PART II WATER SUPPLY

CHAPTER 3 CURRENT WATER SUPPLY SYSTEM IN THE STUDY AREA

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3.1 Existing Water Supply System

3.1.1 Operating Water Supply Systems in the Study Area

An inventory of operating water supply systems was developed through the course of this development study. FINNIDA Master Plan Report was referred in this compilation and the field survey to water supply systems together with questionnaire survey and interviews was carried out by the Study Team. This inventory is presented in Table 3.2 together with the evaluation results on future usage of the existing water sources and its summary is as shown in Table 3.1.

Table 3.1 Summary of Existing Water Supply Systems in Greater Kandy

Name of Operating Body	Number of Operating Water Supply Systems	Total Production Capacity (m^3/day)	Number of Service Connections		
			Domestic	Non-Domestic	Stand-post
NWSDB	23	28,896	17,428	1,258	500
KMC	1	33,400	14,400	3,100	470
Kundasale	1	13,000*	-	-	-
		576	1,150	50	5
Pallekele (CECB)	1	2,000	490	16	44
Pallekele (Gam Udawa)	1	1,200	66	59	5
Ampitaya	1	1,300	1,159	96	52
Wattegama	1	1,400	829	230	42
Peradeniya	1	545	-	-	-
Menikhinne	1	300	788	33	6
Total	31	82,617	36,310	4,842	1,124

Note: * On-going project

There are 31 water supply systems being operated by different institutions in the Greater Kandy Area. They produce a total of 82,617 m^3/d drinking water to serve for 36,310 domestic connections, 4,842 non-domestic connections and 1,124 standposts.

3.1.2 Water Sources

A summary of existing water supply sources serving the Greater Kandy area is presented in Table 3.1 (Revised based on extraction from Water Supply Master Plan for Greater Kandy, FINNIDA, 1994). Existing sources provide about 82,600 m^3/d to study area residents including on-going Hulu Ganga (13,000 m^3/d) and Nilambe Oya (11,500 m^3/d) schemes. Capacities of the existing water sources range from large surface water sources with complete treatment (33,400 m^3/d from the KMC treatment facility on the Mahaweli River) to small groundwater

Table 3.2 Existing Water Supply Schemes in Greater Kandy

No.	NWSDB ID No.	Name of Water Supply System	AGA Division	Name of Operating Body	Service Area	No. of Service Connection (as of Nov.1997)			Supply Continuity (hrs./day in draught season)	Location of Sources		Type*	Present Production Capacity (m3/d)	Borehole Safe Yield (m3/d-FINNIDA)	FINNIDA Plan		Evaluation Result		Present Condition of Water Sources
						Domestic	Non-Domestic	Stand- Post							To be used up to 2005	To be used up to 2015	To be used up to 2005	To be used up to 2015	
1	-	Kandy Municipal Council	KMC	KMC	KMC limits	14,400	3,100	470	24	Mahaweli R. at Getambe		S	33,400	-	33,400	33,400	33,400	33,400	No wastewater treatment facility.
2	-	Ampitiya	Kandy Four Gravets	Ampitiya P/S (N.)	Ampitiya	1,159	96	52	12	Bore-hole at Ampitiya (NWSDB)		G	1,300	1,500	1,300	-	1,300	1,300	Residents complain high hardness.
3	6055	Hanthana	Kandy Four Gravets	NWSDB	Hanthana H.S.	321	134	0	24 (0-6)	Stream at Hanthana		S	450	-	450	450	300	300	Low yield. For supplemental use.
4	6057	Mullepihilla	Kandy Four Gravets	NWSDB	Mullepihilla	59	4	9	2	Stream at Mullepihilla		S	Small (70)	-	-	-	-	-	Almost dry during dry period.
5	6021	Mahakanda	Kandy Four Gravets	NWSDB	Univ. quarters	13	NA	0	24 (0-8)	Stream at Mahakanda, and Nillambe Oya (planned)		S	Small	-	-	-	-	-	Low yield during dry period.
										Bore-hole at Mahakanda		G	Small	NA	-	-	-	-	
6	6056	Akurana	Akurana	NWSDB	Akurana	969	91	53	12	Bore-hole at Welekade		G	1,000	1,770	-	-	1,000	1,000	Total 8 wells. 4 wells on duty, 2 stand-by, and 2 pumps are under repair. GWL is decreasing year by year.
7	6074	Alawathugoda	Akurana	NWSDB	Kurugoda / Konakalagala / Alawathugoda	920	82	33	12	Bore-holes at Vilana		G	240	400	-	-	200	200	Locations of wells are far from Mahaweli R. High elevation. Low pumpage per well.
										Bore-holes at Owissa		G	400	650	-	-	300	300	
8	6065	Rajapihilla	Harispattuwa	NWSDB	Ranawana / Uduwawala / Hunnanoya	743	21	41	12	Bore-hole at Rajapihilla	Old	G	310	NA	-	-	-	-	Low pumpage.
											New	G	680	1,200	680	-	650	650	Good condition.
9	6066	Gohagoda	Harispattuwa	NWSDB	Gohagoda	1,527	48	28	24 (0-6)	Bore-hole at 'Tekkawatta Rd., 6069, and 6067	Old	G	216	700	600	-	-	-	Close to garbage dumping site and low pumpage. To be abolished in future.
											New	G	-	NA	-	-	-	-	Due to decrease of shallow wells water level in surrounding area, residents oppose to operate.
10	6067	Kondadeniya	Harispattuwa	NWSDB	Kondadeniya	887	27	18	12	Bore-hole at Katugastota	Old	G	-	NA	-	-	-	-	Dried. Abandoned.
											New	G	1,440	2,350	2,350	-	-	-	One well dried up, other one was abandoned due to corrupting. Large pumpage because river is near. High iron.
11	6069	Yatihalagala	Harispattuwa	NWSDB	Haloluwa	286	10	4	4	Bore-hole at Haloluwa		G	-	100	-	-	-	-	Abandoned.
										Shallow B.H. at Gannoruwa Rd.		G	1,850	2,000	2,000	-	1,920	1,920	Good quality and quantity. 3 wells are planned. Possible to augment.
12	6076	Hedeniya	Harispattuwa	NWSDB	Hedeniya / Maduwala / Pujapitiya	1,116	62	56	12	Bore-hole at Madadeniya		G	840	1,200	1,200	-	840	-	Containing high iron. Since it is far from Mahaweli R., continuous operation is needed for the time being with iron removal facilities.
										Stream at Bolagala		S	small	NA	-	-	-	-	
13	6077	Kulugammana	Harispattuwa	NWSDB	Heenagama / Nugawela / Kulugammana	1,502	51	17	12	Bore-hole at Ambatenna, and 6067		G	790	900	790	-	450	450	High iron, turbidity and color.
14	6068	Bokkawela	Pujapitiya	NWSDB	Bokkawela	723	22	21	24	Bore-holes at Alagoda Rd. & Madadeniya	Old	G	450	650	390	-	600	600	Good quality. Since it is far from Kandy Plant and is located at high elevation, operation will continue in future.
											New	G	550	NA	-	-			
15	6079	Galhinna	Pujapitiya	NWSDB	Galhinna	356	14	17		Bore-hole at Galhinna		G	80	90	-	-	80	-	Low GWL and pumpage. Pumpage is decreasing. Groundwater is not reliable.
16	6093	Menikhinne	Kundasale	Kundasale P/S (N.)	Menikhinne	788	33	6	4 (0-4)	same to 23		S	-	-	-	-	-	-	
										Bore-hole at Ittamalliyada (NWSDB)		G	300	900	-	-	-	-	Relatively high hardness. Low pumpage. No stand-by well.

Table 3.2 Existing Water Supply Schemes in Greater Kandy

No.	NWSDB ID No.	Name of Water Supply System	AGA Division	Name of Operating Body	Service Area	No. of Service Connection (as of Nov.1997)			Supply Continuity (hrs./day in draught season)	Location of Sources	Type*	Present Production Capacity (m3/d)	Borehole Safe Yield (m3/d-FINNIDA)	FINNIDA Plan		Evaluation Result		Present Condition of Water Sources
						Domestic	Non-Domestic	Stand- Post						To be used up to 2005	To be used up to 2015	To be used up to 2005	To be used up to 2015	
17	6092	Kundasale	Kundasale	Kundasale P/S (N.)	Kundasale New Town	1,150	50	5	24 (0-18)	Bore-hole at Kundasale (NWSDB)	G	576	1,500	1,100	-	-	-	Quality become worse in parallel with WL of Victoria R. Low pumpage and high hardness in dry season.
18	6082	Pallekele (Gam Udawa)	Kundasale	Kundasale P/S (N.)	Gam Udawa / Open Prison Camp / Dodandolla Rd.	66	59	5	13	Bore-hole at Nikulathen (NWSDB)	G	480	1,500	600	-	-	-	High hardness
										Bore-hole at Karadagolla (NWSDB)	G	720				720	720	High hardness
19	-	Pallekele (CECB)	Kundasale	Kundasale P/S	Balagolla Settle. / BOI / Digana Vil.	490	16	44	24 (0-12)	Mahaweli R. (Vic. R.) at Pallekele	S	2,000	-	2,000	2,000	-	-	Intake from Victoria R. Due to 20m fluctuation of W.L., operation is not easy.
20	6092	Kundasale	Kundasale	NWSDB (Bulk Supply)	18-21	-	-	-	-	Hulu Ganga, NWSDB On-going Project	S	13,000	-	-	-	13,000	13,000	New water supply system to be completed in 1999 getting water from Hulu Ganga. (4000m^3/d to BOI, remaining 9000m^3/d will be distributed to service area)
21	6025	Polgolla	Patha Dumbara	NWSDB	Mahaweli A. Qtrs. / Uyanwatta TTC / Coop. School / Open Univ.	171	65	0	12	Mahaweli R. at Polgolla	S	1,500	-	-	-	-	-	Deterioration of civil structure.
22	6071	Balanagala	Patha Dumbara	NWSDB	Polgolla / Balanagala	1,164	36	38	10	Bore-hole at Katugastota-Matale Rd.	G	1,000	1,000	-	-	-	-	Problem in water quality (color).
23	-	Wattegama	Patha Dumbara	Wattegama U/C	Wattegama U/C	829	230	42	8 / 3days (0-8)	Punchimola Stream at Wattegama-Elkaduwa Rd.	S	1,400	-	1,400	1,400	1,400	1,400	Far from Mahaweli R. Treatment is needed.
										Mangalagiriella Stream	S	Small	-	-	-	-	-	Very small, no treatment.
										Rassella Stream	S	Small	-	-	-	-	-	Very small, fear of agrochemical contamination.
24	6025	Polgolla (Napana)	Patha Dumbara	NWSDB	Napana / Madawala	562	12	36	4 (0-4)	same to 6071, and 23	S G	-	-	-	-	-	-	
25	6280	Talatu Oya	Patha Hewaheta	NWSDB	Talatu Oya	274	21	0	NA	Bore-hole at Talatu Oya	G	200	-	-	-	-	-	Very poor yield.
26	6022	Udu/Yatinuwara	Udunuwara	NWSDB	Daulagala / Peradeniya / Pilima Talawa	5,326	468	121	12 (0-8 per 3days)	Mahaweli R. at Sarasavi Uyana, and 30	S	4,600	-	4,600	-	-	-	Rapid sand filter only. Cannot cope with high turbidity in rainy season. Chemical dosing and sedimentation facilities are needed in future.
27	-	Welamboda	Udunuwara	NWSDB	Welamboda		Planned			same to 30	S	-	-	-	-	-	-	
28	-	Peradeniya Teachers Training College	Udunuwara	Peradeniya T.T.C.	Peradeniya T.T.C. / Qtrs	NA	NA	NA	24	Bore-hole at Peradeniya T.T.C.	G	545	NA	-	-	-	-	Water source is Mahaweli River. In dry season, river water flows far from intake, and sand and gravel are sediment in front of intake. Because of small water supply amount, to be abolished in future.
29	6026	Kadugannawa	Yatinuwara	NWSDB	Kadugannawa Town & Suburbs	294	58	0	24	Damba Oya at Kadugannawa-Danture Rd.	S	800	-	-	-	800	800	Continuous use in future.
30	-	Kalugamuwa (O.)	Uda Palatha	NWSDB	Kalugamuwa (O.)	NA	NA	NA	NA	Nillambe Oya	S	11,500	-	-	-	9,000	9,000	Supply 9,000m^3/d to greater Kandy area, and 2,500m^3/d to outside of the area.
31	6059	Mariyawatta (O.)	Uda Palatha	NWSDB	Mariyawatta (O.)	(274)	(21)	0	NA	Mariyawatta S.W. and G.W.	S	-	-	-	-	-	-	
32	-	Gampola (O.)	Uda Palatha	Gampola U/C	Gampola U/C	NA	NA	NA	NA	Paradeka	S	-	-	-	-	-	-	
										New Peacock	S	-	-	-	-	-	-	
33	-	Marassana(O.)	Patha Hewaheta	Patha Hewaheta P/S	Marassana	(224)	(16)	2	12 (0-6)	Stream, and Ma Oya (planned)	S	(2,200)	-	-	-	(2,200)	(2,200)	Will be replaced by new source with full treatment plant.
34	6075	Ankumbura (O.)	Pujapitiya	NWSDB	Ankumbura (O.)	(215)	(32)	8		Bore-hole at Ankumbura	G	-	-	-	-	-	-	
			Total			36,095	4,810	1,116				82,617	18,410	52,860	37,250	65,960	65,040	

Note: (O.) - Outside of the Study Area, (N.) - Bulk Water Supply by NWSDB, (NWSDB) - Owned by NWSDB

Type: S - Surface Water, G - Groundwater

extraction schemes (hundreds to 2,000 m^3/d) to even smaller gravity spring sources with limited treatment. Areas presently served by existing water supply facilities in the study area are illustrated in Figure 3.1. The present (1997) service population in the entire study area is estimated at 544,320, out of a total population of 644,680. It is recommended that several smaller water schemes that produce poor quality water or an excessively expensive to operate be abandoned after 2005. Existing supplies that will continue operation after 2005 have a capacity of 65,960 m^3/d including the as yet unfinished Hulu Ganga and Nilambe Oya projects.

3.1.3 Transmission and Storage Facilities

(Data are extracted from the FINNIDA M/P and revised based on interview with NWSDB)

Existing major transmission lines and reservoirs are illustrated in Figures 3.2 and 3.3. Total length of the existing major transmission mains are estimated to be about 81 km as given in Table 3.3.

Table 3.3 Length of Existing Transmission Pipeline by Size

Materials	Diameter (mm)	Length (m)
PVC	50	1,400
	75	3,000
	90	0
	110	1,110
	140	0
	160	14,030
	225	7,150
	280	1,500
	Sub Total	28,190
Ductile Iron	100	750
	150	9,280
	200	6,154
	250	10,915
	300	2,349
	350	6,616
	400	11,333
	450	2,000
	500	5,800
	Sub Total	55,197
Total		83,387

There are 42 distribution reservoirs in the Greater Kandy area for water supply with capacities ranging from 45 to 3,636 m^3. Details of existing reservoir capacities and locations are presented in Table 3.4.

Table 3.4 Exsisting Reservoirs in Greater Kandy

Service Area		ID. No.	Reservoir Location	Capacity (m3)
Kundasale	Mulewemuduna (lower)	KR1	Mulewemuduna	100
- ditto -	Mulewemuduna (upper)	KR2	Mulewemuduna	225
- ditto -	Ahaspokuna	KR3	Ahaspokuna	650
- ditto -	Vijaya Srigama	KR4	Vijaya Srigama	225
- ditto -	Kolongahawatte	KR5	Kolongahawatte	100
- ditto -	Kundasale	KR6	Kundasale	350
- ditto -	Menikhinna	KR7	Menikhinna	450
- ditto -	Sirimalwatta	KR8	Sirimalwatta	650
- ditto -	Rajawella	KR9	Rajawella Town	100
- ditto -	BOI	KR10		450
- ditto -	Farm School	31	Farm School Premises	500
- ditto -	Gam Udawa	KT1	Opposite Army Camp	320
- ditto -	Dambarawa	KT2	Dambarawa	175
Sub-Total				4,295
Patha Dumbara	Balanagala	500	Balanagala	450
- ditto -	Napana	25N	Napana	150
Sub-Total				600
Harispattuwa, Akurana & Pujapitiya	Bokkawela - Present WSS and Suburbs	12	Bokkawela(Ex)	300
- ditto -	Akurana (part) -Present WSS and Suburbs	10	Akurana	600
- ditto -	Galhinna	11G		150
- ditto -	Hedeniya (part) - Present WSS and Suburbs - Madadeniya	16	Madadeniya(Ex)	300
- ditto -	Kulugammana -Present WSS and Suburbs	14	Kulugammana	300
- ditto -	Rajapihilla (part) Present WSS and Suburbs	15	Rajapihilla	300
- ditto -	Kondadeniya-Present WSS and Suburbs	5	Kondadeniya	300
- ditto -	Gohagoda-Present WSS and Suburbs	65G	Gohagoda	300
- ditto -	Gohagoda	65		600
- ditto -	Yatihalagala - Present WSS and Suburbs	64	Yatihalagala	150
Sub-Total				3,300
Udunuwara, Yatinuwara and Uda Palatha (part)	Daulagala Present WSS and Suburbs	22	Daulagala	1,140
- ditto -	Kalugamuwa	24	Kalugamuwa	1,820
- ditto -		24	Kalugamuwa	180
- ditto -	Eriyagama	36	Eriyagama	860
- ditto -	Kadugannawa Present WSS and Suburbs	38	Kagudannawa(Ex)	560
Sub-Total				4,560
Kandy Municipal Council	Bahirawakanda/Anniwatta	57	Bahirawakanda	91
- ditto -	Primrose	63	Primrose	181
- ditto -	R2 Reservoir Present Distribution Zone	582	Wakarawatta	3,636
- ditto -	R3 Reservoir Present Distribution Zone	583	Wakarawatta	1,136
- ditto -	Dangolla	66	Dangolla	118
Sub-Total				5,162
Kandy Four Gravets	Uda Peradeniya (Lower)	67	Prospect Hill	1,140
- ditto -	Ampitiya, Ketawala, Lewla	60	Ampitiya	900
- ditto -	Meekanuwa	60M	Meekkanuwa	225
- ditto -	Hantana Housing scheme	HT	Hantana (upper)	390
- ditto -	Hantana Housing	61	Hantana (lower)	1,365
- ditto -	Mulluphilla (Lower Level)	60'		45
- ditto -	Mulluphilla (Upper Level)	60"		45
Sub-Total				4,110
Total				22,027

3.1.4 Recent or On-going Water Supply Improvement Projects

Recently, two rather large scale water supply projects were launched. The Nilambe Oya project was completed to supply the water to the area located southern area of the Greater Kandy. While, the Hulu Ganga project has been implemented in the eastern area of the Greater Kandy.

(1) Nilambe Oya Project

Construction was recently (1997) completed on an 11,500 m^3/d water treatment facility on the Nilambe Oya. Construction of the transmission mains and reservoirs has also been completed. This plant with the following facilities serves a portion of the KMC- Iriyagama zone:

- Aeration - Lime and alum chemical dosing
- Flocculation - Rapid sand filtration
- Sedimentation - Chlorination

(2) Hulu Ganga Project

Design work has been initiated on the Hulu Ganga project, which is scheduled for completion by the end of the year 2000. The total estimated cost for the project is Rs.300M, Rs.150M of which has already been allocated by the Government. This project will extract 13,000 m^3/d from the Hulu Ganga near Wattakelle Estate and serve a portion of the Polgolla-Kundasale zone. Of the total, 4,000 m^3/d of this supply is slated for the IDB Zone. The remaining 9,000 m^3/d will be used to serve other portions of the Polgolla-Kundasale zone. When demand in the Polgolla-Kundasale zone exceeds the capacity of the Hulu Ganga project, NWSDB plans to supplement the supply with water from the proposed Katugastota water treatment plant.

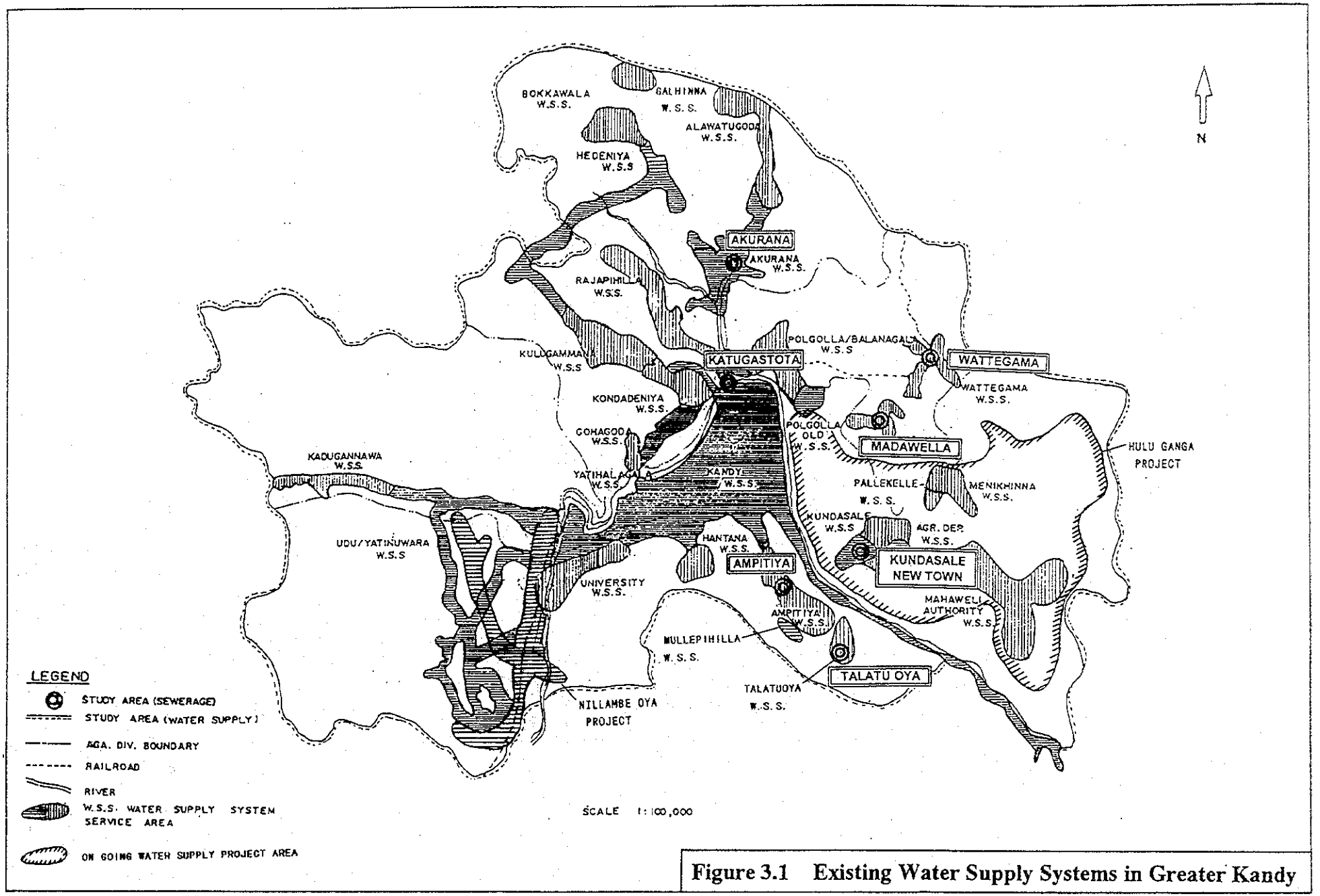

Figure 3.1 Existing Water Supply Systems in Greater Kandy

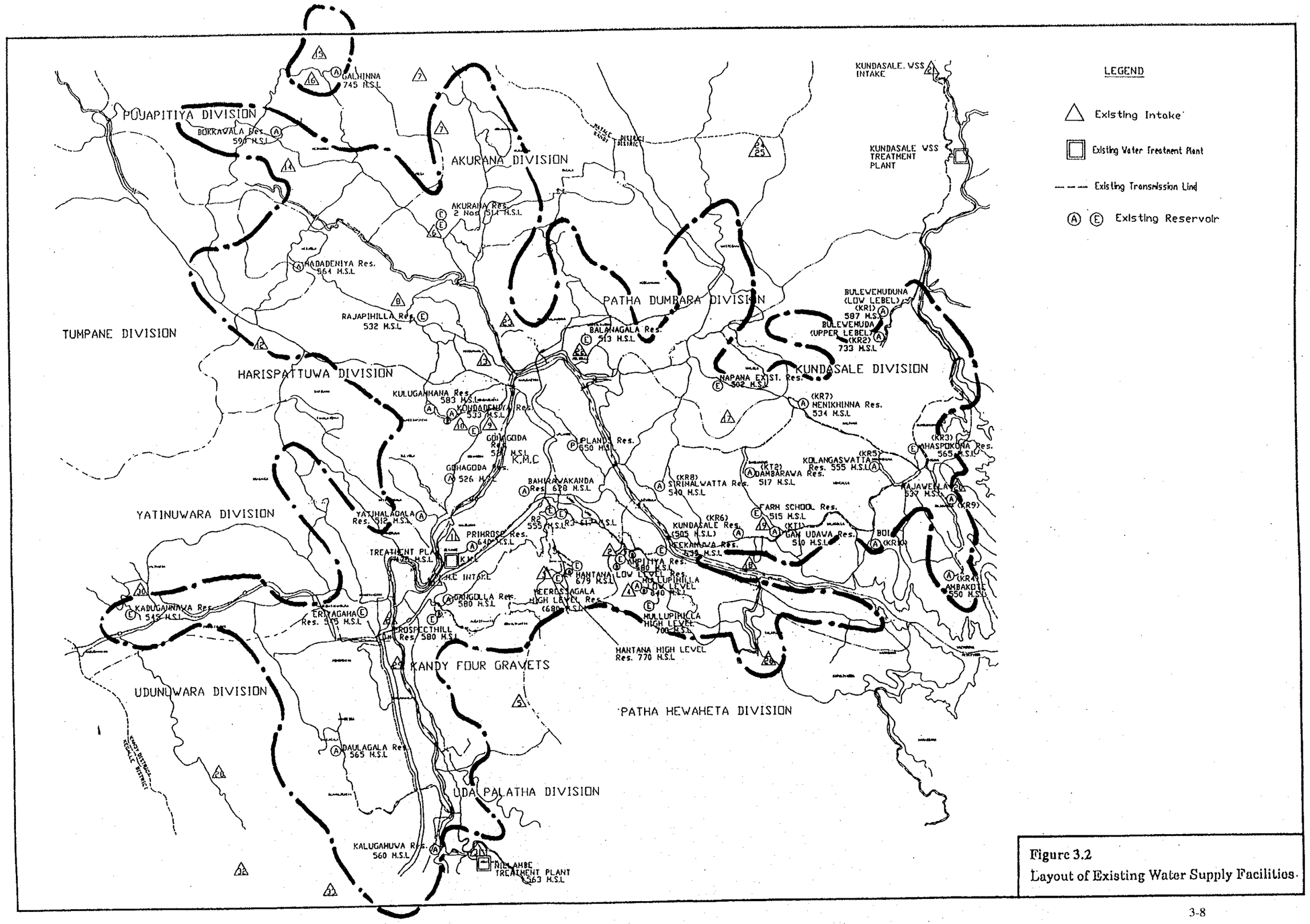

Figure 3.2
Layout of Existing Water Supply Facilities

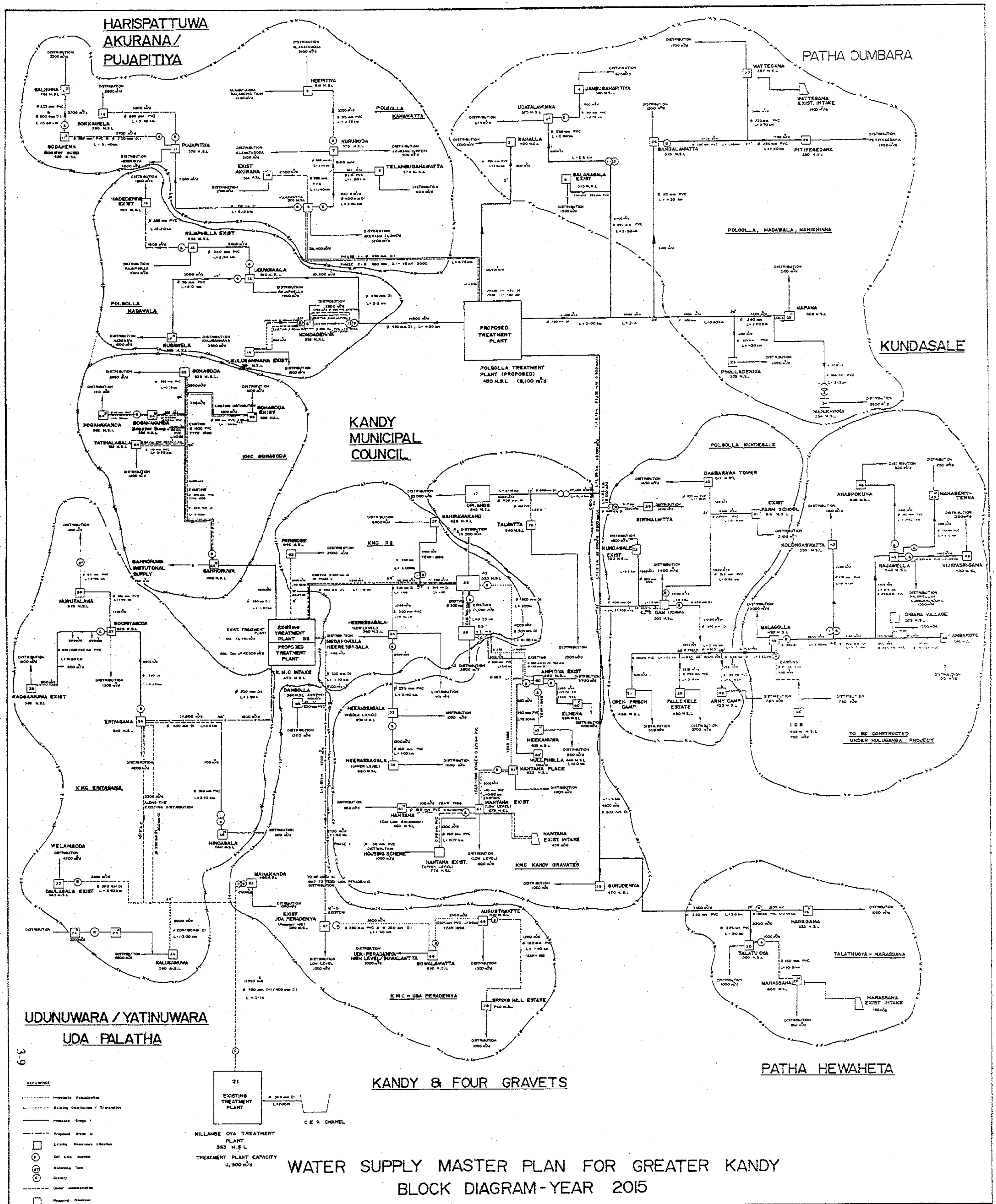

Figure 3.3
Block Diagram of Existing Water Supply Facilities (extraction from FINNIDA M/P)

3.2 Institutional Arrangements for Water Supply and Sanitation

3.2.1 Kandy Municipal Council

(1) *Functions and Responsibilities.*

At the Kandy Municipal Council area, the Office of the Waterworks Engineer undertakes the production, distribution and operation and maintenance activities to meet the water demands of the city. Although, mainly concerned with operation and maintenance, the Office has also been involved in minor capital development works, such as pipeline extensions and tank relocation.

(2) *Customer Base.*

As of 1997, the waterworks system had a total of 17,203 active service connections, of which 14,247 were domestic connections. It also maintains about 517 unmetered standposts and 20 "public bath houses". The official policy is to limit the installation of these public standposts in the future to low-income areas only.

(3) *Tariff Structure.*

Effective January 1998, a new water rate structure was enforced. The previous adjustment was implemented in 1994; the new rate schedule is a significant increase over the last schedule. In addition, a monthly meter rental fee, depending on the size of the meter is charged. The new rates are:

Table 3.5 Water Rate Schedule - KMC, 1998 (unit: Rs./m^3)

Type of Accounts	Consumption (m^3)							
	1-10	11-20	21-25	26-30	31-37	38-44	45-51	>51
Domestic	0.60	1.50	5.50	7.00	7.50	8.00	12.00	15.00
Commer'l	25.0 – 27.0, depending on type of commercial establishment							
Schools	0.00	1.80	6.00	12.00	15.00		20.00	35.00

Table 3.6 Schedule of Monthly Meter Rental Charges - KMC, 1998

Meter Size	Monthly Charge	Meter Size	Monthly Charge	Meter Size	Monthly Charge
6" (150mm)	Rs. 400.00	2" (50mm)	Rs. 150.00	3/4" (20mm)	Rs. 50.00
4" (100mm)	Rs. 250.00	1½" (40mm)	Rs. 100.00	5/8" (16mm)	Rs. 30.00
3" (75mm)	Rs. 200.00	1" (25mm)	Rs. 80.00	1/2" (13mm)	Rs. 20.00

(4) *Organisational Structure*

Operationally, the system is divided into three (3) zones; each headed by a Technical Officer.

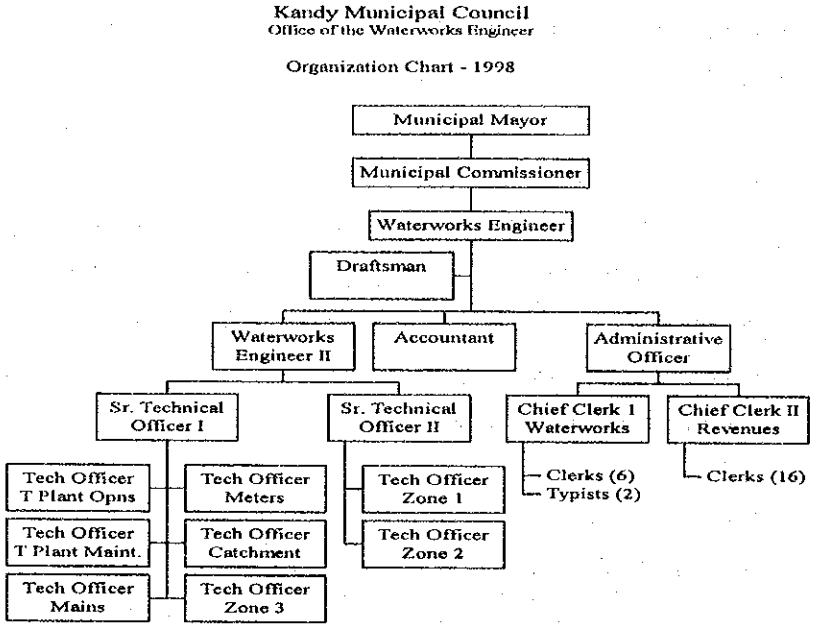

Figure 3.4 Organisational Chart of the Office of the Waterworks Engineer - KMC, 1998

(5) ***Staffing Levels and Personnel Administration***

As of February 1998, the Waterworks office employed 267 staff, including three (3) professional-level staff (2 engineers and 1 accountant); about 156 mid-level or technician-level staff; and 108 laborers. Overall, the staffing ratio is 15.52 staff per thousand connections (which is considered high).

(6) ***Operating Highlights***

1) During 1997, the estimated water produced was 31,641 m^3/day; water billed was 18,335 m^3/day. **Non-revenue water was 42 percent.**
2) Billing and Collection Performance. As of June 1998, outstanding receivables from water sales was Rs.49,101,828.85. The average collection period (from July 1997 to June 1998) was **8.93 months**. This is considered extremely high and unsatisfactory.

Table 3.7 Billing and Collection Data, KMC - Jan 1997 to July 1998

Month KMC	*Consumption m3*	*Billings Rs.*	*Collections Rs.*	*No of Connections*
Jan-97	509,048	4,638,807.79	3,589,250.44	
Feb-97	517,222	4,664,180.27	3,311,156.27	
Mar-97	602,934	3,815,763.52	2,750,506.97	
Apr-97	589,763	4,202,330.28	2,395,256.97	
May-97	527,385	3,744,130.45	4,874,762.78	
Jun-97	508,361	4,184,092.45	4,849,922.12	
Jul-97	498,533	4,213,131.61	3,853,833.80	
Aug-97	484,547	3,751,335.69	3,443,920.95	
Sep-97	495,864	4,220,435.22	3,084,099.70	
Oct-97	714,991	4,597,333.91	3,488,646.53	
Nov-97	512,392	3,874,227.17	6,431,203.44	
Dec-97	661,721	4,194,229.30	7,304,572.29	17203
Total	**6,622,761.00**	**50,099,997.66**	**49,377,132.26**	
Average	**551,896.75**	**4,174,999.81**	**4,114,761.02**	
		Arrears, as of Dec 97:	***40,398,849.71***	***Rs.***
		Avg. Collection Period (1997):	***9.68***	***months***
Jan-98	727,607	6,255,944.03	2,964,751.07	
Feb-98	590,289	6,661,797.28	4,226,085.76	
Mar-98	591,939	8,009,011.00	10,802,808.67	
Apr-98	601,502	7,082,193.46	3,067,649.82	
May-98	597,394	6,970,109.56	4,711,762.75	
Jun-98	574,855	6,163,384.93	6,666,403.05	
Average	**613,931.00**	**6,857,073.38**	**5,406,576.85**	
% Increase	*11.64%*	*38.63%*	*32.89%*	Month-on-month
		Arrears, as of Jun 98:	***49,101,828.85***	***Rs.***
		Avg. Collect. Period (Jul97-Jun98):	***8.93***	***months***

3) Income and Expenses. Income and expenses of the KMC waterworks in 1997 was reported as shown in Table 3.8.

Table 3.8 Income and Expense Data - KMC, 1997

Water Production Costs		**Revenues**	
Staff Salary	11,530,812	Rates and Taxes	44,855,181
Chemical Costs	2,838,819	Others	19,313,458
Materials	2,288,938		
Electricity	43,421,183	**Total Revenue**	64,168,639
Repair Cost	1,299,566		
Others	9,119,758	**Gain (Loss)**	(6,330,437)
Distribution Costs	70,499,076		

4) Budget and Expenses. In 1997, the municipal budget projected the water sales revenue at Rs.87,527,200; and waterworks O&M expense of Rs.84,452,380. As of middle of

the year, both projected revenues and expenses were below budget estimates at 39.49 percent and 25.85 percent, respectively.

(7) *Getambe (KMC) Water Treatment Plant Operations*

The KMC operates a 33,400-m^3/d capacity water treatment plant in Getambe. The actual production is 31,641 m^3/d (operating efficiency, 94.7 percent). Water production costs could not be determined. No major operating issues were reported although the need for better capacity to deal with chlorine-related emergencies was noted.

The plant is managed by an Officer-in-Charge, assisted by four (4) shift supervisors and a mechanical works supervisor. The staff complement consists of 1 laboratory technician, 8 pump operators, 4 driver/mechanics, 2 electrician and labourers. Total staffing is 34.

(8) *Assessment of Institutional Strengths and Weaknesses*

1) The accounts receivables as of June 1998 total Rs.49,101,828.85 (very high). The average collection period (arrears/avg. monthly billing) has improved from 9.68 months to 8.93 months; however, this is not indicative of any effort to collect the arrears. The average monthly billing of the KMC has increased with implementation of the new water rates in January 1998. More efforts are needed to bring the arrears under control. There is little motivation or incentive to collect arrears since the operating budget for the waterworks is always assured.
2) Because of the poor collection, the KMC, in effect, heavily subsidised the waterworks operations to about Rs 13.24 M in 1997 alone.
3) Non-revenue water in 1997 was reported to be 42 percent. At a production cost of Rs.5.42 per m^3, this is equivalent to throwing away Rs.2.19 M per month.
4) The operation at Getambe water treatment plant stands out as a fine example of efficiency and should be considered as a possible training resource for treatment plant operations.
5) Overall, there is a need for stronger commercial orientation in the waterworks office and clearer responsibilities for collection efficiency. The linkage between operating budget and collection performance should be established. Technical operations are generally well-managed except for the huge non-revenue water losses. Improvements to ensure better operational control through accurate monitoring will be required.

3.2.2 Greater Kandy Area outside of KMC

(1) *Functions and Responsibilities*

In the Greater Kandy area, the NWSDB, through its Kandy Regional Office (under the Regional Support Centre for the Central Province or RSC/C) serves the Greater Kandy population (outside the KMC) through about 42 separate facilities or schemes. NWSDB is responsible for the production, distribution and source development activities to serve the growing demand of the area. The FINNIDA Master Plan is the most recent development plan available. The Study Area is under the responsibility of the RSC's Kandy North, Kandy South and Matale districts.

The ***Kandy North District Office***, headed by a District Engineer, operates in the following schemes: the Akurana WSS for **Akurana**; the Rajapihilla, Gohagoda, Kondadeniya, Yatihalagala, Hedeniya and Kalugammana WSS for **Harispattuwa**; the Bokkawela WSS for **Pujapitiya**; the Ampitiya, Hantana, Mullepihilla, Upper Hantana and Mahakanda WSS for **Kandy Four Gravets**; the Polgolla, Balanagala and Polgolla (Napana) for **Patha Dumbara**. The following schemes are also within Kandy North responsibility but are **not** covered by this Study: Galagedara, Madadumbara and Menigamuwa.

The ***Kandy South District Office*** operates the following schemes: the Udu/Yatinuwara, Peradeniya University WSS for **Udunuwara**; the Kadugannawa WSS for **Yatinuwara**. The following schemes are also within Kandy South responsibility but are **not** covered by this Study: Mariyawatte and Ethgala, Maskeliya, Nallatanniya/Sri Pada and Hatten Dikoya. The following schemes under the ***Matale District Office*** are covered in this Study area: Alawathugoda WSS for **Akurana**; ; the Bokkawela, Ankumbura and Galhina WSS for **Pujapitiya.**

Because of its proximity to the NWSDB Workshop in Pallekele, the Kundasale, Menikhinna, Pallekele WSS for **Kundasale** are monitored through the Mechanical-Electrical Engineer based at the Workshop.

(2) *Customer Base*

As of December 1997, there were a total of 34,277 direct connections, as follows:

Domestic	30,883	including government quarters
Commercial	1,637	including tourist facilities
Institutional	1070	
Standpoints	687	

(3) *Tariff Structure*

The following tables show the recently revised tariffs that are applied to all NWSDB-administered systems nation-wide effective 1 October 1997. Rates for bulk supplies are negotiated separately.

Table 3.9 Water Rate Schedule (Partial) – NWSDB, 1998

Category of Accounts	Consumption, m^3					
	1 - 10	11-20	21-25	26-30	31-40	41-50
Domestic, Gov't Quarters, Schools	25.00 min.	1.80	6.00	12.00	15.00	20.00
Comm'l & Ind'l	Rupees 25.00/ m^3					
Unmetered	Domestic, Rupees 300/month					

In addition, a monthly service charge is levied on all non-domestic connections.

Table 3.10 Monthly Service Charges – NWSDB, 1998

Diameter of Connection	Monthly Service Charge
1/2"	50.00 Rupees
3/4"	100.00 Rupees
1" - 2"	200.00 Rupees
2" - 3"	500.00 Rupees
> 3"	1000.00 Rupees

(4) *Organisational Structure*

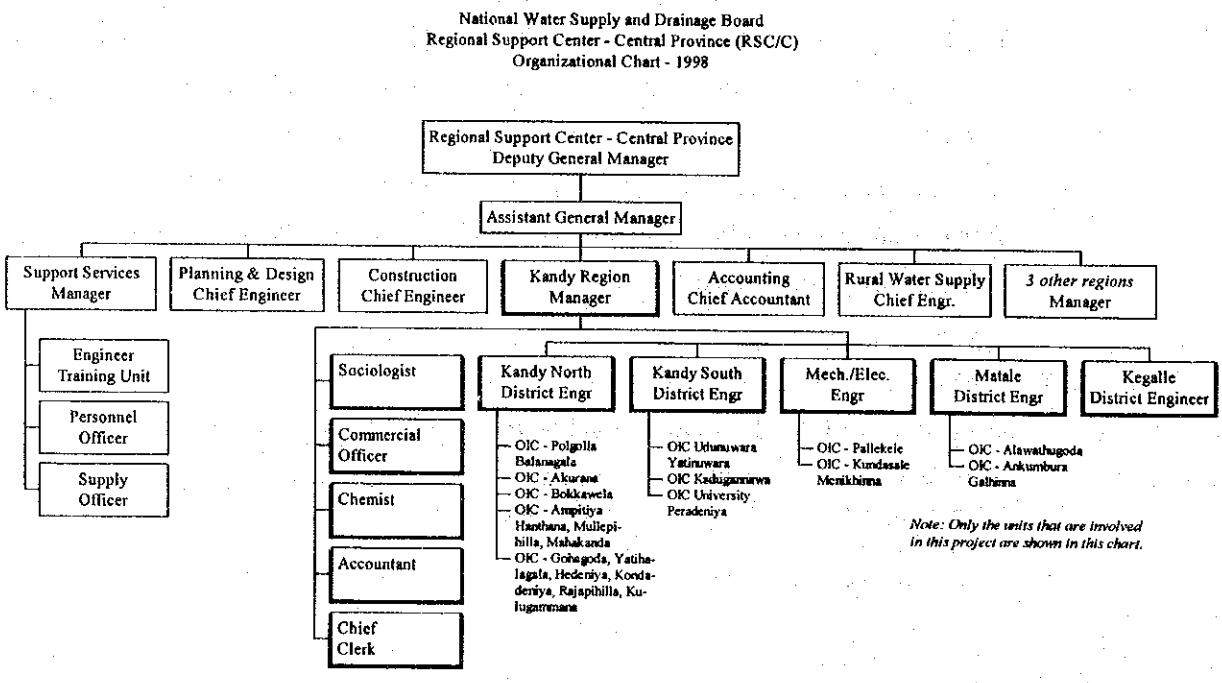

Figure 3.5 Current Organisation Chart of NWSDB - Kandy Region

(5) *Staffing Levels*

For the entire Kandy Region, there are 606 existing personnel as of 1997. The staff profile may be described as follows: Professional & managerial staff, 13; Skilled office workers, 71; Skilled field workers, 303; and Labourers, 219.

(6) *Operating Highlights*

Revenues and costs for the entire Kandy region are presented and discussed. The data available does not segregate areas covered within the study area and those outside.

1) *Billing and Collection.* Consumers are billed monthly; water bills are paid through selected banks or to the various district and regional offices. The total billing in the Kandy region for 1997 amounted to Rs.93,022,050; collection was Rs.90,383,000. Both billing and collection were above the annual target by about 10 percent. As of December 1997, the average collection period (expressed in number of month's equivalent of average monthly sales) overall is **2.95 months** (i.e., accounts receivable/ave monthly water sales).

2) *Arrears from Bulk Supply Accounts.* Two types of connections are provided - bulk and direct. "Bulk" supplies are available for some areas where one organisation is made responsible for the water bill based on the bulk meter. Some urban councils, housing authorities, or similar bodies, operate these bulk water supplies. These organisations are responsible for the distribution, billing and collection and maintenance of the subsystem. There are currently nine (9) organisations receiving bulk supplies including urban councils and the University of Peradeniya. A key issue affecting collection performance is the report that more than half of the arrears come from the bulk supplies. Arrears, as of Dec. 1997, are broken down as follows:

Table 3.11 Billing and Collection of Bulk Customers, NWSDB Kandy Region, 1997

1997	Bulk Customers	Direct Customers	Total
Total Billings, Rs.	44,663,821.00	48,358,229.00	93,022,050.00
Total Collections, Rs.	38,781,000.00	51,502,000.00	90,383,000.00
Arrears as of Dec 1997	12,596,159.60	10,302,442.17	22,898,601.77
Avg. Collection Period	*3.38 months*	*2.56 months*	*2.9 months*

Table 3.11 indicates that billings for bulk services is nearly half of the total billings; this figure has been steadily rising and will likely surpass direct customer billing in the current year. The bulk customer collection performance, however, lags far behind. The outstanding arrears for bulk accounts is now 55 percent of the total amount in arrears. Clearly, better management of its bulk accounts and a thorough review of the bulk supply contracts are critical to arrest this alarming trend.

(7) ***Training and human resources development***

Training within the NWSDB Kandy region is organised and implemented by the Engineer Training Unit (under Support Services) of the Regional Support Centre in co-ordination with the Manpower Training Division (MPTD) at the NWSDB Head Office. Training programs have been conducted for all staff levels. The following table shows the number of NWSDB staff trained from the entire Kandy region.

Table 3.12 Number of NWSDB (Central) Staff Trained, 1995-1997

Category	*1995*	*1996*	*1997*
Senior Managers	9	8	13
Middle Managers	156	71	19
Junior Managers/Supervisors	165	175	8
Technical Professional staff	895	701	197
Clerical Grade staff	1134	68	228
Skilled Grade staff	348	148	38
Office Laborers	21		
Total	*2728*	*1171*	*603*

Training, thus far, has been principally related to office management skills, including computer skills and language skills; and water supply operation and maintenance for both urban and rural areas. Training capacity for sewerage and sanitation skills does not exist. The annual training budget is very low; only Rs.50,000 was allocated for training activities in 1997 for logistics and participation of staff in external courses for the entire region. The Training Unit relies on project funds (such as the rural water supply project) to pursue its activities. It maintains some audio-visual equipment and relies on a roster of local staff to act as resource persons and facilitators. At present, the Unit is a one-man operation. Clearly, more management support is needed to support the training function. The decline of training activities is very apparent from the table above.

(8) ***Sewerage services***

Sewerage is available only at the Hanthana Housing Project of the National Housing Development Authority. Sewerage (and water) facilities were constructed as part of the project. Under current arrangements, NWSDB monitors its costs for collecting and treating wastewater and bills for the actual costs, plus 30 percent overhead. On May 1998, the NHDA transferred the sewerage facilities to the NWSDB. Studies are underway to determine how the sewerage bills could be passed on to the households. Water supply to Hanthana is provided by NWSDB and paid for directly by the consumers.

(9) *Computerisation*

Plans are underway to introduce automation and telemetry in 11 of the 42 schemes; completion is expected by this year. Much of the operating and financial information is processed through computers.

(10) *Assessment of Institutional Strengths and Weaknesses*

1) Staffing. Current staffing ratio (entire Kandy region) is 17.68 staff per thousand connections. Granting that not all the staff are involved in direct delivery of water services, the current staff ratio may be considered high and should be reduced to about 12, in the immediate-term.
2) Training. The NWSDB Kandy region participates in the programs; however, because of budget and staff constraints, training is fast deteriorating. Training capacity for sewerage and sanitation does not exist at either the central or regional level. Technical assistance, possibly in the form of advanced training for selected staff, focussing on Project Management and on Operations and Maintenance, and direct posting of a sanitation/sewerage technical training expert will be useful. The training activities for this Project should be made available to the MC's, UC's and PS's staff..
3) Computerisation. Steps will be needed to further integrate the various information subsystems.
4) Customers. There are about 20,000 pending applications for service connection on file that have not been acted upon due to the inadequacy of the supply. This is indicative of the urgency of need and demand for improvements.

3.2.3 Independently-Managed Water Systems in Greater Kandy

In an increasing number of towns within the study area, Pradeshiya Sabahs (PS's) and Urban Councils (UC's) have been purchasing water supply in bulk from the NWSDB and managing its distribution to consumers; still others are operating the systems independently of the NWSDB. This sub-section examines the institutional situation in these areas.

(1) At **Wattegama**, the Urban Council independently manages the water system.

1) Customer Base. As of July 1998, the system served 1,058 connections (839 domestic; 208 non-domestic and 1 temple) and 42 unmetered standposts.
2) Organisation and Staffing. The office responsible for waterworks operations is part of the UC. The staff directly involved consists of a Technical Officer, one pipefitter-plumber and 3 laborers.

3) Tariff Structure. A monthly flat rate of Rs.50 is charged for all domestic connections; non-domestic connections are charged Rs.75 for the first 50,000 gallons (or 22.7 m^3). The current practice is to meter non-domestic connections only. The meter is used to determine whether or not the monthly consumption exceeds 50,000 gallons (about 22.7 m^3).

4) Billing and Collection. Table 3.13 shows the most recent billing and collection data.

Table 3.13 Billing and Collection Data - Wattegama, Jan-Jun 1998

	Billing	Collection
Jan-98	59,263.50	11,600.00
Feb-98	59,263.50	14,062.00
Mar-98	59,274.00	22,797.50
Apr-98	59,813.50	13,795.00
May-98	59,900.00	16,142.50
Jun-98	61,550.58	24,701.50
	359,065.08	**103,098.50**
	Collection Efficiency:	***29%***

Between January and June 1998 alone, the waterworks office failed to collect a total of Rs.255,966.58. Given the minimal operating requirements (gravity system), it is likely that inspite of this very unsatisfactory collection performance, the water utility still manages to generate a cash surplus. Except for salaries and wages, it is very apparent that there is little or no maintenance being done. There is thus no incentive to collect. Delinquent non-payers are not pursued and the regular payers are penalised by the non-enforcement of collection.

5) Very clearly, service to the residents of Wattegama will not improve by increasing supply alone; in fact, increasing the supply would aggravate the problem. The key issues for Wattegama water supply operations include:

- Improving operational control, including metering of all customers and all production sources.
- A thorough determination of NRW is not possible because of the absence of data. Even a superficial investigation into the conditions of the pipelines shows a very high number of visible leaks in pipe joints.
- Accountability for collection enforcement has to be established. There is no effort to collect unpaid bills.
- Immediate audit of all customer accounts to ensure that all billings and payments made are properly recorded in the books.

- Equitable tariff structure. Assuming an average household size of 5.7 and a consumption of 60 lpcd, the estimated cost for domestic consumption is about Rs.4.87 per m^3, non-domestic unit cost is Rs.3.30 per m^3 only. Domestic consumers, based on the current structure, *subsidise* commercial, non-domestic consumers.

(2) In **Kundasale**, the Pradeshiya Sabha manages the water supply system. The waterworks office buys water in bulk from NWSDB and also operates a small treatment plant (Balagolla) and a production well at Rajawella.

1) Customer Base. As of July 1998, there were 3,970 individual connections (3,588 domestic; 331 non-domestic, and 51 institutional) and 55 metered public standposts. Significantly, the system has 3 major bulk accounts to serve the IDB, Digana Village and BOI. Both IDB and BOI are industrial estates. The public standposts are metered; bills are settled by the consumer association consisting of about 15 to 20 households per standpost.

2) Tariff Structure. Kundasale has a fairly well-developed tariff structure approved in 1992 which is similar to the MCs.

Table 3.14 Water Rate Schedule – Kundasale, 1998

Category of Accounts	Consumption. m^3							
	0-5	6-10	11-15	16-20	21-25	26-10	31-150	>150
Domestic	3.50	4.50	6.00	7.00	8.00	12.00	15.00	500.00
Schools	3.00 per m^3 (with 500.00 deposit)							
Comm'l, Govt	10.00 per m^3		20.00 per m^3					
Industrial	25.00 per m^3 (with Rs.2,000 deposit)							
Tourist Hotel	25.00 per m^3 (with Rs.1,500 deposit)							
Standpost	3.00 per m^3 (with Rs.500 deposit)							

The bulk services to BOI and IDB represent a substantial size of Kundasale's business.

3) Billing and Collection Effort. The following tables show the most recent billing and collection data for Kundasale. Accounts are maintained by schemes making it useful to assess the difference in unit cost of delivered water between the combined Rajawella-Balagolla systems which are independent of the systems which distribute the bulk supplied water.

Tables 3.15 and 3.16 show that the actual expenses to KWW to deliver NWSDB-supplied water is 14.16 Rs; however, the actual effective revenue they derive is Rs.8.15 per m^3. – *an actual loss of Rs.6.01 per m^3 for the NWSDB-supplied water*. Even if KWW can totally eliminate NRW, the most it will achieve is to reduce their losses to Rs.4.93 per m^3. Clearly, tariff adjustments are needed. It is also significant to point out

that the actual expense of KWW to produce and deliver the water is only Rs.8.70 per m^3 which is cheaper then the NWSDB-supplied water which, with all expenses considered, adds up to Rs.14.16 per m^3. Given the current tariff table of KWW which is enforced, the current NRW, the collection efficiency and the consumption pattern of the Kundasale residents, the overall effective revenue derived is Rs.***10.42 per m^3***.

Table 3.15 Effective Tariff, Kundasale Waterworks, 1998

	NWSDB Water	KWW Water	**Total**
Ave monthly collection (Rs), Jan-Jun 98	161,638.74	595,144.32	756,783.06
Ave monthly billing (Rs.), Jan-Jun 98	183,101.79	611,682.23	794,784.01
Ave volume billed (m^3), Jan-Jun 98	19,843	52,801.00	72,644
Effective rate charged (actual income)	Rs.8.15 per m^3	Rs.11.27 per m^3	10.42
Effective rate charged (potential income)	Rs.9.23 per m^3	Rs.11.58 per m^3	10.94
Actual Expense to deliver	Rs.14.16 per m^3	Rs.8.70 per m^3	

Table 3.16 Cost Comparison of NWSDB-supplied vs. Locally-produced Water

A. NWSDB-supplied Water

	Vol Delivered by NWSDB m^3	*NWSDB Bill for Bulk Supply* Rs.	*Amount Paid by KWW* Rs.	*Additional Distribution Expenses,* Rs.	*Totals - Water Sold* *Billed Value* Rs.	*Collection* Rs.
Jan-98	43,160	312,910.00	200,000.00	187,257.47	235,368.50	126,351.15
Feb-98	34,942	253,329.50	200,000.00	132,710.79	217,556.00	192,271.85
Mar-98	35,626	258,288.50	-	256,195.57	210,748.50	303,132.71
Apr-98	28,260	226,080.00	-	219,067.01	202,056.50	123,712.98
May-98	20,700	165,600.00	-	91,747.08	195,457.00	176,934.39
Jun-98	21,331	170,648.00	200,000.00	124,233.78	220,526.00	209,068.10
Jul-98	19,461	155,688.00	-	NA	-	-
Total	*203,480*	*1,542,544.00*	*600,000.00*	*1,011,211.70*	*1,281,712.50*	*1,131,471.18*
Average	*29,069*	*220,363*		*168,535*	*183,101.79*	*161,638.74*

Est Adm. and Supervision Overhead **22,617** 25% on wages of 90,466.55

Adj. Avg. Cost to Distribute Water **191,152 Rs.**

Eff. Cost to deliver NWSDB-supplied water **14.16 Rs./m^3**

B. Locally-produced Water (Balagola and Rajawella)

	Total Production m^3	*Total Billed* m^3	*Total Billing* Rs.	*Total Collection* Rs.	*Operating Expenses* Rs.
Jan-98	59,737	45,248.00	529,535.00	NA	NA
Feb-98	49,423	43,790.00	525,318.00	44,216.00	184,814.49
Mar-98	65,553	53,672.00	612,305.50	110,769.50	162,154.26
Apr-98	65,432	54,221.00	609,672.42	713,156.82	599,936.86
May-98	68,822	58,898.00	690,028.00	346,830.70	160,261.68
Jun-98	65,916	55,108.00	681,073.33	1,643,297.73	378,595.51
Jul-98	56,137	58,670.00	679,088.45	943,961.55	NA
Aug-98	NA	-	566,437.10	958,922.28	
Total	431,019	369,607.00	4,893,457.80	4,761,154.58	1,485,762.80
Average	61,574	46,200.88	611,682.23	680,164.94	297,152.56

Adjustments to Monthly Operating Costs

Per Record	297,152.56	In Feb-Jun 1998	1,485,763	Rs. was reported.
Payable: Power Bills	100,000.00	Unpaid Power Bills of KWW, Rs.	600,000	was estimated.
Contract: Wages	8,383.33	Contract Workers in Feb, Rs.	50,300	
25% Overhead	49,962.11	Admin Cost;	199,848	is the ave monthly wage expense
O&M of Bowser	80,000.00	Rs. per month; maintenance and fuel use records not kept.		

Average Monthly Operating Expense **535,498.01** Rs. (adjusted)

Eff. Cost to deliver KWW-produced water **8.70** Rs./m^3

4) Organisation and Staffing. The billing and collection functions are lodged with the Administrative Branch while a Maintenance Branch handles the technical operations.

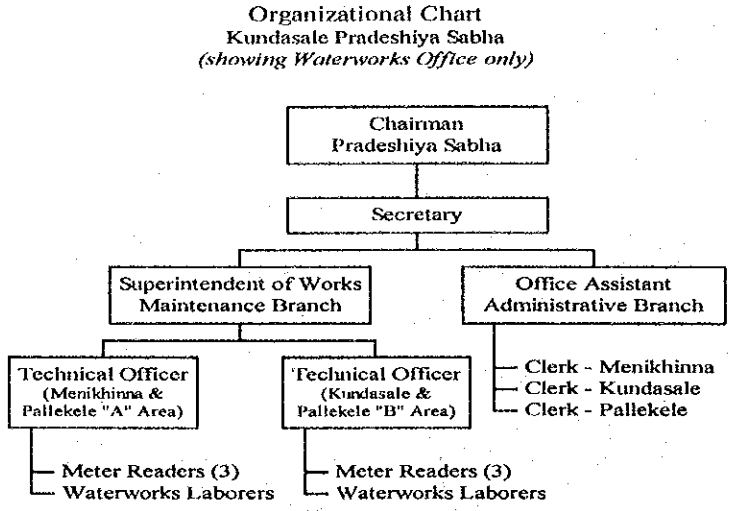

Figure 3.6 Organisational Chart of Kundasale Waterworks Office (KWW)

There are eighty (80) staff deployed for the water system, as follows:

▪ Balagolla Plant	12
▪ Bowser Service	8
▪ Distribution Network	14
▪ Office Staff	4
▪ Laborers	42
Total	**80**

5) The situation in Kundasale comes about because of deficiencies in the bulk contracts with the NWSDB. The immediate key operational issues for Kundasale are due to the insufficient supply of water from the NWSDB. There was a dramatic drop in volume delivered by the NWSDB from 43,160 m^3 in January 1998 to 19,461 m^3 in July 1998 – a 55 percent reduction in volume delivered. This has caused difficulty in satisfying the demands of the Kundasale residents who have deferred paying for their services. KWW would have immediate benefit from a review of the bulk service contract.

(3) ***General Assessment of Independently-run Systems***

The operating and institutional conditions in Wattegama and Kundasale reflect the general situation of the smaller systems which are managed outside the direct responsibility of the NWSDB.

1) Many of the immediate corrective actions at the PS/UC do not require external financing support. Wattegama is a case in point. With better management and effective collection of water bills, they should be able to raise the funds needed to properly operate, maintain and improve the system on their own. The situation is very similar to

the MCs – there are no incentives to improve operational efficiencies. The waterworks office gets its annual budget regardless of collection performance.

2) Since the function of capital improvements continue to reside with the NWSDB, there are very few initiatives by the local authorities to plan out and seek capital financing on their own.

3) The general practice is to remit lump sums to the NWSDB to settle the bills. It is not clear if these payments are proceeds from user charges or an outright appropriation of the PS. The general impression is that remittances of this size had to undergo major decision-making. It is difficult for this to go on every time a water bill has to be settled. It is suggested that a bank account be set up where all collections are deposited and from which payments to NWSDB can be drawn. A major portion of whatever is collected should be remitted as soon as possible, even weekly.

4) The apparent motivation of the PS's/UC's for preferring bulk arrangements is in effect to subsidize the rates. It is difficult and perhaps presumptive to assume that local leaders are unable to take decisions which may have adverse political implications. However, if the local leaders prefer to take short-term and expedient decisions, they should also be prepared to continue making annual allocations to subsidise operations and maintenance and not expect any dramatic improvements in efficiencies. This situation is ultimately more expensive to its residents.

5) These situations point to a role which NWSDB should play in providing a focussed, systematic and continuing program to provide management and technical assistance and to monitor these independent systems. Effective technical and management advisory services by the NWSDB to the PS's/UC's can readily lead to substantial dividends. These services could point out policy and operating deficiencies and initiate corrective actions.

6) It would also be prudent for NWSDB to make thorough institutional assessments prior to introducing capital improvements with a view towards leveraging the adoption of proper policies and practices before any capital development assistance is provided. The NWSDB's ultimate mandate, after all, is not the construction of systems and facilities, per se, but improved access of people to safe water and wastewater services, i.e., systems which work and are sustainable.

3.2.4 Emerging Policy, Management and Institutional Issues

(1) ***General Policy Issues***

1) The NWSDB dominates the sector with a broad set of mandates which ranges from sector policy formulation, project development and construction, operation and main-

tenance and even regulations (tariff setting, service monitoring, etc). The NWSDB roles as system planner (and implementor), service provider and regulator are starting to conflict with each other. The exercise of regulatory functions is usually vested on a third party to ensure adequacy and fairness of tariffs, compliance with environmental standards, adequacy of service delivery, etc. No one seems to be responsible for independent monitoring to ensure that public utilities for water and sewerage are operating within acceptable standards (water losses, collection efficiency, etc) - and that the people are indeed being served at a fair price.

2) There is a growing fear that in order for capital investments to take place, the NWSDB will take over the systems from local authorities – as was the case in Colombo. These issues are being raised by local officials and should be addressed squarely by the NWSDB.

3) Municipal Councils, the Urban Councils and the Predeshiya Sabhas also share in the responsibility for water and wastewater services within their area of jurisdiction. In Kandy City, the KMC has taken on the operation and maintenance role and the rate-setting function. However, further capital improvements on the system, including major rehabilitation works, are still within the NWSDB role. The NWSDB should continue to review the policies and institutional arrangements, particularly the sharing of responsibilities among the sector agencies, local authorities, user groups and the private sector. The goal of this review is to ensure that all residents within the Study area have reasonable access to safe water supplies, hygienic sanitation collection, and waste treatment and disposal facilities.

4) ***Viability of Sewerage Systems.***

To ensure the financial viability and raise the utilisation rate of the new (and proposed) sewerage system, local ordinances requiring commercial and high residential water consumers to connect will be needed to make the sewerage system viable. This can be achieved by a policy decision of the respective Municipal Councils. In addition, a methodology for computing sewerage tariff will have to be formulated based on the cost of operations and other cost recovery policies.

At the Hanthana scheme, for example, the average household water bill comes to about Rs.105 per month. In addition, NWSDB bills the NHDA about Rs.40,000 per month to cover O&M costs for the sewerage services. If these sewerage costs were added on to the water bills (for the 383 Hanthana customers), the sewerage bills would average to Rs 112 per customer – over **100 percent** increase over current service bills. The total service bill per customer would total Rs.215 per month. Being a relatively high-income area, this should not pose a heavy burden to the customers in Hantana. But this may not be true in other areas.

(2) ***Project Implementation Issues.***

Conflicts may arise between land use zoning plans and the proposed STP site in Kandy. The involved parties will have to come to an agreement about the construction and operation of a STP in the proposed site. Careful planning of the capital improvement works in water supply is needed in view of the high leakages in the old distribution lines. The interconnection (of the old and the new facilities) should be phased in zone by zone.

(3) ***Institutional Performance Issues.***

Table 3.17 presents selected performance indicators for the utilities involved in this Study.

Table 3.17 Summary of Selected Institutional Performance Indicators, 1997

	NWSDB Kandy	KMC
Reference Period	*1997*	*1997*
Basic Information		
No of Customers	34,277	17,203
No of Staff	606	267
Total Water Produced, cum	18,664,523	11,549,078
Ave Daily Water Prod, cumd.	51,136	31,641
Total Water Billed, cum	15,826,161	6,692,457
Total Billing, Rs.	93,016,000	50,099,998
Total Operating Expense, Rs.	148,138,791	62,614,405
Total Collection, Rs.	90,446,000	49,377,132
Arrears, Rs.	22,898,601	40,398,850
Peformance Indicators		
Collection Ratio, %	97.2%	98.6%
Non-revenue Water, %	34.00%	42.05%
Unit Cost, Rs/cum produced	7.94	5.42
Unit Cost, Rs/cum billied	9.36	9.36
Ave Collection Period, months	3.04	9.68
Staff/1,000 Connections	17.68	15.52
Operating Ratio	1.59	1.27
Per capita consumption, lpcd	76.95	137.86

Note: the NWSDB Kandy figures are for the entire Kandy region (even outside the study area). This would explain the differences in such indicators as the NRW.

The general key performance issues, as previously presented include:

1) High non-revenue water
2) Uncontrolled arrears and poor on-time payment.
3) Inadequate operational control

3.3 Financial Status of Water Supply Operations

3.3.1 Kandy Municipal Council

(1) Financial Performance Summary

The 1997 annual figures are not yet summarised; however, during the first six months of 1997, it was reported as shown in Table 3.18.

Table 3.18 Annual Financial Performance of KMC Water Supply Scheme (1997)

Water Production Costs		Revenues	
Staff Salary	11,530,812	Rates and Taxes	44,855,181
Chemical Costs	2,838,819	Others	19,313,458
Materials	2,288,938		
Electricity	43,421,183	**Total Revenue**	64,168,639
Repair Cost	1,299,566		
Others	9,119,758	**Gain (Loss)**	(6,330,437)
Distribution Costs	70,499,076		

During the above period, the estimated volume of water produced (adjusted) was about 6,586,305 m^3, water billed (also adjusted) was 4,047,155 m^3. Unaccounted for water is calculated at 38.55 percent.

(2) Billing and Collection Performance

As of December 1996, outstanding receivables from water sales was Rs.37,675,000. Total water sales for 1996 was Rs.59,615,413.72. The average collection period (in 1996) was 6.7 months.

(3) Expense Control and Budgets

In 1997, the municipal budget projected the water sales revenue at Rs.87,527,200; and waterworks operation and maintenance at Rs.84,452,380. As of the middle of the year, both projected revenues and expenses were below budget estimates at 39.49 percent and 25.85 percent, respectively.

(4) Customer Base

As of 1997, the waterworks system had a total of 17,203 active service connections, of which 14,247 were domestic connections. It also maintains about 517 unmetered standposts and 20 "public bath houses". The official policy is to limit the installation of these public standposts in the future to low-income areas only.

3.3.2 Greater Kandy Area outside of KMC

(1) Billing and Collection Performance.

Consumers are billed monthly; water bills are paid through selected banks or to the various district and regional offices. The total billing for 1997 amounted to Rs.93,016,000; collection was Rs.90,446,000. Both billing and collection were above the annual target by about 10 percent. Based on the December 1997 monthly collection report, the average collection (expressed in number of months equivalent of average monthly sales) is 2.95 months (i.e.,

Accounts receivable/Ave monthly water sales). The collection ratio (collection/billing) is a high 97 percent. This indicates that customers eventually pay, but the on-time payment is quite low. Another factor which affects this on-time collection performance is the report that more than half of the arrears come from the bulk supplies. Arrears, as of Dec 1997, are broken down as follows:

Direct customers	Rs.10,302,442.17	45%
Bulk customers	Rs.12,596,159.60	55%
Total	Rs.22,898,601.77	

The above numbers all concern Kandy District including outside Greater Kandy. As of February 1998, arrears for all bulk customers (except for the University) in the study area were reported as Rs.3,3326,564. This is far below the arrears in all Kandy District. The problem is that the arrears do not appear to be well managed.

(2) Expense control and budgets

Expenses are controlled at two levels. Regional support centre level and Kandy District level. Statistics for the Greater Kandy Area do not exist. The costs at the Kandy District level are classified into personnel costs (48.96%), electricity (34.4%), chemicals (9.04%) and so on. All other cost items are less than 3 percent, totalling 7.6 percent. The cost control system is not well developed.

(3) Capital Assets

Capital assets management (financially) is carried out at headquarters level. Regional and District level offices concentrate mainly on operation & maintenance and construction.

(4) Customer Service

Two types of connections are provided - bulk and direct. "Bulk" supplies are available for some areas where one organisation is made responsible for the water bill based on the bulk meter. These bulk water supplies are operated by either the Urban Councils, Housing Authorities, or similar bodies. These organisations are responsible for the distribution, billing & collection, and maintenance of the sub-system. There are currently three (3) organisations in the study area receiving bulk supplies including urban councils and the University of Peradeniya. "Direct" connections are available for individual households or institutions. As of December 1997, there were a total of 34,277 direct connections, classified, as follows:

Domestic	30,883	including govt. quarters
Commercial	1,637	including tourist facilities

Institutional	1070
Standposts	687

There are about 20,000 pending applications for service connection on file which have not been acted upon due to the inadequacy of the supply. This is indicative of the urgency of need and demand for improvements.

3.3.3 Emerging Institutional Performance Issues

Table 3.19 presents selected performance indicators for the utilities involved in this Study. A comparison with performance indicators in Greater Colombo is also presented.

Table 3.19 Summary of Key Institutional Performance Indicators

	NWSDB, Kandy District	KMC	NEMC	NWSDB, Colombo
Reference Period	**1997**	**1997**	**1997**	**1996**
Basic Information				
No. of Customers	34,227	17,203	3,985	178,188
No of Staff	606	267	81	1,591
Total Water Produced (m^3)	18,664,523*	11,549,078	NA	182,401,450**
Avg. Daily Water Produced (m^3)	51,136	31,641	NA	499,730**
Total Water Billed (m^3)	15,826,161	6,692,457	1,282,086	
Total Production Cost (Rs.)	148,138,791*	62,614,405	4,363,135	
Total Billing (Rs.)	93,016,000	50,099,998	3,229,301	
Total Collection (Rs.)	90,446,000	49,377,132	2,260,511	
Arrears (Rs.)	22,898,601	40,398,850	4,363,135	
Efficiency Indicators				
Collection Ratio	97.24%	98.60%	70.00%	
Unaccounted for Water	34.00%*	42.05%	NA	47.00%
Unit Production Cost	7.94	5.42	NA	2.94**
Average Collection Period (month)	3.04	9.68	NA	3.20
Number of Staff / 1,000 Connections	17.68	15.52	20.33	7.30**
Operation Ratio	1.59	1.27	1.35	0.53**
Per capita consumption (l/d)	76.95	137.86	59.98	165.00**

Note: Data with (*) are inferred from the data on Regional Support Center (Central).
Data with (**) are the data in1995.

Institutional Performance: Arrears from bulk customers is a major cause for concern. This is significant because the current NWSDB policy is towards increased bulk provision in the future. Further studies may be needed to examine the terms and conditions towards bulk supplies to ensure that adequate responsibility and accountability is transferred to the "water distributor" and that NWSDB's financial viability is not undermined.

Common financial issues are as follows:

- The water tariffs are far below than the level where water production costs are recovered, especially in the water tariffs for domestic users. As a result, capital investment in plant and equipment is assumed to rely not on internal financial sources but on outside aid.
- UFW (unaccounted for water) is too high.
- The collection rate is generally too low. Introduction of incentive schemes in water charge collection and outsourcing should be considered.
- Operational efficiency is low, and financial efficiencies are poor.
- Water supply accounts are not separated from general administration in municipal council accounting. Water supply accounts needs to be separated and treated like business accounts.
- Financial reporting systems should be improved .
- Introduce dual entry bookkeeping system that clearly identifies assets and liabilities. The flow of funds will be easily traced.
- Introduce cost accounting systems so that the cost of each cost center can be computed.
- In staff education, financial reporting (dual entry bookkeeping) systems cost accounting system need to be incorporated.

As for the bulk sales of water from NWSDB to two PS, the collection rates are better than originally expected at the first stage of this study except for Ampitiya WSS whose bulk customer is Kandy Four Gravets PS. But even in this scheme the PS paid more than the billed amount in 1997 trying to reduce arrears. The bulk water tariff has been increased twice last year from Rs.4.90 to 7.25 per m3. Bulk sales to PS's are summarized in Table 3.20.

Table 3.20 Bulk Supply in 1997 from NWSDB to Two Pradeshiya Sabhas (Except University)

Scheme	Capacity m^3/d	PS	Annual Production m^3	Annual Billing Rs. (B)	Annual Collection Rs. (C)	C/B	Cumulative Arrears Rs. (A)	A/B
Ampitiya	1,500	Kandy Four Gravets	377,565	2,056,438	3,000,000	146%	2,060,514	100%
Menikhinna	450	Kundasale	66,498	425,774	408,516	96%	94,620	22%
Kundasale	600	Kundasale	286,734	1,728,560	1,478,971	86%	312,910	18%
Pallekele	1,500	Kundasale	313,212	1,946,350	1,861,593	96%	858,520	44%
Total	4,050		1,044,009	6,157,122	6,749,081	110%	3,326,564	54%

Uniform bulk rate for all water supply schemes is Rs.4.90 per m^3 (Jan.-Apr. '97), Rs.5.75 (May-Oct.'97), Rs.7.25 (Nov. '97 to date)

CHAPTER 4 PLANNING FUNDAMENTALS FOR WATER SUPPLY SYSTEM

CHAPTER 4 PLANNING FUNDAMENTALS FOR WATER SUPPLY SYSTEM

4.1 Population

4.1.1 Present and Projected Population

A detailed estimate of the 1994 study area population distribution was developed by previous consultants[1]. Although the most recent complete census was carried out in 1981, frequent updates of the census information have been accomplished by means of the household level surveys that were carried out by the Regional Development Division (RDD) of the Ministry of Policy Planning and Implementation. For the Greater Kandy Master Plan population estimate, 1994 RDD data for each Grama Nilidhari falling within the study area was adjusted by comparison with voter registration and housing construction records. Historical growth rates were derived by comparing the 1981 census information with the estimated 1994 population figures. Projected growth rates were then developed that took into account the relative historical growth rates and physical constraints to growth for each area. More recent population data (1996-1996) were obtained from RDD and a comparison indicated very close agreement with the previous estimates. The population projections developed by the previous consultants have therefore been adopted for the purposes of this investigation. A summary of total projected study area population is presented in Table 4.1.

Table 4.1 Projected Total Population in Greater Kandy

Area	1997	2000	2005	2010	2015	2020
Kandy Municipal Council	137,400	144,000	153,000	162,000	171,000	181,000
Four Gravets (Part)	56,600	59,000	63,000	68,000	72,000	77,000
Akurana (Part)	44,200	46,000	49,000	53,000	56,000	60,000
Harispattuwa (Part)	69,400	73,000	78,000	83,000	89,000	94,000
Pujapitiya (Part)	45,200	47,000	51,000	54,000	58,000	61,000
Kundasale (Part)	88,400	92,000	99,000	105,000	112,000	119,000
Patha Dumbara (Part)	53,200	55,000	59,000	62,000	66,000	70,000
Patha Hewaheta (Part)	18,400	19,000	20,000	21,000	23,000	24,000
Udunuwara (Part)	70,000	73,000	77,000	82,000	86,000	91,000
Uda Palatha (Part)	3,280	3,400	3,600	3,900	4,100	4,300
Yatinuwara (Part)	58,600	61,000	65,000	69,000	73,000	77,000
Subtotal-Outside Kmc	507,280	528,400	564,600	600,900	639,100	683,300
Total	644,680	672,400	717,600	762,900	810,100	864,300

4.1.2 Target Water Supply Service Population

The target service area for the proposed master plan water supply facilities have been identified in the 1994 FINNIDA report as those areas with relatively high population densities (over 1,500 persons per km^2) and high growth and water use rates. Approximately thirty percent of the presently served population rely on standposts. Government policy calls for reduction of the standpost service population to 10 percent by the year 2010. In the Kandy MC service area it appears that the rate of standpost population reduction will be considerably accelerated due to a recent decision by the Municipal Council to retire about 65 percent of the existing standposts in the near future. The projected population lying within the target service area boundaries that will be provided with piped water supply under the proposed improvement project is summarized in Table 4.2. The projected composition of the water service population in Greater Kandy (Direct connection and standpost service) is illustrated in Figure 4.1.

Table 4.2 Target Water Supply Service Population in Greater Kandy

Area	1997	2000	2005	2010	2015	2020
Kandy Municipal Council (KMC)	135,000	144,000	153,000	162,000	171,000	181,000
Kandy Four Gravets (Part)	54,400	58,000	62,000	67,000	71,000	77,000
Akurana (Part)	41,600	44,000	48,000	52,000	56,000	60,000
Harispattuwa (Part)	67,000	70,000	76,000	81,000	87,000	92,000
Pujapitiya (Part)	21,600	24,000	26,000	28,000	30,000	32,000
Kundasale (Part)	83,820	87,300	93,800	99,500	106,000	113,000
Patha Dumbara (Part)	41,460	42,900	46,000	48,400	51,600	54,700
Patha Hewaheta (Part)	8,360	8,600	9,400	10,600	12,000	14,000
Udunawara, Yatinuwara & Udu Palatha	91,080	95,400	101,600	110,900	119,000	126,200
Subtotal-Outside KMC	409,320	430,200	462,800	497,400	532,600	568,900
Total	544,320	574,200	615,800	659,400	703,600	749,900

The existing and proposed service area has been subdivided into subareas served by individual reservoirs and the projected service population tributary to each reservoir estimated as shown in Appendix 4.1.

[1] Water Supply Master Plan for Greater Kandy, NWSDB, FINNIDA, 1994

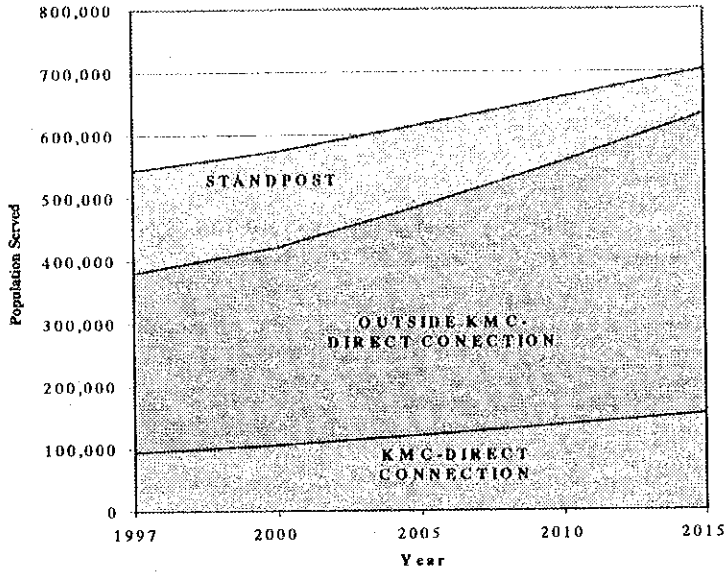

Figure 4.1 Water Supply Service Population in Greater Kandy

4.2 Design Quantities

4.2.1 Non-revenue Water

Billed water quantities for the Kandy MC system for 1997 indicated an average water use of 18,335 m^3/d. During the same period, total water production was 31,641 m^3/d, as shown in Table 4.3. This results in non-revenue water of 42 percent of total production. The 1994 FINNIDA report, which was based on 1993 records, indicated that non-revenue water at that time was 45 percent. This three percent decrease represents a welcome although modest improvement within a four year period.

Table 4.3 Non-revenue Water in KMC

Month	Production (m^3/d)	Billed Quantity (m^3/d)	NRW (%)
January	948,493	509,048	46
February	880,561	517,221	41
March	973,607	602,934	38
April	940,239	589,761	37
May	990,765	527,284	47
June	979,479	558,360	43
July	984,894	498,532	49
August	974,782	484,547	50
September	968,771	495,867	49
October	1,002,420	734,690	27
November	920,039	512,492	44
December	985,028	661,721	33
Total	11,549,078	6,692,457	42
Average (m^3/d)	31,641	18,335	

Non-revenue water figures for areas outside of the KMC vary from 18 to 70 percent as shown in Table 4.4. As indicated in Table 4.4, the better managed systems have an average NRW of 28 percent, while the average for the less well managed systems average almost 48 percent.

Table 4.4 NRW in Areas Outside of KMC

Area	NRW (percent of production)
Low NRW Areas	
Talatuoya	18.2
Hanthana	28.6
Hediniya	29.0
Udu/Yatinuwara	31.0
Average Low NRW Areas	**28.0**
High NRW Areas	
Mullepihilla	37.2
Bokkawala	38.2
Balanagala	40.4
Akurana	42.0
Ampitiya	43.4
Rajapihilla	54.3
Polgolla	55.3
Gohagoda, Kondadeniya and Yatiha-	70.6
Average High NRW Areas	**47.7**

It is apparent from the performance of the better managed systems, with NRW as low as 18 percent, that significant lowering of current NRW losses are quite possible. Present levels of non-revenue water are unacceptably high and reduction to a more reasonable figure, say 25 percent, should be given the highest possible priority in any water system improvement project. The water demand projections in the FINNIDA report assumed that non-revenue water would be constant over the planning horizon at 38 percent of total production.

A major modification was made to the FINNIDA demand projection to reflect the design philosophy of the present investigation. It was assumed that NRW would be reduced from its' present level of 42 percent to 25 percent by 2015. Given the high cost of the proposed new water sources, it would be prudent to reduce overall demand with a vigorous NRW reduction program, in concert with the development of new sources of supply. For the purposes of this investigation, the FINNIDA report water demand projections have been adopted basically unchanged with the exception that it has been assumed that non-revenue water will be reduced to 25 percent in as short a period as is practical. The impact of this modification on projected demand is substantial, as shown in Table 4.5.

Table 4.5 Comparison of Projected Water Demand for Greater Kandy

Year	Population Served	FINNIDA Demand Incl. NRW (m^3/d)	Revised Demand Incl. NRW (m^3/d)
1997	544,320	113,190	110,041
2000	574,200	125,250	119,474
2005	615,800	139,700	122,856
2010	659,400	157,950	133,365
2015	703,600	175,900	141,647
2020	749,900	192,500	159,730

It is recognized that reduction of non-revenue water, particularly in an older system, can be a lengthy and difficult process and it is not possible to estimate when during the planning period savings from a non-revenue water reduction program will actually occur. The potential savings from reducing the current high levels of non-revenue water represent, in effect, a new water source equal to 17 percent of the total demand. Reduction of non-revenue water should be considered as a potentially inexpensive alternative water source whenever the development of new sources are being contemplated.

4.2.2 Unit Water Use

Approximately 30 percent of the presently served population both in the KMC and outside of the KMC rely on standposts. Allowing for the standpost service population, the average supply in the study area is as follows:

Kandy Municipal Council	206 lpcd
Outside of KMC	181 lpcd
Greater Kandy Average	195 lpcd

Although the unit supply rates inside and outside of the KMC are within ten percent of each other, they are the result of two very different service connection policies. KMC policy has been to provide connections to all applicants regardless of the supply situation, while the NWSDB has pursued a policy of denying new connections where supplies were judged to be inadequate. The result of these differing policies has been that the KMC currently has very few outstanding applications for service connections while the NWSDB has a backlog of about 20,000 applications. This implies that the difference between supply and actual demand in the present KMC service area is greater that indicated by the average unit supply

figure noted above. If, for example, the NWSDB were to allow connection of it's entire backlog of service connection appplications without additional supplies, the unit supply rate would reduce to less than half of the 181 lpcd presently being supplied. Conversely, if KMC connection policy had been similar to that of the NWSDB, their present unit supply rate would be much higher than 206 lpcd. Unit water demand rates used to estimate future demand have therefore been adjusted to take this difference in service connection policy into account (see Table 4.6). Because of the different assumptions regarding NRW, the projected per capita rates used for the current study are substantially lower than those used in the FINNIDA report (see Table 4.7).

Table 4.6 Per Capita Water Demand Rates in Greater Kandy

KMC (lpcd)	1997	2000	2005	2010	2015
Domestic	99	101	108	115	121
Non-domestic	55	58	61	65	69
NRW	112	115	95	81	63
Total	266	274	264	261	253
Outside KMC (lpcd)					
Domestic	76	78	82	90	98
Non-domestic	29	30	32	36	41
NRW	76	78	64	57	46
Total	181	186	178	183	185
Greater Kandy (lpcd)					
Domestic	82	85	89	96	104
Non-domestic	35	37	39	43	48
NRW	85	88	72	62	50
Total	202	210	200	201	202
NRW %	42	42	36	31	25

Table 4.7 Comparison of Per Capita Water Demand Rates for Greater Kandy

Unit Water Demand (lpcd)		
Year	FINNIDA	Revised
1997	208	202
2000	218	210
2005	227	200
2010	240	201
2015	250	203

As can be seen from Table 4.7, unit water demand rates for domestic and non-domestic use have been projected to increase substantially over the planning period (22 to 41 percent). At the same time, NRW rates are expected to decrease by over 40 percent, resulting in a leveling out of total unit demand rates over the planning period.

4.2.3 Projected Water Demand

Projected water demand for the study area is summarized in Table 4.8 and illustrated in Figure 4.2. Details of estimated water demand in Greater Kandy by reservoir tributary service area are given in Appendix 4.2.

Table 4.8 Projected Water Demand in Greater Kandy

KMC Demand (m^3/d)	1997	2000	2005	2010	2015
Domestic	13,365	14,570	16,500	18,610	20,730
Non-domestic	7,425	8,352	9,333	10,530	11,799
NRW	15,120	16,560	14,535	13,122	10,773
Total	35,910	39,482	40,392	42,282	43,263
Outside KMC Demand (m^3/d)					
Domestic	31,306	33,556	38,156	44,766	52,253
Non-domestic	11,717	12,906	14,689	17,965	21,631
NRW	31,108	33,556	29,619	28,352	24,500
Total	74,131	80,018	82,464	91,083	98,384
Total Greater Kandy Demand (m^3/d)					
Domestic	44,671	48,100	54,680	63,396	72,944
Non-domestic	19,142	21,258	24,022	28,495	33,430
NRW	46,228	50,116	44,154	41,474	35,273
Total	110,041	119,474	122,856	133,365	141,647

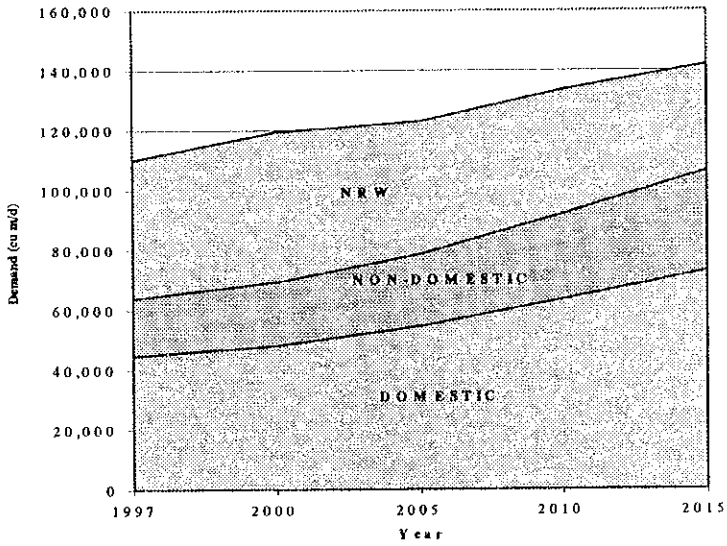

Figure 4.2 Projected Water Demand in Greater Kandy

CHAPTER 5 WATER SUPPLY SYSTEM LONG-TERM DEVRLOPMENT PLAN

CHAPTER 5 WATER SUPPLY SYSTEM LONG-TERM DEVELOPMENT PLAN

5.1 General

In the previous chapters, it was proved that augmentation of the water supply capacity is the most critical issue in the study area. This is due to various reasons, e.g., lack of existing supply capacity, unfavorable quality, deterioration of existing facilities, and increase of water demand. This chapter presents discussions and an examination of the long-term development plan (Master Plan) of the water supply system in the study area.

5.2 Policy for Planning

The long-term development plan for the water supply system in the Greater Kandy Area was planned in accordance with the following planning policies:

- Raw water intake facilities, water treatment plants, transmission pipes, and distribution reservoirs required to fulfil the demands up to the target year 2015. The distribution pipelines are not planned physically because there is insufficient data to carry out a detailed hydraulic analysis of network system, and it is out of scope of this Study. However, the cost required for the distribution pipelines connecting the new reservoirs and the existing distribution pipeline network, and for improvement of network is estimated to some extent.
- Continuous water supply for 24 hours a day even in dry season so that residents can enjoy a satisfactory water supply.
- Existing water sources shall continue to be used in the future, unless a significant problem arises because the capital and operation costs are too high, and the cost of water will increase if only treated water is supplied from the plants at the Mahaweli River for all of the water demand throughout the Greater Kandy area.
- The new water supply system and the existing water supply system are to be connected so that development cost for the transmission/distribution system can be minimized.

5.3 Conditions for Facility Planning

5.3.1 Water Source

(1) Conditions of Existing Water Sources

Topographic conditions of Kandy municipality and its surrounding area are mostly continuous steep small mountains with shallow bedrock and flat lands are seen in the limited areas. The existing water supply system is utilizing groundwater and surface water (the Mahaweli River and its tributaries).

A summary of existing water supply sources serving the Greater Kandy area is presented in previous Table 3.1. Existing sources provide about 58,000m^3/d to study area residents (on-going Hulu Ganga and Talatu Oya schemes are excluded). Water sources range from large surface water sources with complete treatment (33,400 m^3/d from the Kandy Municipal Council treatment facility on the Mahaweli River) to small groundwater extraction schemes (hundreds to 2,000 m^3/d) to even smaller gravity spring sources with limited treatment.

Because of location of remote area, ground water source is the important sources for those areas, though the supplied amount is small and not sufficient for the demand. The present conditions and prevailing problems with present groundwater source are summarized in Appendix 5.1. Most of the existing wells are extracting groundwater from aquifers above the bedrock layer, this has caused:

- Problems pertaining to the groundwater itself, such as a decrease in discharge during the dry season and a deterioration of the water quality.
- Problems pertaining to well design and construction, such as; mismatching of well design and pump specifications with actual site conditions; and over-pumping beyond safe yield.

Surface water is utilized from the Mahaweli River, the largest river in Greater Kandy area, the Nillambe Oya river, the Hulu Ganga river, and other small tributaries of the Mahaweli River. These tributaries have remarkable decrease of river flow during the dry season and therefore constant intake amount is limited through the year. The Mahaweli River has also same seasonal change of flow rate, especially noteworthy decrease in drought season. It also shows shifting of streamline by season resulting interference to water intake. Major existing water supply systems utilizing surface water are shown below.

Table 5.1 Existing Water Sources of Surface Water

Name of Water Supply System	Name of River for Water Intake	Intake Amount (Water Supply Volume)
KMC	Mahaweli Ganga	33,400 m^3/day
Kalugamuwa	Nillambe Oya	11,500 m^3/day (9,000 m^3/day to GK)
Kundasale	Hulu Ganga	13,000 m^3/day (on-going)
Udu/Yatinuwara	Mahaweli Ganga.	4,600 m^3/day
Pallekele (CECB)	Mahaweli Ganga	2,000 m^3/day
Polgolla	Mahaweli Ganga	1,500 m^3/day

It is recommended that several small water sources that produce poor quality water or an excessively expensive to operate be abandoned after 2005. Existing supplies that will continue operation after 2005 have a capacity of 65,960 m^3/d (see Table 3.1) including the as yet unfinished Hulu Ganga and Talatu Oya projects, and 65,040 m^3/d for the target years 2015.

(2) Study on New Water Source

Water sources to be developed for augmentation is the balance between demand in the target year and existing water sources to be continued. It was calculated at 104,940 m^3/d as shown in Table 5.2.

Table 5.2 Required Water Source Development

	Calculation	Adopted
Maximum Daily Demand in 2015 (120% of daily average) (a)	169,980 m^3/d	—
Existing Source to be continued (b)	65,040 m^3/d	—
Required Development (a-b)	104,940 m^3/d	110,000 m^3/d

The groundwater potential has been examined from the viewpoint of water source expansion to cope with water demand (110,000 m^3/day) in Greater Kandy area in the target year of 2015. The evaluation results are summarized as follows (refer to Chapter 8 and Appendix 5.2):

(1) Potential area for groundwater development is limited and unevenly distributed.

(2) Most of existing wells have small discharge at less than 1,000 m^3/day and some of them have only several hundreds m^3/day.

(3) Some wells yield high hardness groundwater (there are cases exceeding the maximum desirable level of 500 mg/l, though they are below the maximum permissible level of 600 mg/l).

Taking account of the above mentioned locality of groundwater characteristics, the groundwater development is deemed suitable as one of measures for small scale water supply system, but not applicable for wide-area water supply system covering Greater Kandy area.

Considering the magnitude of water source need at 110,000 m^3/day, the target source of surface water is focused on the Mahaweli River, the largest river in the Greater Kandy area. In utilization of surface water of this river (daily average flow rate of 5.5 million m^3/day and annual average flow rate of about 2 billion m^3/day), assurance of continuous water intake even in drought season is prerequisite. FINNIDA report mentioned based on data of Mahaweli Authority that 180,000 m^3/day, as weekly average intake amount, is possible even during the drought season.

Daily flow rate data (refer to Table 5.3 and Appendix 5.3) were collected for the period of 11 years (1987-1997) from the Department of Irrigation (hereinafter referred to as DI) and Water Management Secretariat of Mahaweli Authority (hereinafter referred to as WMSMA). Gauging stations of these data are located at Peradeniya and the Polgolla Dam, which is about 11 km downstream from Peradeniya. Between these two stations, the Nunpan River and other small rivers are flowing into the Mahaweli River with small catchment areas. Therefore, flow rates at two stations are considered to be more or less same amount. However, the minimum flow rates of both stations are differed each other, and observed in different days.

In order to attain a reliable water source evaluation, the WMSMA data is primarily referred to as it is considered the most dependable source of flow data. It shall be noted that:

- WMSMA data showed that a "0" flow rate was recorded for 40 days during August to November in 1987, which is normally considered as the rainy season.
- In 1988, a "0" flow rate was also recorded for 12 days in the same period.
- These abnormal data are deemed to have been caused by the recording of "no data" as "0" flow rate or an inaccurate reading of the flow gauge.

In processing WMSMA data, any such data having "0" flow rate in 1987 and 1988 was omitted and data for the 9 year period from 1989 to 1997 was utilized. This data is summarized in Table 5.3.

Table 5.3 River Flow of Mahaweli Ganga

Minimum Flow of Mahaweli Ganga									Maximum Flow of Mahaweli Ganga				
Date			Minimum Flow		Average		Weekly		Date			Minimum Flow	
			MCM	m^3/d		m^3/d		m^3/d				MCM	m^3/d
1989	April	15	0.281	281,000					1989	July	22	79.066	79,066,000
1990	April	2	1.100	1,100,000					1990	Jan	4	45.584	45,584,000
1991	March	30	0.264	264,000					1991	Oct	30	18.119	18,119,000
1992	March	19	0.573	573,000					1992	July	16	33.030	33,030,000
		20	0.186	186,000			*						
		21	0.079	79,000	*		*						
		22	0.037	37,000	*		*						
		23	0.039	39,000	*		*						
		24	0.107	107,000	*	65,500	*						
		25	0.388	388,000			*						
		26	0.325	325,000			*	165,857					
		27	0.284	284,000									
		28	0.223	223,000			*						
		29	0.140	140,000	*	140,000	*						
		30	0.190	190,000			*						
		31	0.116	116,000	*	116,000	*						
	April	1	0.268	268,000			*						
		2	0.160	160,000	*	160,000	*						
		3	0.220	220,000			*	188,143					
		4	0.350	350,000									
		5	0.220	220,000			*						
		6	0.301	301,000			*						
		7	0.170	170,000	*	170,000	*						
		8	0.252	252,000			*						
		9	0.210	210,000			*						
		10	0.269	269,000			*						
		11	0.234	234,000			*	236,571					
		12	0.299	299,000									
		13	0.269	269,000									
		14	0.303	303,000									
		15	0.329	329,000									
1993	March	16	0.324	324,000			*		1993	June	4	46.660	46,660,000
		17	0.387	387,000			*						
		18	0.246	246,000			*						
		19	0.250	250,000			*						
		20	0.473	473,000			*						
		21	0.147	147,000	*		*						
		22	0.284	284,000			*	301,571					
	March	31	0.282	282,000			*						
	April	1	0.318	318,000			*						
		2	0.319	319,000			*						
		3	0.121	121,000	*	121,000	*						
		4	0.259	259,000			*						
		5	0.187	187,000			*						
		6	0.314	314,000			*	257,143					
1994	April	2	0.438	438,000					1994	Aug	2	29.340	29,340,000
1995	April	3	0.897	897,000					1995	June	17	50.130	50,130,000
1996	May	31	0.245	245,000					1996	Oct	18	35.540	35,540,000
1997	March	27	0.594	594,000			*		1997	Sep	24	17.150	17,150,000
		28	0.426	426,000			*						
		29	0.044	44,000	*		*						
		30	0.061	61,000	*		*						
		31	0.131	131,000	*	78,667	*						
	April	1	0.380	380,000			*						
		2	0.474	474,000			*	301,429					

In 1992, a serious drought occurred causing the monthly rainfall in January to fall to about 40 percent of its normal average monthly rainfall level with February and March having no rainfall (refer to rainfall data). The river flow also reflected this reduction in rainfalls by falling to about 166,000 m^3/day. This flow rate was less than the 180,000 m^3/day reported by FINNIDA. The number of days showing flow rates of less than 180,000 m^3/day were 8 days in 1992; 2 days in 1993; and 3 days in 1997.

The actual intake volume will be about 160,000 m^3/day which includes the new Water Treatment Plant, the existing KMC Water Treatment Plant and the Kalugamuwa Water Treatment Plant (which was not operating during the field survey period). Based on evaluation of this past performance, sufficient intake volume could have been secured during all past years, except for 1992. It should be noted, however, that abnormally dry years may cause restrictions of the supply volume and therefore the existing groundwater sources should be retained for possible utilization. The NWSDB, the executing agency of the water supply project, has secured the water rights from the Mahaweli Authority for the utilization of 180,000 m^3/day from the Mahaweli River.

Regarding groundwater development, this Study has mainly focused on the potential of the Greater Kandy area and did not cover the identification of other possible yields at individual sites because of constraint of time and the availability of data including test well boring. In the long-term plan, there are, therefore, no plans for the development of groundwater sources in order to avoid confusion about total water availability. However, groundwater sources are available and reliable in remote area, it is obvious that it is more economical than to utilize centralized surface water sources with a treatment system. In this relation, the survey and investigation of groundwater development are deemed indispensable to secure stable water sources both in quantity and quality which may be present in fault zones running through the area as presented in Chapter 8. By conducting such a survey and investigation before the implementation of future phases of the project, the potential groundwater for development could be identified in remote areas to reduce the total project cost and to secure stable water sources.

From the above evaluation, it was determined that the most suitable source of surface water was the Mahaweli River.

5.3.2 Location for Water Intake and Water Treatment Plant

The locations of the proposed water intake and water treatment plant are at the left-bank of the Mahaweli River at Kondadeniya, north of the center of the Greater Kandy area (refer to Figure 5.1). Although it is desirable to locate the water intake and water treatment plant near to the water supply service area, the actual locations were determined as described below.

(1) Location of Intake Facility

The Mahaweli River is flowing with the shape of an arc from southwest to southeast passing along the northern boundary of the KMC's, large water demand area. At the southwest of the KMC, there is an intake facility belonging to a major existing water treatment plant of the KMC, while to the northeast, there is the Polgolla Dam which is utilized for irrigation and power generation the flow rate of which is drastically decreased downstream.

Regarding water levels, the existing KMC intake point is 460 to 464 m above MSL, the normal operating water level of the Polgolla Dam is 441 m above MSL, and the Farm School intake point at Lake Victoria is 438 m above MSL which often drops by about 20m in the dry season. Considering these hydraulic characteristics of the river, the new intake point should be located, as far as possible, up stream of the river to minimize the total pumping head and to achieve economical performance.

There is a solid waste dumping site on the left bank of the river opposite the northwest section of the KMC. Due to the possibility of pollution caused by leachate from the dumping site flowing into the river, the new intake facility should be located upstream of the dumping site.

Taking into account these conditions, the new intake facility should be located in the six km section of river between the existing KMC intake point and the solid waste dumping site.

The solid waste-dumping site is located approximately 600 m upstream of the proposed site of the water treatment plant. Since it is desirable to locate the intake the intake facility close to the treatment plant in order to reduce the capital and operation costs, it is proposed to site the new intake facility 400 m upstream of the said dumping site.

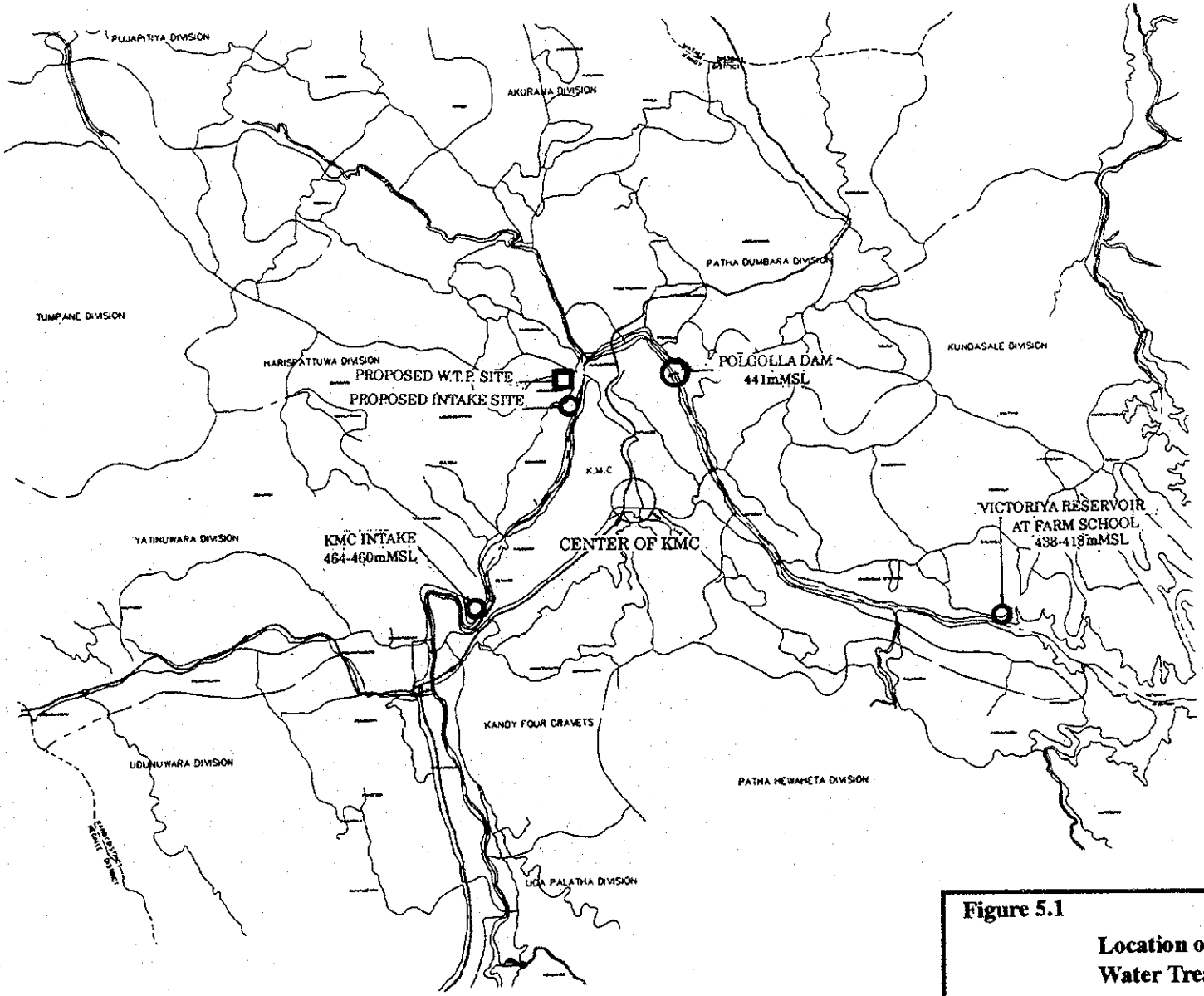

Figure 5.1

Location of Water Intake and Water Treatment Plant

(2) Location of Water Treatment Plant

The desired site for the water treatment plant shall have gentle slopes with sufficient ground area together with the following:

1) It should be located near to the intake point
2) It should be located between the intake facility and the center of the service area or distribution reservoir.
3) It should be located at a high elevation to allow gravity flow or to lessen the pumping head for water distribution to the majority of the service area.

The proposed water treatment plant having a supply capacity of about 110,000 m^3/day requires approximate 4 to 5 ha of land area. Kandy Municipality and its suburban area are situated on steep mountainous areas with its plains almost fully utilized. The tops of hills and slopes are utilized for houses and hotels, etc.

The demand center of the Greater Kandy area is the KMC town center. It is therefore desirable to locate the intake point and the water treatment plant near to the center of the KMC. However, due to constraints in the selection of the intake site at the Mahaweli River, the location of the new water treatment plant will also be similarly restricted.

There are two possible locations for the new water treatment plant; namely; near to the intake point; or to a high elevation to allow the gravity flow to the major service area. In the case of Kandy, the latter location has already been occupied by hotels and residences. Though some undeveloped natural woods are situates on steep slope or in narrow areas they would require large capital investments for land preparation and the provision of access roads.

Taking into account the above, it is recommended that the proposed treatment plant be located at the rice field in Kondadeniya near to the Mahaweli River. This site has a gentle slope with sufficient land area.

5.3.3 Treatment

(1) Peak Factor for Maximum Day Demand

Water supply facilities should be designed to satisfy daily water demand. In order to

meet this, the capacity was decided based on maximum daily demand levels. The maximum daily demand is generally calculated from the "Peak Factor" which is defined as the ratio of the maximum daily demand to the average daily demand.

In determining the peak factor, daily water consumption records for at least ten years should be examined. However, obtaining the daily consumption record was not possible. Consequently, the water production records at the water treatment plants or readings of bulk water meters installed on transmission lines and/or at service reservoirs and water meters at house connections will be used for that purpose instead. Should this information not be available, flow rates will be estimated by pump operation records. .

In the Kalu Ganga Water Supply Study (Nov. 1994, JICA), the following is stated:

- Actual records of the Labugama water treatment plant indicated that the appropriate peak factor was assessed to be between 1.10 to 1.15.
- Based on the actual records of the Kalatuwawa water treatment plant, the optimum peak factor was assessed to be less than 1.20.
- Based on the actual records of the Ambatale water treatment plant, the peak factor was estimated to be 1.16.
- The most appropriate value of peak factor is 1.15.

The Greater Kandy area is much smaller than the Colombo area. Therefore, the peak factor is considered to be higher than that of the Colombo area. The actual daily consumption record, however, are not available. In addition, the production record, are not applicable for the assessment of the peak factor because has been operated at full capacity due to the lack of water in the service area. The records show the fluctuation of monthly production to be in the range of 97 percent to 103 percent of average production levels. Based on the monthly billing record in 1997, the peak factor for monthly water consumption was calculated to be 1.29 in November. However, the consumption records are also not totally reliable because of a lack of accuracy in measurement and estimation of the volume of billed water.

Based on the experiences in Japan, the recommendable peak factor is calculated to be about 1.2 (refer to Appendix 5.4).

Taking into account the above considerations, the peak factor for maximum daily demand to the daily average demand is proposed to be 1.2.

(2) Design Capacity

For the determination of the design capacity of the treatment facilities, water use within the treatment plant site and unpredictable losses were estimated at 5 percent of the nominal treatment capacity, based on the experiences of other treatment plants.

(3) Treated Water Quality

Treatment quality at the proposed water treatment plant should meet the water quality standards for drinking water in Sri Lanka. The quality standards are specified in SLS 614, 1983; Part 1 Physical and Chemical Requirement, and Part 2, Bacteriological requirements (which are similar to the WHO Standards) as given in Appendix 5.5.

5.3.4 Transmission and Distribution

(1) General

The Friction Formula used in the design of pipelines: Hazen-Williams Formula

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

where, H: friction loss (m)
C: friction coefficient
120 for cement lined DCIP and SP (for nominal diameter)
130 for PVC pipe (for internal diameter)
D: diameter of pipe (m)
Q: flow rate (m^3 /sec)
L: pipe length (m)

Maximum flow rate 2.0 m/sec

Optimum pipe diameters are determined by taking into account the capital and O&M costs for both the pipeline and pumping facility.

(2) Transmission

Pipe Material: Ductile cast-iron pipe (DCIP) for diameter 250 mm or larger
Unplasticized polyvinyl chloride (uPVC) pipe for dia. less than 250 mm

Internal lining: Cement mortar lining (DCIP)

Peak Factor: 1.2 (times of daily average demand)

(3) Distribution Reservoir

Storage capacity of reservoir: more than 6 hours of the maximum daily average demand

5.4 Considerations for Optimum System

5.4.1 Number of Water Treatment Plants

In the Master Plan by FINNIDA, the central and western zones will be served by the existing and new Kandy plants, and the new Katugastota plant will serve the eastern and the northern zones. In addition, each plant was located near the centers of their respective service zones.

The Kundasale project was commenced by the NWSDB after the completion of the FINNIDA study. In the project, a new plant with a supply capacity of 13,000 m^3/d will be constructed and will serve the area located north of Mahaweli River in the eastern zone. Construction of this new plant is expected to be completed in 1999.

In addition, the site for the new Katugastota plant recommended in the FINNIDA Master Plan was cancelled because of the expected difficulty of land acquisition. Instead, a new candidate site for the proposed treatment plant (hereinafter referred to as "the Katugastota plant") was located 3.5 km west of the former site. The new Katugastota plant site is located about 8 km away from the existing Kandy plant and the new Kandy plant site. The Katugastota site has enough area to accommodate the plant of the required total capacity ($110,000m^3/d$).

Because of the change in basic conditions which had been assumed in the FINNIDA M/P, the need for the re-examination was raised and a new arrangement for the of service zones was considered.

In the re-examination of the system, two alternatives were prepared in terms of allocation of required treatment capacity. Alternative 1 is a two-plant system plan consisting of the existing KMC and new Katugastota plants, and Alternative 2 is a three-plant system plan consisting of the existing KMC, and the new Kandy and new Katugastota plants.

As a result of the preliminary examination, the allocation of required treatment capacity for the new treatment plants for Alternative 2 was decided as follows:

Table 5.4 Required Treatment Capacity for New Treatment Plants

	Calculated	Adopted
New Kandy Plant	20,000 m^3/d	20,000 m^3/d
New Katugastota Plant	84,940 m^3/d	90,000 m^3/d
Total	109,440 m^3/d	110,000 m^3/d

The results of the comparison are presented in Table 5.5. Taking into account the above characteristics for each alternative in particular the construction costs and O&M, Alternative 1 is recommended.

Table 5.5 Comparison of Integrated and Separate Supply Systems

	Alternative 1 Two Plants Plan	Alternative 2 Three Plants Plan
Treatment Plants	110,000 m^3/d New Katugastota Plant (33,400 m^3/d Existing Kandy Plant)	20,000 m^3/d New Kandy Plant 90,000 m^3/d New Katugastota Plant (Existing Kandy Plant)
Number of Facilities, O&M (for new fac.)	- Intake facility 2, - Treatment plant 2. Advantageous	- Intake facility 3, - Treatment Plant 3 Disadvantageous
Req'd Site Area	- about 4.4 ha (for new WTP)	- about 1.8 ha + 3.9 ha (for new WTP)
Present Land Use of the Site	- New Katugastota plant Paddy Field. Free from flooding.	- New Kandy plant Paddy field. Vicinity of future governmental administrative complex. Along the river and fear of flooding. Require 2,5m high earth-filling. - New Katugastota plant Same to Alt.1
Intake and Raw Water Conveyance	- New Katugastota plant 2.2 km long conveyance to avoid contamination from the garbage dumping site. From impoundment of the Polgolla Dam. Stable water level except 5 year interval 1 month long maintenance period.	- New Kandy plant Existing KMC plant intake tower can be utilized. But, weir for intake during low water level period is necessary. - New Katugastota plant Same to Alt.1
Transmission	- Longer transmission line to Kandy Four Gravets.	- Each plant locates near the center of respective service zone.
Direct Construction Cost (Million Rs.)	6,618	7,504
O & M Cost (Million Rs.)	230 per year	245 per year

5.4.2 **Type of Intake Facility** (refer to Appendix 5.6)

The proposed water intake facility is located 400 m upstream of the solid waste dumping site in order to avoid water pollution which may be caused by untreated leachate from the dumping site.

The water level of the Mahaweli River at this location is influenced by the Polgolla Dam and is stable between 438.9m amsl and 440.7m amsl except during maintenance work on the dam and diversion conduit. Water in the Polgolla Dam impoundment is drained for one month once in every five years for maintenance. The structure of the intake facilities shall be decided taking into account the low water level caused by the maintenance work and the high flood level (446.4m amsl).

The proposed intake point has a regular depth of about 2 m due to the Polgolla Dam. The intake facility is designed as an open inlet taking into the advantageous condition that the river flow has straight line and that the riverbed is mostly flat. The bottom slab of the intake facility is designed to be 2 m lower than the present riverbed, which is assumed to be at the original height of the riverbed before the accumulation of sediments. It is also necessary to ensure that line of the river will be excavated by a bulldozer once every five years during maintenance of the dam in order to maintain the designed depth of the intake facility.

The meteorological characteristics of the study area is of high rainfall intensity in a short period with river flow rapid enough to flush out sand and mud. It seems the turbidity of the Mahaweli River increases to more than 1,000. Raw water turbidity after sedimentation at the existing KMC plant is around 10 in the dry season and about 40 to 50 in the rainy season. However, it increases to more than 100 about 10 times a year, sometimes reaching a maximum close 300. In order to protect the intake pump and to prevent the inflow of sand and mud into the conveyance pipeline, a grit chamber should be provided just after the intake facility. Though the dam impoundment itself acts as a grit chamber when the normal operational water level of the dam is maintained, silt and sand may flow into the intake facility when the water level drops during the said maintenance period.

By the use of a grit chamber, the wear and tear of the intake pump will be dramatically reduced, thus allowing a standard pump type to be considered for the water intake. A one-stage pumping facility can send raw water to the new Katugastota water treatment plant, unlike the two-stage pumping facility at the existing KMC water treatment plant.

Silt and sand that accumulate at the water intake and intake conduit will be removed by a bulldozer when the streamline needs to be cleaned. If silt and sand accumulate rapidly, a sand pump will be used to facilitate removal.

Accumulated silt and sand in the grit chamber will be removed manually by emptying one of the two chambers or by means of a sand pump.

An intake tower is further option for the water intake, but has not been considered in the Study because of the following reasons:

- If an intake weir is not provided, the streamline will not be secured by means of a bull-dozer. This is similar measure used at the inlet mouth during the periods of low water level.
- The excessive wear and tear of the intake pump, to be installed inside the intake tower, may occur due to the inflow if silt and sand.
- Two-staged pumping facilities are required, if a grit chamber is not provided.

Other possible alternatives are an intake weir; and infiltration gallery. These alternatives have however not been adopted because of the following:

- Intake weir (flush-board weir)

  When the water level of the Polgolla Dam is at normal conditions, the flush-boards of the intake weir are removed to allow a smooth stream of flow and to avoid the sedimentation of silt and sand at the upstream side of weir. When the water level is lowered, the flush-board of the weir will be installed to maintain a steady water level and sufficient intake volume, since will result in silt and sand accumulating on the upstream side. The flush-board will be removed during the dry season. As this is a major cost item, instead of the intake weir, sandbags will be used during the maintenance period of the dam. When the water level in the Polgolla impoundment is low during the maintenance period, sandbag will be piled on a part of riverbed and sediments removed by the bulldozer to secure the waterway to the intake mouth.
- Infiltration gallery

  To assess the possibility for application of an infiltration gallery, a detailed investigation on the distribution of riverbed rock is necessary. However, sedimentation of silt during normal operation will cause clogging of the infiltration gallery. Therefore the use of an infiltration gallery is not recommendable.

5.4.3 Type of Treatment Facility

Because of high turbidity, the coagulation-sedimentation and rapid sand filtration method will be used for the Katugastota treatment plant, the same as the existing Kandy plant. The required area for the plant is about 4.5 ha including the area needed for the backwash

water treatment facilities. Since the elevation of a part of the site is under the planned high water level of the Polgolla impoundment, it will be filled so that facilities except sludge lagoons will be above the high water level.

A water quality examination of the Mahaweli river shows contamination to some extent by non-treated wastewater discharges from human activities, such as Free-NH_3, NO_2, Total Coliform, and E. Coliform. As mentioned above, raw water turbidity increases to a few hundred or more than 1,000 in a short period with wide ranging variations. The existing KMC plant uses the Pulsator type system developed by a French manufacturer. However, it is not functioning well because of upward flow and temperature increase caused by sunlight. This raises the flock layer and coagulated flock flows from the outlet troughs. In the study, the horizontal flow sedimentation tank is recommended because it is easier to adjust for fluctuation of turbidity and water temperature thus allowing relatively easy operation.

5.5 Phasing of Project Implementation

The water supply condition in the study area is different in respective water supply schemes. The KMC system shows rather good performance while other local schemes show worse performance. On the other hand, the funding requirement for the implementation of the whole project is deemed too large for obtaining funds from local sources and foreign finance assistance agencies. In this regard, it is recommendable that the project be separated into several phases.

In order to cope with a phased implementation program, it is necessary to prioritize the subcomponents of the project. This section presents a discussion of the phasing and of privatization the construction plan for long-term development.

5.5.1 Phased Development Plan

The possible water supply capacity of the exiting water supply system in the year 2005 is estimated to be 65,960 m^3/d on a maximum daily supply capacity basis. The deficit for the estimated water demand of 147,780 m^3/d in 2005 is expected to be 81,820 m^3/d. In the year 2015, the possible water supply capacity of the existing water supply systems is estimated to be 65,040 m^3/d. The deficit for a water demand of 169,920 m^3/d in 2015 is expected to be

104,880 m^3/d. Thus, the total design capacity of the proposed Katugastota water treatment plant was determined to be 110,000 m^3/d.

From the existing water treatment facilities, the KMC water treatment plant with a capacity of 33,400 m3/d, Kundasale plant with a capacity of 13,000 m^3/d, and Kalugamuwa plant with a capacity of 9,000 m^3/d will be utilized as sources of bulk water supply in addition to the proposed new plant.

Taking into account the size of the fund requirement and the allocated period of 15 years for the project, it would be appropriate to divide the project period into three phases. It is also recommended, that the total capacity of the proposed Katugastota water treatment plant also be divided into three phases. The capacity in each phase was equalized to make the investment size uniform.

In order to construct the total development capacity in three phases, the development capacity in each phase is recommended to be 1/3 of 110,000 m^3/d or 36,670 m^3/d. The water supply capacity of the new treatment plant will be augmented every five years with 1/3 of total capacity. In the second phase another 1/3 of the required development capacity will be constructed by the year 2010 and the remaining 1/3 shall be constructed by the year 2015. Table 5.6 shows a summary of the water balance in the three phases. The projected water demand and proposed augmentation plan of supply capacity are presented in Figure 5.2.

Table 5.6 Water Balance in Three Phases

	2005	2010	2015
Water Demand (daily average) a	122,900 m^3/d	133,400 m^3/d	141,600 m^3/d
Water Demand (daily maximum) b	147,430 m^3/d	160,040 m^3/d	169,980 m^3/d
Continued Existing Sources c	65,960 m^3/d	65,960 m^3/d	65,040 m^3/d
Augmented Supply (by new plant) d	36,670 m^3/d	73,330 m^3/d	110,000 m^3/d
Deficit to Demand (daily max.) e	44,800 m^3/d	20,750 m^3/d	(5,060 m^3/d)
Deficit to Demand (daily avg.) f	20,270 m^3/d	(5,890 m^3/d)	(33,440 m^3/d)

As shown in Table 5.6, the shortage of water supply to total water demand in 2005 is 44,850 m^3/d for a daily maximum demand or 20,270 m^3/d for daily average demand. However, this shortage will be gradually decreased as the project progresses. In the year 2015, after completion of the project, supply capacity will exceed the water demand.

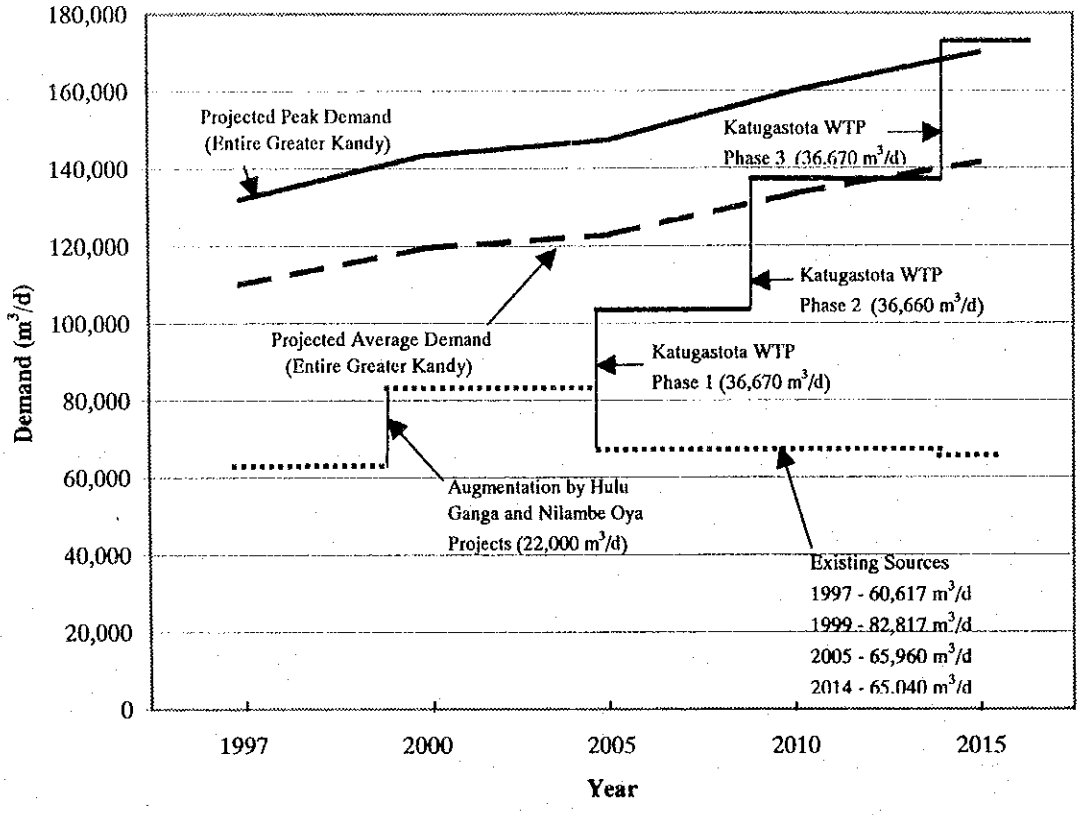

Figure 5.2 Greater Kandy Water Demand vs. Supply Capacity

5.5.2 Priority of Service Areas

As discussed in the previous section, 36,670 m^3/d will be supplied from the proposed Katugastota water treatment plant in the first project phase. This is not sufficient to fulfill the water demand in the whole of Greater Kandy. The capital cost for development of the transmission and distribution system is also limited. Hence, a phased construction program will be applied not only for the treatment plant but also the transmission and distribution system. The pipelines and reserves shall be developed to cope with treated water quantity. Because of this, prioritization of service area is required.

The study team conducted a survey for current water supply, including conditions such as duration of water interruption. The survey area covered 11 districts including the KMC and its fringe areas. The KMC, Udunuwara, and Yatinuwara areas enjoy a water supply for approximately 20 hours a day, while other eight areas receive a supply for 12 hours or less a day. In a qualitative analysis, taking account of the population and water supply hours, the

KMC, Harispattuwa, and Kundasale are suffering from a lack of water supply. The KMC, Kandy Four Gravets, Harispattuwa, and Kundasale are ranked at "A" and Akurana and Patha Dumbura are ranked at "B", respectively (refer to Table 5.7 and Figure 5.3).

The KMC has an existing water treatment plant with a capacity of 33,400 m^3/d taking raw water from Mahaweli River. As the plant is currently forced to supply water to the surrounded area, the existing capacity is not sufficient. The KMC is categorized to be the highest priority area because of its high level of lurbanization and large population (25 percent of the total population in the study area).

Kandy Four Gravets is located adjacent to the KMC and is being developed as a bed-town of the KMC with its increasing population. The water supply is dependent on small-scale surface water supply systems which suffers from water shortage in the dry season. Kandy Four Gravets is categorized to be a high priority area.

Harispattuwa is developing as a bed-town of the KMC and is increasing its population in the same way as Kandy Four Gravets. Water is supplied by Gohagoda, Kondadeniya, and Kulugamana water supply systems. Kondadeniya and Kulugamana, which are still suffering from a lack of water, are also prioritized.

A part of Kundasale is at present supplied by the water supply systems of Pallekele, Menikhina, etc. A water supply expansion project has been planned to take raw water from Hulu Ganga River. The project aims at covering most of the area of the northern part of the Mahaweli River by the year 1999, although the project implementation schedule is delayed at the moment. Priority, therefore, of Kundasale is not as high.

On the other hand, the southern part of the Mahaweli River, Ampitiya and Muluphilla, which the KMC water supply system formerly covered but which presently is presently out of operation due to lack of water, remains as a high priority area.

Akurana is ranked at B. However, the main water supply systems of Kahawatta and Kurugoda, which withdraw groundwater, have suffered a decrease of pumpage due to increasing drawdown. Thus, Akurana should also be highly prioritized.

Table 5.7 Priorities in Water Supply Service Areas

Target Zone	Number of Samples	Service Population (A)	Daily					Weekly					Daily				Weekly				Daily + Weekly	
			Uninterrupted (%)	Interrupted (B)		Sometimes Interrupted (C)		Uninterrupted (%)	Interrupted (D)		Sometimes Interrupted (E)		Service pop. x Interrupted (F = A x B)	Service pop. x Sometimes Interrupted (G = A x C)	Total (H=F+G)	Rank	Service pop. x Interrupted (I = A x D)	Service pop. x Sometimes Interrupted (J = A x E)	Total (K=I+J)	Rank	Total (L=H+K)	Rank
				%	Rank	%	Rank		%	Rank	%	Rank										
KMC	803	129,000	66.7	22.1	B	11.3	C	76.9	15.4	B	7.7	C	28,509	14,577	43,086	A	19,866	9,933	29,799	B	72,885	A
Kandy Four Gravets	98	52,000	23.2	50.7	A	26.1	A	26.0	55.0	A	19.0	B	26,364	13,572	39,936	B	28,600	9,880	38,480	B	78,416	A
Akurana	100	40,000	38.3	43.3	A	18.4	B	23.3	68.3	A	8.4	C	17,320	7,360	24,680	B	27,320	3,360	30,680	B	55,360	B
Harispattuwa	102	65,000	35.8	51.0	A	13.2	C	7.5	83.0	A	9.5	C	33,150	8,580	41,730	A	53,950	6,175	60,125	A	101,855	A
Pujapitiya	100	20,000	42.9	19.0	B	38.1	A	38.0	38.0	A	24.0	B	3,800	7,620	11,420	C	7,600	4,800	12,400	C	23,820	C
Kundasale	99	81,500	40.0	60.0	A	-	C	5.6	94.4	A	-	C	48,900	-	48,900	A	76,936	-	76,936	A	125,836	A
Patha Dumbara	100	40,500	35.2	38.8	A	27.0	A	27.0	54.0	A	19.0	B	15,714	10,935	26,649	B	21,870	7,695	29,565	B	56,214	B
Patha Hewaheta	99	8,200	54.6	25.5	A	14.9	C	57.4	25.6	A	17.0	B	2,091	1,222	3,313	C	2,099	1,394	3,493	C	6,806	C
Udunuwara	100	61,000	74.0	6.0	C	20.0	B	76.0	12.0	C	12.0	C	3,660	12,200	15,860	C	7,320	7,320	14,640	C	30,500	C
Uda Palatha	101	2,200	38.2	25.0	B	36.8	A	33.8	42.6	A	23.6	B	550	810	1,360	C	937	519	1,456	C	2,816	C
Yatinuwara	103	25,000	88.2	3.0	C	8.8	C	87.2	2.9	C	8.9	C	750	2,200	2,950	C	725	2,225	2,950	C	5,900	C
Total or Average	1,805	524,400	50.5	34.5		15.1		42.6	47.1		10.2											

Note)

1) Actual served population as of 1997 is adopted as service population
2) Possibility on water supply interruption is assumed as follows ;
   Ranking A : More than 25 %, B : 25 - 15 %, C : Less than 15 %
3) Ranking on daily/weekly water supply interruption is based on the total point ;
   Ranking A : More than 40,000, B : More than 20,000, C : Less than 20,000
4) Overall evaluation is also based on total point ;
   Ranking A : More than70,000, B : More than 50,000, C : Less than 50,000
5) Weighted % is presented as "average"