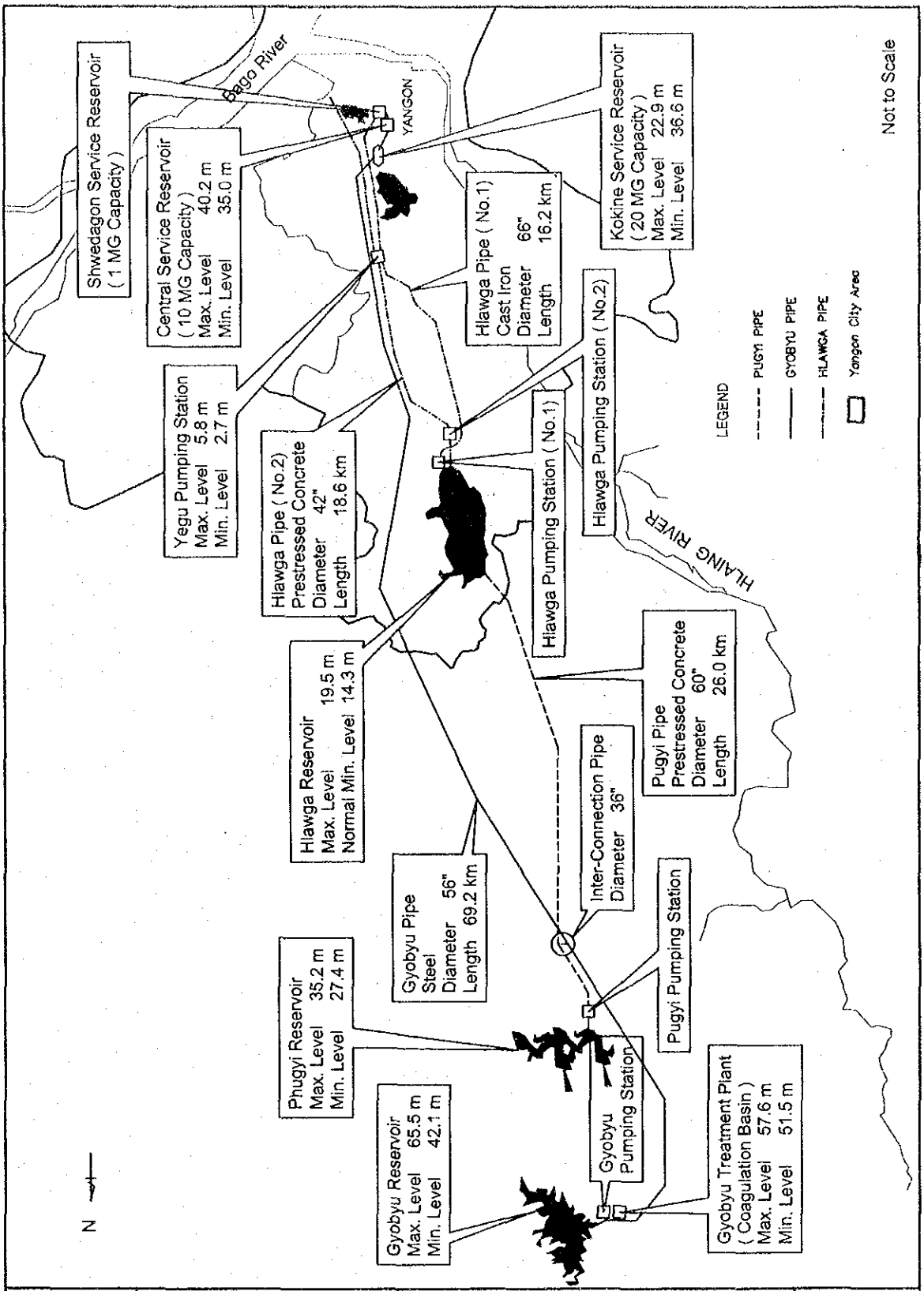
2) Pumping Station

There is a pumping station (P/S) completed in 1962, downstream of the reservoir. Water is conveyed to Yegu P/S by steel pipe with diameter of 1,400 mm (56 inch). If the water level in the reservoir is high enough, stored water is conveyed to the city by gravity through a by-pass but if water level is low, pumps will be operated. Pump operation record is shown in Appendix H, which shows the relation between reservoir water level and pump operation.

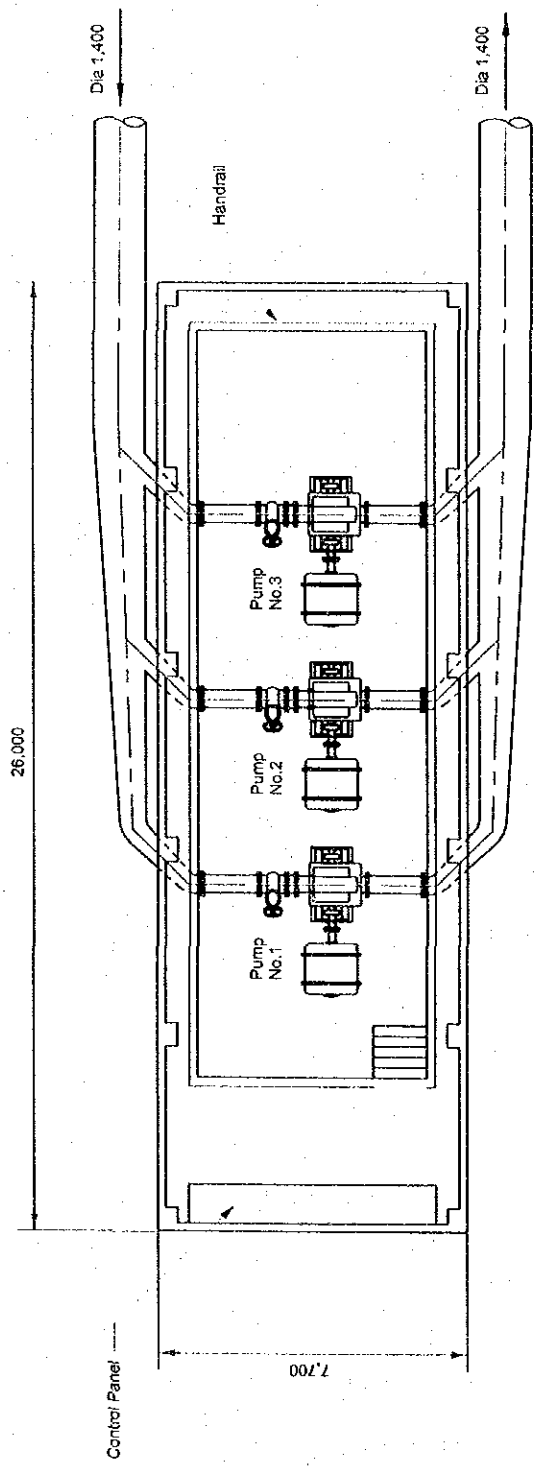
The following are the pump specifications:

3,310 m^3/hr x 184 kW x 13.7 m x 3 units (1 unit stand-by)
Horizontal single stage double suction centrifugal pump
Manufactured in 1982

Operational status is good, without major breakdown. However, pumps are seldom used due to the water level fluctuation in reservoir and also to frequent power failure. In 2000, total pump operation hour was 1,592 hours, mainly in March, May and June, at the end of dry period. So far, pumps have not been operated in 2001. Flow and pressure measurements are not conducted.



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 3.22
	General Plan of Reservoirs and Transmission Pipes	



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 3.23
	Plan of Gyobyu Pumping Station	

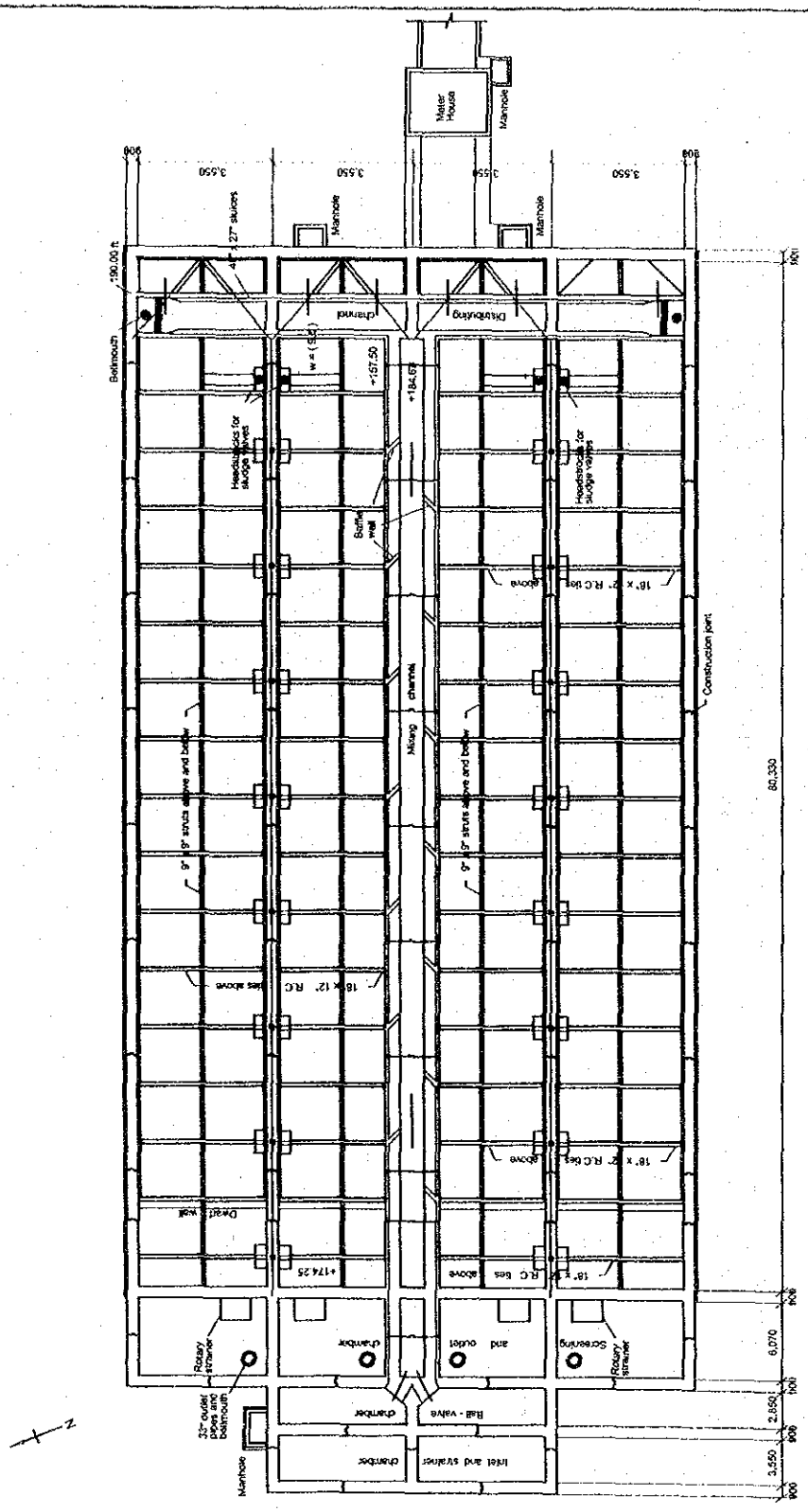
3) Water Treatment Plant

Gyobyu water treatment plant was completed in 1940 with nominal treatment capacity of 123,000 m^3/day (27 MGD). The following box shows the treatment unit process and specifications.

Aeration	By perforated pipe
Alum injection	Alum dissolved in chemical building is injected by gravity only when turbidity of raw water is high
Sedimentation	Lateral flow sedimentation tank, ^{W} 10.0 m x ^{L} 81.6 m x 4 Channels
Screening	By Micro-strainer
Chlorination	Not practiced for 20 years
Flow Measurement	Not conducted for 20 years

There is also one chemical building, one chlorine house and one meter house. However, the latter two buildings are not functioning due to the lack of unavailability of chlorine and malfunction of flow meter.

Same as the pumping station, WTP is seldom operated. According to the operation record, it was operated 36 days in January and February of 2001 and not operated in 2000. WTP is operated only when the turbidity of raw water is high. Raw water is pumped from the pumping station. Alum dissolved in the Chemical Building is injected through pipe at the upstream of the mixing channel (refer to Figure 3.24). However, since baffle walls of this channel have deteriorated, its mixing effect is insufficient and therefore the following sedimentation process is also ineffective. Treated water is conveyed to the City by gravity.



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR
Plan of Gyobyu Water Treatment Plant	FIG 3.24

(2) Pugyi Reservoir

1) Reservoir

Construction work on Phugyi reservoir was launched in 1973 and completed in 1988. This reservoir has a catchment area of 70.6 km^2 (27.27 sq.mile) and water surface area of 17.61 km^2 (6.80 sq.mile) at full water level. Maximum storage volume is approximately 104.6 million m^3 (23,000 million gallon). The crest level of the spill way is +35.1 m (115.5 ft) above mean sea level. Water is withdrawn from the intake tower and it has two intake ports for selective water intake:

1st Intake Ports	+32.0 m (91.5 ft)
2nd Intake Ports	+27.4 m (76.5 ft)

2) Pumping Station

There is a pumping station built in 1988 downstream of the reservoir. Water is conveyed by pre-stressed concrete pipe with diameter of 1,500 mm (60 inch) and pumped to Hlawga reservoir, located downstream. The pump specification is as follows:

5,160 m^3/hr x 450 kW x 24 m x 3 units (1 unit stand-by)
Horizontal double suction centrifugal pump
Manufactured in 1980

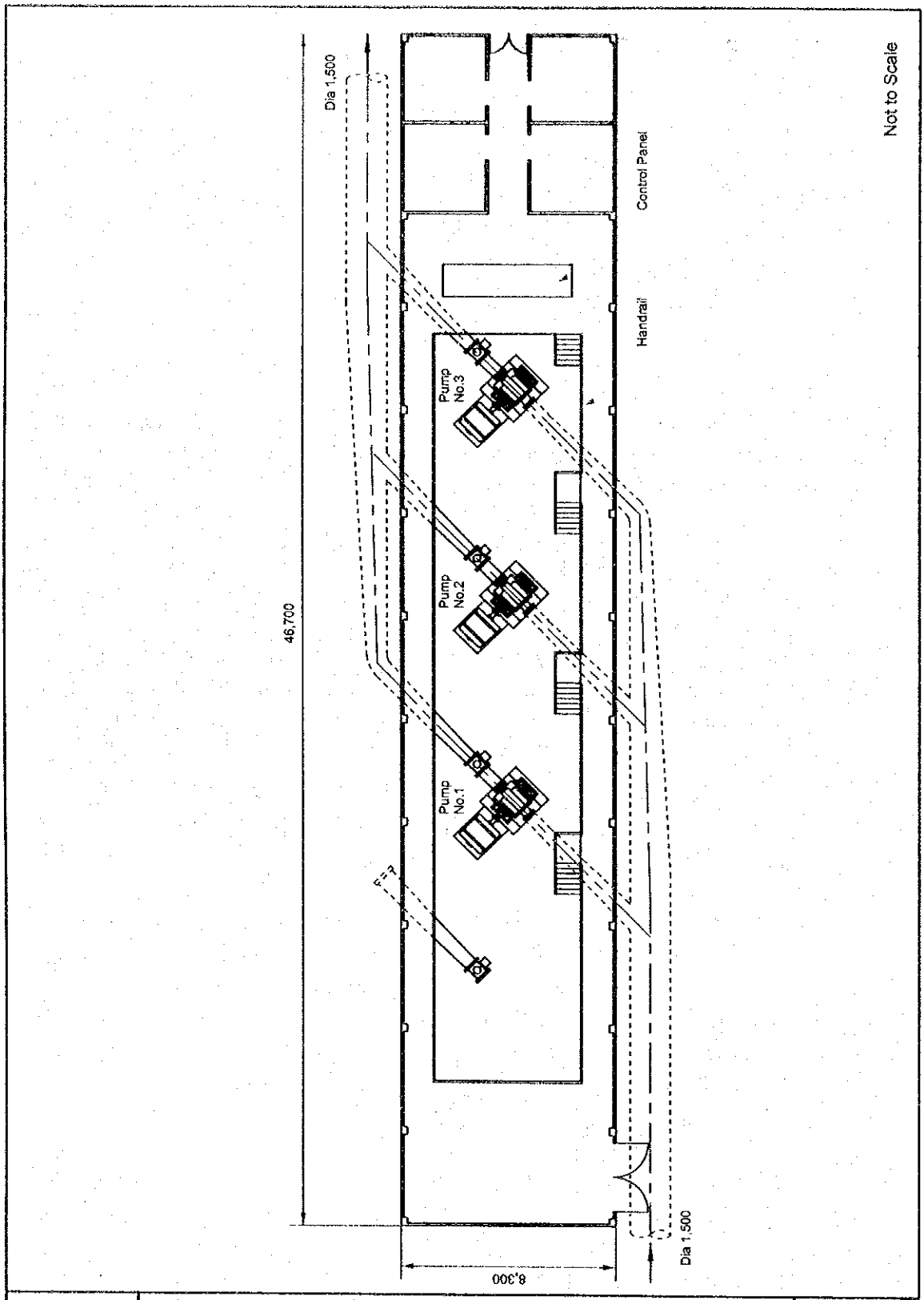
Three pumps are operated alternately. Because of frequent power failure, pump operation has been affected adversely, but recently power supply condition was greatly improved by the installation of a new transformer. Appendix D shows the operation record in 2000. Operational status is good. Distribution flow and pressure is monitored here and according to the latest record, flow was 9,469 m^3/hr (50 mgd) and pressure was 6.70 kgf/cm^2 (95 psi). The plan of this P/S is shown in Figure 3.25.

(3) Hlawga Reservoir

1) Reservoir

Built in 1904, Hlawga reservoir has a catchment area of 27.2 km^2 (10.5 sq.mile) and water surface area of 11.4 km^2 (4.40 sq.mile) in full water level. Maximum storage volume is approximately 54.6 million m^3 (12,000 million gallon). The spill way is also equipped and the crest level is +18.9 m (62 ft) above mean sea level. Water is withdrawn from the intake tower and it has three intake ports to cope with water level fluctuation.

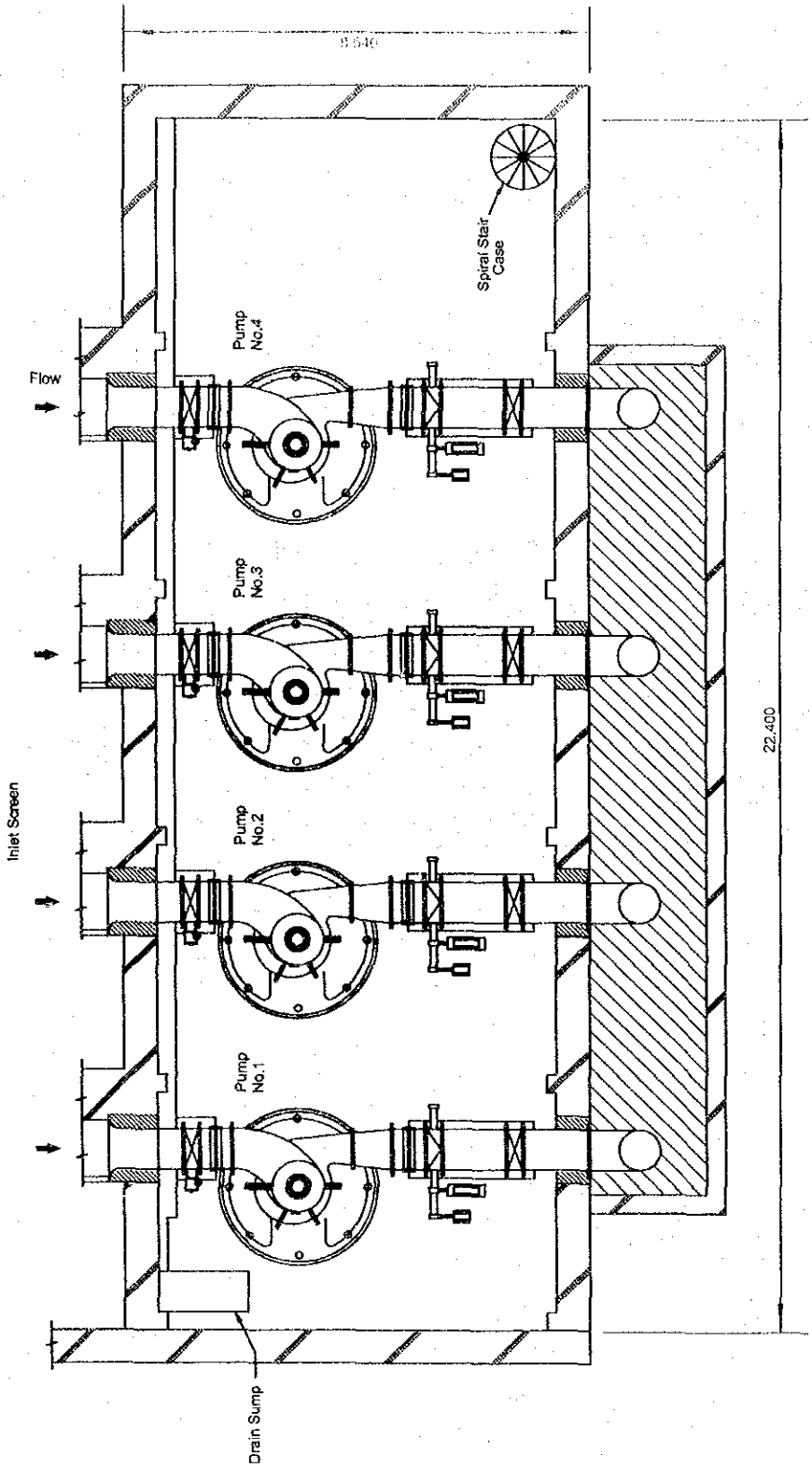
1st Intake Ports	+16.8 m
2nd Intake Ports	+14.9 m
3rd Intake Portt	+13.0 m



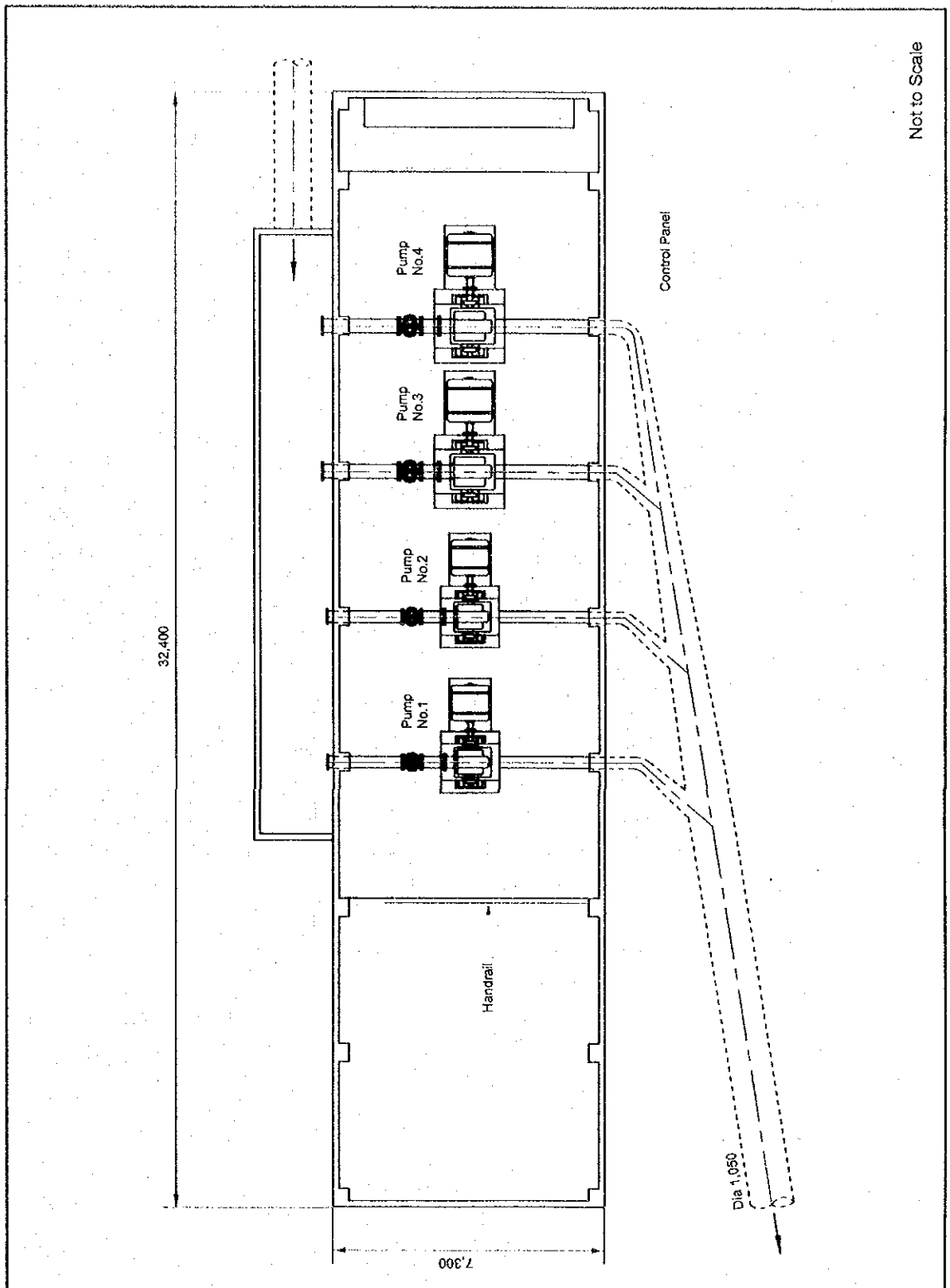
THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR

FIG 3.25

Plan of Phugyi Pumping Station



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 3.26
	Pump of Hlawga Pumping Station (No.1)	



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 3.27
	Plan of Hlawga Pumping Station (No.2)	

(4) Yegu Pumping Station

1) Reservoir

Built in 1906, Yegu P/S receives water from Gyobyu reservoir directly and Phugyi reservoir indirectly, through Hlawga reservoir. The storage reservoir in Yegu P/S is Reinforced Concrete (RC) made underground reservoir with dimension of ^{L}23.16 m x ^{W}22.3 m x ^{D}3.3 m x 2 units, and capacity of 3,409 m^3 (750,000 gallon). Overflow weir is set at an elevation of 5.60 m above mean sea level. Figure 3.26 shows the plan of this P/S.

2) Pumps

The followings are the pump specifications:

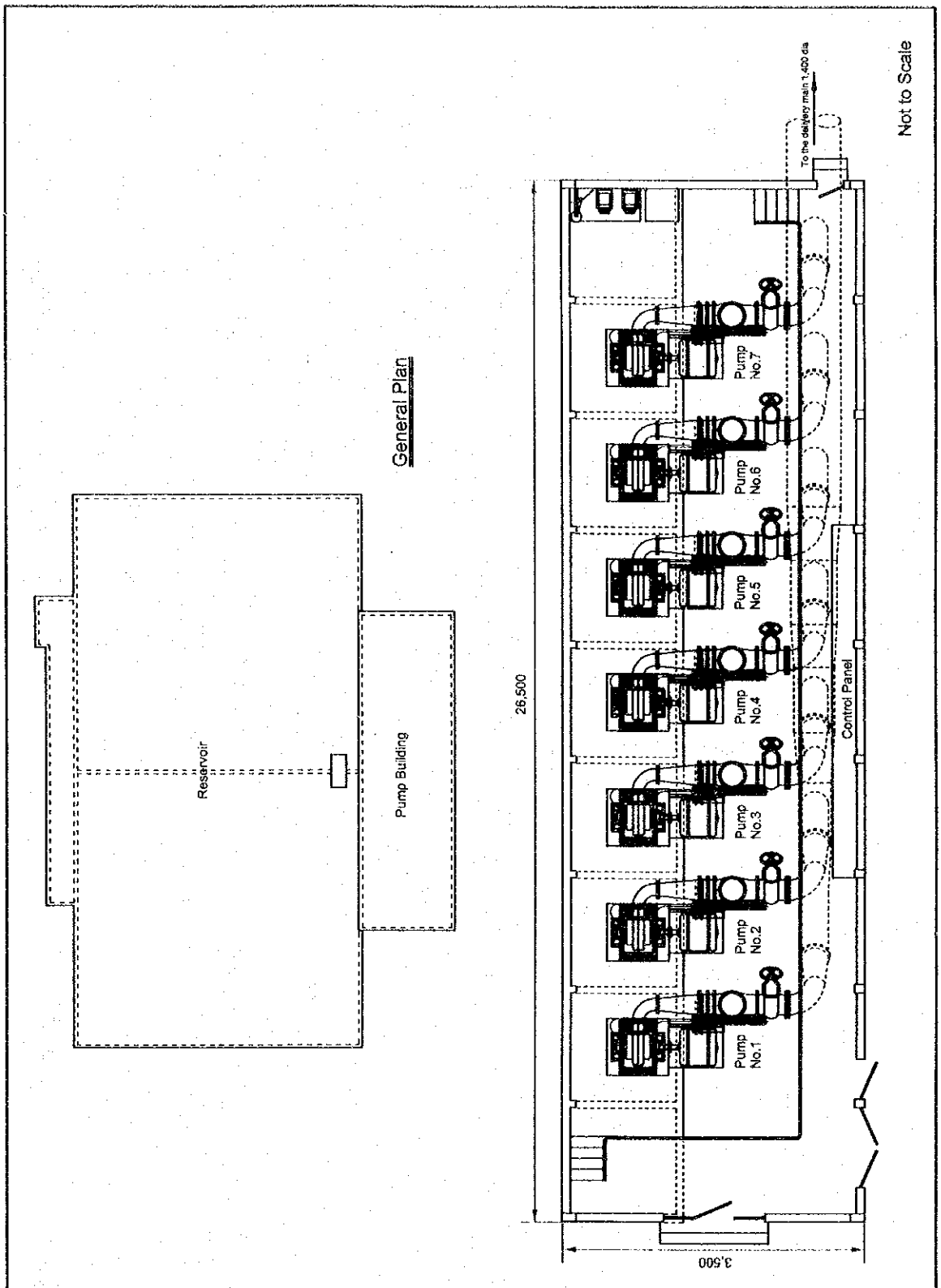
1,982 m^3/hr x 275 kW x 44 m x 7 units (2 units stand-by)
Horizontal single stage double suction volute pump
Manufactured in 1990

According to the operation record, six pumps are operated alternately. Pumps are controlled daily to maintain constant water level in reservoir below the said over flow level of 5.60 m. Pump operation status is satisfactory so far but all pumps, motors and electric panels have already been deteriorated. Since Yegu P/S is playing an important role as "key station" of whole Yangon water supply system, replacement of sand equipment shall be taken into account distribution flow nor pressure is not monitored.

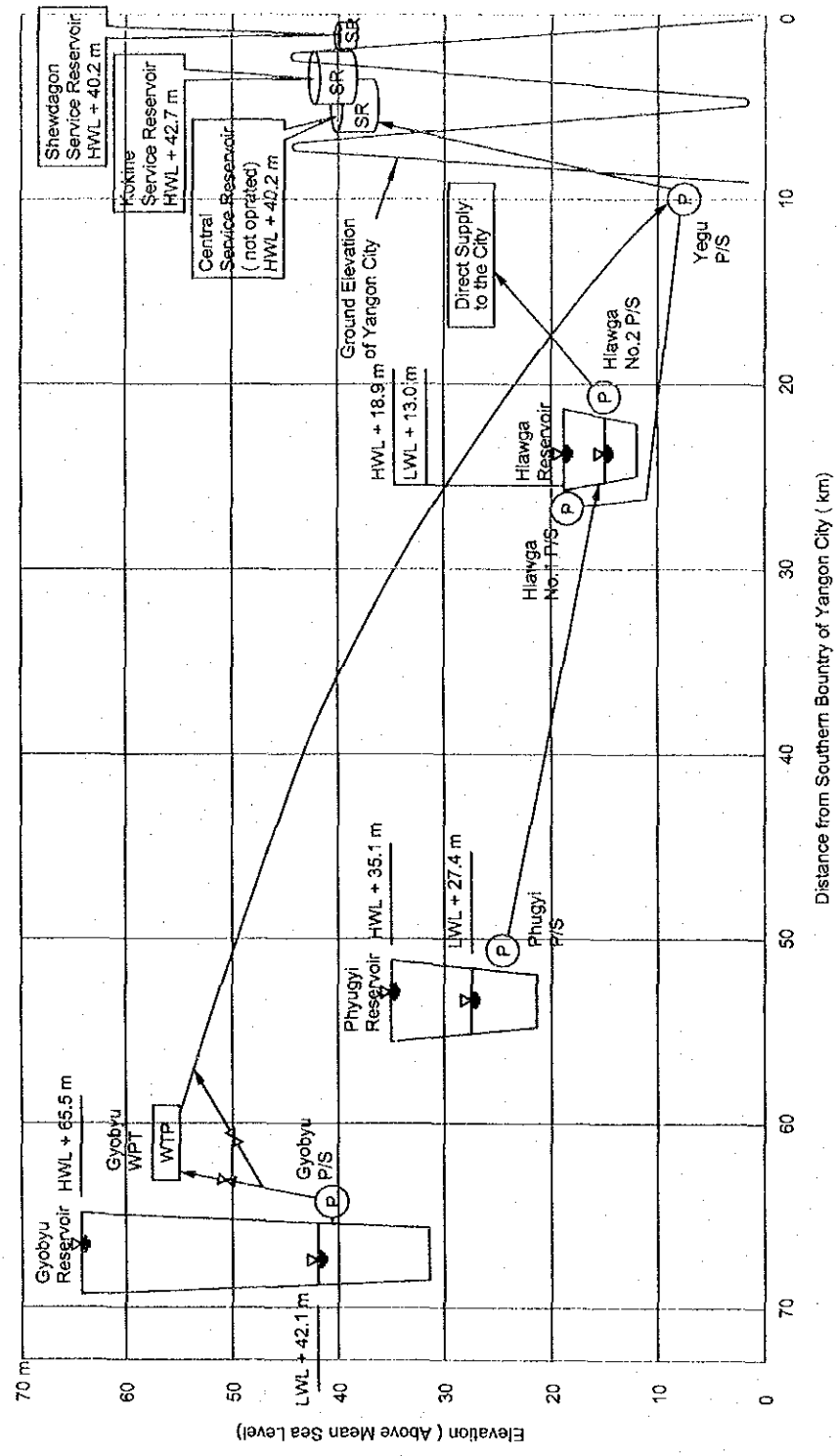
3) Chlorination Facility

There is chlorination house adjacent to the pump house. From three RC made bleaching powder dissolving tank, chlorine liquid with 25 % concentration is directly injected to the distribution main. Although three units of ejector with capacity of 430 L/hr are installed, only one unit is operated. According to the interview to the YCDC officers, chlorination is seldom conducted due to the unavailability of bleaching powder.

Figure 3.29 shows the elevation of these existing water supply facilities.



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 3.28
	Plan of Yegu Pumping Station	



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 3.29
	Elevation Diagram of Water Supply System	

3.5.2 Transmission System

(1) Outline of the System

As shown in Figure 3.30, there are four transmission pipelines and their specifications are as follows;

Table 3.25 Specifications of Transmission Pipelines

Name	Pipe Material	Diameter	Length (km)	Operation Starting Year
Gyobyu Pipeline	Mild Steel Pipe	1,400 mm (56 inch)	69.2 km	1940
Phugyi Pipeline	Pre-stressed RC Pipe	1,500 mm (60 inch)	26.0 km	1988
Hlawga Pipeline (No.1)	Pre-stressed RC Pipe	1,650 mm (66 inch)	16.7 km	1988
Hlawga Pipeline (No.2)	Cast Iron Pipe	1,050 mm (42 inch)	19.0 km	1904
Transmission Pipelines from Yegu P/S to Service Reservoirs	Cast Iron Pipe	225 mm (9 inch)	25.3 km	1904

Figure 3.30 shows the schematic diagram of the whole water supply system.

As shown in the figure, Gyobyu, Phugyi and Hlawga (No.1) Pipelines are connected to Yegu P/S and the remaining Hlawga No.2 Pipeline is directly connected to the distribution networks within the City. While, large volume of water is also extracted directly from these transmission pipelines, as shown in the following box.

Name	Distributed Facilities or Township
Gyobyu Pipeline	Mingalardon T/S, North Okkalapa T/S
Hlawga Pipeline (No.1)	Military Hospital, Shwepitha T/S, Insein T/S, Mayangon T/S, Hlaing T/S, Kamayut T/S
Hlawga Pipeline (No.2)	Military Hospital, Mingalardon T/S

In the Ngamoeyeik reservoir, an intake tower for water supply purpose was already constructed but transmission pipeline has not yet completed. Only 17.0 km out of total length of 47.75 km has been competed so far. Steel pipeline with diameter of 1,400 mm (56 inch) was installed starting from the Hlawga reservoir.

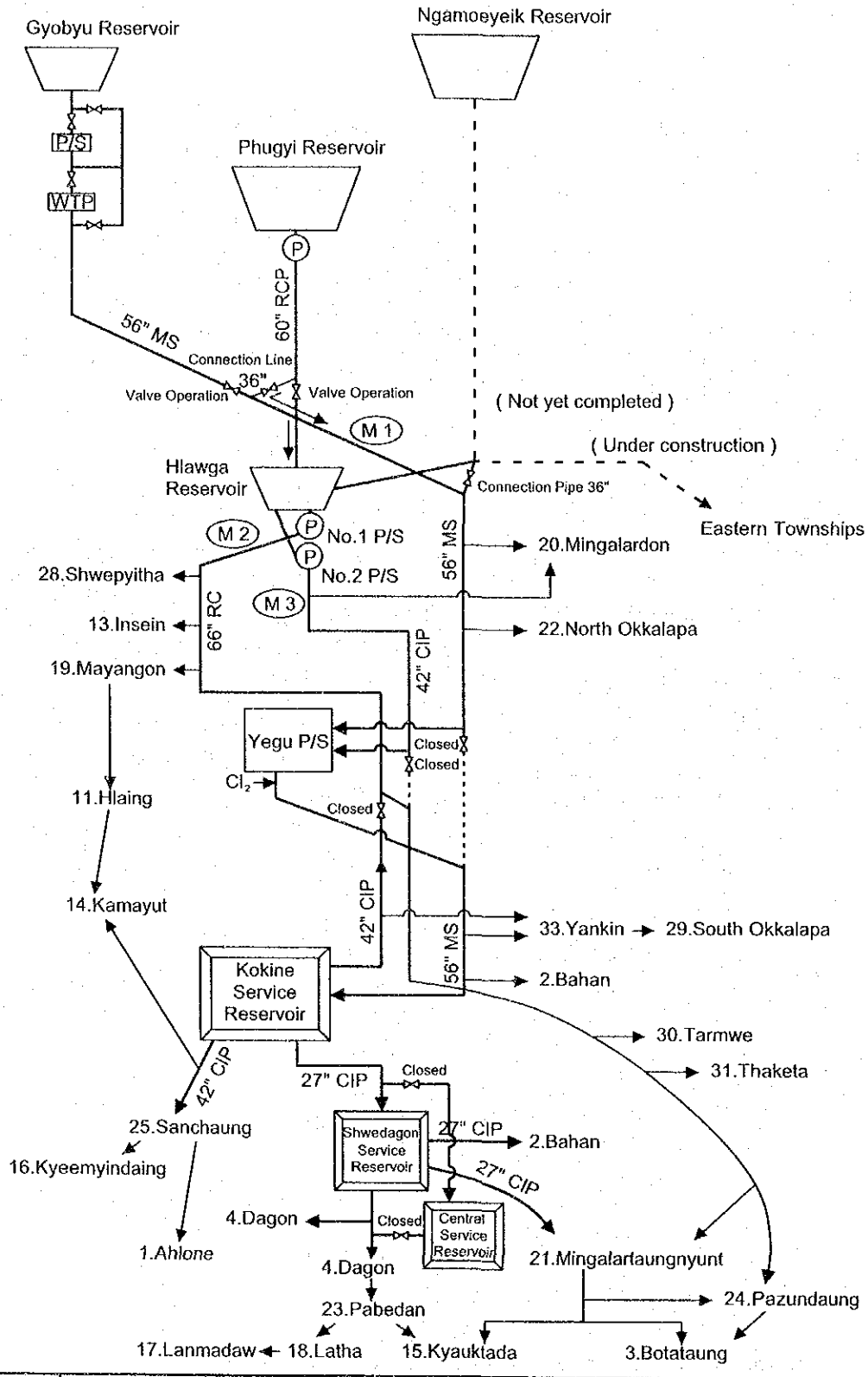
(2) Flow Measurement

On August 22 2001, flow measurement using an ultrasonic flow meter and a propeller-type flow meter was conducted at three points;

- Gyobyu-Phugyi transmission pipeline inter-connection point
- Hlawga No.1 transmission pipeline
- Hlawga No.2 transmission pipeline

Locations of measurement sites are also shown in Figure 3.30.

Measurement results are presented in Table 3.26 and Figure 3.31. Total flow was 350,800 m^3/day. Since these three transmission pipelines, namely Gyobyu and Hlawga No.1 and No.2 transmission pipelines are conveying water to the City Area, total flow amount of these pipes can be called as "Net Production Amount".



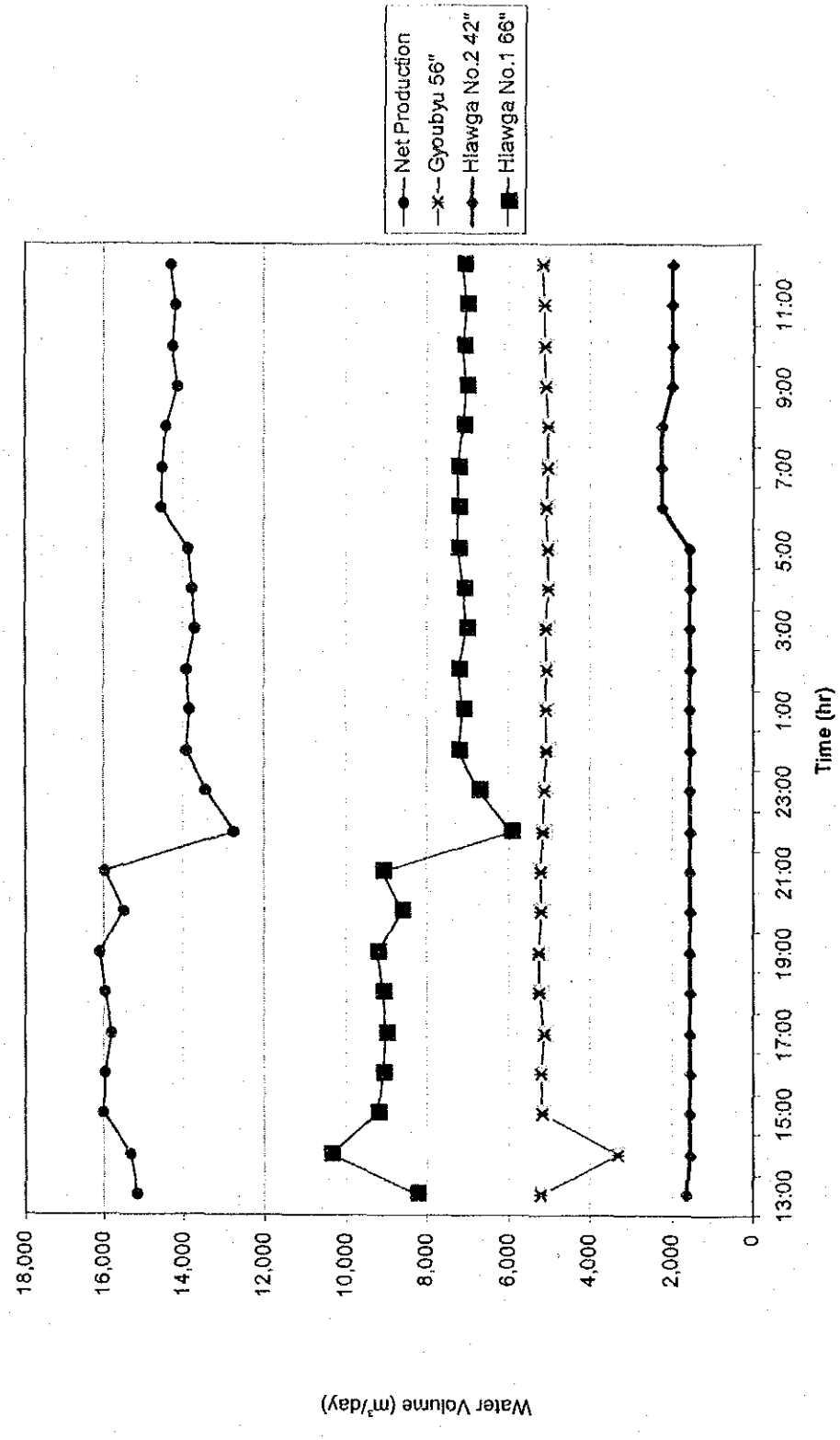
JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 3.30
	Shametic Diagram of the System	

Table 3.26 24 Hour Flow Measurement for Production Sources

Test Date 2001/8/22

Sites / Time	Gyoubyu 56"	Hlawga No.2 42"		Hlawga No.1 66"			Net Production
	M1	M2		M3			M1+M2+M3
	Ultra-sonic	Probeflo	Operated Pump	Probeflo	Operated Pump		
Time	(m^3/hr)	(m^3/hr)	No.4	(m^3/hr)	No.1	No.4	(m^3/hr)
13:00	5,200	1,674	OFF	8,262	ON	ON	15,136
14:00	3,320	1,600	OFF	10,376	ON	ON	15,296
15:00	5,160	1,600	OFF	9,223	ON	ON	15,983
16:00	5,200	1,600	OFF	9,127	ON	ON	15,927
17:00	5,130	1,600	OFF	9,031	ON	ON	15,761
18:00	5,240	1,600	OFF	9,127	ON	ON	15,967
19:00	5,260	1,600	OFF	9,223	ON	ON	16,083
20:00	5,230	1,600	OFF	8,647	ON	ON	15,477
21:00	5,210	1,600	OFF	9,127	ON	ON	15,937
22:00	5,170	1,600	OFF	5,957	ON	ON	12,727
23:00	5,120	1,600	OFF	6,725	ON	OFF	13,445
0:00	5,090	1,600	OFF	7,206	ON	OFF	13,896
1:00	5,080	1,600	OFF	7,109	ON	OFF	13,789
2:00	5,070	1,600	OFF	7,206	ON	OFF	13,876
3:00	5,070	1,600	OFF	7,013	ON	OFF	13,683
4:00	5,060	1,600	OFF	7,109	ON	OFF	13,769
5:00	5,060	1,600	OFF	7,206	ON	OFF	13,866
6:00	5,070	2,246	ON	7,206	ON	OFF	14,521
7:00	5,060	2,246	ON	7,206	ON	OFF	14,511
8:00	5,050	2,246	ON	7,109	ON	OFF	14,405
9:00	5,070	2,009	ON	7,013	ON	OFF	14,092
10:00	5,110	2,009	ON	7,109	ON	OFF	14,228
11:00	5,130	2,009	ON	7,013	ON	OFF	14,152
12:00	5,170	2,009	ON	7,109	ON	OFF	14,288
Average	5,055	1,752		7,810			14,617

TOTALS By Source	Gyoubyu 56"	HlawgaNo.2 42"		Hlawga No.1 66"			Net production
	121,330	42,047		187,439			350,816
Remarks	Gravity Flow	Pump No.4 was operated		Pump No.1 & 4 was operated			



THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR

FIG 3.31

24 Hour Flow Fluctuation by Prodection Sources

(3) Pumping Flow

1) Gyobyu Reservoir

In case of Gyobyu P/S, pump was not operated at the day of flow measurement and velocity coefficient of pipe was estimated using Hazen-Williams Formula as shown in the following box.

Parameter	C	D	Q	L	H_1	H_2
Dimension	None	m	m^3/sec	m	m	m
Case 1	88	1.4	1.404	22,357	21.93	21.93

where;

C: Velocity Coefficient

D: Pipe Diameter = 1.4 m (56 inch)

Q: Flow = 1.404 m^3/sec = 121,330 m^3/day (result of flow measurement)

L: Pipe Length = 22,357 m (from Gyobyu reservoir to the inter-connection)

H_1: Calculated Head Loss

H_2: Natural Head = 62.77 (Gyobyu Reservoir water level) - 19.44 (Pipe invert level at interconnection point) – 1.4 (pipe diameter) - 20.00 (remaining water head) = 21.93 m

Thus, velocity coefficient of transmission pipe was estimated at 88.

As aforementioned, Gyobyu P/S is seldom operated and therefore, gravity flow is the major flow from Gyobyu Reservoir throughout a year. Daily water volume conveyed by gravity flow from Gyobyu Reservoir was calculated based on the above conditions and reservoir water level in 2000. Detailed data is shown in Appendix D.

2) Hlawga No.1 Pumping Station

As shown in Tables 3.26, No.1 and No.4 pump were operated on the day of flow measurement. No.1 pump was operated 24 hours, while the No.4 was operated only from 13:00 to 22:00. Therefore, two pump were operated from 13:00 to 22:00 and one pump was operated from 23:00 until 12:00 in the following day. Average discharge during "two pump operation period" and "one pump operation period" was compared as shown in the following box.

Items	Average Discharge (m^3/hr)	Nominal Pump Discharge (m^3/hr/unit)	Ratio
Two Pump Operation	8,810	4,980	1.77
One Pump Operation	7,096	4,980	1.42

Note) Detailed data is shown in Appendix D

Even in case of "one pump operation", average discharge exceeded the nominal pump discharge but it is due to the natural water head of Hlawga Reservoir. Water level of reservoir on the measurement day was +56.08 inch (+17.09 m), while pump installation elevation was +35.08 inch (+10.69 m) above mean sea level.

In case of "two pump operation", total discharge was suppressed by pipe friction.

Daily pumped flow was estimated based on the operation record in 2000 using these ratios. Refer to Appendix D for detailed data.

3) Hlawga No.2 Pumping Station

Pump No.4 with nominal discharge of 2,700 m^3/hr was operated from 6:00 to 12:00. However, as shown in Table 3.26, constant flow was measured even during none operation hours. Even when pumps are not operated, there is gravity flow inside the transmission pipe since there is a natural water head just like as No.1 P/S.

Based on the conditions at measurement day, velocity coefficient of transmission pipe was estimated as in the following box.

Parameter	C	D	Q	L	H_1	H_2
Dimension	None	m	m^3/sec	m	M	m
Case 1	85	1.05	0.49	14,200	8.60	8.69

where;
C: Velocity Coefficient
D: Pipe Diameter = 1.05 m (42 inch)
Q: Flow = 0.49 m^3/sec = 1,764 m^3/hr (nearly equal to the result)
L: Pipe Length = 14,200 m (from Hlawga No.2 P/S to Yegu P/S)
H_1: Calculated Head Loss
H_2: Natural Head = 17.09 (Hlawga Reservoir water level) - 5.90 (Yegu P/S reservoir HWL) – 2.5 (Loss at P/S) = 8.69 m

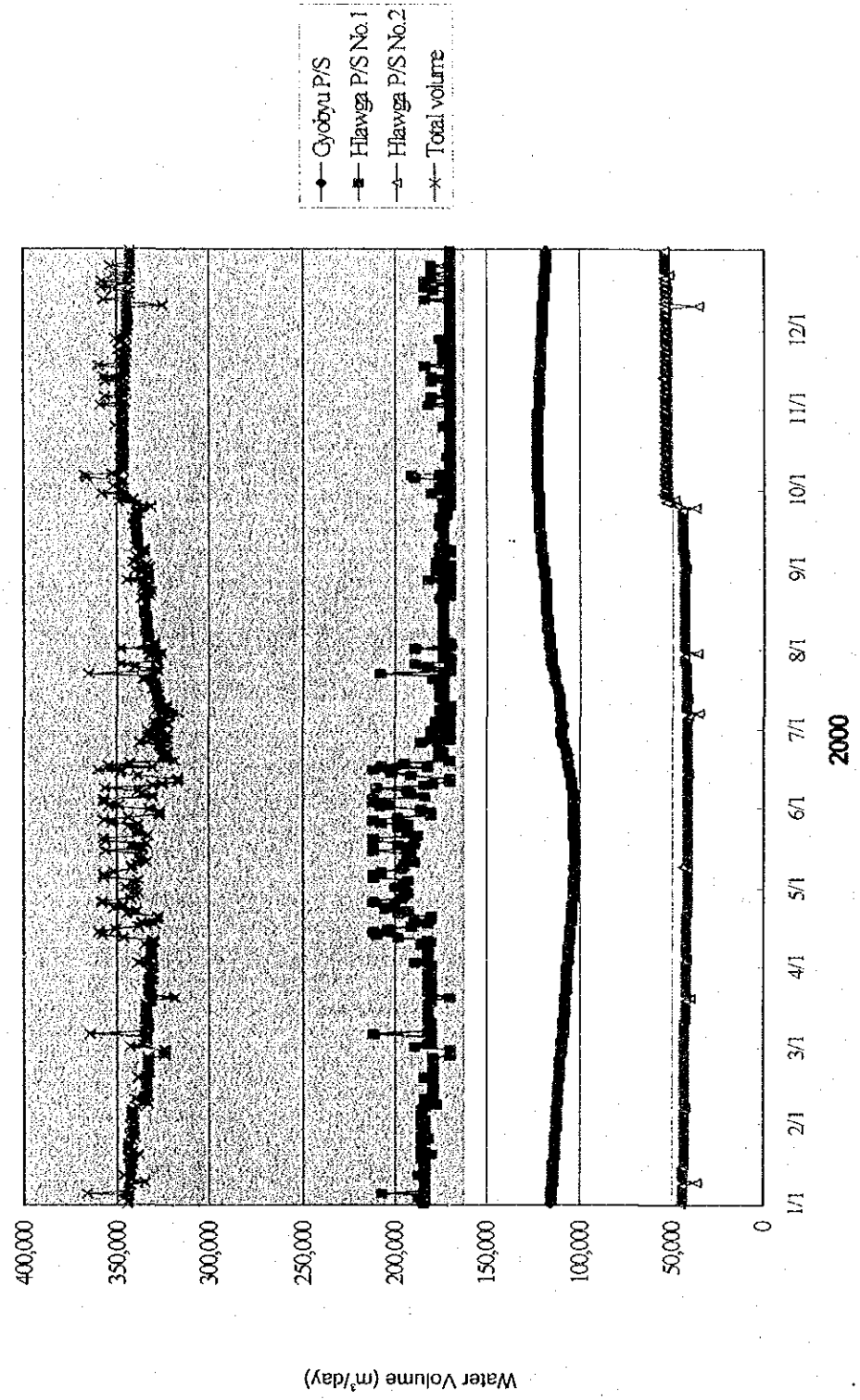
Thus, velocity coefficient of transmission pipe was estimated at 85.
Pumped flow in 2000 was estimated based on;

- Pump operation record (pump efficiency = 80 %)
- Gravity flow calculated based on reservoir water level and conditions mentioned above

Appendix D shows detailed data.

4) Total Pumping Flow

Figure 3.32 shows the flow in three transmission pipes and their total.
As shown in the figure there is flow fluctuation caused by pump operation effected by seasonal water level fluctuation in reservoirs and power failure, no pump operation.
However, as shown in the flow measurement results pumps have considerable capacity to convey water to the City Area as far as power is available. The possible pumping amount is assumed as around 350,000 m^3/day.



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 3.32
	Transmission Volume from the Existing P/S	

3.5.3 Distribution System

As described in the previous section, three transmission pipes are connected to Yegu P/S and one is directly connected to distribution network in the City. Water pumped from Yegu P/S is sent to Kokine Service Reservoir and eventually to Shwedagon Service Reservoir. The followings are the specifications of these service reservoirs;

Table 3.27 Characteristics of Service Reservoirs

Name	Dimension	Capacity	H.W.L./L.W.L.
Kokine Service Reservoir	RC made Semi-underground reservoir ^{L} 90.2 m x ^{W} 85.2 m (widest) x ^{D} 6.1 m x 2 units	90,900 m^3 (20 MG)	+42.7 m/+36.6 m (above MSL)
Shwedagon Service Reservoir	RC made underground reservoir ^{L} 19.2 m x ^{W} 38.8 m x ^{D} 6.1 m	4,545 m^3 (1 MG)	+40.2 m/+34.1 m (above MSL)
Central Service Reservoir	RC made underground reservoir Dimension is unknown	45,450 m^3 (10 MG)	+40.2 m/+34.1 m (above MSL)

Note) MSL = Mean Sea Level

Further, there is another service reservoir called "Central Service Reservoir", however, due to the structural defect and heavy leakage it has not been operated.

As to the distribution network, it was comprised of various pipe diameters, materials and pipe ages. The following table shows the summary of the existing pipe network, which were the results of our quick survey. One of the problems is that there is no proper network database with YCDC. Thus, we carried out quick pipeline survey in our limited time. The results of the pipeline survey is summarized in Appendix F. YCDC needs update the pipeline data as soon as possible.

Table 3.28 Summary of Existing Pipe Network (unit of pipe length: ft)

Pipe Age (Years)	Pipe Materials						Total	
	CIP	MSP	DIP	GIP	PVC	RCP	Length	%
Over 100	0	0	0	0	0	0	0	0.0
70 to 100	628,168	0	0	0	0	0	628,168	29.2
50 to 70	211,121	0	61,076	20,878	4,800	32,249	330,124	15.3
20 to 50	496,165	0	27,500	20,281	11,657	37,150	592,753	27.5
Less than 20	81,053	0	4,700	93,398	386,198	38,546	603,895	28.0
Total	1,416,507	0	93,276	134,557	134,557	107,945	2,154,940	100.0

Note) CIP = Cast Iron Pipe, MSP = Mild Steel Pipe, DIP = Ductile Iron Pipe
GIP = Galvanized Iron Pipe, RCP = Reinforced Concrete Pipe,
PVC = Polyvinyl Chloride Pipe
Source: JICA Study Team

As can be seen in the table, 71% of the pipe is Cast Iron Pipe and aged pipe (over 50 years) is about 57%

Leakage from aged pipe, especially over 50 years, is highly suspected. Further, improper pipe installation methods, inappropriate pipe connection, inferior pipe material, valves and fittings can be another cause of losses, which is accounted as over 50 % of distributed water volume.

Table 3.29 Summary of Existing Pipe Network (unit of pipe length: m)

Pipe Age (Years)	Pipe Materials						Total	
	CIP	MSP	DIP	GIP	PVC	RCP	Length	%
Over 100	0	0	0	0	0	0	0	0.0
70 to 100	191,468	0	0	0	0	0	191,468	29.2
50 to 70	64,350	0	18,616	6,364	1,463	9,830	100,623	15.3
20 to 50	151,233	0	8,382	6,182	3,553	11,323	180,673	27.5
Less than 20	24,705	0	1,433	28,468	117,715	11,749	184,069	28.0
Total	431,757	0	28,431	41,013	122,731	32,902	656,834	100.0

Source: JICA Study Team

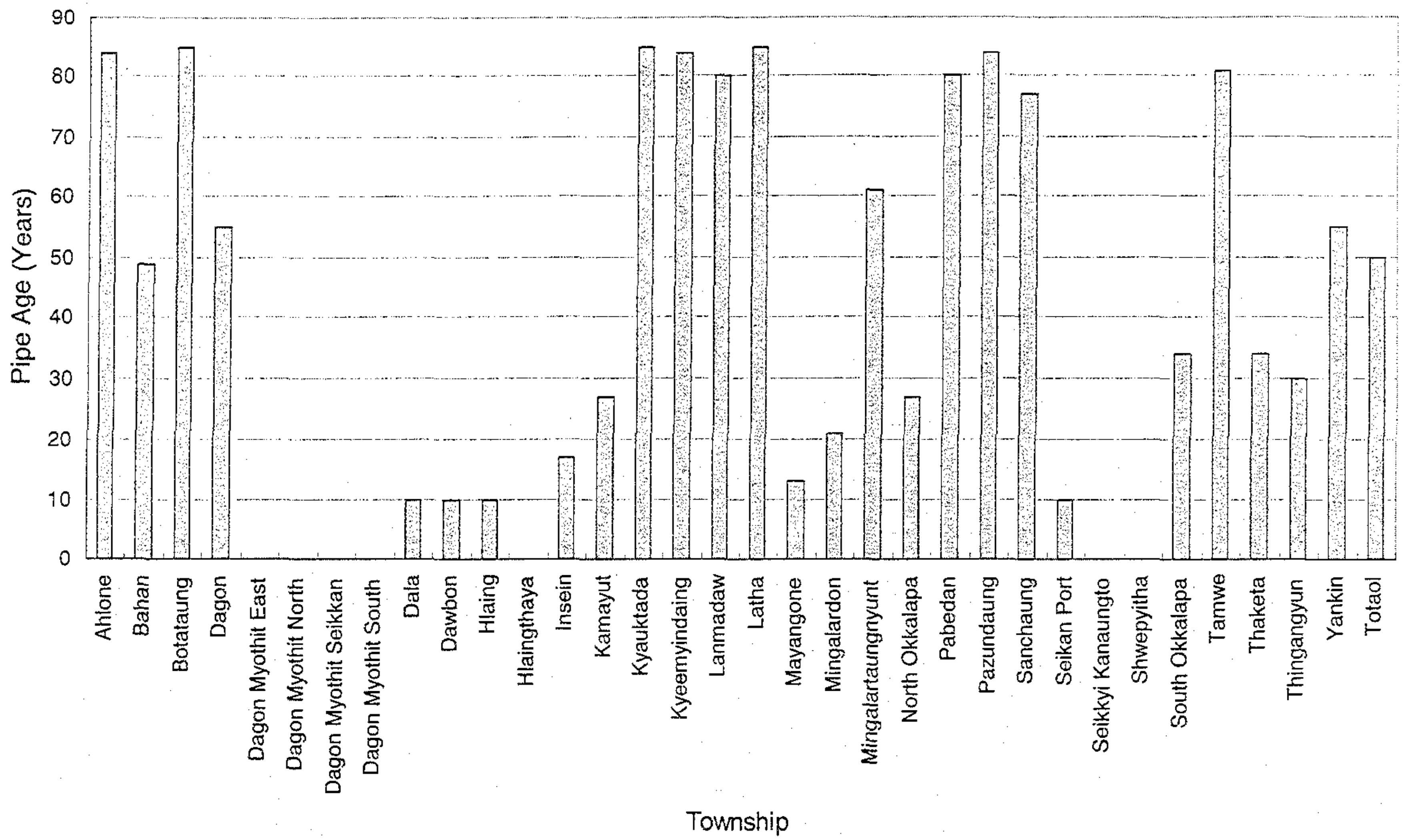
Also, new projects are on-going, including connecting distribution main to the existing Ngamoeyeik Pipe to supply water to Dagon Seikkan T/S, which is now being implemented by YCDC. Since Ngamoeyeik pipe has not been completed, said distribution main has been temporally connected to Gyobyu pipe through connection pipe, as shown in Figure 3.28. So, water from Gyobyu reservoir will be diverted to this new distribution main in the beginning, but upon completion of Ngamoeyeik pipe, water from Ngamoeyeik reservoir will be supplied. RC pipes with diameter of 900 to 400 mm are installed. This project is scheduled to complete in March 2002.

The Figure 3.33 shows aged pipe by township by township, based on the pipe investigation. Overall average age is 50 years, which could be said very old. Bahan is the exception which has slightly less than 50 years average age. The replacement of aged pipe is also one of urgent project. The Figure 3.34 shows targeted aged pipes (PVC is more than 20 years, the others are more than 50 years ages), which exist in 14 townships and total length is 350 km approximately as shown in Table 3.30. Those pipes really need to be replaced soon.

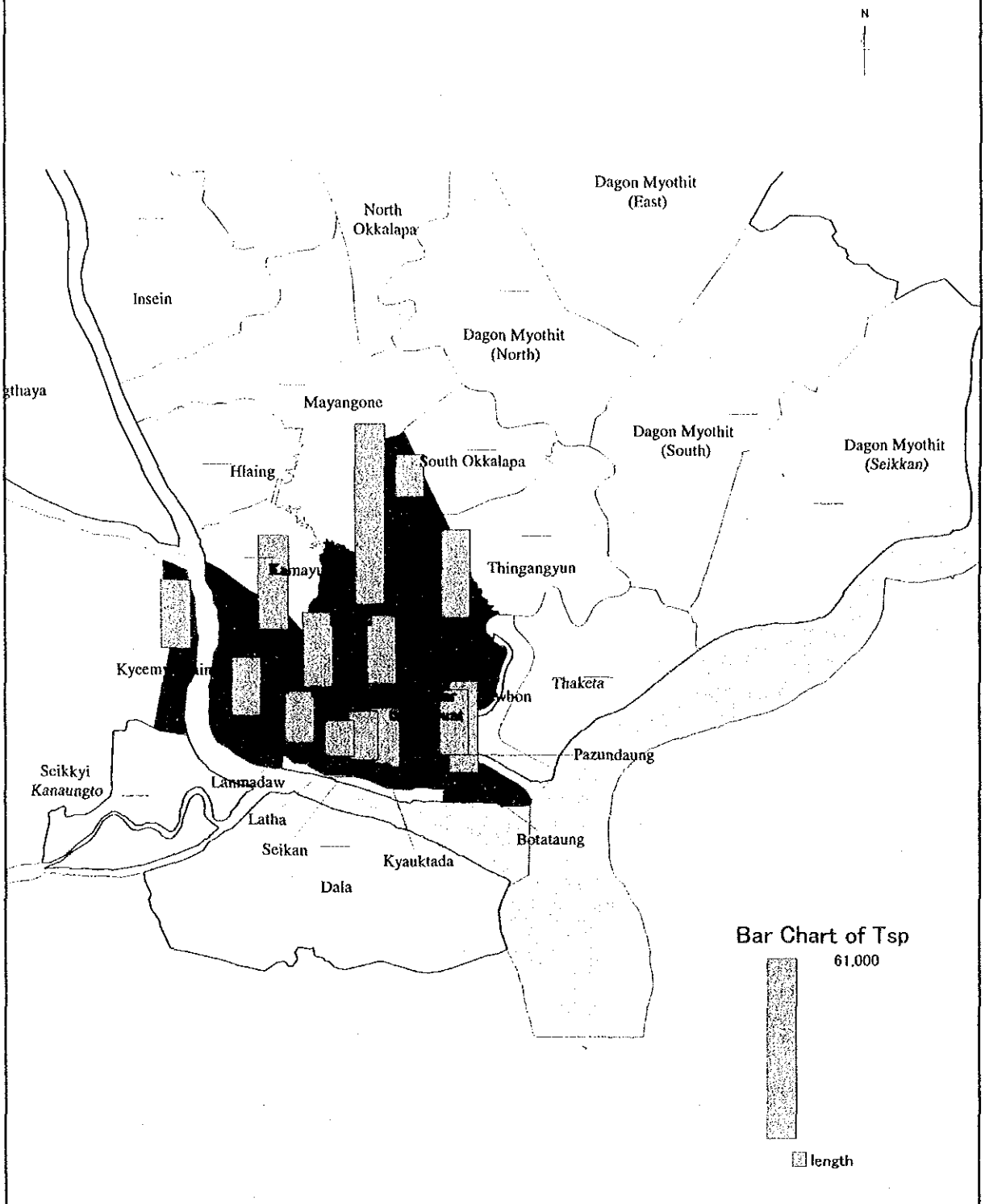
Table 3.30 Aged (Over 50 Years, Except Bahan) Pipe Network by Townships (m)

Township	Diameter (mm)											Total (m)
	75	100	125	150	200	225	250	300	350	400	450	
Ahlone	0	2,300	0	15,400	0	0	0	500	0	0	1,400	19,600
Bahan	5,200	11,000	0	32,300	1,400	2,000	800	8,100	0	0	0	60,800
Botataung	0	900	0	17,700	400	400	0	11,300	0	0	600	31,300
Dagon	1,700	5,300	0	10,200	0	5,600	0	2,600	300	0	0	25,700
Kyauktada	2,600	0	0	11,700	300	700	0	4,900	0	0	0	20,200
Kyeemyindaing	0	6,100	0	15,900	0	1,400	0	0	0	0	0	23,400
Lanmadaw	1,200	1,000	0	8,400	0	4,700	0	2,900	0	0	0	18,200
Latha	1,000	0	0	6,700	0	1,900	0	2,600	0	0	0	12,200
Mingalartaungnyunt	0	1,900	0	12,900	0	0	700	7,100	0	0	900	23,500
Pabedan	0	0	0	9,000	0	1,000	0	6,100	0	0	0	16,100
Pazundaung	200	2,100	0	14,100	0	0	900	3,600	0	0	800	21,700
Sanchaung	0	5,200	0	21,700	0	4,400	0	0	0	400	0	31,700
Tamwe	1,000	7,600	0	18,600	0	2,000	0	0	0	0	1,000	30,200
Yankin	1,400	7,400	0	2,500	300	0	1,000	1,700	0	0	0	14,300
Total (m)	14,300	50,800	0	197,100	2,400	24,100	3,400	51,400	300	400	4,700	348,900

Source: JICA Study Team



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 3.33
	Average Age of Distribution Pipe by Township (weighted by pipe length)	



JICA	THE STUDY ON IMPROVEMENT OF WATER SUPPLY SYSTEM IN YANGON CITY IN THE UNION OF MYANMAR	FIG 3.34
	Targetted Aged Pipes in 14 Townships	

3.5.4 Major Issues

(1) Gyobyu Water Treatment Plant

Due to the insufficient chemical mixing effect in the existing mixing channel, plant has not displayed its nominal capacity. Improvement of Alum injection device and said mixing channel is desirable. Tube or plate settler shall be installed in sedimentation tank to upgrade its sedimentation capacity. Further, chlorination has been conducted only when chlorine gas is available. Considering the recent unavailability of chlorine gas, which used to be imported from India, disinfection shall be performed by bleaching powder, which is most common procedure currently in Yangon. Therefore, rehabilitation of chlorination building is also needed.

(2) Pumping Stations

So far, the operational status of each P/S is satisfactory, not causing serious breakdowns. However, most of the pumps and electric equipment, including control panels have been operated over 20 years and deteriorated. Although each P/S has stand-by pumps, replacement of duty pumps and related equipment shall be considered toward the stable water supply through the future.

(3) Disinfection

Currently, chlorination using bleaching powder is only conducted in Yegu P/S but due to the unavailability of chemical, present chlorination is quite insufficient. Bleaching powder is only available in 2 months and during the remaining 10 months, raw water from reservoirs is distributed without any disinfection. It is quite serious issue since unsafe water might cause health hazard to the consumers. Continuous chlorination shall be conducted through the year at Gyobyu WTP, Hlawga No.2 P/S and Yegu P/S.

(4) Distribution Pipelines

As aforementioned, the existing pipeline is comprised of various pipe materials and pipe age, some nearly 100 years old. Therefore, there is a great possibility of leakage from deteriorated pipes, joints and also from inferior valves, fittings. Improper pipe laying and pipe connection methods can be another cause. Leaked pipelines, especially in low-pressure areas, are vulnerable to contamination as well. For the efficient use of limited water source and to secure safe water supply, leakage from pipelines shall be eliminated immediately.

(5) Central Service Reservoir

Built in 1965, this service reservoir has a capacity of 45,450 m^3 (10 MG). However, due to the heavy leakage from walls, this reservoir has not been operated. Considering its huge capacity, advantageous location and elevation, 40.2 m above mean sea level, rehabilitation plan shall be prepared to fully utilize this important and useful service reservoir.

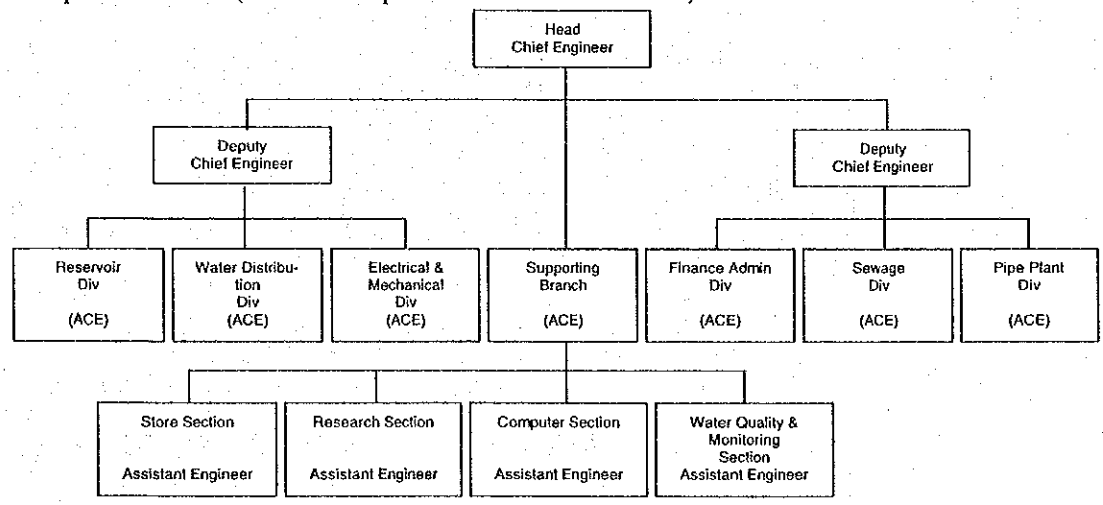
3.6 ORGANIZATIONAL STRUCTURE OF WATER SUPPLY AND SANITATION ENGINEERING DEPARTMENT

For the purpose of water sector management, WSS department has organized itself into 6 divisions and 4 sections (Figure 3.35). The role and functions of the department are listed in Appendix K-1.

The head of office is the Chief Engineer (CE) who is assisted by 2 deputy CEs. Of the two posts, one is vacant at the time of the study. Each division is headed by an Assistant Chief Engineer (ACE) while an Assistant Engineer (AE) is incharge of a section. The ACE and the AE report directly to the CE.

The responsibilities of the CE, deputy CE and the AE are found in Appendix K-2 and K-3.

The field organization of WSS consists of four district water supply & sanitation engineers and 32 township WSS offices (one township office is to be established).



ACE means Assistant Chief Engineer.

Figure 3.35 Organization Chart of Water Supply & Sanitation Engineering Department

3.6.1 Role and Functions of Divisions / Sections

The main activities of 6 divisions and 4 sections are summarised below.

(1) Reservoir Division

As the name implies, this division is responsible for the operation, maintenance, repair and protection of the three reservoirs which supply water to the City. It is also responsible for the development of Ngamoeyeik reservoir which is being developed at present. All of its 487 staff organized into three clusters is based in the reservoir sites namely, Gyubyu, Hlawga and Phugyi. Each staff cluster is headed by an Assistant Engineer (AE) backed by a team of skilled and unskilled workers. The head of reservoir division is based in the head office in the City Hall.

(2) Water Distribution Division

The ACE providing leadership to this division together with the supporting staff are located in the head office. The division has three sections namely, house connections, operation & maintenance and pipeline. In reality, these sections do not exist. The relevant tasks are accomplished by shifting staff from other locations entirely on an ad-hoc basis. The four district offices (section 3.6.2) report to this division.

The division is responsible for the operation and maintenance, and repair of the entire water supply pipe network from the main pumping stations down to the customer off take pipe lines and water supply fixtures.

The organization chart for the division is presented in Figure 3.36.

The main activities of this division are:

- Implement water distribution activities in 28 townships
- Operation and maintenance (O&M) and major repair of the transmission main pipes, distribution mains and distribution pipes
- Inspection and control of water leakage from the transmission and distribution lines
- Approve / reject applications for: (a) new water / sewage connections, (b) installation of meters, (c) authorise change from one type of connection to another type upon request by the customer, (d) approval of internal connections and other applications relating to the management of water and sanitation system
- Provide leadership and guidance to township teams in all work areas pertaining to the division

It is to be highlighted that leakage control and pipeline major repair work teams are currently attached to this division. The relevant work teams are established by picking up professional staff members from different areas of the organization on an ad-hoc basis. This arrangement is not conducive for the development of specialized skills and professional advancement of members of the relevant task-oriented teams.

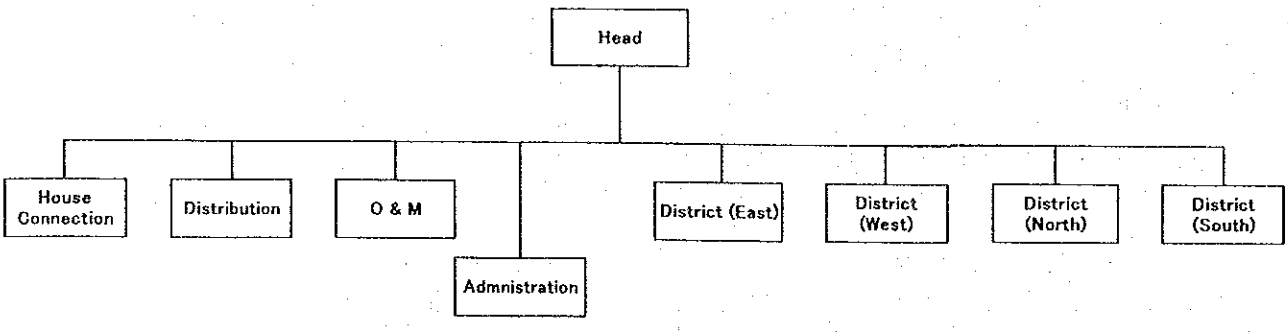


Figure 3.36 Organization Chart of Water Distribution Division

(3) Electrical and Mechanical Division

This division is headed by an ACE. Work of the division is carried out by a team of engineers, technicians, skilled and unskilled workers. The division is located within the City Hall

building of YCDC.

The division has three work areas namely, electrical, mechanical and tube wells. The main responsibility of the division is to undertake repairs for electrical and mechanical equipment such as pumps and compressors relating to water pumping.

The organization chart for the division is given in Figure 3.37.

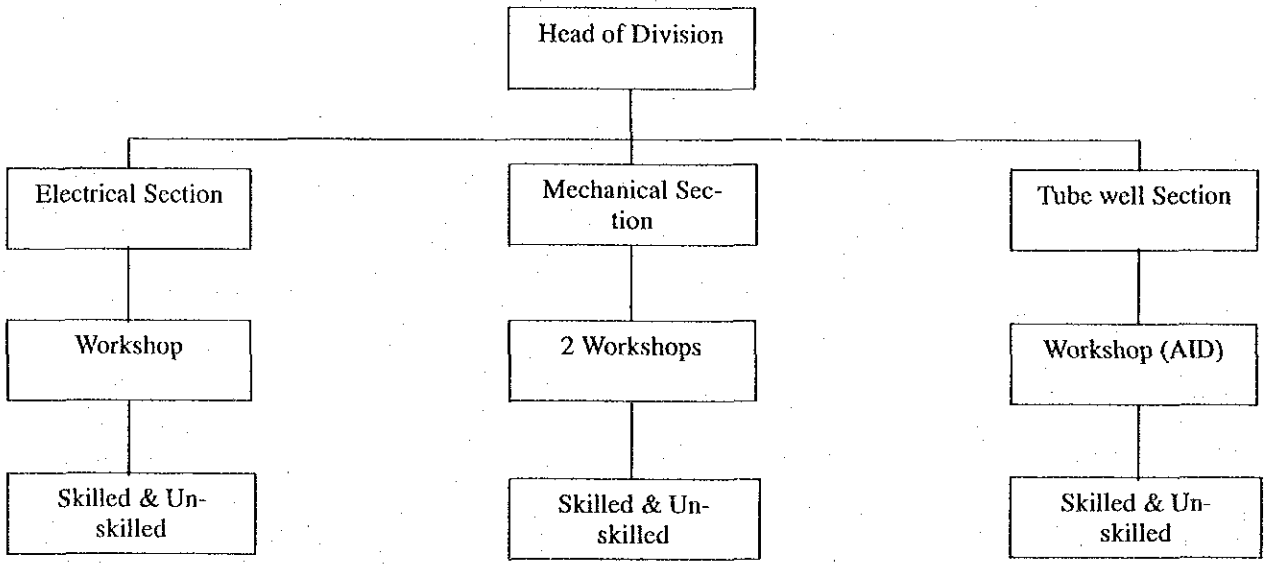


Figure 3.37 Organization Chart of Electrical and Mechanical Division

The main activities of the division are:

- Operation, maintenance and repair of 217 YCDC tube wells, 67 submersible pumps, 67 compressors and 67 motors
- Maintenance of electric parts such as transmission wires and repair of relay switches
- Installation of water pumps in pumping stations and tube wells
- Administering 12 engineers (5 senior staff and 7 junior staff), a team of plumbers, electricians, technicians, and clerical staff

Spare parts are obtained either from WSS store or are bought from the market.

The division has several mobile work teams ready to be dispatched out to different locations where problems are reported. The task of teams is to identify and subsequently repair defective electrical and mechanical gadgets.

(4) Pipe Plant Division

Located in Insein township, this division is responsible for the construction of three types of reinforced concrete pipes and their laying in designated areas. It operates a production factory, carries out quality checks of products manufactured and administers a team of engineers,

technicians, skilled and unskilled workers, and office staff. The organization chart for the division is given out as Figure 3.38.

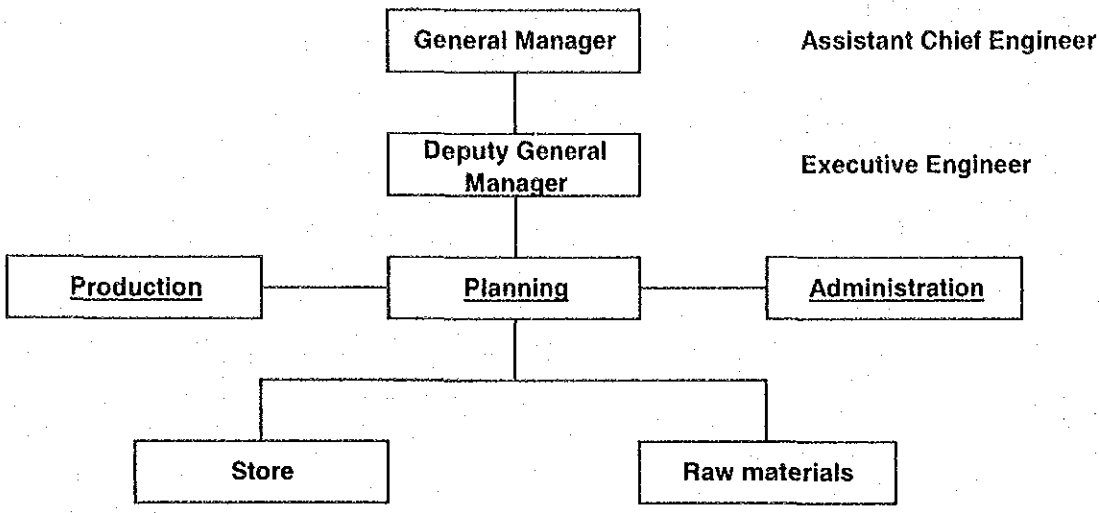


Figure 3.38 Organization Chart of Pipe Plant Division

Among the main activities of the division are:

- Plan the requirement of pipelines and other hardware items
- Organize for production including the procurement of raw materials and storage.
- Plan and execute quality control work
- Cut drains to lay pipelines and transport to work sites
- Lay the pipelines in designated areas

(5) Sewage Division

This division is responsible for the operation and maintenance of the sewage line collecting the sewer from 8 townships. The division itself is organized to work in two field locations each under the charge of a sanitation engineer. The two field locations correspond to the areas where sewer lines are in operation.

The organization structure of the division is found in Figure 3.39.

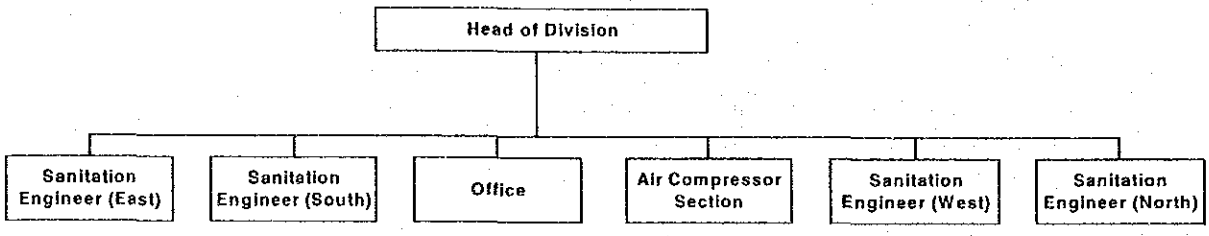


Figure 3.39 Organization Chart of Sewage Division

(6) Administration and Finance Division:

This division has two branches namely, finance and administration. The division is responsi-

ble for all financial and administrative matters pertaining to the work of WSS. Staff salaries and wages however, are paid directly by the Budget and Accounts Department of YCDC. Preparation of revenue and expenditure forecasts, monitoring the actual level of revenue and expenditure, monitoring and recording revenue collected by townships and advising township offices on financial matters are the main functions.

The organization chart for the division is given in Figure 3.40.

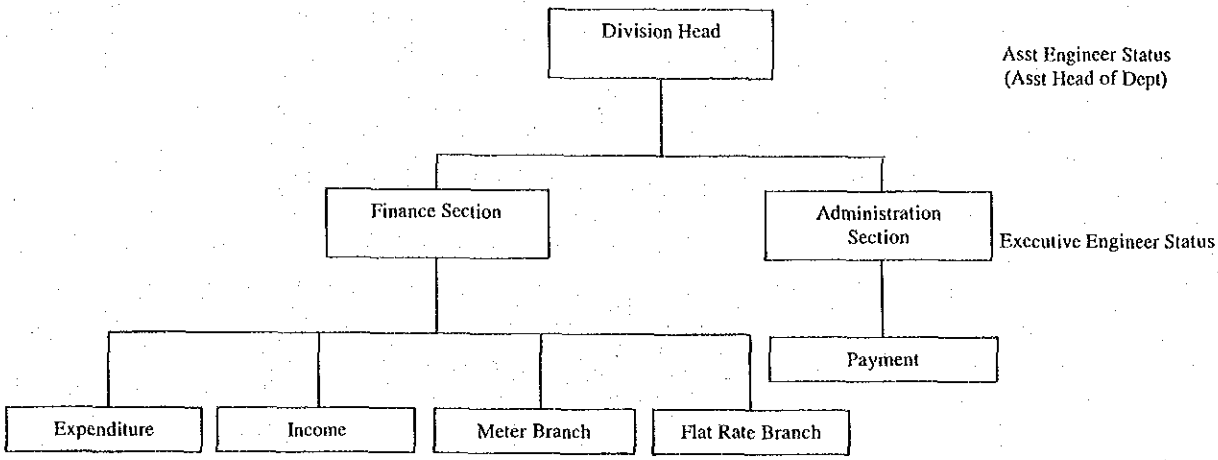


Figure 3.40 Organization Chart of Administration and Finance Division

(7) Store section

WSS has a small store the management of which is the responsibility of this section. The staff includes two engineers and security guards. None of the engineers have had any training on store management or inventory control.

As expected, the stocks are not computerised nor are movement of parts and fixtures. Items are issued from this store, subject to availability, to townships on approval by the CE.
The organization chart for the store section is found in Figure 3.41.

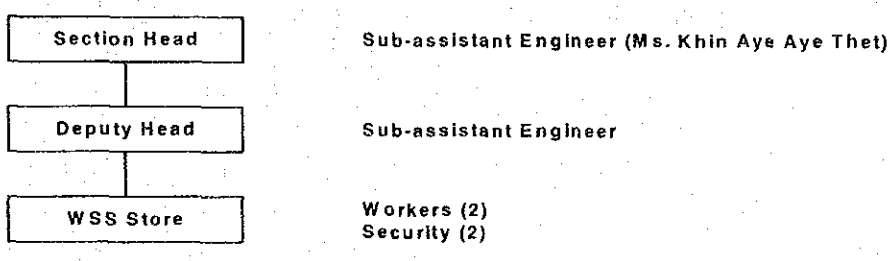


Figure 3.41 Organization Chart of Store Section

(8) Computer Section

This is a newly established section in WSS. Data computerization and production of flat rate water bills (section 3.6.8) are the main functions of this section. The section is not involved in any programming work as before which is now handled under a contract with a private firm.

The activities of the section are listed below:

- Draw pipe network and diagrams managed by WSS and computerize information. It doesn't include location of service networks and connections. Network diagrams for 27 townships as at 1995 are available in the computer.
- Prepare flat rate water bills every quarter and dispatch to finance section for onward transmission to township staff via district offices
- Area of each township based on 1990 aerial photos is available in their computer
- Organization chart of WSS, number of cadre posts but no actual staff data on townships
- Maintain records on number of meters by township after August 2000

The section has no computerised data on township population, household numbers, water use levels, raw water production, information on spareparts, chemicals and other supplies and information on water use by customers connected to meters; nor data on the progress of payment of bills by customers are kept by this section.

(9) Research Section

Research section is the latest addition to the department of water supply and sanitation. Formerly, a part of the present water quality monitoring section, research section is just a few months old now. The section's staff consists of a sectional head, 3 SAEs and 2 draught men. The current staff has no skills or experiences in planning for and implementation of research work.

The current functions of this section are:

- To collect and store various engineering drawings such as reinforced concrete structures, underground tanks, pipeline support structures, etc.
- To check and review engineering designs completed by others in the department
- Review bills of quantities relating to engineering design work
- Prepare engineering designs for structures and completion of drawings for such structures.

Obviously, the section does not undertake any research relating to water supply and sanitation at present. It is necessary to formulate a list of "research" functions, a research plan and a few research studies. Such activities will have to be commenced after strengthening the section with qualified and skilled staff to plan and execute research activities.

(10) Water Quality and Monitoring Section

This is a newly established section. It is in the process of organizing work at this stage. The main role of this section is to collect water samples from various locations, analyse samples

for water quality and report the results. The section does not have a laboratory yet.

All section heads attend weekly meetings chaired by the CE

3.6.2 Field Organization

The organization in head office is backed up by 4 district offices and an office in each of the 33 townships to carry out all relevant activities. However, one township office have not been established to-date.

(1) District Organization

The organization structure of the district office is given in Figure 3.42.

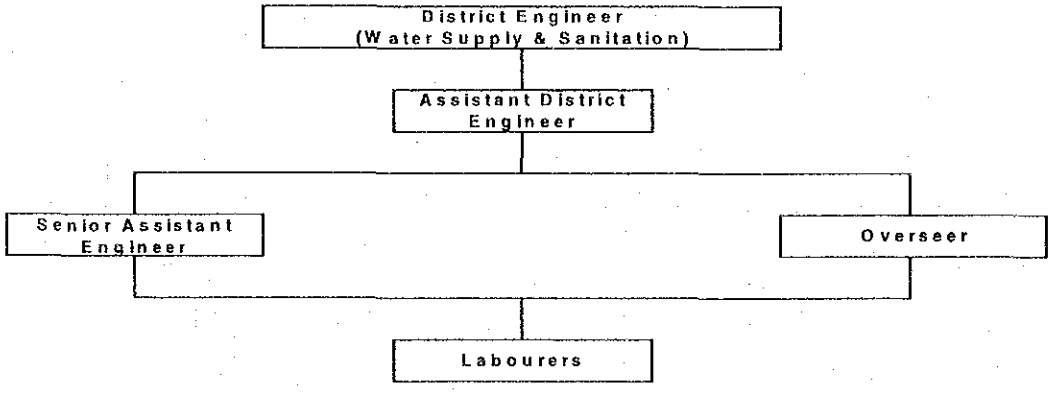


Figure 3.42 District Organization of Water Supply & Sanitation Engineering Department

The 33 townships are grouped under 4 district offices in order to facilitate supervision and coordination of work. Appendix Table K-4 gives the grouping of townships under the four districts.

The head of district office is the district water supply and sanitation engineer. Other technical staff in the district office includes 1 assistant district engineer, 1-2 senior-assistant engineers, an overseer and 1-2 labourers.

The function of district office is mainly supervisory. The technical staff attached to the district office assist township technical staff by way of advice. All reports and correspondence from the township office to the head office is channelled via district office. The district staff is expected to check, verify and correct reports, if needed, before forwarding them to the water distribution division.

The district WSS engineer reports to the head of water distribution division.

(2) Activities of District Engineer (DE)

The district engineer is responsible for the following tasks:

- Inspection and checking water supply and sanitation work (leakage from the network, connections, meters, water consumption, septic tanks, water waste, illegal connections etc.)
- Supervision of work of townships WSS office
- Inspection work and preparation of reports pertaining to the district
- Checking technical reports generated by township WSS offices every Friday before forwarding to the relevant divisions.
- Attends following meetings:
  - ✓ Meeting with the relevant township staff every Tuesday
  - ✓ Conduct meetings at township engineer's office occasionally
  - ✓ Technical staff meetings chaired by YCDC district executive officer (DEO) every month
  - ✓ Meeting chaired by CE every Monday.
  - ✓ Monthly meetings with CE and all water supply staff

(3) Township organization

The township water supply and sanitation office staff includes 1-3 township water supply and sanitation engineers, technical staff such as 1-2 technicians, other field staff and clerical staff. The staff numbers and their method of operations are discussed in section 3.6.4.

The organization structure of the township WSS office is found in Figure 3.43.

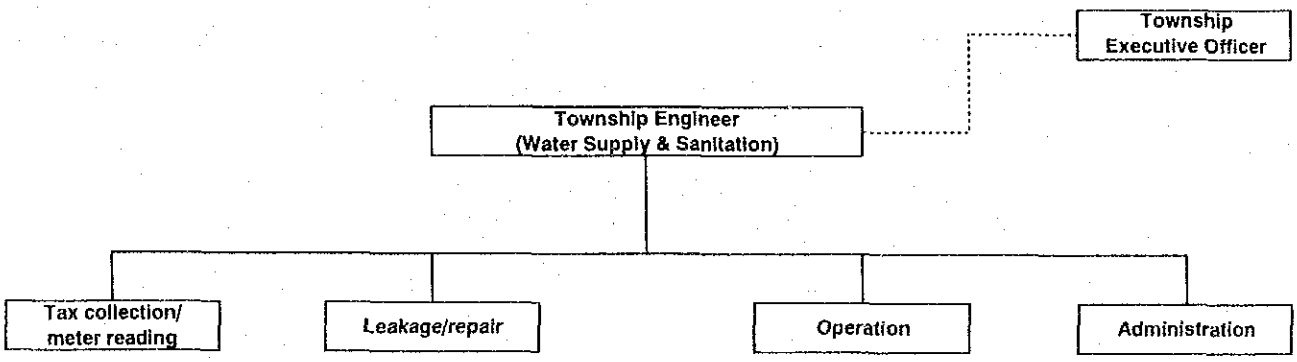


Figure 3.43 Township Organization of Water Supply & Sanitation Engineering Department

(4) Tasks of township engineer

Water supply and sanitation activity within townships is the main responsibility of the township engineer. The main tasks of the township engineer are:

- Attend to all water supply technical matters ie. O&M of the pipe network, repair, prevention of leakage, cleaning communal systems,
- Attend to sanitation matters
- Regulatory matters of water supply

- Cost recovery
- Administrative matters connected with above tasks

In order to perform the above tasks, the staff of the township is organized into four teams as follows:

- Operation and maintenance team
- Breakage detection and leakage control team
- Meter reading and collection of water charges
- Administration

In some townships with sewer lines, another team is responsible for the operation and maintenance of the system including detection of problems and effecting repairs.

The township engineer and his team of staff are supervised by the district engineer who in turn operates under the head of water distribution division.

3.6.3 Cross Cutting Issues

The analysis of structure and functions of divisions, sections and field offices of WSS and their current work programmes lead to a number of common issues. The purpose of this section is to identify these issues and then to highlight the main concerns.

(1) Vision statement and goal setting

Activities of many modern organizations are guided by their own vision statement. In working towards the organization's vision, the organization will then set out a goal for achievement during a specified time period. The professional staff across the organization should be involved in making the vision statement while the goals are set out for each work unit and/or area of the organization with the full participation of the staff concerned.

In spite of the fact that WSS is entrusted with planning and implementation of an important service for the City, the organization does not have a vision statement to guide its own operations. Nor goals of any kind are set out for accomplishment during a specified time period at present. The establishment of goals and working out a strategy would guide the accomplishment of the goal in a satisfactory manner.

Some areas among several others where goal setting and development of strategies would be relevant in the present context are:

- provide water connections to the majority of City dwellers
- conversion of flat rate connections to metered connections
- revenue enhancement based on proper targets
- staff training
- improvement of customer relations and reduction of loss of potable water supplied through the pipe network
- increase water production to feed the entire population.

The absence of a vision and a plan for the organization appears to be mainly a result of not having a planning division within its portfolio.

(2) Planning and Programming

Another major obstacle for the accomplishment of water supply in the City is the absence of a comprehensive plan. As much as there is no plan for YCDC, none of the divisions and sections of WSS have a plan either. A plan would identify targets for achievement based on which a work programme will have to be developed. WSS has none of them.

The only document that may be used for work programming at present is the budgetary forecast which in no way is a plan. The forecast is prepared along the lines of what was done in the previous year. It does not consider what is needed pro-actively in order to provide an effective water service for the City population.

As there is no plan, the preparation of a work programme tailored towards the plan does not arise. As a result, almost all activities are determined purely on an ad-hoc basis. In the absence of a plan for each of the 6 divisions and 4 sections, the staff respond towards daily needs in a passive way. Because of the current status of affairs, even what is needed on a routine basis cannot be accomplished satisfactorily.

The absence of a work plan makes it impossible to evaluate what was accomplished. Hence, as expected, the performance evaluation of any of the work undertaken is not done at present.

The work "planning" and programming tools utilized at present are the two meetings chaired by the CE. The first meeting is for heads of divisions, sections and district engineers held in head office on every Monday while the second meeting is for township engineering staff held on the first Monday of each month. The CE announces important notices and sometimes advises the staff on what needs to be done during the up-coming month. The meeting is not followed by the preparation of specific work items for each township.

(3) Coordination of water supply sector activities

The YCDC (through its WSS) has the main responsibility for supplying water to the City population. This has been an over-riding objective of YCDC and all its predecessors right from the inception of this institution (then known as Municipal Committee) on August 1, 1874. As it has not been able to provide water to all City inhabitants, several other players have evolved over the years. The fact that a large number of institutions and organizations are involved in the City water supply, it is essential that their work is coordinated in an effective manner. Coordination is an important tool to avoid work duplication, make use of available resources to the best, resource coordination and also to avoid any possible collusion among different players.

At present, work coordination with other ministries and departments is occasionally undertaken leaving out several other ministries. WSS has no coordination arrangements with Min-

Ministries of Co-operatives, Industry I and II, Education, Health, Livestock Breeding and Fishery and Home Affairs. These Ministries have several water supply systems of their own in operation within the City.

In the meantime, WSS is not involved in any coordination of water supply-related work of non governmental organizations (NGOs) in the study area. As expected in an atmosphere of above nature, the township staff has no knowledge of which organizations and agencies are working in their area and what water supply standards they bring into the City. The staff does not undertake inspection of work and quality of hardware installed by other organizations particularly the other Ministries, organizations and the NGOs.

(4) The policy of organization

There is no formal policy document outlining the main objectives of the organization. Some areas where a coherent policy is lacking include overall policy regarding water supply connections, meters installation, coordination of water supply work, supply planning and improvement, and almost all other issues pertaining to this department's role. The functions of divisions / sections are not specified, which in many cases are in the minds of senior staff rather than on paper.

It is to be pointed out that the absence of a coherent policy is one of the main obstacles to achieving the basic task of the department, namely, City water supply.

3.6.4 Human Resources

The main task of WSS department particularly of township staff is communication with people. This includes their own colleagues, supervisors, customers of varied types and clients. In addition, the officials need to plan and execute ways of providing overall leadership including effective coordination of activities among all players in Yangon water sector. As already discussed in Chapter 2 the water sector comprises of a large number of players ranging from private individuals to NGOs and other ministry staff.

The Government's policy with regard to service delivery is changing. It recognizes the highest level of service performance needed and encourages users to pay for the service provided. It also highlights that the staff have to play a key role and to deliver their tasks diligently. The WSS staff will need new directions, new work styles, an enhanced professional outlook, re-orientation of styles of work and change of attitudes towards work. Such result will only come from a dynamic human resource planning and development programme.

Among the important strategies of developing and managing human resources are staffing, recruitment and placement, job analysis, salaries and incentives and training. The aspects of training are presented in a separate section.

(1) Staffing

The total number of established posts in the department is 2,425. At the end of the financial

year of 2001, there were 1,362 staff members in service. Of this number, 77% were in the field. The established positions comprise of 161 professional engineers and 1,201 posts of other ranks (Table 3.31). There are 1,063 vacancies through out the department. Out of the vacant positions, 39 positions are professional engineering posts while the balance 1,036 positions are for other ranks. Included in the vacancies are one post of Deputy Chief Engineer. Moreover, the research section is unmanned at present.

Table 3.31 Distribution of Permanent Staff of Water Supply & Sanitation Department

Staff Category	Numbers of Staff		
	Professional	Other Ranks	Total
Head office	70	235	305
Pipeplant Division (site)	10	101	111
District offices	15	10	25
Township offices	26	430	456
Other sites	20	121	141
Reservoir sites	20	304	324
Total	161	1,201	1,362

Source: Finance & Administration Division, Water Supply & Sanitation Department
Note: As at March 2001

(2) Job Analysis

Job analysis is an important task to determine which tasks are performed by which staff. This analysis indicates the types and numbers of staff needed to perform the main tasks of the organization. Hence, the analysis helps to achieve the objectives of the organization through the best utilization of existing human resources.

The starting point for job analysis is the job descriptions for different staff. The department at present has no job descriptions for the staff. What is available is the task list to be performed by the head of the department, the deputy head and the heads of divisions and sections. There is no task list for other positions including the frontline staff of the townships. The available task list is too general which is more related to the cadre positions rather than the specific tasks the officers are expected to perform.

The absence of job descriptions makes it impossible to evaluate the performance of staff which in turn is a major hindrance towards achieving the objectives of the organization.

(3) Ratio of Professional to Non-professional Staff

A professional is one who has qualifications and/or experience as a sub-assistant engineer or above. The hierarchy of professional positions within the department is listed below:

- Chief engineer (CE)
- Deputy chief engineer (DyCE)
- Assistant chief engineer (ACE)
- Executive engineer (EE)
- Assistant engineer (AE)

- Sub-assistant engineer (SAE)

Of the 1,362 positions in service, only 161 are professional engineers. This gives the ratio of professional to other rank 1:7.45 for the entire organization. The same ratio in the field is 1:10.61.

The positions in-command of the townships indicate that the majority is manned at least by one engineer (Table 3.32).

Table 3.32 Type of Engineers in-command of Township Water Supply Operations

Township	Type of Engineer in-command and Number		
	AE	SAE	Supervisor *
Ahlone		1	
Bahan	1	2	
Botataung		1	
Dagon		1	
Dagon Myothit (East)	**	**	*
Dagon Myothit (North)		1	
Dagon Myothit (Seikan)		1	
Dagon Myothit (South)			1
Dala		1	
Dawbon		1	
Hlaing		1	
Hlaingthayar			1
Insein		1	
Kamayut			1
Kyauktada		1	
Kyeemyindaing		1	
Lanmadaw			1
Latha		1	
Mayangone		1	
Mingalardon		1	
Mingalartaungnyunt		2	
North Okklapa			1
Pabedan		1	
Pazundaung			1
Sanchaung			1
Seikkan (Port)	**	**	**
Seikkyi Kanaungto		1	
Shwepyitha		1	
South Okklapa		2	
Tamwe			1
Thaketa			1
Thinganchaung			1
Yankin		1	
Total	1	24	11

Source: Township Survey
* Non-engineer grade
** Staff not established. Work undertaken by staff from other townships

The above data reveal that 11 (or 1/3rd) of townships have no qualified water supply engineers to manage operations. Instead, the work in these townships is undertaken by experienced staff who don't have professional engineering qualifications.

There is an apparent shortage of qualified engineers within the department. In the meantime, there is evidence that the available professional engineers are not fully utilized. For instance, some townships (eg. South Okkalapa, Mingalartaungnyunt and Bahan) have more than one engineer per each of the three townships while others are under-staffed with regard to the same profession.

Perhaps the above anomalies could be a result of absence of human resource development plan, planning in general, absence of target setting and programming to achieve the targets. Anyway, the existence of above problems is counter-productive as far as the improvements needed within the City water sector are concerned.

(4) Professional Staff Composition

As the title of the department (Water Supply and Sanitation Engineering) suggests, almost all professional staff within are engineers. The rare exceptions are the water quality monitoring section where an environmental scientist is incharge and the finance and administration division where accountants and administrative staff are incharge. Of more serious nature is that some engineering professionals are expected to carry out other tasks without ever receiving any training in the subjects assigned to them (eg. Store management, research).

While engineering is necessary and an important component of the water supply organization, other areas such as work programming and management, and planning and customer liaison are just as essential to effective planning and implementation of a coherent and comprehensive programme aimed at water supply improvement. A better mix of disciplines is required to ensure that the staff is exposed to a comprehensive range of skills required for the effective performance of their multidisciplinary tasks.

The department should have in its portfolio professional staff from several other areas. Among them are planners, policy analysts, analysts and programme monitoring specialists, stores management and inventory control, human resource management, community participation, customer relations, among other related disciplines.

Another concern is that one-third of the professional engineering staff have not had any opportunity to advance in their profession. Still another concern is that many engineering positions have been filled by staff who have gained years of experience in the department. Though it was not possible to obtain data to verify, it is doubtful whether this group of engineers were ever exposed to a proper engineering course in their career.

The above practice may well be necessary to provide opportunities in career progression for the experienced staff within the department. It is equally important that these staff are well trained in their profession. Almost total absence of water supply technical training aggravates the current position plagued with lack of professionalism, professional outlook, insufficient motivation and attitude among the professional staff. Issues relating to training are discussed

in section 3.6.6.

(5) Salaries, Wages and Other Incentives

The department currently has 3,775 salaried positions and a large number of flat rate (temporary) positions. The mean monthly salary of an employee in the department is Ks.4,000. Discussions with finance staff indicate that a private sector employee in Yangon receives about Ks.10,000 month. Hence, the departmental employees are under-paid compared to their counterparts in the private sector.

Although the salary itself of YCDC staff is rather low, they are eligible for several other non-salary benefits such as free rice, low house rent, allowances and a few other perks. However, these benefits would not add more than Ks.2,000 per employee per month. This suggests that the effective salary of an employee considering other benefits works out to be Ks. 6,000 which is still Ks.4,000 short of the private sector salaries.

3.6.5 Customer Focus

One of the main tasks to be accomplished by employees across the department is "interaction" with customers. Communication with and obtaining feedback from customers are routine tasks of engineers as well as other front-line staff. The three main purposes of current interactions are to collect water charges, to deliver the water bill or to advise on broken pipes/ water leaks.

(1) Profile of Customers

The customers with whom the township officials deal with at present range from illiterate people to communal groups, domestic householders and commercial customers.

In terms of customer numbers, the staff has to deal with:

(a) About 112,000 customers with proper water connections
(b) Approximately 20,000 households obtaining water from communal tanks
(c) Approximately 52,000 households collecting water from lakes/ponds

The township staff has very little transactions with foreign customers and government staff. The information needs and the ability to grasp information among this wide range of customers are largely variable. Hence, it is of utmost importance that WSS staff plan and implement appropriate strategies to improve their productivity.

(2) Present Practice, Opportunities and Problems

At present, customer interactions are mainly with those who have proper water connections. This means the officers have no productive contacts with larger community of water users from communal tanks, and lakes and ponds at all.

The dominant method of interactions between the officials and customers at present is almost exclusively face-to-face. The present practice is to visit the relevant customers at their home and in some cases at work place, meet the customer or leave a message if unavailable. All

township engineers have stated that many of the customers are not available at the time of their visit forcing them to make multiple visits to the same customer. The current practice is not only time consuming but also is ineffective.

The use of other methods such as small group meetings and discussions, securing the assistance of other community-based organizations to educate customers, the use of printed media etc. could be more effective. None of these methods are employed by the frontline staff at present.

The department has no posters, leaflets or other brochures to improve customer awareness about water service activities. The use of printed media such as posters to explain about water service activities would be quite effective among the less educated customers in particular. Although two types of newspapers (namely, City News and National News) are in circulation, the extent to which this print media penetrates to the customers in the field is unknown. Observations indicate that the level of penetration is not satisfactory.

It was reported that radio and television are occasionally used by the department to make announcements of water rates and repair work to the network.

It is extremely rare that the frontline staff has organized discussions, meetings and other events aimed at improving customer awareness with regard to water sector activities. There was no data available concerning educational activities of the staff.

Of particular concern is the non-utilization of opportunities available such as the public educational campaigns organized by their counterparts in the health department. For instance, township health officers plan and organize several educational activities among the public every year (Table 3.33).

The WSS staff should look for such opportunities as entry points to the community if not able to organize similar activities by themselves. In this connection, the need for better coordination of activities between the two departments should also be highlighted.

The engineers in-charge of water supply in all 28 townships were unanimous in their decision with regard to their main problem, the customer relations. The four main difficulties they are battling with at present are listed below:

- Meeting customers as they are not home at the time of visit
- Get them to pay water bill
- Get them to agree to water charge
- Educating customers on water use and reduction of water misuse/waste

There is clear evidence that the majority of township WSS engineers do not have a proper record of their customers including an accurate list. They have no record of the number of customers obtaining water from communal tanks, lakes and ponds, and the number of free

water connections. In such a situation, the starting point to develop interactions with the customers has to begin with the preparation of an accurate list of all of their water customers.

Table 3.33 Distribution of Health Educational Programmes by Townships

Township	1999		2000	
	No. of health talks	Participants	No. of health talks	Participants
Ahlone	281	466	881	1646
Bahan	332	1270	360	1487
Botataung & Seikkan (Port)	168	1381	148	1205
Dagon	227	750	210	680
Dagon (East) & (South)	459	1128	989	1945
Dagon (North) & (Seikkan)	1023	3537	612	1398
Dala	567	1179	456	1028
Dawbon	902	2977	840	2602
Hlaing	799	2005	862	1820
Hlaingtharyar	1211	2850	1142	2409
Insein	960	2966	844	2100
Kamaryut	818	1379	551	984
Kyauktada	1055	4150	1246	4208
Kyeemyindaing	1237	5427	1048	4402
Lanmadw	1008	7004	1424	8014
Latha	832	2120	720	1600
Mayangone	441	1025	369	760
Mingalardon	167	558	194	709
Mingalartaungnyunt	615	3996	863	4208
North Okkalapa	695	5763	608	5124
Pabedan	317	2096	174	1022
Pazundaung	35	184	68	309
Sanchaung	325	484	786	1024
Seikkyi Kanaungto	208	293	94	124
Shwepyitha	33	1454	38	1044
South Okkalapa	778	3577	821	3840
Tamway	1198	1605	942	1308
Thaketa	263	1968	241	1703
Thingangyun	493	2250	680	2403
Yankin	161	1561	301	1092
Total	17608	67403	18512	62198

Source: YCDC Health Department

The root of the current problems in customer relations is likely to emanate from the lack of exposure of the frontline staff to planning and implementation of educational programmes among customers. Hence, the staff needs opportunities to enhance their capacity which could partly be met by training.

It is to be noted that customers being the most important client of the department, it is essential that WSS professional staff improve their customer interactions and relations.

(3) Customer Needs

Customers need basic awareness, information such as where to pay bills, assistance in filling various forms, education to conserve water and training on how to maintain the part of the network they are responsible for. Many of these services are not available to the customers from WSS staff at present. In the absence of any directions to customers on above matters, their perception of officials is to collect water "charges" and/or to police their water use practices. In such an atmosphere, it is quite likely that customers are not willing enough to extend their cooperation to the staff.

(4) Customer Assistance Policy, Strategy and Guidelines

There is no policy, strategy or guidelines available to assist customers. In the meantime, relevant specialists who could assist preparation of policies and guidelines are also not in place. One of the starting points would therefore be to develop a policy and a set of guidelines for customer relations. Together with this new initiative, it is also important to develop a training programme so that the professional staff could gain necessary knowledge and skills required for them to develop an effective programme of customer interaction.

(5) Community Participation

Another issue related to customer relations is to enhance community participation skills of the staff. As mentioned earlier, the department staff does not have interactions with two groups who obtain water from communal tanks and lakes/ponds. Customers who obtain free water from the supply network should also be added to this list. These groups of customers are of particular importance to the department as water charges are not levied on them. The manner by which the participation of the communal groups could be secured in the O&M of the relevant facilities should be one important area to look into.

As discussed in section 3.3.2, the staff of the department is responsible for cleaning communal tanks, clearing of weeds around the lakes and purifying water by adding chlorine and/or alum at its own expense. The users of these facilities have no involvement in their management. It would be worthwhile to secure the participation of the communities for cleaning facilities at least.

The skills needed to secure the participation of such communities on the part of the officials is quite different from that of the commercial orientation discussed in the previous sections. At present, there is no direction, resources or any plan to provide the staff with much needed relevant skills in community participation. Such skills when acquired would also be relevant in dealing with some of the poorest customers who have significant difficulties in the payment of water tariffs.

3.6.6 Training

The purposes of training analyses were to identify the present status of staff training as well as to ascertain areas where training is lacking. In the absence of accurate data on staff training together with the subjects of such training, other opportunities were made use of to gather the relevant data. Apart from interviews with the township staff, a quick review of training facilities provided at the YCDC training school was also carried out.

(1) Training Practice

Discussions with staff of the department at all levels clearly indicate lack of training to perform the tasks assigned to them in an efficient manner. The current training practice of the department is fourfold.

The most common system is for the senior staff to impart on-the-job technical training on the junior staff. This type of training is unsystematic and is inadequate if not combined with formal training.

The second type of "technical" training for sub-assistant engineers and aqssistant engineers is provided by the YCDC training school. A review of the syllabus of this course, the manner it is presented and the facilities indicates that this training itself is focussed on administrative aspects of engineering rather than "technical" per se. The number of trainees for this particular course is 50 which is far in excess of the number who can effectively be trained on a technical subject, at one time.

The third type is clerical staff training while the fourth type is training of accountants. Both these courses are conducted by the training school.

The above discussion reveals that the emphasis of current training is "administrative" rather than technical. The absence of any engineering training focussed on water supply in this predominantly engineering organization is not appropriate. As a matter of fact, there is no training in water supply presented to the staff at present.

Not withstanding the above, the importance for the new recruits to undergo a course of orientation training before the work is begun and exposure to in-service training after sometime on the job are to be noted.

(2) Training Performance

Data collected on staff training for the year ended 31 March 2001 is presented in Table 3.34.

Table 3.34 Township Staff Training during 2000/01

Township	Training Programmes (No.)	Number of Participants by Type of Training				
		Administrative	Clerical	Accounts	Management	Engineering Management (preliminary)
Dagon (Seikkan)	4	2	2	1	5	
Dowbon	5	8	5	3	6	
Hlangthayar	5	2		1	2	
Kyeemyindaing	3	7				18
Latha	3	*	*			*
Mingalardon	1			1		
Mingalar-taungnyunt	2				2	1
North Okklapa	1	1				
Pabedan	2		1		1	
Pazundaung	1				1	
Seikky Kanaungto	1				1	
South Okklapa	4	4		2		
Thaketa	1	1				
Total	33	25	8	8	18	19

The conclusions that can be drawn from above data can be summarised as follows:

- Staff of only 13 out of 33 townships had training opportunities during the past year
- Out of the 456 staff numbers attached to townships, only 78 staff (17%) have had the opportunity of training during the whole year
- Training is predominantly biased on administrative aspects of training

As discussed earlier, the current engineering management course of training is more administrative than technical. In fact, the departmental staff do not have an opportunity for real technical training at present.

The above state of affairs is not conducive to the progress of this predominantly technically-oriented department.

(3) Training facilities

As mentioned above, the only formal training facility available to the staff is what is offered by the YCDC training school. The main issues concerning the facilities available at the school are summarised below:

- The school has a reasonable syllabus covering administrative and accounting subjects
- The syllabus on engineering is inadequate while there is no syllabus on water supply engineering training
- Current syllabus does not focus on institutional, customer relations, planning, programming, evaluation, coordination and other related issues
- The school facility includes one large lecture-hall which is not suitable for interactive training
- School does not have any facility such as workshop, laboratory etc to offer technical training
- Almost all of the resource persons / trainers are drawn from YCDC and other ministries. This category of trainers have only a limited time to spend with the trainees
- Training aids are insufficient and are limited
- Though the school has residential facility, it is not utilized for whatever reasons.

It is necessary to address above concerns in an attempt to develop an effective programme of training for the technical staff of the department. In this connection, the design of a well-balanced water supply training programme should be a main priority. It is to be highlighted that the important institutional issues should also be included in the programme.

The WSS officials need strategies for effective interactions with customers, commercial orientation and a higher degree of professionalism. Different skills, new reorientation and an enhancement of existing skills are needed to address these challenging demands. Well designed, planned and properly implemented training on management, technology, communication, customer relations, consumer awareness creation, training and education, monitoring, and planning surveys, data collection and reporting skills are needed by the staff.

3.6.7 Operation & Maintenance and Repairs

The current responsibility for operation and maintenance (O&M) of the water supply facility is vested mainly with WSS while the customer is responsible for his supply line and all internal connection work. The department is responsible for the O&M and repairs of reservoirs, transmission and distribution lines, other facilities, water pumps and other fitouts. The customer is responsible for any repairs or leaks from the service connection supplying water to him/her.

The manner by which the above parties attend to O&M and repairs of the respective part of the network is presented in the sub-sections to follow.

(1) Minor O&M tasks and repair works

The mechanism to effect O&M and repairs by the department is twofold. Firstly, smaller repairs and/or leaks in the secondary distribution lines are fixed by the township staff. The relevant staff look for such problems while undertaking routine inspections of the township area and undertake repairs as defects are detected. For this purpose, the township engineer is provided with an advance fund of Ks.10,000 to purchase parts and materials while the work itself is undertaken by the skilled workers and technicians attached to the township office. The advance fund is replenished on production of receipts to the F&B department.

If the repair cost exceeds the limit of the township engineer, the task is accomplished by the relevant district engineer utilizing a similar advance fund mechanism available to him/her. The advance fund for the district engineer is Ks.50,000.

One main problem faced by the township engineering staff is the lack of required tools and sometimes the spareparts in the WSS's store. This forces the relevant staff to purchase spareparts and fittings from shops where the parts of the correct standard and specifications are reported to be unavailable. The staff is yet to find a solution for the lack of tools.

In both cases, materials such as cement, iron and some pipes should be obtained from the YCDC main store, subject to availability.

(2) Major O&M tasks and repair works

Major O&M problems and repairs to the distribution lines become the responsibility of a team of technical staff in the head office. The same team is also responsible for the O&M and repair of main transmission lines, distribution lines and other major defects of the system. The actual responsibility lies with four teams each headed by a senior engineer attached to the water distribution division.

Upon identifying the site through information provided either by township staff or through own inspections carried out by team members, an investigation whose aim is to estimate parts and thereby to establish the cost is undertaken. Once repair work needed is identified and the cost is known, a Work Authority (WA) is prepared for approval by a team of senior officers including the CE himself. The WA is submitted to the Coordination Department for checking, auditing and making adjustments which is then submitted to the F&B Department for payment.

In theory, repair work can be effected only after this procedure has been completed. However, in practice, the work teams undertake the repair or the maintenance work immediately after detection utilizing "borrowed" funds or spareparts obtained on credit. Unlike the township engineer and the district engineer, these special teams do not have the benefit of an advance fund or a store under their charge to facilitate repair and/or maintenance task at hand.

The work teams at present do not have a proper place within the bureaucracy. Placing them in a proper division may lead to further recognition of their work and thereby bring about reputation to the work team. Such a strategy would also enhance their own professional advancement.

(3) Repair of Customer Connections

By regulation, customers are responsible for maintenance and repair of the pipeline, taps and other fittings fixed to customer's service line. The relevant work has to be accomplished by a licensed plumber hired by the customer.

The township staff in their routine work checks the status of customer connections and advise the relevant customer to fix if found to be either defective or water is leaking. The customer is given 3 days time to repair the defect obtaining the service from a private plumber (see next sub-section).

(4) Private plumbers

The department maintains a list of licensed water and sanitation engineers, licensed plumbers and working plumbers. The Appendix Table K-5 gives a list of registered plumbers by type.

The department also conducts examinations and only those who pass the test are registered as plumbers. Customers are expected to engage registered plumbers to get their internal connections done and to fix defects.

(5) Unaccounted for Water and Water Leaks

Unaccounted for Water (UfW) control is an integral part of network management which is affected by changes of other parameters involved in a water supply system.

The following definition is used for UfW:

"UfW is the difference between production of water into supply (WIS) and the consumption that is known or for which a reasonable estimate can be made".

The principal components for consideration in UfW include:

- Network Leakage
- Customer Pipe Leakage
- Unrecorded Consumption
- Free Supplies
- Underassessment of Use
- Meter under-registration
- Operational Use by YCDC Water Supply Department (e.g mains flushing)

At present, YCDC does not collect information or evaluate any of these components individually, so it must be remembered that any calculation of UfW includes them all and the contribution of any single element can only be guessed at and the actual leakage remains unknown.

1) Present status

As has been the case for all sectors of this report, detailed data relating to UfW has been sparse or unavailable for whatever reason. Thus, there has been limited scope for quantitative analysis and the level of confidence in such analysis as has been possible is relatively low. This means that greater reliance has been placed on a qualitative review, generally by means of visual inspection and discussion with numerous YCDC staff.

Much of the present water supply and distribution network is very old, with a larger part having been constructed in the early period of the City's development. This rate of

distribution network extension and reinforcement has not been continued and has not kept pace with the increase of customers obtaining water from the City network.

To make the situation even more difficult, the consumption demand of the population has been greater than the supply available for some years. Unaccounted for Water will only make this difficult situation worse.

To bring the context up to date, the water supply system is operated with the emphasis on just keeping things running on an ad-hoc basis.

The global UfW figure is estimated, in terms of average daily volumes, to be:

UfW	=	Total Production	-	Total consumption(estimate)
	=	399	-	140
	=	259Mld		
UfW Ratio	=	259/399		
	=	65%		

Some points should be borne in mind and used as a caution to the estimated results obtained above. These are based on qualitative observations and include:

- There is no data on the various components of UfW to enable apportionment and so this remains only a general result, to be treated with caution
- This calculation of UfW is very approximate and should be improved
- Registered consumption is probably underestimated
- Unaccounted for consumption is likely to be at least as significant as actual leakage
- Leakage component is relatively low and at present, because of low pressure and intermittent supply
- Service leaks is probably the greater part of the leakage component, at present.

2) Current leakage & loss control policy and practice

YCDC does not presently have a specific policy concerning leakage and UfW control. No particular section or person(s) in the organisation were identified as having responsibility for water leaks control and/or UfW control. Leakage control is a part of the operations and maintenance of the network, but it is incorporated as a subsidiary part of other functions at the township level or the respective sections of the transmission main system.

The responsibility of these staff is for the YCDC network only. The customer is solely responsible for the service pipe, which begins at the stop tap/connection ferrule on the distribution pipe.

3) UFW related Activities

- Measurement of Bulk Flows

There is no flow measurement or assessment made by staff for UFW working. No meters are installed anywhere in the network

- Leakage & Inspection

Water Supply Department staff routinely inspect their area and the network This inspection is done by walking the route of the pipes and making visual checks for evidence of leakage.

The method of leakage control applied in Yangon is Passive Leakage Control (PLC). Reliance is placed on the appearance of water on the ground surface. This form of leak detection is carried out as a part of the general duties of the staff concerned, rather than as a specific leakage function. However, in Yangon the soil permeability is relatively low and so a sizeable leak can be expected to migrate readily to the surface.

No activities routinely take place at night during the quiet periods, when ambient noise and also demand are minimum, so that leakage is most easily detected.

The YCDC network is mostly buried, but a lot of service pipe work is visible on the ground. This pipe work has leakage on a significant proportion of those seen, which is considered to be an appreciable contributor to the total volume of losses because of the installation conditions. Operational losses are not given a high priority for repair unless they cause problems. For example, Yegu Pump Station has some sizeable leaks that are well-known and have been running for some considerable time. Service Reservoir losses are not recognised at all by YCDC and no information is available on the matter.

YCDC Staff are supposed to monitor the condition of customer connections. While visiting properties they will note any leaks, problems with meters, illegal connections etc. and report them to the customer for further action.

- Installation of Pipe work

Distribution main pipes and larger diameter pipes are the roads laid under or along saide YCDC report that the depth of cover ranges from 3 to 7 feet. Smaller and secondary distribution pipes are sited at the edge of the roadway or alongside, with 2 to 3 feet depth of cover. Less attention has been given to conditions of installation.

The long length of service pipes for house connections (see below) indicates that the secondary distribution network is weak and does not extend into each street to permit direct, short service pipe connections to be made.

With these conditions of the pipe work plus the age of the system and the present limitations of operations and maintenance, there is a potential for large background leakage volumes and the infrastructure condition will be poor.

- Pipe Joints

The system has been installed over a long period and different parts of the system are different ages. In association with this, the type of joints used has changed periodically.

The majority of joints in the system are lead joints, which indicates a potential high background leakage. The most common type of major repair carried out is lead joints on cast iron pipe repairs are carried out largely by manual labour, with minimal specialist tools and equipment.

Presently the network is subject to only very low supply pressures, sometimes negative, and intermittent supply, which limits the potential for losses, especially at joints, which are generally pressure dependent leaks.

- Service Connections

The service pipes on customer connections are the responsibility of the consumer. The division between the customer and YCDC is at the stop-tap. Customers have to repair service pipe leaks.

Each house connection is supposed to have a stop tap installed just after the ferrule. The stop tap does not have a valve box and is usually buried, so any operation of the valve requires excavation.

- Water Byelaws and Technical Standards for Consumers

The regulations and technical standards relating to connections and the extent to which they are enforced are important considerations. Without good standards and controls on pipe work outside its responsibility, the water supply utility risks high losses of water.

In conjunction with control mechanisms for connections to the water supply, a critical factor is public awareness of the importance of "good behaviour" to avoid wasting water. As discussed in section 3.6.5, this is a main issue to be considered in future planning.

- Domestic Metering

YCDC policy is universal metering for all domestic (and commercial) consumers. It is at present only partially complete at 22% of the total and will take many more years to attain 100% metering at the current rate of installation.

Once installed, meters are left in place until and unless they are reported as broken. Meters are not replaced a periodic basis. Many meters are likely then to be underegistering significantly and so contributing to UfW

- Un-metered Consumption

YCDC does not collect any information or perform any studies on representative samples of un-metered consumers to establish and then maintain up-to-date estimates of per capita consumption by group or category. In the absence of information on un-metered use, it is not possible to assess how this compares with metered use. Estimation has been made

- Production and consumption estimates

YCDC does not have any production or bulk metering installed to give present or

historical data on production of water into supply. circa 350 Mld (77 mgd)

An estimate of total consumption based on meter use has been made. This is expected to give an underestimate of consumption as some known large users are un metered (e.g. some of the Government connections).

(6) Bye-laws, Regulations and Penalties, and Enforcement

Certain bye-laws and regulations pertaining to water supply have been framed under YCDC. The bye-laws and regulations are aimed at conforming to certain standards in water supply on the one hand and to reduce waste of water. Many of these regulations have their origin in the Rangoon Municipal Manual of 1922 which are applied at present. The organization is in the process of revision and adaptation of a set of new bye-laws, regulations and processes using the 1922 Rangoon Municipal Act as the basis.

Regulations covering all areas of water supply, measurement of water use, protection of water bodies, supply networks and facilities, water misuse, and connections including plumbing work done by licensed plumbers are in force. Table 3.35 lists some of the regulations and the penalty for non enforcement.

Table 3.35 Examples of Regulations and the Penalty

Item	Penalty
Re-connection fee for HH and commercial units	Ks.1900
Illegal connection	Ks.25,000
Illegal electric pump fitted to pipeline	Ks.25,000
Illegal septic tank	Ks.25,000
Use of illegal size of septic tank pipe	Ks.10,000

Source: YCDC

The above fees can either be paid to the township engineer or to the administrative and finance division in the head office.

As discussed in section 3.6.7 (5), there was evidence that the regulations are not strictly enforced in fixing connections and in plumbing work. Some of the draw-backs relating to the non-enforcement of regulations are discussed elsewhere in the report.

The above status of affairs could be due either to staff, particularly the field workers being unaware of the bye-laws and regulations or the available rules are not enforced for what ever reasons.

Although many of the senior staff are aware of these regulations the junior staff is found to be not well knowledgeable of such regulations. Equally important as the staff awareness are the water customers who are expected to be aware of regulations. There is a large vacuum in so far as the awareness and knowledge of the water customers goes with respect to bye-laws and regulations.

(7) Supplies & Spareparts

Timely availability in adequate numbers of the right spareparts is an essential necessity for effective management of the water sector. Management of spareparts and supplies is all the more important in the study area given the lengthy pipeline network, the use of many pumps and other machinery, and the aged-old pipe network. The frequently used spareparts include pipes and fittings, lead, joints and chemicals such as alum and chlorine.

The spareparts are obtained from WSS's store which is not managed satisfactorily (Section 3.6.4). Only four townships namely, Dala, North Okklapa, South Okklapa and Thinganchaung have their own store for spareparts and chemicals.

As the frequently used spareparts are not always available in the store, almost all township staff have reported as purchasing them from the market. Reliance on open purchases poses some obvious problems such as price variation and the unavailability of parts of the correct size, dimension and specifications. Under such circumstances, staff is forced to use parts of lower standards creating many other problems.

Most of the spareparts are locally manufactured. There are many private companies in Yangon which import and keep stocks of spareparts and chemicals such as bleaching powder and aluminium sulphate.

It is appropriate that WSS stocks adequate quantity of right spareparts in its own store to be used in water supply operations. Such a strategy would contribute to an effective management of O&M and repairs in addition to being more economical.

(8) Data Recording, Analysis and Retrieval

The members of township water supply teams are expected to collect data and prepare reports for transmission to the higher levels of the bureaucracy. This includes some of the basic records such as customer numbers by types of water connections and wards, data on payment of water bills, data on water disconnections, and other related areas. Information on other agencies and community organizations working in the water sector of their area should also be added to the list of useful data.

There is evidence that the large majority of townships does not have up-to-date and an accurate database covering any of the areas mentioned above. As mentioned in section 3.6.5, the majority of townships does not have even a list of their water customers. It is quite understood that this particular limitation has a substantial negative impact on their work performance.

It is also to be highlighted that data should be made use of in improving their own work performance. Such an emphasis is not given in current data collection efforts.

The officials should be trained on effective data management including the use of data in the actual work performance in their respective areas as mentioned above.

3.6.8 Water Tariffs

Tariffs on water are the main source of revenue for operations of WSS. Revenue from tariffs is also to be the main source of financing of the improvement of water supply sector in future. The government policy clearly supports the collection of charges in a way which is not a burden on people.

The review of the water tariffs is important in particular to determine a coherent tariff policy and thereby to eliminate inconsistencies.

This section discusses water tariffs, the current policy and the present structure. A history of development of water tariffs is given as a backdrop to the section.

(1) History of Water Tax

In terms of the authority vested in the YCDC Act, WSS has the power to collect tariffs from customers. The relevant sections of the authority stipulates that:

> "If the water user fails to pay water charges or fail to observe any directive relating to use of water, the connection may be severed"
>
> (Section 13, YCDC Water Supply Byelaws)

Reference to water tax has been made in the Rangoon Municipal Manual of 1922. According to the Manual, the earliest water tariffs took the form of property tax where each customer obtained water from the works owned by the Committee (Rangoon Development Corporation -RDC) had to pay a specified amount. It is likely that this was the first instance where water tax was levied by the RDC.

The Metcalf & Eddy (1981) report states that the tariff rates were revised in October 1978 and the implementation was planned from January 1980. However, there was no reference to whether or not actual collection began as per the new rates announced in 1978. Discussions with YCDC staff indicate that the actual year when water tariffs collection began was in 1991. The YCDC sources further indicate that even if the tariffs were collected prior to 1991, only a handful of customers may have paid as the collection procedures at that time were in a state of infancy.

The tariffs structure introduced in 1991 was of two different types as listed below:

- Tariffs based on meter reading
- Unmetered tariffs (flat rate)

The water tariffs based on the property tax which had its origin in the RDC were continued.

However, certain categories of customers were exempted from payment of tariffs. Hence, this category receives water free of charge.

The tariffs introduced in 1991 and the subsequent revisions are shown in Tables 3.36 and 3.37.

Table 3.36 Flat Rate Water Tariffs

Period	Types of Customer (rates in Kyats per month except for foreign customers)			
	Domestic	Government	Commercial	Foreign (US$ per month)
1991 end of April to June 1994	30	Minimum of 60 to a maximum of 80,000	(estimated). Data not available	US $ 25/month
1994 end of July to March 1995	60	60 to 80,000	n.a.	US $ 25/month
1995 April to June 1997	90	60 to 80,000	n.a.	US $ 25/month
1997 July to present	120	80 to 107,000	405 to 25,000	US $25/month

Source: YCDC

Table 3.37 Metered Water Tariffs (Kyats/'000 gals)

Period	Types of Customer (rates in Kyats per month except for foreign customers)			
	Domestic	Government	Commercial	Foreign
1991 April-March 1995	10	15	90	*
1995 April – June 1997	15	15	90	
1995 April – present	15	20	135	*
1997 July – present	30	20	135	

Source: YCDC

* US $ 2 per '000 gallons for households and US $4 per '000 gallons for commercial use.

According to the above data, the first tariffs introduced in 1991 were of two types namely, metered and unmetered (flat rate) rates. Each type had four different categories of customers.

Subsequently, there had been three tariff rate reviews. It is interesting to note that the tariffs structure originally introduced in 1991 had been intact though the actual rate itself changed over the years. The rates for foreign customers remained unchanged during the last ten years.

The review of past tariffs indicates that the rate for domestic consumers increased by 300% for the flat rate and 200% for the metered rate while the commercial metered rate increased only by 50% during the same period. The lowest rate of increase of 33% has been registered for government establishments.

(2) Water Tariffs Based on the Property Tax

In 1981 the water tax was 3.25% of the property value in Rangoon area. A water tax based on the property value had been levied on customers without RCDC service connection within 300 feet of a public water point or standpipe.

The property tax is determined annually by the Assessors' Department of YCDC which is notified to each customer every year.

Water tariffs at 3.25% of the property tax is levied on customers in two townships obtaining water from communal tanks (Table 3.7) It is to be noted that customers in eleven townships

who obtain water from communal tanks are not charged while the customers in two townships are charged for water from the same source.

The policy regarding the imposition of the water tax (based on property tax) therefore appears to be inconsistent. Also, all customers in some wards where communal tanks are in operation are charged 3.25% of property tax irrespective of their using water from the communal tanks. It is to be pointed out that many customers obtain water from their own private sources but are required to pay the water tax. This is yet another example of inconsistency in charging for water.

(3) Current tariffs Policy

The current YCDC's policy on water tariffs seems to depend on the relative poverty of the customer in question. In this regard the directives appear to be threefold. Firstly, tariffs related to the volume of water used is charged directly from customers who have provided with water connections and meters. Secondly, customers who have no meters are charged a flat rate which is determined by considering the type for which water is used and the volume of use. Thirdly, customers who are provided with water through communal systems are charged only if the community can afford the payment of fee. Although it may be appropriate to exempt poorest of the poor from payment of water tariffs, this policy needs to be consistent throughout the City. Moreover, the line of demarcation of "wealthy" from "poor" category is also not clear.

(4) Current tariffs structure

At present, the tariff structure established in 1991 is in place. They basically are of twofold, namely metered and unmetered rates. Individual tariff rates are established within each of the two types. The different customer types and the relevant tariffs are shown in Table 3.38.

Table 3.38 Current Water Tariff Structure

Category	Flat Rate (Ks/month)	Metered Rate (Ks/'000 galloons)
Religious (temple, mosque, church, pagoda), Embassies and communal tanks in 11 townships	Free*	Doesn't apply
Communal tanks in 2 townships	3.25% of property tax	Doesn't apply
Households (domestic I)	120	30
Households (domestic II) **	202	30
Government	80-100,000-estimated	20
Commercial/industry	405 to 25,000***	135
Foreign (commercial)	$25- estimated	$ 4
Foreign (household)	$25	$2

Source: YCDC Records and personal communications with Finance staff
Notes: * See Table 3.7 for 11 townships.
** Means a large house with a compound or condominium apartments. If more water is needed the policy makes it possible to obtain a separate line where the rate would still be Ks.202 per month
*** Minimum flat rate is Ks.405 per month. The actual rate is estimated after an inspection had been carried out by a team of YCDC officials.

The above Table indicates the presence of eight different types of tariffs for the flat rate while the different types in the case of the metered rate are five.
The present tariffs are not structured to discourage waste or high consumption.

(5) Billing and Collection mechanism

The institutional mechanism to collect tariffs is twofold. With regard to metered rates, water meters are read by a team of staff from township every month. The task of these teams is to visit each household where a water meter is fixed, read the meter, and prepare the bill to the customer.

Large apartments with one meter are served with one bill based on the actual meter reading. The occupants in the building will have to come to a shared agreement as to the proportion of the bill each household want to pay. The bill is issued to the owner of the apartment who is responsible to reach an agreement on the amount of the bill each household will pay, collect money and then pay the bill.

The unmetered customers are served with a computer-generated bill produced by the Computer Section of WSS in accordance with the rate relevant to them. The bills are distributed among customers by the meter reading team referred to above. A bill based on flat rate is issued to each occupant of the apartment without a meter.

In both cases above, the bills are given to customers in person who are required to pay the amount shown within 10 days. Failure to pay up water rates within the stipulated time period

results in two reminder notices being delivered to the customer followed by the final notice for water disconnection. The disconnection notice when approved by CE, is effected by township WSS staff.

It was not possible to analyse performance in payment of water bills due to absence of accurate records.

Discussions indicate that the performance in payment of water rates (both flat and metered) appears to be high.

Customers are expected to pay the bill either at the office of the township engineer, the office of the executive officer or at the head office depending on the type of bill (Table 3.39.).

Table 3.39 Bill Payment Office by Customer Type

Customer Type	Flat Rate Bill	Bill based on Meter
Domestic	EO's office	Township Engineer's office
Commercial	Township Engineer's office	Township Engineer's office
Government	Head Office (FE Section)	Head Office (FE Section)
Foreign	Head Office (FE Section)	Head Office (FE Section)

Source: Township Staff Communication

All customers except for the government category are to pay the bill in cash.

The main problems faced by the meter reading and billing teams are:

- Not having access to the meter as the compound is found to be locked up
- Not able to meet the responsible person of the house during the day time
- Refusal by customers to pay up the bill as the amount shown presumably is higher than their expectation
- Difficulty on the part of the meter reading teams to persuade customers to pay the bill

All of the 27 townships where water tariffs are in force have reported that they are having to deal with one or several of the problems outlined above. This appears to be a main issue affecting the work performance of meter reading staff.

The strategy being adopted by the relevant staff to overcome above problems is to visit the same customers several times. They have also reported the challenging nature of their task having to explain customers about their rates and how they are calculated. The absence of a strategic awareness and an information delivery programme aimed at customer education is yet another main issue affecting work performance of the frontline staff of townships.

3.6.9 Financial Analysis Of Ycdc Water Sector Operations

This section presents the current status of financial operations of the Yangon City Development Committee's (YCDC) Water Supply and Sanitation (WSS) Engineering Department. Specifically the section discusses sources of revenue and expenditure and their past trends as well as the

analysis of different components of revenue and expenditure items. The current budgetary policy of YCDC is provided as a backdrop to the discussion.

(1) Budgetary Policy and Water Sector Financing Strategy

Being an institution of Ministerial status in the Union of Myanmar, YCDC is a separate financial body in its own right. Similar to other viable financial institutions, the current policy of YCDC is to collect money from customers for the services rendered. This includes the policy of charging for town water supply and other connected services such as connection fees from its customers. As mentioned earlier, the YCDC is empowered to collect revenue and impose penalties on defaulters by the law.

The current budgetary policy envisages that all revenues collected by each of the 21 departments of YCDC including the WSS(Water & Sanitation) Engineering Department are credited to the General Account (GA). The Budget and Finance Department is responsible for the management of the GA. Funds from this account are allocated to each of the 21 departments based on their individual annual operational budgetary requirements (see below). Under the current policy, the individual departments including the WSS have no authority to determine areas for capital expenditure within their operations. Similarly, the departments are not authorised to include items of expenditure requiring policy directives in their forecasts. Such matters have to be cleared by the executive committee of the YCDC before sanctioning.

Each department prepares a budgetary forecast of its intended revenue and expenditure for the period 1st April to 31st March of the following year. This is submitted to the Budget and Accounts department for approval. It is the responsibility of each department to operate within the approved budget during the financial year. The annual forecast is reviewed in mid-year in order to determine any financial short falls and/or excess. This exercise is followed by the actual adjustment of revenue and expenditure against the approved annual budget.

The strategy for financial operations involves reimbursement of expenditure already incurred on any item on submission of receipts to the Budget and Accounts department. In this process, the relevant department prepares a work authority (WA) for each potential item of expenditure. This is submitted to the Coordination department for checking, auditing and making adjustments if necessary before passing over to the Budget and Accounts department for payment. Actual expenditure against the approved WA is paid to the relevant department or the work team on submission of claims, in installments.

Furthermore, officers holding specified positions are issued with advance funds to be disbursed on various items of expenditure. For example the district WSS engineer incharge of a district has Ks.50,000 advance account while a township engineer has an advance of Ks.10,000 to be spent on urgent small-scale work items.

Although the revenue collected is credited to the GA and the expenditure incurred in the provision of water service is provided from this account, the actual revenue and expenditure

accounts of the WSS are kept separately. This makes it possible to analyse water sector financial position fairly accurately. The next section describes the main revenue and expenditure categories of WSS Department.

(2) Water sector revenue and expenditure

As already mentioned in the above section, the WSS department collects revenue for various services provided to its customers. It receives funds from the GA to pay for the expenditure incurred. The current position with regard to revenue is examined in the next section followed by an analysis of expenditure.

1) Revenue from water

The WSS Department's annual undiscounted revenue ranged from Ks. 58 millions in 1991/92 to as much as Ks. 530 millions in 2000/01. This represents an increase in revenue by 10 times during the past decade. The undiscounted mean annual revenue for the past ten years stood at Ks. 302.43 millions.

Revenue forecasts for the past ten years match well with the actual collection (Appendix Table K-7) indicating a healthy financial discipline of the department.

The revenue for WSS operations is brought about by three (3) main sources namely, water tariffs, connection fee and other revenue. The total revenue itself and the contribution to the total by each source have registered a consistent increase (except for 1998/99) for the past ten years. The possible reason for lower revenue in 1998/99 may be due to the civil disturbance in Yangon in that year. The actual revenue figures for the study period are found in Appendix Table K-7.

Water tariffs represent the dominant share of departmental revenue whose contribution however declined from 80 % of the total revenue in 1990/91 to about 60% of the revenue in 2000/01. This decline is attributable to a progressive lowering in the water tariffs collected from government departments including the defence establishments from a high of 35% in 1990/91 to as low as 13% in 2000/01. Though private water tariffs increased in the mid 1990s it subsequently levelled off to about 50% of the total revenue. All in all water tariffs which made up as much as four-fifth of the revenue in early 1990s declined to three-fifth of revenue by 2000/01. Had the tariffs contribution by government departments remained at its 1990 value, the proportion of tariffs in the total revenue would have still represented as much as the four-fifth level.

The second large share in water revenue comes from connection fee. This includes the combined connection fee payable by customers for new water as well as sewage connections. The Figure 3.44 reveals that the revenue from connection fee was 14% of the total revenue in 1991 which has registered a sharp rise to reach 36% of the total revenue in 2000/01.

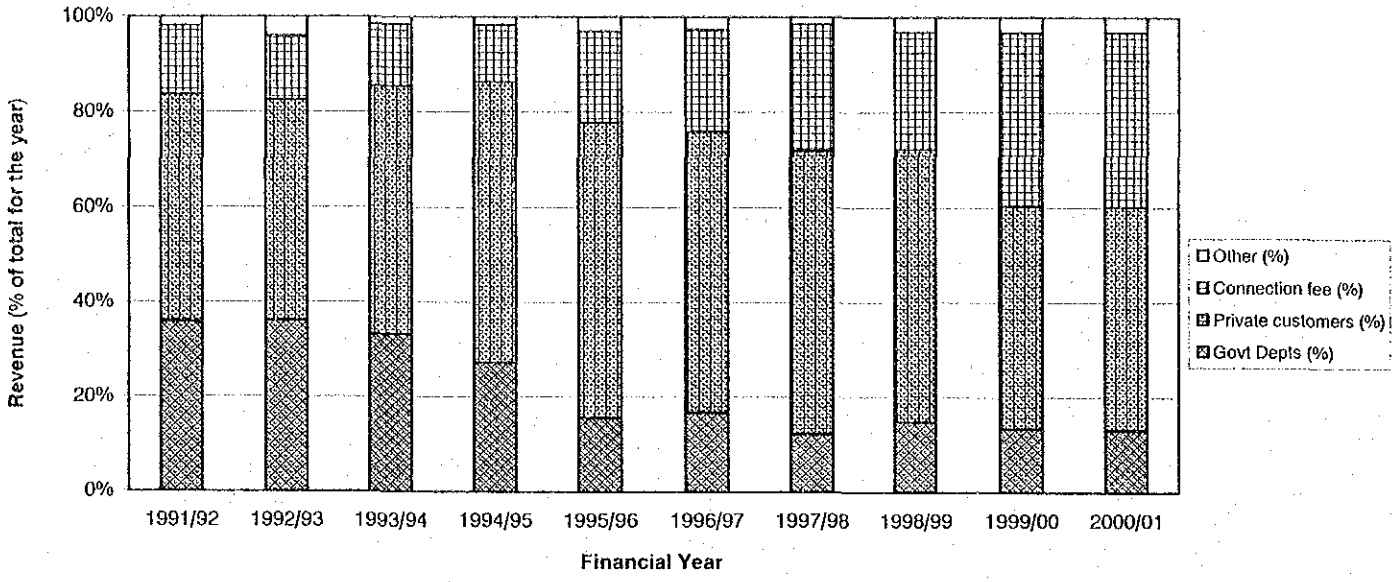


Figure 3.44 Revenue for Water Service by Source and Financial Year

The last component of the revenue is other income which includes items such as penalty charges, over-due tariffs etc. This is the smallest component of the overall water revenue which has registered a small rise to about 3% in 2000/01 from its value of 1% in the early 1990s.

2) Water expenditure

WSS's expenditure in the provision of water service includes the salaries and wages paid for its staff, cost of maintenance of infrastructure and the operational costs. The capital expenditure incurred by the WSS department is not available for analysis. It is to be noted that the maintenance cost does not include operational costs of vehicles in connection with the provision of water services.

The Figure 3.43 illustrates the proportional change in expenditure over the last 10 years while the actual expenditure amounts are found in the Appendix Table K-8.

The expenditure forecasts (Appendix K-8) for the past ten years show that the department has been able to operate within its forecast only in 1991/92; its actual expenditure has outweighed the forecasts for all other accounting years. The actual expenditure has been nearly double the forecasts in 1997/98 and again in 2000/01 years.

The mean annual expenditure (excluding capital costs) incurred in operating and maintaining the YCDC water service during the past ten years has been Ks. 101 millions. The maximum expenditure of Ks.240 millions was incurred in 2000/01 while the minimum expenditure of Ks.49 millions was in 1991/92.

The dominant share of expenditure amounting to about 50 % of the total had been for overhead charges followed by maintenance cost representing 29% (Figure 3.45).

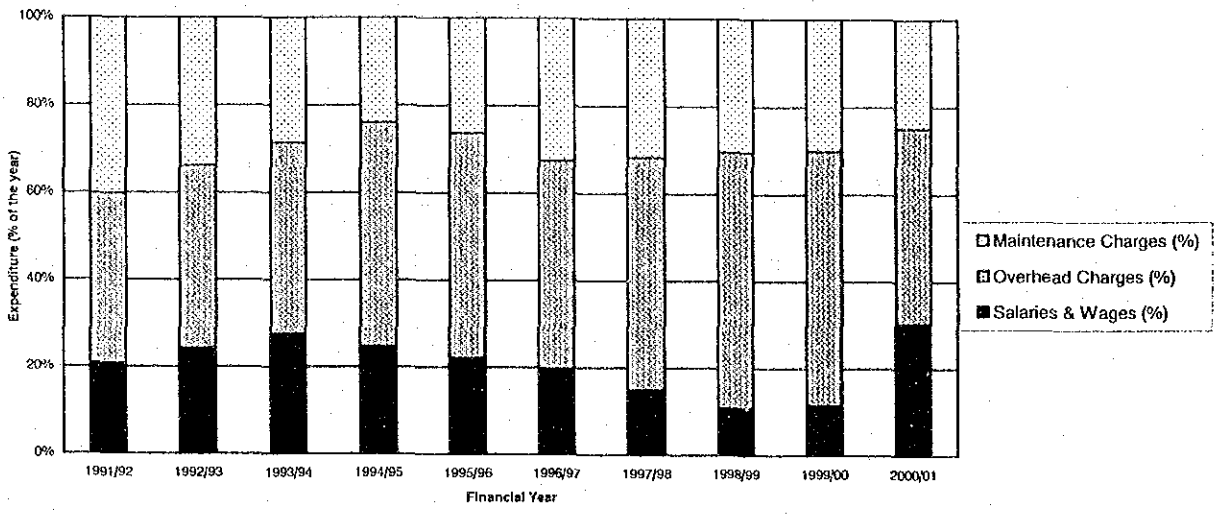


Figure 3.45 Water Service Expenditure by Financial Year

The maintenance cost includes machinery operation costs, maintenance of pipelines and the operation and maintenance of the reservoirs, tubewells and the pumping stations. The maintenance cost has registered a sharp decline in its proportion from 40% in 1991/92 to as low as 24% in 2000/01.

It is to be noted that the above reduction will have a negative impact on the longevity of operational efficiency of machinery, equipment and the distribution network which in turn will negatively affect the performance of the water supply system in the long-run.

The share of salaries and wages which stood at 20% in 1991/92 had comedown to 15% in 1997/98, it increased to 30% in 2000/01 as staff salaries were revised in 2000.

(3) Comparison of water revenue and expenditure

The revenue and expenditure for the past 10 years are graphically presented in the Figure 3.46. It reveals that the revenue from water services has been in excess of expenditure right throughout the ten-year period. During 1993/94 the expenditure rose slightly but the revenue registered a sharp increase. This was the period when water tariffs collection increased. The past trend clearly indicates that the WSS is financially viable as far as the operational expenditure and the revenue are concerned. The current status reveals the capacity of the WSS to operate independently of any subsidy or financial assistance to run the water programme for the City. However, it is to be noted that the capital expenditure including depreciation cost is not included in the above analysis.

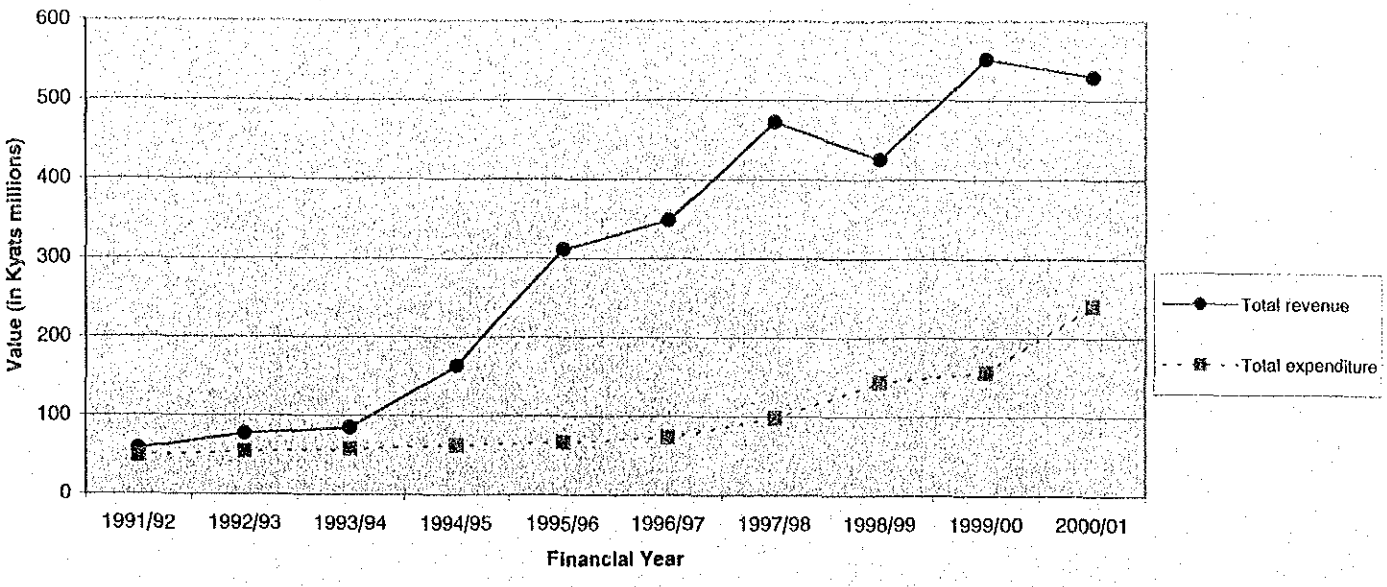


Figure 3.46 Revenue from and Expenditure for Water Services by Year

3.7 CONSUMER SURVEY ON WATER USE

In order to solve the problems of the water supply system in Yangon City, understanding of the water supply situation from the viewpoint of the water consumer is important. Hence, the consumer survey for both domestic and non-domestic consumers was conducted in the whole Yangon City of 33 townships during the period of May to July 2001.

3.7.1 Domestic Consumers

Domestic consumer survey is categorized into two types of customers: YCDC customers and non-YCDC customers. Out of 563 houses analyzed, YCDC consumers consist of 364 houses (64.7 %) and non-YCDC consumers 199 (35.3 %). Figure 3.47 shows the types of YCDC water supply, 45 % of customers have in-house tap, 24 % yard tap and 25 % both in-house and yard taps. Figure 3.48 shows water sources for no-YCDC customers, the most popular source is own tube (49.8 %) followed by water purchase from private water sources (17.1 %) and rainwater (12.4 %).

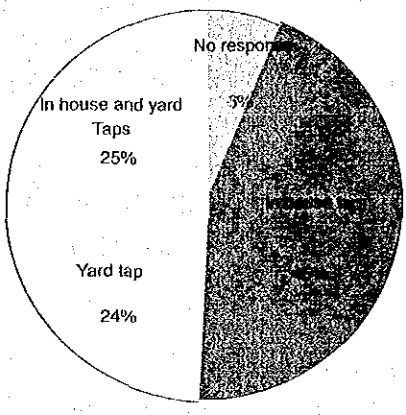


Figure 3.47 Location of YCDC Water Tap

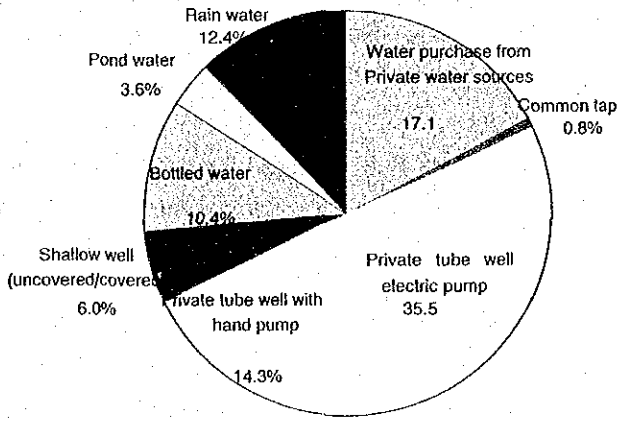


Figure 3.48 Water Source for Non-YCDC

The survey estimated the average daily household water consumption at 228 gallon: 261 for YCDC customers and 167 for non-YCDC customers. Average per capita consumption per day is 184 litters, 220 for YCDC customers and 126 for non-YCDC customers. 45.8 % of YCDC customers and 82.7 % of non-YCDC customers have supplied water sufficiently all year. The average water costs is 293 kyats for YCDC customers and 579 kyats for non-YCDC customers, 77.4 % and 39.9 % think it right amount respectively.

75.5 % of YCDC customers have no willingness to pay more for current YCDC water supply services, but for the improved water supply service, 83.4 % have willingness to pay more. Figure 3.49 and 3.50 show the willingness to pay for 24 hours' clean water and drinkable water supply. The average willingness to pay for clean water is 321 kyats per month, for drinkable water 383 kyats.

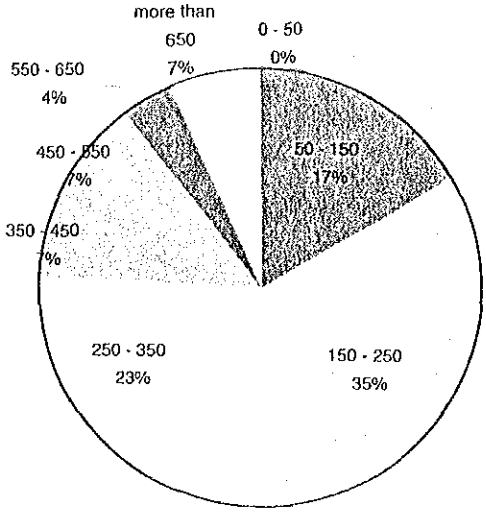


Figure 3.49 Willingness to Pay for 24 Hours' Clean Water Supply (Kyats/month)

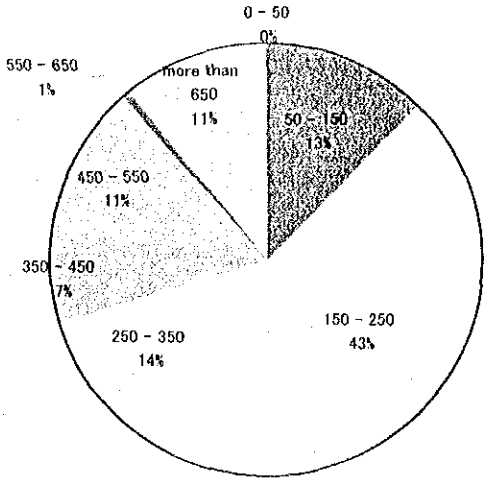


Figure 3.50 Willingness to Pay for 24 Hours' Drinkable Water Supply (Kyats/month)

Out of 198 households of non-YCDC customers, 168 households (85 %) have willingness to connect YCDC water supply system and willingness to pay for clean and necessary amount of water supply is 559 kyats, for drinkable and necessary amount of water supply is 797 kyats.

3.7.2 Non-Domestic Consumers

This survey covers 103 non-domestic consumers: 40 consumers (39 %) for industrial consumers, 45 (44 %) for commercial and 18 (17 %) for public. Figure 3.51 shows water supply sources. The main source is YCDC water followed by dug well and private owned tube well.

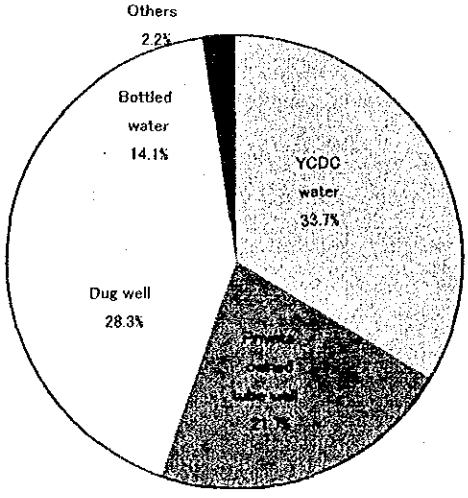


Figure 3.51 Water Supply Source

The average monthly water consumption is 598 m^3 for industrial and 296 m^3 for commercial consumers. 94 % of all consumers have supplied water sufficiently all year; 93 % satisfy the quality of main water source and 91 % quantity.

The total average water costs is 11,073 kyats for industrial and 11,429 kyats for commercial. 92 % of YCDC customers have no willingness to pay more for current YCDC water supply service. Figure 3.52 shows the willingness to pay for improved 24 hours' drinkable water. The average amount is 4,778 kyats for industrial, 9,219 for commercial, and 2,169 for public.

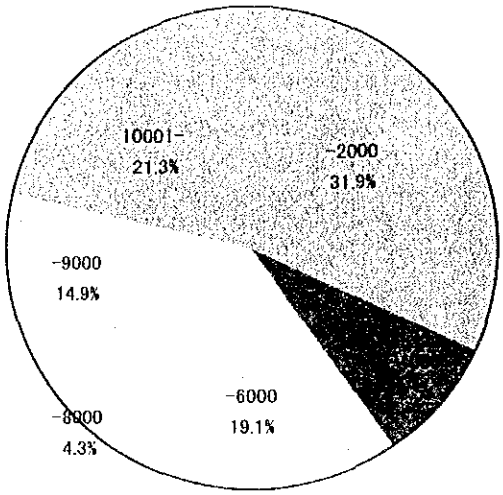


Figure 3.52 Willingness to Pay for 24 Hours' Drinkable Water Supply