CHAPTER 8

SEWERAGE MASTER PLAN

8 SEWERAGE MASTER PLAN

8.1 PLANNING FRAMEWORK

8.1.1 Basic Development Policies, Goals and Strategies

(1) Target Year

The target year of the Sewerage Master Plan is 2025 with phased implementation of sewerage projects. The first stage implementation will include priority projects following the adoption of the Master Plan.

(2) Sewerage Development Strategy

The goals of the Master Plan are betterment of living environment and water quality improvement in the Arabian Sea. In order to reach these goals, following strategies are recommended to adopt.

- To implement branch sewers as much as possible to reach better living environment.
- To use nallahs/drains as much as possible as sewage collectors not targeting complete separate system.
- To rehabilitate existing facilities to restore their original function and capacities.
- To treat all the collected sewage with the effluent BOD of less than 80 mg/l.
- To construct new facilities if capacities of rehabilitated/replaced existing facilities are not sufficient to collect and treat generated sewage.

(3) Selection of Service Area / Area of Sewerage Master Plan

The study area is the whole Karachi City consisting of 18 towns. In spite of the Study Area, the Master Plan is to cover only inner 15 towns because detailed information such as possible sites for sewage treatment plants, and actual locations of newly developing colonies in future are not clarified. Besides, it is envisaged that the unit implementation cost for outer 3 towns where there are few sewerage facilities is considerably high. Inner 15 towns are defined as the areas of Karachi City other than outer three towns of Keamari, Gadap and Bin Qasim and include urbanized areas in these three towns adjacent to parts of inner 15 towns. Outer three towns are defined as Keamari, Gadap and Bin Qasim Towns excluding urbanized areas as shown in **Table 81.1.1** and **Figure 81.1.1**.

Table 81.1.1 Towns Comprising Karachi City

			Relevant Towns /Cantonments
Inner 15 Towns **586 km^2**	Towns / Cantonments	Right Bank Side of Lyari River	SITE, Baldia, Orangi, North Nazimabad, New Karachi, Gulberg, Liaquatabad and Malir Towns
		Left Bank Side of Lyari River or Right bank Side of Malir River	Lyari, Saddar, Jamshed, Gulshan-e-Iqbal and Shah Faisal Towns
		Left bank Side of Malir River	Landhi and Korangi Towns
		Cantonments	Karachi, Clifton, Faisal, Malir and Karachi Creek Cantonments
	Other Urbanised Area		Urbanised areas adjacent to above towns in Keamari, Bin Qasim and Gadap Towns
Outer 3 Towns 2,366 km^2			Keamari, Bin Qasim and Gadap Towns (Except above mentioned areas)

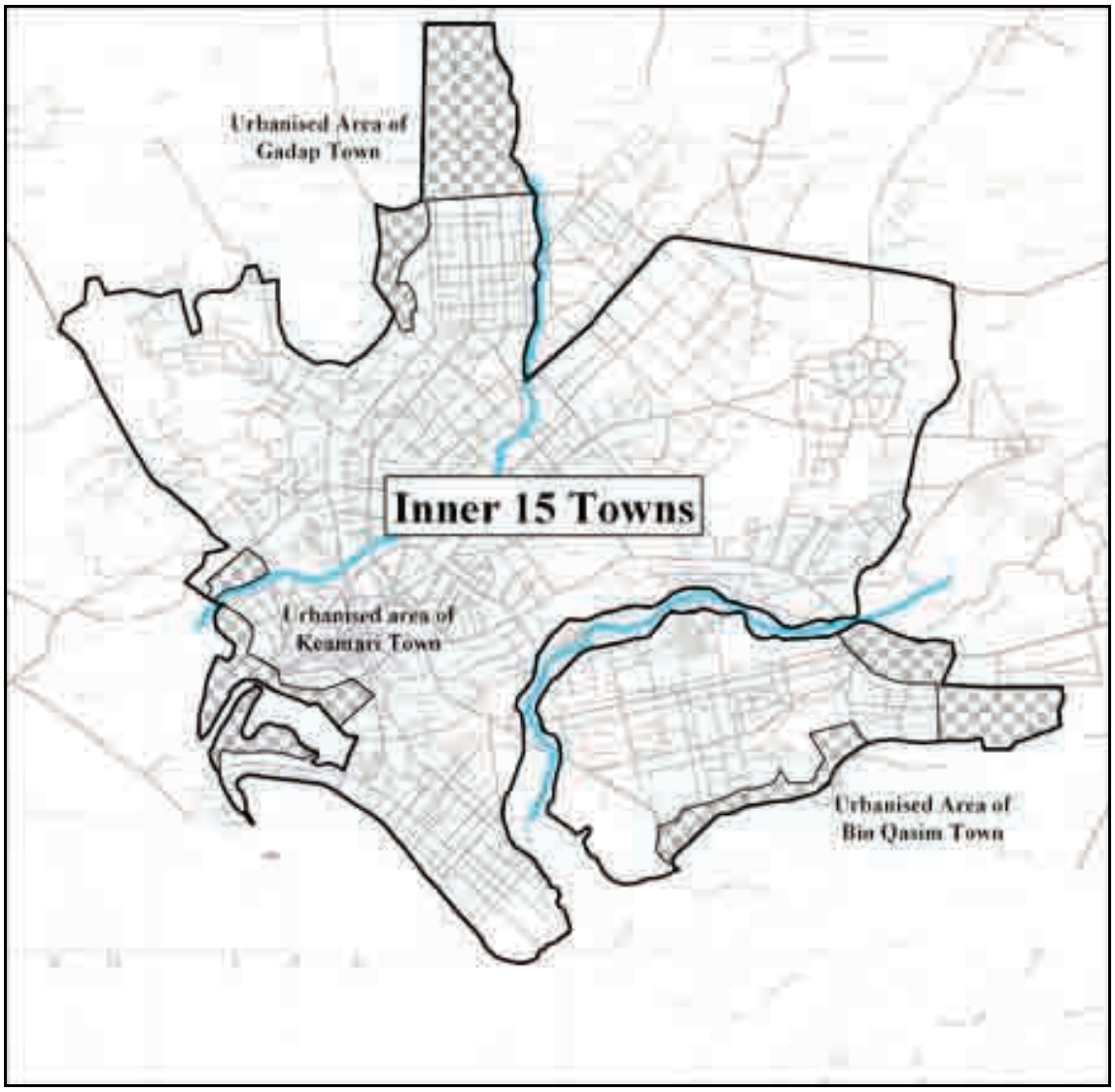

Figure 81.1.1 Schematic of Inner 15 Towns

As for outer three towns, supposing that a number of sewage treatment plants with the capacity of 4.4 mgd (20,000 m^3/d) for each will be constructed step by step taking the urban development in these three towns into account, the cost to implement 36 TPs (total capacity of 720,000 m^3/d to treat the generated sewage of 689,000 m^3/d) and sewers/pumping stations necessary to collect and convey the sewage in these three towns is estimated to be Rs. 85,300 Million. On the other hand, the cost is Rs. 105,300 Million for inner 15 towns. The latter is 23% larger than the former, but the unit cost for the inner 15 towns is Rs. 4,100 per capita which is one-third of the unit cost for the outer three towns of Rs. 12,300 per capita. EIRR (Economic internal return ratio) is calculated for both cases of the sewerage plan with outer three towns and without outer three towns, whose result is shown in **Table 81.1.2**. The EIRR without outer three towns and that with outer three towns are 6.7% and 3.8%, respectively. It is concluded that the sewerage plan without outer three towns is economically viable and hence it is recommended to implement.

Table 81.1.2 IRR of Sewerage Project

	Master Plan Area (km^2)	Population in Area (Person)	Total Base Cost (Million Rs.)	EIRR
Inner 15 towns only	586	25,582,000	105,300	6.7%
Inner 15 towns with Outer 3 towns	2,953	32,506,000	190,600	3.8%

Though sewerage implementation plan in these outer three towns is not included in the Master Plan, once water is supplied in these three towns, sewage is inevitably generated. Generated sewage will certainly deteriorate the water environment as well as living environment unless some measures are taken to collect, convey and treat generated sewage. An option to solve the problem is to involve land/housing developers in sewerage facilities implementation and their operation and maintenance. It is recommended that the developers implement inner sewerage facilities such as branch sewers under KW&SB management at the time of land/housing development and add its cost on land/housing price. Concurrent implementation of road, water supply pipe, sewers and other underground structure can reduce the respective construction costs. Even in this case, KW&SB will be responsible for implementing and operating major sewerage facilities such as trunk sewers and sewage treatment plants.

(4) Collection System

1) Separate system will be adopted in principle.
2) Interception of nallahs before flowing into Arabian Sea to convey all the collected sewage to treatment plants
3) Nallahs and drainages are to be used as much as possible as trunk sewers.
4) Extension of Lyari Interceptor up to New Karachi
5) New installation of Malir Interceptors at both sides of Malir River

(5) Handling Non-domestic Sewage (including industrial wastewaters)

1) Industrial wastewaters comprise non-domestic sewage but are not estimated separately from other kinds of non-domestic sewage.
2) Non-domestic sewage generated in respective sewer districts is to flow into respective sewage treatment plants in principle, but toxic matters containing wastewaters are to be excluded unless these matters are removed beforehand.
3) Non-domestic sewage is supposed to have BOD concentration of 250 mg/l when flowing into sewerage facilities based on NEQS.
4) Factories are required to install pre-treatment facilities when and where necessary to meet the effluent standard stipulated in NEQS.

(6) Sewage treatment

1) The treatment level to meet the NEQS, namely effluent BOD of less than 80 mg/l
2) Either High Rate Trickling Filter or Waste Stabilization Pond System is adopted as treatment process in principle. Activated sludge process might be adopted only if the available land for the sewage treatment plant is too small to adopt these two processes.
3) Existing sewage treatment plants are rehabilitated to restore their original function and extended if necessary within respective site areas. New treatment plant(s) might be needed if the total capacities of extended treatment plants are not sufficient to treat the generated sewage in 2025, the target year of the Master Plan.

8.1.2 Sewage Generation

(1) Future Population

Chapter 6 discusses town-wise future population that is shown in **Table 81.2.1** and population density is shown in **Table 81.2.2**.

Table 81.2.1 Town-wise Future Population

		Future Population (Person)				
		2006	2011	2016	2021	2025
1	Keamari					
	Urbanized Area 1	82,095	86,720	92,264	98,740	103,920
	Urbanized Area 2	208,096	216,048	225,580	236,714	245,622
	Urbanized Area 3	137,127	140,866	145,349	150,585	154,773
	Sub-Total	427,318	443,634	463,193	486,039	504,315
2	SITE	720,068	772,637	835,651	909,249	968,127
3	Baldia	643,782	784,294	952,723	1,149,444	1,306,821
4	Orangi	1,116,962	1,210,963	1,323,641	1,455,246	1,560,530
5	Lyari	925,708	938,854	954,611	973,016	987,740
6	Saddar	945,829	999,117	1,062,994	1,137,600	1,197,285
7	Jamshed	1,138,680	1,265,611	1,417,763	1,595,471	1,737,637
8	Gulshan-e-Iqbal	1,027,454	1,433,010	1,919,145	2,486,936	2,941,169
9	Shah Faisal	515,508	544,553	579,368	620,031	652,561
10	Landhi	1,056,812	1,287,471	1,563,960	1,886,890	2,145,234
11	Korangi	884,428	1,168,020	1,507,959	1,904,997	2,222,627
12	North Nazimabad	765,820	830,191	907,352	997,474	1,069,572
13	New Karachi	1,050,261	1,109,433	1,180,363	1,263,207	1,329,482
14	Gulberg	699,910	758,741	829,261	911,627	977,520
15	Liaquatabad	988,284	1,002,318	1,019,141	1,038,790	1,054,509
16	Malir	621,348	707,465	810,692	931,258	1,027,711
17	Bin Qasim					
	Urbanized Area 1	449,683	593,860	766,690	968,574	1,130,053
18	Gadap					
	Urbanized Area 1	135,765	143,415	152,584	163,293	171,860
	Urbanized Area 2	178,458	226,217	300,850	429,286	677,714
	Sub-Total	314,223	369,632	453,434	592,579	849,574
	Sub-Total	14,292,078	16,219,804	18,547,941	21,308,428	23,662,467
19	Cantonment					
	Karachi Cantonment	22,067	28,025	35,166	43,507	50,180
	Clifton Cantonnment	13,240	16,815	21,100	26,104	30,108
	Faisal Cantonment	130,931	166,281	208,654	258,144	297,737
	Malir Cantonment	276,083	350,622	439,970	544,327	627,812
	Korangi Creek Cantonment	48,058	61,031	76,585	94,751	109,282
	Sub-Total	490,379	622,774	781,475	966,833	1,115,119
20	Defence	396,252	482,737	586,407	707,490	804,356
	Sub-Total	886,631	1,105,511	1,367,882	1,674,323	1,919,475
	Total	15,178,709	17,325,315	19,915,823	22,982,751	25,581,942

	Future Population (Person)				
	2006	2011	2016	2021	2025
Inner 15 Towns and Urbanised	14,292,078	16,219,804	18,547,941	21,308,428	23,662,467
Cantonments	490,379	622,774	781,475	966,833	1,115,119
Defence	396,252	482,737	586,407	707,490	804,356
Total	15,178,709	17,325,315	19,915,823	22,982,751	25,581,942

Note:
(1) See **Section 6.1** for details about population projection
(2) Area of Keamari Town, Bin-Qasim Town and Gadap Town shows inhabitable one out of the total areas.
(3) "Urbanised area" shows the areas of Keamari Town, Bin-Qasim Town and Gadap Town adjacent to inner 15 towns and to be sewered along with inner 15 towns. For the location of "Urbanised Area", refer to **Figure 81.2.1**.

Table 81.2.2 Town-wise Area and Population Density

		Area (km^2)	Population Density (Person/ha)				
			2006	2011	2016	2021	2025
1	Keamari						
	Urbanized Area 1	2.5	328	347	369	395	416
	Urbanized Area 2	7.8	267	277	289	303	315
	Urbanized Area 3	3.9	352	361	373	386	397
2	SITE	25.4	283	304	329	358	381
3	Baldia	29.2	220	269	326	394	448
4	Orangi	23.5	475	515	563	619	664
5	Lyari	8.0	1,157	1,174	1,193	1,216	1,235
6	Saddar	24.1	392	415	441	472	497
7	Jamshed	23.4	487	541	606	682	743
8	Gulshan-e-Iqbal	53.7	191	267	357	463	548
9	Shah Faisal	11.7	441	465	495	530	558
10	Landhi	39.1	270	329	400	483	549
11	Korangi	41.5	213	281	363	459	536
12	North Nazimabad	16.7	459	497	543	597	640
13	New Karachi	20.5	512	541	576	616	649
14	Gulberg	13.8	507	550	601	661	708
15	Liaquatabad	10.9	907	920	935	953	967
16	Malir	17.8	349	397	455	523	577
17	Bin Qasim						
	Urbanized Area 1	21.1	213	281	363	459	536
18	Gadap						
	Urbanized Area 1	5.3	256	271	288	308	324
	Urbanized Area 2	20.9	85	108	144	205	324
19	Cantonment						
	Karachi Cantonment	5.7	39	49	62	76	88
	Clifton Cantonnment	3.4	39	49	62	77	89
	Faisal Cantonment	33.9	39	49	62	76	88
	Malir Cantonment	71.4	39	49	62	76	88
	Korangi Creek Cantonment	12.4	39	49	62	76	88
	Total	126.8	39	49	62	76	88
20	Defence	38.3	103	126	153	185	210
Overall		585.9	259	296	340	392	437

	Area (km^2)	Population Density (Person/ha)				
		2006	2011	2016	2021	2025
Inner 15 Towns and Urbanised Area	420.8	340	385	441	506	562
Cantonments	126.8	39	49	62	76	88
Defence	38.3	103	126	153	185	210
Overall	585.9	259	296	340	392	437

Note:
Population density in 2025
- Overall population density of 562 persons per hectare for inner 15 towns and urbanized parts of outer 3 towns
- Though the population density of Cantonment is not so high compared with other areas but its area is already sewered.
- Defence (DHA) currently has some areas to develop but they are expected to be developed and the population density will be 210 persons per hectare.

Figure 81.2.1 shows urbanised areas of outer 3 towns to be included in sewerage system in inner 15 towns.

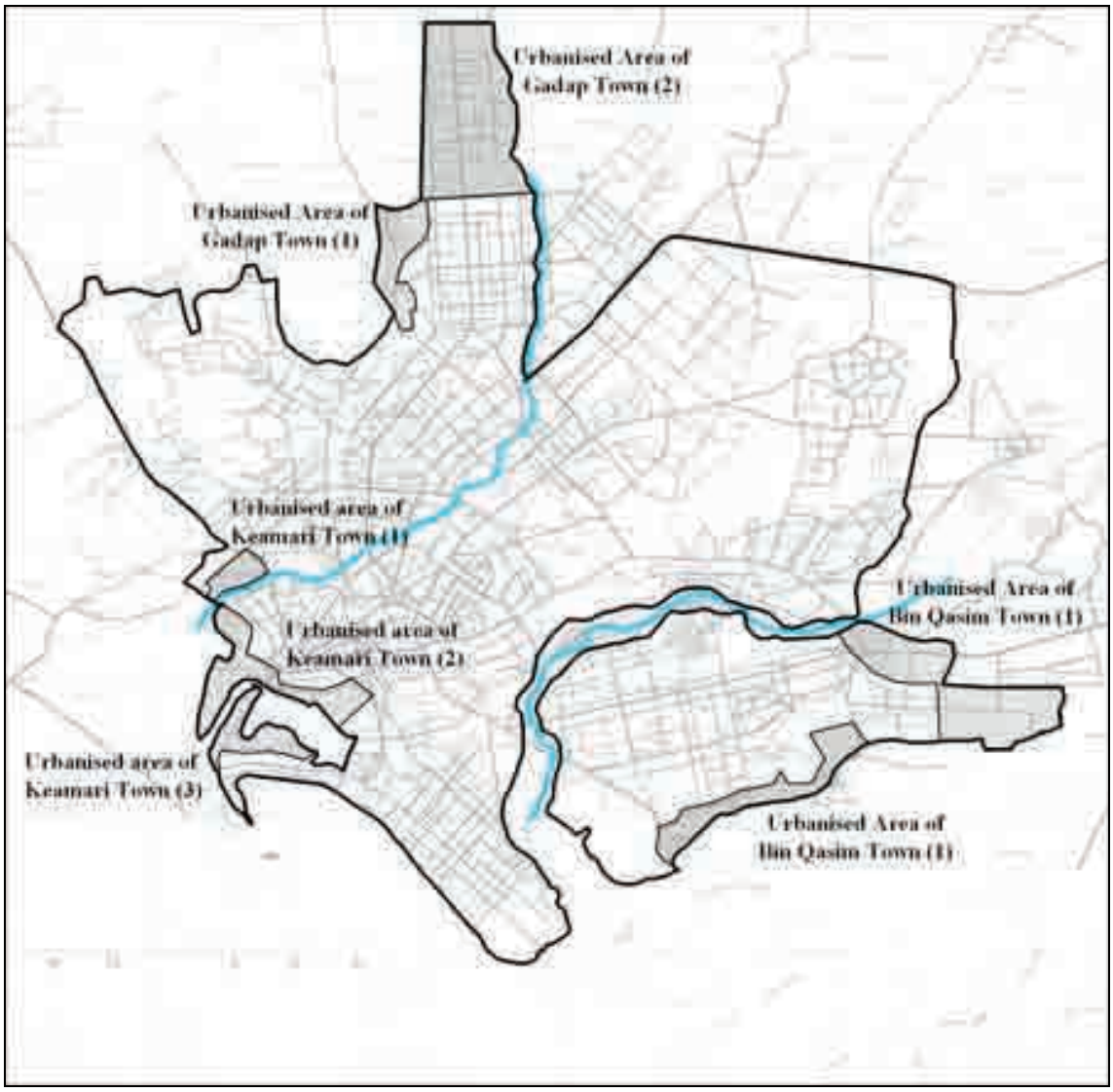

Figure 81.2.1 Urbanised Area of Outer 3 Towns

(2) Coverage Rate (or connection rate)

Present town-wise branch sewer coverage rate is assumed based on the estimated road lengths and interviews with KW&SB and it is summarized in **Table 81.2.3.**

Table 81.2.3 Town-wise Branch Sewer Coverage Rate

		Area (km^2)	Road Density (m/ha)	Road Length (km)	Existing Sewer Length (km)	Coverage Rate	Adopted Coverage Rate	Remarks
1	Keamari (Urbanised Area 1)	2.5	170	43	No data		25%	SITE
	Keamari (Urbanised Area 2)	7.8	170	133			70%	Saddar
	Keamari (Urbanised Area 3)	3.9	170	66			70%	Saddar
2	SITE	25.4	170	432	115.4	26.7%	25%	
3	Baldia	29.2	170	496	41.3	8.3%	10%	
4	Orangi	23.5	270	635	36.9	5.8%	10%	
5	Lyari	8.0	270	216	68.7	31.8%	40%	
6	Saddar	24.1	270	651	72.3	11.1%	70%	Jamshed
7	Jamshed	23.4	270	632	459.7	72.7%	70%	
8	Gulshan-e-Iqbal	53.7	170	913	164.0	18.0%	15%	
9	Shah Faisal	11.7	270	316	68.8	21.8%	20%	
10	Landhi	39.1	170	665	110.7	16.6%	20%	
11	Korangi	41.5	170	706	276.2	39.1%	50%	
12	North Nazimabad	16.7	270	451	396.9	88.0%	90%	
13	New Karachi	20.5	270	554	302.1	54.5%	50%	
14	Gulberg	13.8	270	373	487.1	130.6%	90%	
15	Liaquatabad	10.9	270	294	255.8	87.0%	90%	
16	Malir	17.8	270	481	146.1	30.4%	35%	
17	Bin Qasim (Urbanised Area 1)	21.1	170	359	No data		20%	Landhi
18	Gadap (Urbanised Area 1)	5.3	170	90	No data		50%	New Karachi
	Gadap (Urbanised Area 2)	20.9	170	355			10%	Orangi
19	Cantonment	126.8	90	1,141	No data		90%	
20	Defence	38.3	170	651	No data		30%	
	Total / Weighted average	585.9	182	10,653			48%	

Note:
(1) Road densities of 170 and 270 meters per hectare are estimated based on satellite images.
(2) Existing sewer length is obtained from respective engineers in charge.
(3) Since the coverage rate of Saddar town situated in the centre of Karachi City, 11%, is judged too low, and it is assumed to be the same as that of Jamshed town next to it.
(4) Little data is available on coverage rates of outer 3 towns, and it is assumed coverage rates of urbanised areas are supposed to be the same as those of respective neighbouring towns as described in Remarks.

Coverage rate is expected to be 100% by the target year of 2025 until which it is supposed to linearly increase. **Table 81.2.4** summarizes the trend of coverage rates of respective towns towards the target year of 2025. Present coverage rates of Cantonment and Defence are 90% and 30% and those in 2025 will be 100%, respectively.

House connections will be constructed gradually where branch sewers are implemented but flow rates to pumping stations and sewage treatment plants are estimated supposing that service connections will be completed where the area is sewered.

Table 81.2.4 Future Sewer Coverage Rate

		Area (km^2)	Futura Coverage Rate				
			2006	2011	2016	2021	2025
1	Keamari (Urbanised Area 1)	2.5	25%	45%	64%	84%	100%
	Keamari (Urbanised Area 2)	7.8	70%	78%	86%	94%	100%
	Keamari (Urbanised Area 3)	3.9	70%	78%	86%	94%	100%
2	SITE	25.4	25%	45%	64%	84%	100%
3	Baldia	29.2	10%	34%	57%	81%	100%
4	Orangi	23.5	10%	34%	57%	81%	100%
5	Lyari	8.0	40%	56%	72%	87%	100%
6	Saddar	24.1	70%	78%	86%	94%	100%
7	Jamshed	23.4	70%	78%	86%	94%	100%
8	Gulshan-e-Iqbal	53.7	15%	37%	60%	82%	100%
9	Shah Faisal	11.7	20%	41%	62%	83%	100%
10	Landhi	39.1	20%	41%	62%	83%	100%
11	Korangi	41.5	50%	63%	76%	89%	100%
12	North Nazimabad	16.7	90%	93%	100%	100%	100%
13	New Karachi	20.5	50%	63%	76%	89%	100%
14	Gulberg	13.8	90%	93%	100%	100%	100%
15	Liaquatabad	10.9	90%	93%	100%	100%	100%
16	Malir	17.8	35%	52%	69%	86%	100%
17	Bin Qasim (Urbanised Area 1)	21.1	20%	41%	62%	83%	100%
18	Gadap (Urbanised Area 1)	5.3	50%	63%	76%	89%	100%
	Gadap (Urbanised Area 2)	20.9	10%	34%	57%	81%	100%
19	Cantonment	126.8	90%	90%	90%	90%	100%
20	Defence	38.3	30%	30%	30%	65%	100%
	Weighted Average	585.9	48%	60%	72%	86%	100%

(3) Population in Sewerage Service Area

Town wise population in sewerage service area, or sewered population, is computed by multiplying the future population shown in **Table 81.2.1** and the future sewer coverage rate shown in **Table 81.2.4**, whose result is summarized in **Table 81.2.5**.

Table 81.2.5 Town-wise Future Population in Sewerage Service Area

		Future Population in Sewer Service Area (Person)				
		2006	2011	2016	2021	2025
1	Keamari					
	Urbanized Area 1	20,524	38,796	59,486	83,149	103,920
	Urbanized Area 2	145,667	168,290	193,524	221,764	245,622
	Urbanized Area 3	95,989	109,727	124,694	141,074	154,773
	Sub-Total	262,180	316,813	377,704	445,987	504,315
2	SITE	180,017	345,653	538,775	765,683	968,127
3	Baldia	64,378	264,183	546,562	931,655	1,306,821
4	Orangi	111,696	407,903	759,352	1,179,515	1,560,530
5	Lyari	370,283	523,782	683,301	850,109	987,740
6	Saddar	662,080	778,260	911,937	1,065,752	1,197,285
7	Jamshed	797,076	985,844	1,216,291	1,494,704	1,737,637
8	Gulshan-e-Iqbal	154,118	535,493	1,146,437	2,041,905	2,941,169
9	Shah Faisal	103,102	223,553	359,818	515,605	652,561
10	Landhi	211,362	528,541	971,301	1,569,098	2,145,234
11	Korangi	442,214	737,697	1,150,811	1,704,471	2,222,627
12	North Nazimabad	689,238	769,019	907,352	997,474	1,069,572
13	New Karachi	525,131	700,695	900,803	1,130,238	1,329,482
14	Gulberg	629,919	702,834	829,261	911,627	977,520
15	Liaquatabad	889,456	928,463	1,019,141	1,038,790	1,054,509
16	Malir	217,472	368,627	561,084	803,823	1,027,711
17	Bin Qasim					
	Urbanized Area 1	89,937	243,795	476,155	805,446	1,130,053
18	Gadap					
	Urbanized Area 1	67,883	90,578	116,446	146,104	171,860
	Urbanized Area 2	17,846	76,199	172,593	347,948	677,714
	Sub-Total	85,729	166,777	289,039	494,052	849,574
	Sub-Total	6,485,388	9,527,932	13,645,124	18,745,934	23,662,467
19	Cantonment					
	Karachi Cantonment	19,860	25,223	31,649	39,156	50,180
	Clifton Cantonnment	11,916	15,134	18,990	23,494	30,108
	Faisal Cantonment	117,838	149,653	187,789	232,330	297,737
	Malir Cantonment	248,475	315,560	395,973	489,894	627,812
	Korangi Creek Cantonment	43,252	54,928	68,927	85,276	109,282
	Sub-Total	441,341	560,498	703,328	870,150	1,115,119
20	Defence	118,876	144,821	175,922	459,869	804,356
	Sub-Total	560,217	705,319	879,250	1,330,019	1,919,475
	Total	7,045,605	10,233,251	14,524,374	20,075,953	25,581,942

	Future Population in Sewer Service Area (Person)				
	2006	2011	2016	2021	2025
Inner 15 Towns and Urbanised	6,485,388	9,527,932	13,645,124	18,745,934	23,662,467
Cantonments	441,341	560,498	703,328	870,150	1,115,119
Defence	118,876	144,821	175,922	459,869	804,356
Total	7,045,605	10,233,251	14,524,374	20,075,953	25,581,942

(4) Per Capita Domestic Water Consumption and Sewage Generation

Per capita water consumption discussed in **Chapter 6** is shown in **Table 81.2.6**.

Table 81.2.6 Per Capita Domestic Water Consumption

		Per Capita Domestic Water Consumption (lpcd)				
		2006	2011	2016	2021	2025
1	Keamari	64.64	64.69	68.85	78.20	85.45
2	SITE	67.50	67.55	71.89	81.65	89.22
3	Baldia	60.29	60.34	64.22	72.94	79.70
4	Orangi	60.29	60.34	64.22	72.94	79.70
5	Lyari	60.29	60.34	64.22	72.94	79.70
6	Saddar	85.80	85.87	91.38	103.80	113.42
7	Jamshed	76.84	76.90	81.84	92.96	101.57
8	Gulshan-e-Iqbal	83.90	83.97	89.36	101.50	110.91
9	Shah Faisal	73.02	73.07	77.77	88.33	96.52
10	Landhi	60.29	60.34	64.22	72.94	79.70
11	Korangi	60.29	60.34	64.22	72.94	79.70
12	North Nazimabad	81.29	81.35	86.58	98.34	107.46
13	New Karachi	60.29	60.34	64.22	72.94	79.70
14	Gulberg	79.42	79.48	84.59	96.08	104.98
15	Liaquatabad	74.18	74.23	79.00	89.73	98.05
16	Malir	65.12	65.17	69.36	78.78	86.08
17	Bin Qasim	66.51	66.56	70.83	80.45	87.91
18	Gadap	60.29	60.34	64.22	72.94	79.70
19	Cantonment	60.29	60.34	64.22	72.94	79.70
20	Defence	135.66	135.76	144.49	164.12	179.33

Note: See **Section 6.2** for detail.

Per capita sewage generation is calculated by multiplying per capita water consumption by return factor. The return factor for per capita water consumption is said to be in the range between 0.6 and 0.8, which is a common practice in Pakistan. The average of the range, 0.7, will be applied in the preparation of the Master Plan. The ratio of 0.7 is applied in Greater Karachi Sewerage Plan (S-III) prepared by KW&SB, too. The ratio will be adopted to non-domestic sewage as well.

No allowance for groundwater infiltration is considered because the groundwater table in Karachi City is generally lower than sewer depth.

Table 81.2.7 Return Factor and Allowance for Groundwater Infiltration

Item	Criteria
Return Factor to Water Consumption	0.7
Allowance for Groundwater Infiltration	No allowance

Domestic sewage generation is calculated by multiplying town-wise population in sewerage service area, per capita domestic water consumption and return factor shown in **Table 81.2.7**. Non-domestic sewage generation is calculated in the same manner. **Table 81.2.8** summarizes calculated domestic sewage generation and non-domestic sewage generation.

Table 81.2.8 Town-wise Sewage Generation

		Domestic Sewage (m^3/d)					Non Domestic Sewage (m^3/d)					Total (m^3/d)				
		2006	2011	2016	2021	2025	2006	2011	2016	2021	2025	2006	2011	2016	2021	2025
1	Keamari															
	Urbanized Area 1	929	1,757	2,867	4,552	6,216	295	679	1,166	1,703	2,143	1,224	2,436	4,033	6,255	8,359
	Urbanized Area 2	6,591	7,621	9,326	12,139	14,691	2,294	3,222	4,149	4,947	5,536	8,885	10,843	13,475	17,086	20,227
	Urbanized Area 3	4,343	4,969	6,009	7,722	9,257	1,381	1,933	2,484	2,951	3,277	5,724	6,902	8,493	10,673	12,534
	Sub-Total	11,863	14,347	18,202	24,413	30,164	3,970	5,834	7,799	9,601	10,956	15,833	20,181	26,001	34,014	41,120
2	SITE	8,505	16,343	27,111	43,764	60,463	9,170	17,363	26,964	39,469	49,864	17,675	33,706	54,075	83,233	110,327
3	Baldia	2,717	11,158	24,569	47,569	72,908	744	3,934	9,348	16,623	23,469	3,461	15,092	33,917	64,192	96,377
4	Orangi	4,714	17,229	34,134	60,224	87,062	958	3,623	6,977	11,507	15,474	5,672	20,852	41,111	71,731	102,536
5	Lyari	15,628	22,123	30,715	43,406	55,106	3,887	5,552	7,365	9,676	11,392	19,515	27,675	38,080	53,082	66,498
6	Saddar	39,765	46,778	58,334	77,436	95,055	63,800	72,487	83,514	100,283	112,409	103,565	119,265	141,848	177,719	207,464
7	Jamshed	42,874	53,068	69,678	97,262	123,548	9,282	12,792	16,996	22,041	25,957	52,156	65,860	86,674	119,303	149,505
8	Gulshan-e-Iqbal	9,052	31,474	71,713	145,080	228,339	5,310	17,961	38,066	70,319	101,609	14,362	49,435	109,779	215,399	329,948
9	Shah Faisal	5,270	11,435	19,587	31,881	44,088	4,453	9,549	15,349	22,702	28,744	9,723	20,984	34,936	54,583	72,832
10	Landhi	8,921	22,324	43,661	80,116	119,683	4,928	11,826	21,322	35,771	49,097	13,849	34,150	64,983	115,887	168,780
11	Korangi	18,664	31,159	51,730	87,028	124,001	12,659	19,983	30,284	46,458	60,725	31,323	51,142	82,014	133,486	184,726
12	North Nazimabad	39,221	43,794	54,991	68,667	80,453	8,341	9,372	11,240	13,120	14,300	47,562	53,166	66,231	81,787	94,753
13	New Karachi	22,164	29,596	40,492	57,708	74,172	4,825	6,541	8,593	11,432	13,658	26,989	36,137	49,085	69,140	87,830
14	Gulberg	35,020	39,104	49,101	61,312	71,836	7,600	8,661	10,478	12,211	13,297	42,620	47,765	59,579	73,523	85,133
15	Liaquatabad	46,183	48,245	56,359	65,250	72,376	10,173	10,468	11,520	12,467	12,864	56,356	58,713	67,879	77,717	85,240
16	Malir	9,914	16,817	27,242	44,330	61,929	17,944	28,463	41,705	61,368	78,269	27,858	45,280	68,947	105,698	140,198
17	Bin Qasim															
	Urbanized Area 1	4,187	11,358	23,609	45,361	69,540	8,027	21,122	40,663	70,607	98,789	12,214	32,480	64,272	115,968	168,329
18	Gadap															
	Urbanized Area 1	2,865	3,826	5,234	7,460	9,588	4,773	10,685	17,557	6,368	5,110	7,638	14,511	22,791	13,828	14,698
	Urbanized Area 2	753	3,218	7,758	17,766	37,810	251	4,793	19,563	13,738	20,150	1,004	8,011	27,321	31,504	57,960
	Sub-Total	3,618	7,044	12,992	25,226	47,398	5,024	15,478	37,120	20,106	25,260	8,642	22,522	50,112	45,332	72,658
	Sub-Total	328,280	473,396	714,220	1,106,033	1,518,121	181,095	281,009	425,303	585,761	746,133	509,375	754,405	1,139,523	1,691,794	2,264,254
19	Cantonment															
	Karachi Cantonment	838	1,065	1,423	1,999	2,800	1,133	1,408	1,752	2,231	2,858	1,971	2,473	3,175	4,230	5,658
	Clifton Cantonnment	503	639	854	1,200	1,680	680	845	1,051	1,339	1,715	1,183	1,484	1,905	2,539	3,395
	Faisal Cantonment	4,973	6,321	8,441	11,862	16,611	6,724	8,356	10,393	13,242	16,953	11,697	14,677	18,834	25,104	33,564
	Malir Cantonment	10,487	13,329	17,799	25,013	35,026	14,180	17,620	21,915	27,922	35,747	24,667	30,949	39,714	52,935	70,773
	Korangi Creek Cantonment	1,825	2,320	3,098	4,354	6,097	2,468	3,067	3,814	4,860	6,223	4,293	5,387	6,912	9,214	12,320
	Sub-Total	18,626	23,674	31,615	44,428	62,214	25,185	31,296	38,925	49,594	63,496	43,811	54,970	70,540	94,022	125,710
20	Defence	11,289	13,763	17,793	52,831	100,969	2,494	2,914	3,476	9,459	16,635	13,783	16,677	21,269	62,290	117,604
	Sub-Total	29,915	37,437	49,408	97,259	163,183	27,679	34,210	42,401	59,053	80,131	57,594	71,647	91,809	156,312	243,314
	Total	358,195	510,833	763,628	1,203,292	1,681,304	208,774	315,219	467,704	644,814	826,264	566,969	826,052	1,231,332	1,848,106	2,507,568

	Domestic Sewage (m^3/d)					Non Domestic Sewage (m^3/d)					Total (m^3/d)				
	2006	2011	2016	2021	2025	2006	2011	2016	2021	2025	2006	2011	2016	2021	2025
Inner 15 Towns and Urbanised	328,280	473,396	714,220	1,106,033	1,518,121	181,095	281,009	425,303	585,761	746,133	509,375	754,405	1,139,523	1,691,794	2,264,254
Cantonments	18,626	23,674	31,615	44,428	62,214	25,185	31,296	38,925	49,594	63,496	43,811	54,970	70,540	94,022	125,710
Defence	11,289	13,763	17,793	52,831	100,969	2,494	2,914	3,476	9,459	16,635	13,783	16,677	21,269	62,290	117,604
Total	358,195	510,833	763,628	1,203,292	1,681,304	208,774	315,219	467,704	644,814	826,264	566,969	826,052	1,231,332	1,848,106	2,507,568

Note: Non-domestic sewage generation is calculated by multiplying non-domestic consumption in service area of each town by the return factor

8.1.3 Quality of Sewage

(1) Quality of Domestic and Non-domestic Sewage

For existing three TPs, sewage generation in litre per capita per day (lpcd) and BOD generation in gram per capita per day (gmcd) are calculated using sewage flow (m^3/d) and influent BOD concentration (mg/l). Per capita sewage generation is obtained by dividing sewage flow by served population and BOD generation is obtained by multiplying influent BOD concentration by sewage generation. The result of the calculation is shown in **Table 81.3.1**. The average BOD generation is calculated to be 50 gmcd.

Table 81.3.1 Design Parameters in Existing Three Treatment Plants

	Treatment Capacity		Served Population	Sewage Generation (lpcd)	Design Influent BOD Concentration (mg/l)	BOD Generation per Capita-day (gmcd)
	(m^3/d)	(mgd)				
TP－1	232,000	51	1,600,000	145	385	56
TP－2	209,000	46	1,600,000	131	365	48
TP－3	245,000	54	2,000,000	123	385	47
Average						50

Source: KW&SB except BOD generation calculated by the Study Team.

Non-domestic sewage including industrial wastewaters is assumed to be treated within their premises to meet the NEQS, BOD of less than 250 mg/l, and discharged to public sewers.

(2) Quality of Domestic and Non-domestic Sewage

Table 81.3.2 shows town-wise BOD loading and **Table 81.3.3** shows overall BOD concentration. For design purpose, the BOD concentration of 600 mg/l in 2025, rounded over of 592 mg/l, will be applied.

For details about population, sewage generation and BOD generation of each town, refer to **Appendix A81.1.**

Table 81.3.2 Town-wise BOD Loading of Sewage

		Domestic Sewage (kg/d)					Non Domestic Sewage (kg/d)					Total (kg/d)				
		2006	2011	2016	2021	2025	2006	2011	2016	2021	2025	2006	2011	2016	2021	2025
1	Keamari															
	Urbanized Area 1	1,026	1,940	2,974	4,157	5,196	74	170	292	426	536	1,100	2,110	3,266	4,583	5,732
	Urbanized Area 2	7,283	8,415	9,676	11,088	12,281	574	806	1,037	1,237	1,384	7,857	9,221	10,713	12,325	13,665
	Urbanized Area 3	4,799	5,486	6,235	7,054	7,739	345	483	621	738	819	5,144	5,969	6,856	7,792	8,558
	Sub-Total	13,108	15,841	18,885	22,299	25,216	993	1,459	1,950	2,401	2,739	14,101	17,300	20,835	24,700	27,955
2	SITE	9,001	17,283	26,939	38,284	48,406	2,293	4,341	6,741	9,867	12,466	11,294	21,624	33,680	48,151	60,872
3	Baldia	3,219	13,209	27,328	46,583	65,341	186	984	2,337	4,156	5,867	3,405	14,193	29,665	50,739	71,208
4	Orangi	5,585	20,395	37,968	58,976	78,027	240	906	1,744	2,877	3,869	5,825	21,301	39,712	61,853	81,896
5	Lyari	18,514	26,189	34,165	42,505	49,387	972	1,388	1,841	2,419	2,848	19,486	27,577	36,006	44,924	52,235
6	Saddar	33,104	38,913	45,597	53,288	59,864	15,950	18,122	20,879	25,071	28,102	49,054	57,035	66,476	78,359	87,966
7	Jamshed	39,854	49,292	60,815	74,735	86,882	2,321	3,198	4,249	5,510	6,489	42,175	52,490	65,064	80,245	93,371
8	Gulshan-e-Iqbal	7,706	26,775	57,322	102,095	147,058	1,328	4,490	9,517	17,580	25,402	9,034	31,265	66,839	119,675	172,460
9	Shah Faisal	5,155	11,178	17,991	25,780	32,628	1,113	2,387	3,837	5,676	7,186	6,268	13,565	21,828	31,456	39,814
10	Landhi	10,568	26,427	48,565	78,455	107,262	1,232	2,957	5,331	8,943	12,274	11,800	29,384	53,896	87,398	119,536
11	Korangi	22,111	36,885	57,541	85,224	111,131	3,165	4,996	7,571	11,615	15,181	25,276	41,881	65,112	96,839	126,312
12	North Nazimabad	34,462	38,451	45,368	49,874	53,479	2,085	2,343	2,810	3,280	3,575	36,547	40,794	48,178	53,154	57,054
13	New Karachi	26,257	35,035	45,040	56,512	66,474	1,206	1,635	2,148	2,858	3,415	27,463	36,670	47,188	59,370	69,889
14	Gulberg	31,496	35,142	41,463	45,581	48,876	1,900	2,165	2,620	3,053	3,324	33,396	37,307	44,083	48,634	52,200
15	Liaquatabad	44,473	46,423	50,957	51,940	52,725	2,543	2,617	2,880	3,117	3,216	47,016	49,040	53,837	55,057	55,941
16	Malir	10,874	18,431	28,054	40,191	51,386	4,486	7,116	10,426	15,342	19,567	15,360	25,547	38,480	55,533	70,953
17	Bin Qasim															
	Urbanized Area 1	4,497	12,190	23,808	40,272	56,503	2,007	5,281	10,166	17,652	24,697	6,504	17,471	33,974	57,924	81,200
18	Gadap															
	Urbanized Area 1	3,394	4,529	5,822	7,305	8,593	1,193	2,671	4,389	1,592	1,278	4,587	7,200	10,211	8,897	9,871
	Urbanized Area 2	892	3,810	8,630	17,397	33,886	63	1,198	4,891	3,435	5,038	955	5,008	13,521	20,832	38,924
	Sub-Total	4,286	8,339	14,452	24,702	42,479	1,256	3,869	9,280	5,027	6,316	5,542	12,208	23,732	29,729	48,795
	Sub-Total	324,270	476,398	682,258	937,296	1,183,124	45,276	70,254	106,327	146,444	186,533	369,546	546,652	788,585	1,083,740	1,369,657
19	Cantonment															
	Karachi Cantonment	993	1,261	1,582	1,958	2,509	283	352	438	558	715	1,276	1,613	2,020	2,516	3,224
	Clifton Cantonnment	596	757	950	1,175	1,505	170	211	263	335	429	766	968	1,213	1,510	1,934
	Faisal Cantonment	5,892	7,483	9,389	11,617	14,887	1,681	2,089	2,598	3,311	4,238	7,573	9,572	11,987	14,928	19,125
	Malir Cantonment	12,424	15,778	19,799	24,495	31,391	3,545	4,405	5,479	6,981	8,937	15,969	20,183	25,278	31,476	40,328
	Korangi Creek Cantonment	2,163	2,746	3,446	4,264	5,464	617	767	954	1,215	1,556	2,780	3,513	4,400	5,479	7,020
	Sub-Total	22,068	28,025	35,166	43,509	55,756	6,296	7,824	9,732	12,400	15,875	28,364	35,849	44,898	55,909	71,631
20	Defence	5,944	7,241	8,796	22,993	40,218	624	729	869	2,365	4,159	6,568	7,970	9,665	25,358	44,377
	Sub-Total	28,012	35,266	43,962	66,502	95,974	6,920	8,553	10,601	14,765	20,034	34,932	43,819	54,563	81,267	116,008
	Total	352,282	511,664	726,220	1,003,798	1,279,098	52,196	78,807	116,928	161,209	206,567	404,478	590,471	843,148	1,165,007	1,485,665

	Domestic Sewage (m^3/d)					Non Domestic Sewage (m^3/d)					Total (m^3/d)				
	2006	2011	2016	2021	2025	2006	2011	2016	2021	2025	2006	2011	2016	2021	2025
Inner 15 Towns and Urbanised	324,270	476,398	682,258	937,296	1,183,124	45,276	70,254	106,327	146,444	186,533	369,546	546,652	788,585	1,083,740	1,369,657
Cantonments	22,068	28,025	35,166	43,509	55,756	6,296	7,824	9,732	12,400	15,875	28,364	35,849	44,898	55,909	71,631
Defence	5,944	7,241	8,796	22,993	40,218	624	729	869	2,365	4,159	6,568	7,970	9,665	25,358	44,377
Total	352,282	511,664	726,220	1,003,798	1,279,098	52,196	78,807	116,928	161,209	206,567	404,478	590,471	843,148	1,165,007	1,485,665

Note:

Per Capita BOD loading: 50 g/capita-d

BOD concentration of non-domestic sewage: 250 mg/l

Table 81.3.3 Quality of Sewage

		2006	2011	2016	2021	2025
Domestic	Quantity (m^3/d)	358,195	510,833	763,628	1,203,292	1,681,304
	BOD Loading (kg/d)	352,282	511,664	726,220	1,003,798	1,279,098
	BOD Concentration (mg/l)	983	1,002	951	834	761
Non Domestic	Quantity (m^3/d)	208,774	315,219	467,704	644,814	826,264
	BOD Loading (kg/d)	52,196	78,807	116,928	161,209	206,567
	BOD Concentration (mg/l)	250	250	250	250	250
Total	Quantity (m^3/d)	566,969	826,052	1,231,332	1,848,106	2,507,568
	BOD Loading (kg/d)	404,478	590,471	843,148	1,165,007	1,485,665
Overall BOD Concentration (mg/l)		713	715	685	630	592

8.1.4 Environmental Quality Standard

Revised National Environmental Quality Standards (NEQS), approved on December 28, 1999 by PEPC (Pakistan Environmental Protection Council), is the latest effluent standard discharged to public water bodies from industrial premises and others. "Effluent" includes treated effluent from sewage treatment plants. Relevant water qualities are shown in **Table 81.4.1**.

Table 81.4.1 Environmental Quality Standard

Parameter	Unit	Standards	
		Into Inland Water	Into Sea
BOD (5 days at 20 degrees C)	mg/l	80	80
COD	mg/l	150	400
Total Suspended Solids	mg/l	200	200
Faecal Coliforms	MPN/100ml	Not applicable	Not applicable

Source: PEPC (Pakistan Environmental Protection Council)

The standards imply that required treatment level is intermediate, not secondary, and that no disinfection is needed.

8.1.5 Design Criteria for Sewerage Facilities

(1) Sewer Network

There are no established design guidelines for sewerage planning in Pakistan. Instead, every consulting firm has its own guidelines for several parameters and applies them in preparing sewerage planning and facility design. Therefore, design criteria for the preliminary design of trunk/branch sewers in this Master Plan are mainly in accordance with Japanese criteria for sewerage facilities design taking the guidelines prepared by the local consulting firms into account. Criteria adopted for design of branch and trunk sewers are shown in **Table 81.5.1**.

Table 81.5.1 Design Criteria for Branch Sewer and Trunk Sewer

Item	Criteria
(1) Design flow	Peak flow (Maximum hourly sewage flow) Peak factor: 1.5
(2) Flow formula Gravity flow	Manning's formula $Q = A \times V$ $V = (1/n) \times R^{(2/3)} \times I^{(1/2)}$ Where Q: Flow rate (m^3/s) A: Flow section (m^2) V: Flow velocity (m/s) n: Roughness coefficient (Manning's n) Manning's n=0.015, for concrete pipe and box culvert R: Hydraulic radius (m) I: Gradient
(3) Depth of flow	Full depth for pipe 90% depth for box culvert
(4) Minimum Velocity	0.8 m/s
(5) Maximum Velocity	3.0 m/s
(6) Diameter of Sewer	Branch Sewer: 10" (254 mm) Sub-main Sewer: 12" to 36" (305 mm to 914 mm) Trunk Sewer: 42" (1000mm) or larger
(7) Pipe materials	Ready-made concrete pipe for gravity sewer Cast iron pipe for pressure main
(8) Diameter of ready-made concrete pipe	For branch sewer 10" (254 mm) For sub-main sewer 12", 15", 18", 24", 27", 33", 36" (305, 381, 457, 610, 686, 838 and 914 mm, respectively) For trunk sewer 42", 48", 54", 66", 72'' and 84" (1070, 1220, 1370, 1680, 1830 and 2130 mm, respectively) Concrete pipes of these diameters are produced at a factory in Karachi. Box culvert will be adopted when large diameter of more than 84'' is required

Branch sewers and sub-main sewers in the table are defined as those that collect sewage from houses and other premises and convey the collected sewage to trunk sewers and nallahs/drains that flow into sewage treatment plants with diameters not exceeding around 1,000 mm.

(2) Pumping Station

Pumping stations relevant to trunk sewer line such as Clifton Pumping Station are considered in this Master Plan. Criteria adopted for preliminary design of these pumping stations are shown in **Table 81.5.2.**

Table 81.5.2 Design Criteria for Pumping Station

Item	Criteria
(1) Design flow	Peak flow (Maximum hourly sewage flow) Peak factor: 1.5
(2) Standby pump capacity	50 % of peak flow
(3) Screen facility	Bar screen, spacing of less than 20 mm
(4) Type of pump equipment	Conventional type (NOT submergible type) Pumps are supposed to be installed outside the sump because they are large scale ones.
(5) Constituent of pump equipment	A number of pumps of the same medium capacity will be installed for easier operation/maintenance and extension.
(6) Friction loss at pressure main	Hazen-Williams formula $h = 10.666 \times (Q/C)^{1.85} \times D^{-4.87} \times L$ Where h: Friction loss (m) Q: Flow rate (m^3/s) C: Velocity coefficient (110, for cast iron pipe) D: Pipe diameter (m) L: Pipe length (m)
(7) Specification of pump equipment a) Pump diameter	$D = 146 \times (Q/V)^{0.5}$ Where D: Pump inlet/outlet diameter (mm) Q: Flow rate (m^3/m) V: Velocity (= 1.5-3.0 m/s)
b) Motor power	$P = (0.163 \times \gamma \times Q \times H / \eta) \times (1+\alpha)$ Where P: Motor Power (kW) γ: Specific Weight Q: Discharging flow (m^3/s) H: Pump head (m) η: Pump efficiency α: Allowance of motor power

(3) Sewage Treatment Plant

Three existing sewage treatment plants were designed so as to meet the effluent standard of BOD of less than 80 mg/l as stipulated by NEQS. The standard is not always met for the time being. It is needless to say that the current standard has to be met all the time at every sewage treatment plant to begin with until the target year of 2025. Next step might require more stringent effluent standard to restore the beautiful beaches of the Arabian Sea, which will be discussed in the course of the implementation of the Master Plan to propose.

As discussed in **Section 8.1.4**, the effluent standard stipulated by NEQS does not require secondary level for sewage treatment. Intermediate treatment level that gives effluent BOD concentration of less than 80 mg/l will be applied.

Three existing sewage treatment plants have applied either high rate trickling filter process (TP-1 and TP-2) or waste stabilization pond system consisting of anaerobic and facultative ponds (TP-3). When extension and/or replacement of existing plants is needed, the process currently applied will be applied in respective plants within the site area constraints taking the less energy consumption and treatment efficiency of these processes into account. Either of these two processes will be applied to new treatment plants to construct, if any, within the site availability.

Since the influent BOD concentration is calculated to be as high as 600 mg/l in the future, ordinary biological treatment processes need some pre-treatment. Anaerobic pond system is applied in TP-3 prior to facultative pond, but the system cannot be applied to other TPs taking its longer retention time of 1.4 days resulting in large site area requirement into account. Instead, Upflow Anaerobic Sludge Blanket (UASB) system is recommended as pre-treatment

facility.

As for TP-1 and TP-2, the present high rate tricking filter facility will be rehabilitated and operated within its life span and treatment facilities will be extended as the sewage flow increases along with the addition of UASB to lower influent BOD. Either high rate trickling filter process or the waste stabilization pond system consisting of anaerobic and facultative ponds will be applied depending on sewage flow and site availability in new and extended treatment plants.

Anaerobic pond or UASB is expected to reduce influent BOD concentration of 600 mg/l to 300 mg/l or the removal efficiency of 50 %. The main part of treatment process of facultative pond or high rate trickling filter is expected to further reduce BOD concentration to 80 mg/l which meets the effluent quality standard stipulated in NEQS.

If the land allotted for a sewage treatment plant site is not large enough to adopt waste stabilization pond system or high rate trickling filter system, activated sludge process might be adopted following the UASB.

Table 81.5.3 summarizes influent/effluent qualities and treatment efficiencies on BOD basis of these processes.

Table 81.5.3 Influent and Effluent Qualities of Three Processes

Name of process	Influent BOD (mg/l) to the process	Effluent BOD (mg/l) to the process	BOD removal efficiency At the process (%)
UASB + High rate trickling filter			
UASB	600	300	50
High rate trickling filter	300	80	74
UASB + Activated Sludge Process			
UASB	600	300	50
Activated Sludge Process	300	80	74
Waste Stabilization Ponds			
Anaerobic pond	600	300	50
Facultative pond	300	80	74

The design criteria of waste stabilization pond, no matter whether it follows anaerobic pond or not, is not fully established and its design will follow the criteria applied to the existing TP-3. As for high rate trickling filter and relevant settling tanks, design guidelines of Japan are referred to in terms of hydraulic loading, BOD volumetric loading and overflow rate.

Table 81.5.4 summarizes design parameters of UASB, high rate trickling filter process (consisting of primary settling tank, trickling filter and secondary settling tank), anaerobic pond and facultative pond.

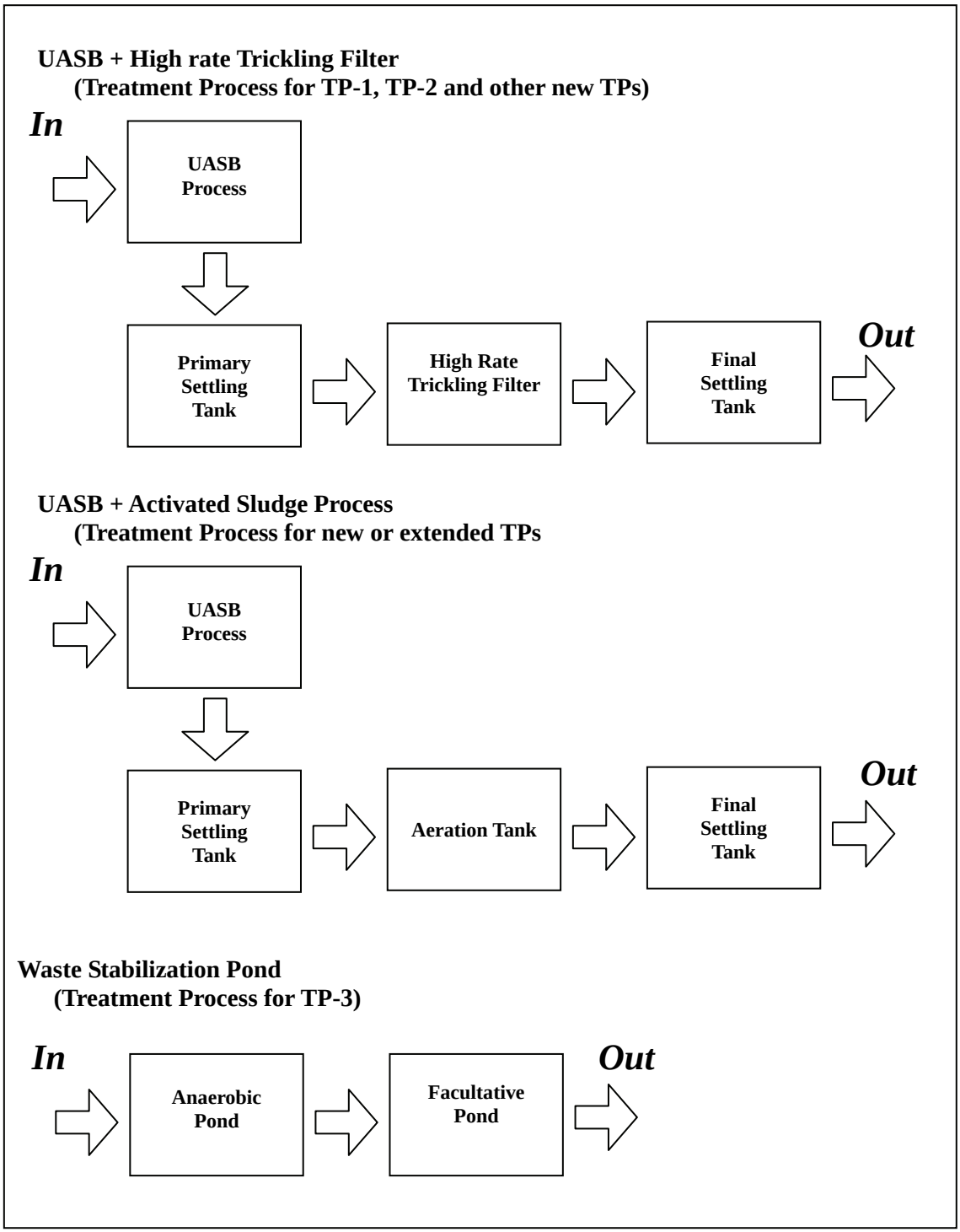

Figure 81.5.1 Schematic of Wastewater Treatment Processes

Table 81.5.4 Design Parameters of Unit Processes of Three Sewage Treatment Processes and Sludge Treatment Process

Name of unit process	Design parameter	Dimension and others
UASB + High Rate Trickling Filter		
UASB	Retention time of 10 hours	Effective water depth of 6 m
Primary settling tank	Overflow rate of 50 $m^3/m^2/d$	Tank diameter of less than 50 m
High rate tricking filter	Hydraulic loading of 15 $m^3/m^2/d$ BOD volumetric loading of 1.2 $kg/m^3/d$	Filter depth of 1.5 m Tank diameter of less than 45 m
Final settling tank	Overflow rate of 30 $m^3/m^2/d$	Tank diameter of less than 50 m
UASB + Activated Sludge Process		
UASB	Retention time of 10 hours	Effective water depth of 6 m
Primary settling tank	Overflow rate of 50 $m^3/m^2/d$	Tank diameter of less than 50 m
Aeration tank	BOD-SS loading of 0.54 kg/kg/d	Tank depth of 6 m
Final settling tank	Overflow rate of 30 $m^3/m^2/d$	Tank diameter of less than 50 m
Waste Stabilization Pond		
Anaerobic pond	Retention time of 1.4 days	Water depth of 2.5 m
Facultative pond	Retention time of 5.5 days	Water depth of 1.5 m
Sludge Treatment		
Sludge thickening tank	Solids loading of 90 $kg/m^2/d$	Retention time of 12 hours
Sludge drying bed	Sludge thickness of 20 cm	Retention time of 14 days
Belt press filter	Filtration rate of 140 kg/m/h	Belt width of 3 m

Based on the above mentioned parameters, the capacity of each of existing TP-1 and TP-2 is evaluated as 24.2 mgd (110,000 m^3/d). For the details about the evaluation, refer to **Appendix A81.2**.

(4) Sludge Disposal

Dewatered or dried sludge is partly sold and used as soil conditioner at present. The amount of sludge will certainly increase in the future as the sewage generation increases and collection/treatment ratios increase. Taking the value of sludge as fertilizer and soil conditioner into account, it is recommended to sell dewatered sludge as much as possible. The possible profit obtained by selling sludge might lead to the reduction of operation and maintenance costs of sewage treatment plants. For expected sludge use/disposal site in the future, refer to **Appendix A81.3**.

8.2 ALTERNATIVE STUDY

8.2.1 General

Some alternatives are discussed for sewerage systems for inner 15 towns. The total sewage generation in inner 15 towns in 2025 is estimated to be 552 mgd (2,508,000 m^3/d). Compared with the future possible total capacities of three existing TPs of 102 mgd (465,000 m^3/d), around 450 mgd (2,043,000 m^3/d) of treatment capacity will be deficient. Sludge drying beds and unused lands occupy considerable parts of the site areas in TP-1 and TP-2 among three existing TPs. Making effective use of unused land and the conversion of drying beds to mechanical dewatering equipment will help enhance treatment capacities to a greater extent. Except for the site for TP-4 construction in Korangi Creek Cantonment area, little vacant land is available for TP construction within inner 15 towns.

KW&SB implemented an interceptor at the right bank side of Lyari River and the intercepted sewage is treated at TP-3. Lyari interceptor will be extended up to New Karachi Town in the near future. The plan to construct two new interceptors at the both bank sides of Malir River has been established and it is expected to be implemented in the near future.

Three alternatives for sewer district layout are investigated among which the most appropriate one will be selected as the Master Plan. Schematics of these three alternatives are shown in **Figures 82.1.1** to **82.1.3**, respectively. Sewer networks and magnitude of pumping stations and sewage treatment plants needed to implement respective alternatives are discussed below.

Three alternatives are first evaluated in qualitative terms, and costs for respective alternatives are compared and finally the most appropriate alternative is selected.
Alternatives are arranged taking the following prerequisites and constraints into account.

- Treatment level until 2025 targets effluent BOD concentration of 80 mg/l
- The concept of Lyari Interceptor extension and new installation of Malir Interceptor, proposed in S-III, will be duplicated in the Master Plan.
- Existing drains and nallahs are fully made use of as trunk sewers.
- TP-3 site has no room for extension, whereas both TP-1 and TP-2 sites have some extra space for their extension.
- The site of around 160 ha is assured for the construction of TP-4 in Korangi Creek Cantonment area.
- It is extremely difficult to obtain other sites for sewage treatment plant construction within inner 15 towns.

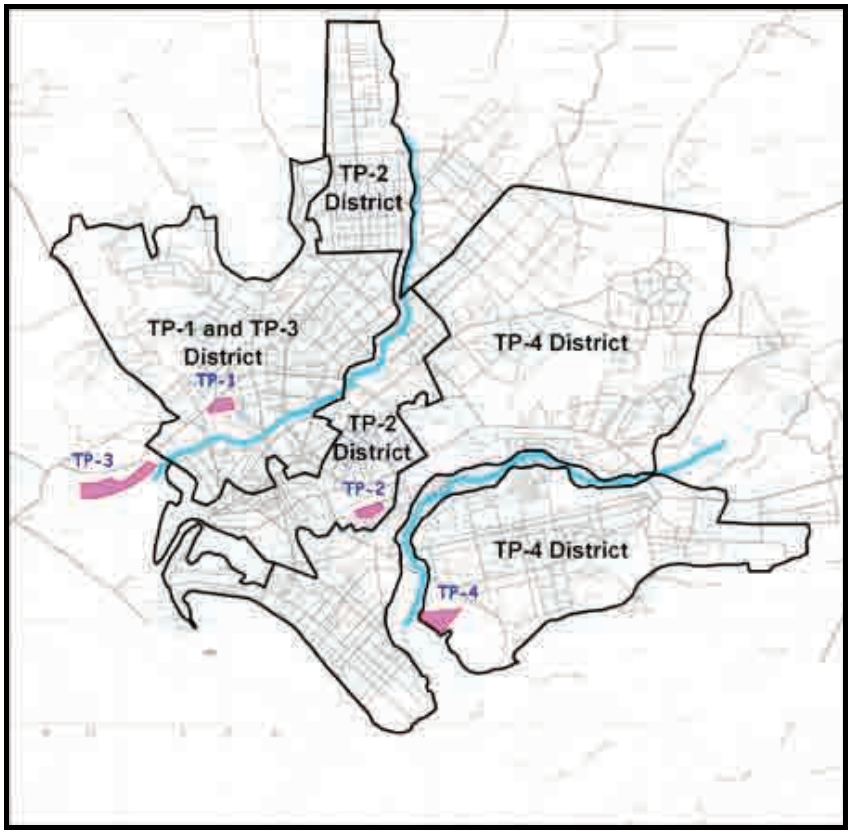

Figure 82.1.1 Schematic of Alternative 1

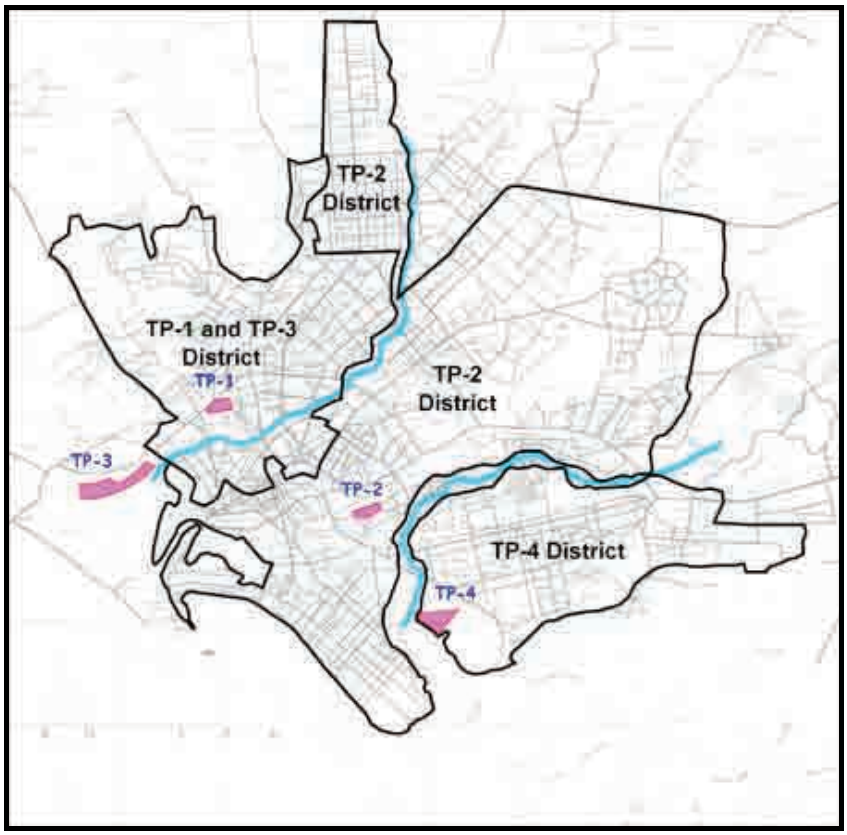

Figure 82.1.2 Schematic of Alternative 2

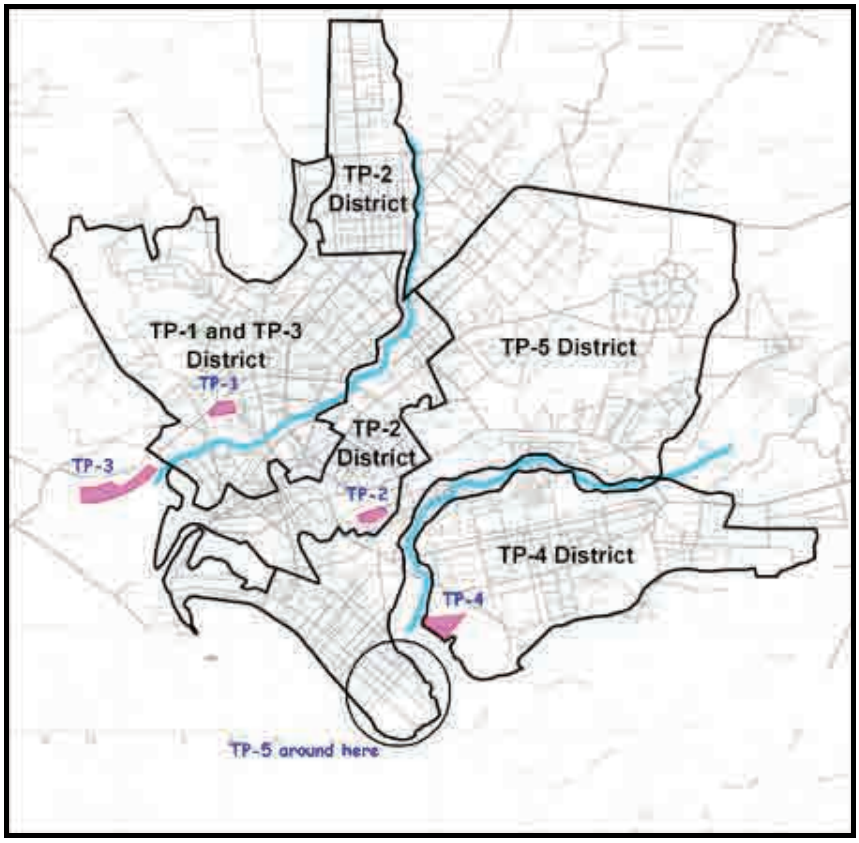

Figure 82.1.3 Schematic of Alternative 3

8.2.2 Description of Alternatives

(1) Alternative 1

Concept

- To cope with the increased amount of sewage through the replacement and extension of existing sewage treatment plants TP-1 and TP-2, and new installation of TP-4.
- To make use of natural configuration of land in which the city is divided by Lyari and Malir Rivers but to allow trunk sewers to cross the river if needed.

Layout

- TP-1 and TP-3 District at the right bank side of Lyari River in principle
- TP-2 District for the upstream area of the right bank side of Lyari River and the down stream area between Lyari and Malir Rivers
- TP-4 District at the upstream of the area between Lyari and Malir Rivers and at the left bank side of Malir River

Trunk Sewer

- Lyari interceptor at the right bank side of Lyari River extended to New Karachi to flow into TP-3
- Newly installed Malir Interceptor at the right bank side of the river flows into TP-4.
- Newly installed Malir Interceptor at the left bank side of the river flows into TP-4.

Pumping Station

- Existing four pumping stations of Jamila, Chakiwara, Clifton, Korangi and new

pumping stations at left bank side of Lyari River, within Karachi Port area and at coast side of Bin Qasim Town (common for all the alternatives)

Sewage Treatment Plant

- To replace and extend TP-1 with the capacity of 110 mgd (500,000 m^3/d)
- To replace and extend TP-2 with the capacity of 108 mgd (490,000 m^3/d)
- The capacity of TP-3 will remain the same as the existing one of 54 mgd (245,000 m^3/d)
- To install new sewage treatment plant of TP-4 with the required capacity of 284 mgd (1,290,000 m^3/d)

(2) Alternative 2

Concept

- To cope with the increased amount of sewage through the replacement and extension of existing sewage treatment plants TP-1 and TP-2 including the adoption of area-efficient activated sludge process and new installation of TP-4
- No Malir River crossing

Layout

- TP-1 and TP-3 District: same as Alternative 1
- TP-2 District for the upstream area of the right bank side of Lyari River and the area between Lyari and Malir Rivers
- TP-4 District for the left bank side of Malir River.

Trunk Sewer

- Lyari Interceptor at the right bank side of Lyari River extended to New Karachi will flow into TP-3.
- Newly installed Malir Interceptor at the right bank side of the river flows into TP-2
- Newly installed Malir Interceptor at the left bank side of the river flows into TP-4

Pumping Station

- One new pumping station within DHA area and the other new one in Jamshed Town both connected to TP-2 in addition to common seven pumping stations mentioned in Alternative 1

Sewage Treatment Plant

- To replace and extend TP-1 with the required capacity of 110 mgd (500,000 m^3/d)
- To replace and extend TP-2 with the capacity of 273 mgd (1,240,000 m^3/d)
- TP-3 will remain the same with existing capacity of 54 mgd (245,000 m^3/d)
- To install new TP-4 with the required capacity of 119 mgd (540,000 m^3/d)

(3) Alternative 3

Concept

- To cope with the increased amount of sewage through the replacement and extension of existing sewage treatment plants TP-1 and TP-2, and new installation of TP-4 and TP-5.
- To make use of natural configuration of land in which the city is divided by Lyari and Malir Rivers

Layout

- TP-1 and TP-3 District: same as Alternative 1
- TP-2 District: same as Alternative 1

- TP-4 District for the left bank side of Malir River
- TP-5 District in the area between Lyari and Malir Rivers except TP-2 District area

Trunk Sewer

- Lyari Interceptor at the right bank side of Lyari River extended to New Karachi flows into TP-3.
- Newly installed Malir Interceptor at the right bank side of Malir River to TP-5
- Newly installed Malir Interceptor at the left bank side of Malir River flows into TP-4.

Pumping Station

- Same as Alternative 1

Sewage Treatment Plant

- To replace and extend TP-1 with the required capacity of 110 mgd (500,000 m^3/d)
- To replace and extend TP-2 with the required capacity of 108 mgd (490,000 m^3/d)
- TP-3 will remain the same with existing capacity of 54 mgd (245,000 m^3/d)
- To install new TP-4 with the required capacity of 119 mgd (540,000 m^3/d)
- To install new TP-5 with the required capacity of 167 mgd (760,000 m^3/d)

8.2.3 Comparison of Alternatives

Table 82.3.1 compares all the three alternatives. For details about NPV (Net Present Value) shown in the **Table 82.3.1**, refer to **Appendix A82.1**.

Table 82.3.1 Comparison of Alternatives

		Alternative 1 (RECOMMENDED)	Alternative 2 (TP-2 adopts ASP)	Alternative 3 (Additional TP in DHA area needed)
How to accept increased sewage		To replace and extend existing three sewage treatment plants, TPs-1, 2 and 3 To implement new sewage treatment plant TP-4 in Korangi Creek Cantonment area	To replace and extend existing three sewage treatment plants, TPs-1, 2 and 3 To implement new sewage treatment plant TP-4 in Korangi Creek Cantonment area	To replace and extend existing three sewage treatment plants, TPs-1, 2 and 3 To implement new sewage treatment plants of TP-4 in Korangi Cantonment and TP-5 in the south end of TP-5 District or in the other appropriate site.
Geographical considerations		Malir Interceptor (Right bank) crosses Malir River (TP-4 District) Sewage generated at a part of Lyari River left bank is diverted to TP-1 and TP-3 District crossing Lyari River as it is.	Malir Interceptor (Right bank) is connected to TP-2, not crossing Malir River Sewage generated at a part of Lyari River left bank is diverted to TP-1 and TP-3 District crossing Lyari River as it is.	Malir Interceptor (Right bank) goes to TP-5, not crossing Malir River Sewage generated at a part of Lyari River left bank side is diverted to TP-1 and TP-3 District crossing Lyari River as it is.
District Layout		TP-1 and TP-3 District: Right bank side of Lyari River except New Karachi and Gadap, and some part of left side bank of Lyari River (Catchment of two pumping stations of Jamila and Chakiwara) TP-2 District: New Karachi and Gadap in right bank side of Lyari River and a part of area between Lyari and Malir Rivers TP-4 District: Large part of area between Lyari and Malir Rivers and whole of the left bank of Malir River	TP-1 and TP-3 District: Same as Alternative 1 TP-2 District: New Karachi and Gadap in right bank side of Lyari River and whole of area between Lyari and Malir Rivers TP-4 District: Whole of the left bank of Malir River	TP-1 and TP-3 District: Same as Alternative 1 TP-2 District: Same as Alternative 1 TP-4 District: Whole of the left bank side of Malir River TP-5 District: Area between Lyari and Malir Rivers except area of TP-2 District
Schematic of District Layout		**Figure 82.3.1**	**Figure 82.3.2**	**Figure 82.3.2**
Trunk Sewers /Interceptors/ Pressure Main		Some trunk sewers to TP-1 Trunk sewer from New Karachi to TP-2 Pressure main from Clifton PS to TP-2 Lyari Interceptor (Right) to TP-3 Malir Interceptor (Right) to TP-4 crossing Malir River Malir Interceptor (Left) to TP-4	Some trunk sewers to TP-1 Trunk sewer from New Karachi to TP-2 Pressure main from Clifton PS to TP-2 Lyari Interceptor (Right) to TP-3 Malir Interceptor (Right) to TP-2 Malir Interceptor (Left) to TP-4	Some trunk sewers to TP-1 Trunk sewer from New Karachi to TP-2 Pressure main from Clifton PS to TP-2 Lyari Interceptor (Right) to TP-3 Malir Interceptor (Right) to TP-5 Malir Interceptor (Left) to TP-4
Pumping Stations		TP-1 and TP-3 District: Jamila PS, Chakiwara PS TP-2 District: Iqbal PS, Clifton PS (to TP-2) TP-4 District: Karachi Port PS, Korangi PS, Bin Qasim PS	Same seven pumping stations as Alternative 1 and two pumping stations of Jamshed and DHA Jamshed PS to lift up sewage of Malir Interceptor (Right) to TP-2 DHA PS to lift up sewage of DHA area to Clifton PS	Same seven pumping stations as Alternative 1
Sewage Treatment Plants		TP-1(Existing): Replace and extend to 110 mgd (500,000 m^3/d) TP-2 (Existing): Replace and extend to 108 mgd (490,000 m^3/d) TP-3 (Existing): 54 mgd (245,000 m^3/d) as it is TP-4 (New): Construct new 284 mgd (1,290,000 m^3/d) plant	TP-1(Existing): Replace and extend to 110 mgd (500,000 m^3/d) TP-2 (Existing): Replace and extend to 273 mgd (1,240,000 m^3/d) TP-3 (Existing): 54 mgd (245,000 m^3/d) as it is TP-4 (New): Construct new 119 mgd (540,000 m^3/d)	TP-1(Existing): Replace and extend to 110 mgd (500,000 m^3/d) TP-2 (Existing): Replace and extend to 108 mgd (490,000 m^3/d) TP-3 (Existing): 54 mgd (245,000 m^3/d) as it is TP-4 (New): Construct new 119 mgd (540,000 m^3/d) TP-5 (New): Construct new 167 mgd (750,000 m^3/d)
Evaluation	**General**	**Advantages:** Energy saving process such as HRTF and WSP is adoptable in all four TPs. However, mechanical dewatering is adopted fully in TP-1 and TP-2, and partly in TP-4 due to land constraints. Land acquisition for new sewage treatment plants is not required. **Disadvantages:** Additional stretch crossing Malir River for Malir Interceptor (right) is required to divert sewage to new sewage treatment plant TP-4 located at the opposite side of the River.	**Advantages:** No new trunk sewer crossing Malir Rivers is required. Land acquisition for new sewage treatments plant is not required. **Disadvantages:** More efficient process such as Activated Sludge Process with mechanical dewatering has to be adopted in sewage treatment plant TP-2; because the flow to TP-2 exceeds its maximum capacity of 119 mgd (540,000 m^3/d) if High Rate Trickling Filter is adopted. And additional pumping stations are necessary to lift up sewage of Malir Interceptor (Right)	**Advantages:** Energy saving process such as HRTF and WSP is adoptable in all five TPs. However, mechanical dewatering is adopted fully in TP-1, TP-2 and TP-5 due to land constraint. Amount of sludge to be mechanically dewatered is slightly larger than Alternative 1. **Disadvantages:** Land acquisition for new sewage treatment plant TP-5 located in high-class residential lots of DHA area will require cumbersome procedure as well as long time to settle.
	Environmental and Social Aspects	Land acquisition is needed for three new pumping stations (total area of 1.5 ha.)	Land acquisition is needed for five new pumping stations (total area of 2.5ha.) Number of affected people is larger than in case of Alternative 1. TP-2 adopting activated sludge process consumes lots of energy for its operation, which might lead to high risks of sewage flooding in case of power failure.	Land acquisition is needed for new TP-5 (75 ha) and three new pumping stations (total area of 1.5 ha). Number of affected people is largest among three alternatives.
	Net Present Value (NPV) of Construction and O&M Costs for 30 years	**NPV: Rs. 61,500 Million** Its total construction cost and O&M costs are nearly the same as those of Alternative 3. Hence, its NPV is nearly the same as that of Alternative 3.	**Rs. 69,500 Million** Its total construction cost and O&M cost are the highest among the three alternatives. Especially, construction cost and O&M cost of sewage treatment plant TP-2 which adopts activated sludge process and mechanical dewatering are very high.	**Rs.61,600 Million** Its total construction cost and O&M costs are nearly the same as those of Alternative 1. Hence, its NPV is nearly the same as that of Alternative 1.
Conclusion		Its NPV is nearly the same as that of Alternative 3. Energy intensive and high O&M skill requiring process such as activated sludge process is not adopted. Furthermore, no additional land is required. The alternative is judged technically, economically and environmentally viable and is **recommended**.	Activated sludge process consumes high energy and requires sophisticated operation skills. Power failure might cause health risks. Hence, the alternative is not viable from technical, environmental, social and economic view points.	Its NPV is nearly the same as that of Alternative 1, but land acquisition for new sewage treatment plant of TP-5 is inevitable, which needs long time and troublesome procedures and affects largest population. Hence, this alternative is not viable from technical, procedural, environmental and social view points.

8.2.4 Proposed Sewer District Arrangement

Among three Alternatives of 1, 2 and 3, Alternative 1 is judged to be the most viable one for the following reasons.

- By diverting some flow to TP-2, TP-1 can be extended within its site area.
- By diverting some flow to TP-4, TP-2 can be extended within its site area.
- No additional sewage treatment plant is needed except for TP-4 which is indispensable to treat the sewage at the left bank side of Malir River even if the plant does not receive the diverted flow from TP-2.
- The absence of large scale TP-2 with activated sludge process and related trunk sewers/pumping stations will lead to less construction and O&M costs

It is reviewed how to divert the sewage flow in order to solve the insufficient capacities of TPs taking the following points into account.

- To use existing sewers as much as possible
- To try not to divert the sewage flow generated in the areas where trunk sewers already exist.
- To use nallahs/drains as sewers in the areas of Malir Town, Shah Faisal Town, Malir Cantonment and Faisal Cantonment where there are no trunk sewers.
- To construct new interceptors to intercept the sewage collected through nallahs/drains.
- To construct a new sewage treatment plant, TP-4, at the left bank side of Malir River, according to the result of sewage flow diversion as well as to treat the sewage generated at the left bank side of Malir River.

The sewage is to be diverted as shown in **Table 82.4.1**. **Figure 82.4.1** shows the district arrangement.

Table 82.4.1 Outline of Sewage Diversion

Direction of Diversion	Description	Remarks
Crossing Lyari River	The sewage generated in the areas between Lyari and Malir Rivers, covered by Jamila and Chakiwara pumping stations, is currently diverted to the right bank side of Lyari River, which will continue to be applied. The diverted sewage will be treated at TP-3.	Arrow No.1 in **Figure 82.4.1**
	The sewage generated in New Karachi Town and a part of urbanised area of Gadap Town is conveyed by trunk sewers to the left bank side of Lyari River crossing the River. The diverted sewage will be treated at TP-2.	Arrow No.2 in **Figure 82.4.1**
Crossing Malir River, From Right Bank Side To Left Bank Side	Malir Interceptor (right bank side) will cross Malir River and the intercepted sewage will be treated at new TP-4.	Arrow No.3 in **Figure 82.4.1**

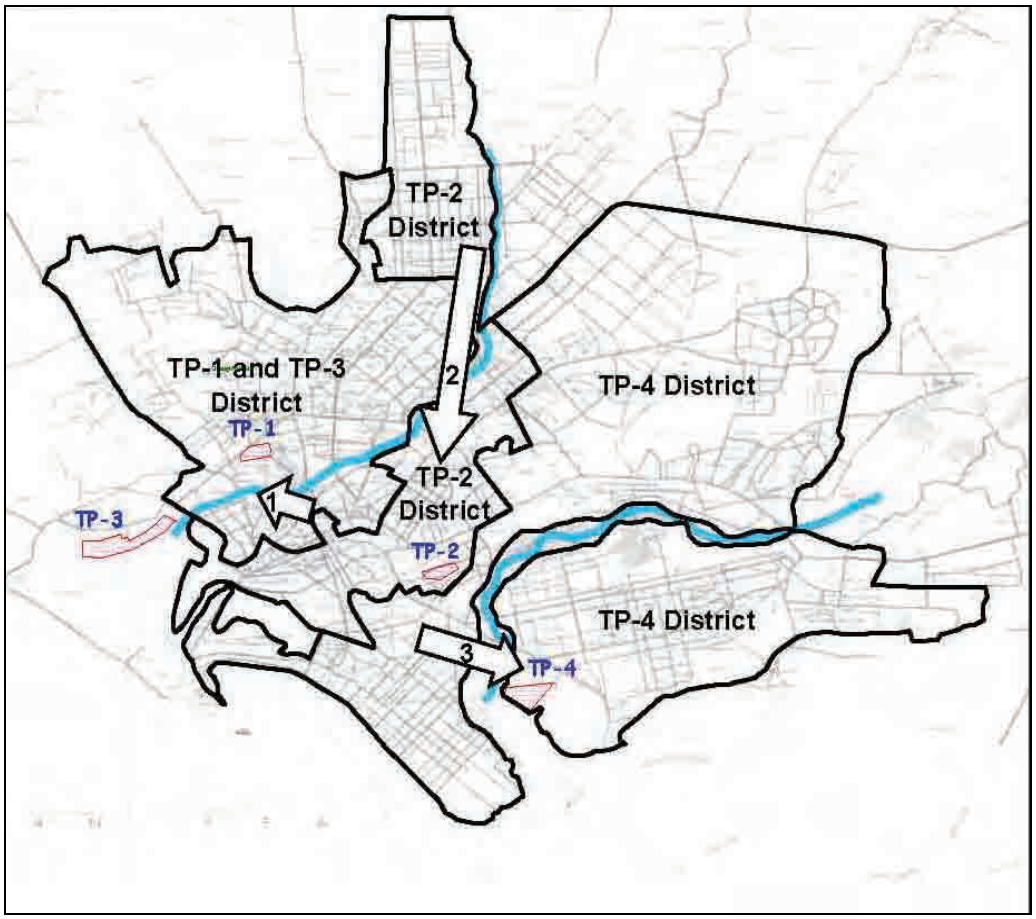

Figure 82.4.1 District Arrangement

New sewer district arrangement established based on above mentioned sewage flow diversion is outlined in **Tables 82.4.2** and **82.4.3**.

Table 82.4.2 Sewer District–wise Populations

	Population (person)				
	2006	2011	2016	2021	2025
TP-1 and TP-3 District	6,522,000	7,015,000	7,606,000	8,297,000	8,849,000
TP-2 District	2,980,000	3,353,000	3,817,000	4,401,000	5,013,000
TP-4 District	5,676,000	6,957,000	8,492,000	10,285,000	11,720,000
Total	15,178,000	17,325,000	19,915,000	22,983,000	25,582,000

	Population in Sewer Service Area (person)				
	2006	2011	2016	2021	2025
TP-1 and TP-3 District	3,314,000	4,435,000	5,906,000	7,458,000	8,849,000
TP-2 District	1,580,000	2,149,000	2,907,000	3,913,000	5,013,000
TP-4 District	2,150,000	3,648,000	5,710,000	8,704,000	11,720,000
Total	7,044,000	10,232,000	14,523,000	20,075,000	25,582,000

Table 82.4.3 Sewer District-wise Sewage Generation in Sewer Service Area

	Domestic Sewage (m^3/d)				
	2006	2011	2016	2021	2025
TP-1 and TP-3 District	172,000	223,800	311,500	439,400	563,500
TP-2 District	79,600	108,400	156,400	239,700	334,200
TP-4 District	106,600	178,600	295,700	524,300	783,600
Total	358,200	510,800	763,600	1,203,400	1,681,300

	Non Domestic Sewage (m^3/d)				
	2006	2011	2016	2021	2025
TP-1 and TP-3 District	58,900	85,800	121,000	145,800	173,800
TP-2 District	45,600	63,800	97,000	117,900	147,300
TP-4 District	104,300	165,700	249,700	381,000	505,200
Total	208,800	315,300	467,700	644,700	826,300

	Total (m^3/d)				
	2006	2011	2016	2021	2025
TP-1 and TP-3 District	230,900	309,600	432,500	585,200	737,300
TP-2 District	125,200	172,200	253,400	357,600	481,500
TP-4 District	210,900	344,300	545,400	905,300	1,288,800
Total	567,000	826,100	1,231,300	1,848,100	2,507,600

For details on population, sewage generation and BOD generation of each Sewer District, refer to **Appendix A82.2.**

8.3 PROPOSED MASTER PLAN

Figure 83.1.1 shows the overall layout of major sewerage facilities of proposed three sewer districts of TP-1/TP-3, TP-2 and TP-4.

8.3.1 TP-1 and TP-3 Districts

(1) General Description

The TP-1 and TP-3 District stretches both bank sides of Lyari River as shown in **Table 83.1.1** and **Figure 83.1.1**.

Table 83.1.1 Overview of TP-1 and TP-3 Districts

	Relevant Towns	Remarks
Right bank of Lyari River	Keamari, SITE, Baldia, Orangi, North Nazimabad, Gulberg, Liaquatabad, Gadap	
Left bank of Lyari River	Saddar, Jamshed	Jamila PS catchment, diverted by pressure
	Lyari, Saddar,	Chakiwara PS catchment, diverted by pressure

Note: Small urbanised parts of Keamari Town and Gadap Town will be included in this district

In TP-1 District, sewage is collected by piped sewers and flows into TP-1, while in TP-3 District the sewage is partly collected by piped sewers but flows into nallahs/drains on its way and finally flows into Lyari Interceptor that is connected to TP-3. These two sewer districts are difficult to geographically separate each other and are discussed together in this section.

The districts include all the towns except New Karachi Town and Gadap Town at the right bank side of Lyari River and drainage areas of two pumping stations of Jamila and Chakiwara. The sewerage system in the areas at the left bank side of the River has been planned together with that at the right bank side, whose concept will be followed in the formulation of the Master Plan.

The right bank side of Lyari River includes the industrial zone of SITE as well as the urbanized area having a large population. The drainage areas of Jamila and Chakiwara pumping stations consist of most densely populated areas in Karachi.

Lyari Interceptor was constructed to intercept nallahs/drains flowing into Lyari River. It currently functions as planned conveying intercepted sewage to TP-3. On the other hand, TP-1 receives the sewage collected by piped sewers. The basic concept how to collect and convey collected sewage in these two districts will remain the same in the formulation of the Master Plan.

Covered area, population and sewage generation of TP-1 and TP-3 District are shown in **Table 83.1.2**.

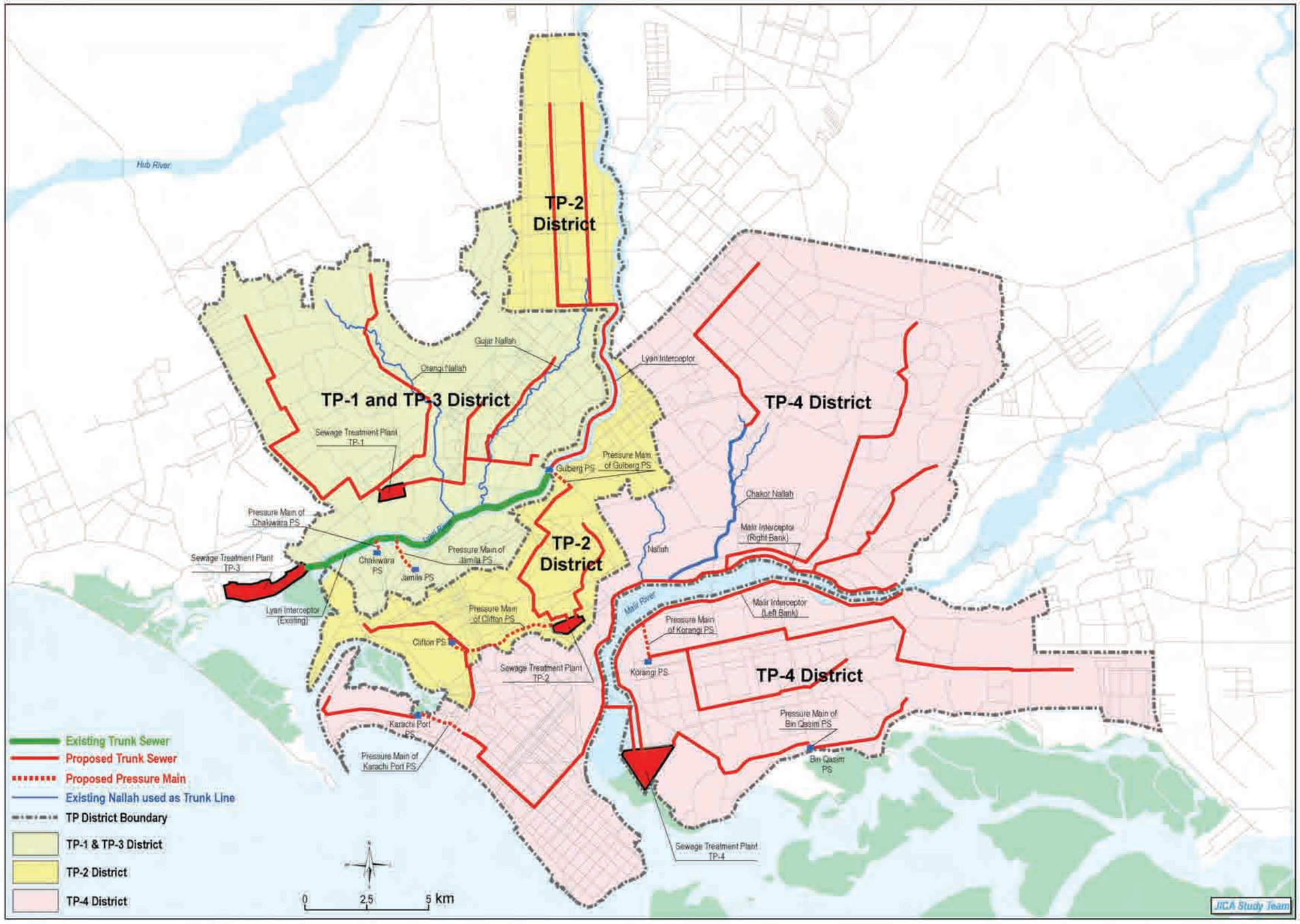

Figure 83.1.1 Layout of Major Sewerage Facilities of TP-1/TP-3, TP-2 and TP-4 Districts

Table 83.1.2 Design Basis of TP-1 and TP-3 Districts

	District Area (km^2)	Population	Sewage Generation (m^3/d)	Sewage Generation (mgd)
Right Bank Side of Lyari	125.4	7,078,000	585,700	128.9
Left Bank Side of Lyari	19.9	1,771,000	151,600	33.4
Total	145.3	8,849,000	737,300	162.3

(2) Trunk Sewer / Nallah, Drain

Existing two trunk sewers of 54" and 66" diameters are connected to TP-1 collecting the sewage generated in North Nazimabad, Gulberg and Liaquatabad Towns at the right bank side of the River. But, flow capacities of these two existing trunk sewers are not enough for future sewage flow. Therefore, new trunk sewers will be proposed in the Master Plan to relieve them.

Two new trunk sewers are planned in the Master Plan to collect the sewage generated in Orangi and Baldia Towns and convey the collected sewage to TP-1. The sewage generated in the district not covered by these new trunk sewers will flow into Lyari Interceptor via existing nallahs/drains and then finally flow into TP-3.

The existing Lyari Interceptor will be extended northeast to New Karachi Town. In the early stage, before 2021, existing Lyari Interceptor and its extended part convey sewage in New Karachi Town and a part of urbanised Gadap Town to TP-3. After 2021, the sewage should be diverted to the opposite side of Lyari River at the south end of extended part of Lyari Interceptor due to increased sewage generation. Therefore, New Karachi Town and the part of urbanised Gadap Town comprise TP-2 District as shown later. Gujjar Nallah, Orangi Nallah and other drains/nallahs will be intercepted by the Interceptor and the sewage flowing in these nallahs/drains will flow into TP-3. The additional flow from these nallahs/drains can be treated at TP-3 within its present capacity.

At present, TP-1 effluent is discharged to a nearby nallah, but it is needed to construct a pipeline or a channel exclusively for effluent discharge in the future when the flow to TP-1 increases. It is envisaged that the effluent discharge channel will be constructed at the time of first extension of the treatment facilities. The conduit will be double box culvert catering for 500,000 m^3/d of average daily flow with the dimension of 2 m by 2 m for each. It will be 2,100 meters long, be directed to the south passing near PS-s and finally flow into Lyari River.

Table 83.1.3 summarizes trunk sewers in TP-1 and TP-3 Districts.

Table 83.1.3 Outline of Trunk Sewers in TP-1 and TP-3 Districts

	Diameter / Size (inch / mm)	Length (m)	Remarks
A. New Trunk Sewer (Right bank side of Lyari River)			
Conduit	42" to 84"	26,300	
Box Culvert	1750mm × 1750mm × 2	11,300	
Sub-total		37,600	
B. New Trunk Sewer (Left bank side of Lyari River)			
Conduit	42" to 54"	5,200	
Sub-total		5,200	
C. Effluent Discharging Channel of TP-1			
Box Culvert	2000mm × 2000mm × 2	2,100	
Sub-total		2,100	
Total		44,900	

For flow calculation of trunk sewers, refer to **Appendix A83.1**.

(3) Branch Sewer and Sub-main Sewer

Table 83.1.4 shows length of branch sewers and sub-main sewers in these two sewer districts. Road length in each town is calculated by multiplying the area of each town by respective road densities. Supposing 97.5% of road length is the length of branch sewers and 4.5% of road length is the length of sub-main sewers, the lengths of branch sewers and sub-main sewers are calculated in each town. Taking coverage rates into account, lengths of existing branch sewers in each town are estimated. If the coverage rate is 80%, branch sewers corresponding to 20% have to be newly constructed. It is supposed that 20% of the existing branch sewers need rehabilitation.

Table 83.1.4 Outline of Branch and Sub-main Sewer of TP-1 and TP-3 Districts

		Right Bank of Lyari River	Left Bank of Lyari River	Total
Area (km^2)		125.4	19.9	145.3
Road Length (km)		2,762	537	3,299
Branch Sewer (km)	Total	2,693	524	3,217
	Existing	1,206	303	1,509
	Rehabilitation (20% of Existing)	241	61	302
	Newly Construct	1,487	221	1,708
Sub-main Sewer (km)	Newly Construct	124	24	148

(4) Pumping Station

1) Jamila Pumping Station

Existing Jamila Pumping Station is located in Saddar Town at the left bank side of Lyari River to convey sewage generated in a part of Saddar Town and Jamshed Town to Lyari Interceptor presently, and will be operated in 2025 as it is.

The required capacity of Jamila PS in 2025 is estimated to be 1.880 m^3/s (at peak) that exceeds the present capacity of 0.910 m^3/s and wet sump, pumps and motors have to be equipped as the flow increases. The existing equipment has been remarkably aged and needs to be replaced.

In 2025, target year of the Master Plan, the collected sewage at this pumping station should be conveyed via a 1,200 mm diameter pressure main of 1,800 m long crossing Lyari River to Lyari Interceptor at the opposite side of Lyari River instead of existing aged pressure main.

Table 83.1.5 outlines Jamila PS.

Table 83.1.5 Outline of Jamila Pumping Station

	Design Flow	Description		
Jamila PS	1.880 m^3/s (112.8 m^3/m) (peak)	Pump	Capacity of Pump	42.3 m^3/m/unit
			Number (on duty)	3
			Number (standby)	1
			Total installed Capacity	169 m^3/m
		Generator	Capacity	500 kVA × 1
		Pressure Main	Diameter	1,200 mm
			Length	1,800 m

2) Chakiwara Pumping Station

Existing Chakiwara Pumping Station is located in Lyari Town at the left bank side of Lyari River to convey sewage generated in most of Lyari Town to Lyari Interceptor presently, and will be operated in 2025 as it is. The required capacity of Chakiwara PS in 2025 is estimated to be 0.752 m^3/s (at peak) that is smaller than the present capacity of 0.972 m^3/s, which means no extension is needed. However, the existing equipment has been remarkably aged and needs to be replaced.

In 2025, the collected sewage at this pumping station should be conveyed via an 800 mm diameter pressure main of 1,400 m long crossing Lyari River to Lyari Interceptor at the opposite side of Lyari River instead of existing aged pressure main.

Table 83.1.6 outlines Chakiwara PS.

Table 83.1.6 Outline of Chakiwara Pumping Station

	Design Flow	Description		
Chakiwara PS	0.752 m^3/s (45.1 m^3/m) (peak)	Pump	Capacity of Pump	16.9 m^3/m/unit
			Number (on duty)	3
			Number (standby)	1
			Total installed Capacity	68 m^3/m
		Generator	Capacity	200 kVA × 1
		Pressure Main	Diameter	800 mm
			Length	1,400 m

(5) Sewage Treatment Plant TP-1

The sewage generation in TP-1 and TP-3 District is estimated to be 162 mgd (737,300 m^3/d) in 2025. Since estimated flow into TP-3 through Lyari Interceptor in 2025 will be 54 mgd (241,900 m^3/d), the rest of the total sewage generation of 108 mgd (495,400 m^3/d) will be treated at TP-1.

It is envisaged that existing facilities of TP-1 will be rehabilitated and functional continuously until 2021. After 2021, these facilities will be demolished due to their life span expiration and construction of new facilities will be required.

TP-1 occupies the site area of around 49 ha that enables the construction of the sewage treatment plant with the capacity of 110 mgd (500,000 m^3/d) within the present site area with mechanical dewatering.

1) Sewage and Sludge Treatment Processes

As discussed in **Section 8.1**, TP-1 will apply high rate trickling filter following UASB process as pre-treatment for reduction of high influent BOD concentration. Sludge will be thickened by gravity thickening tank then be mechanically dewatered due to land constraint for placement of drying beds.

2) Basic Conditions

The facilities of TP-1 are designed based on the basic conditions as shown in **Table 83.1.7**.

Table 83.1.7 Basic Conditions for TP-1

Item	Basic Conditions	
Location	SITE Town	
Area of Site	49 ha (owned by KW&SB)	
Design Sewage Flow	109 mgd (495,400 m^3/d)	
Treatment Capacity	Number of Trains: Capacity per Train: Total Capacity:	6 18.3 mgd/train (83,300 m^3/d/train) 110 mgd (500,000 m^3/d)
Design Sewage Quality	BOD	Influent: 600 mg/l Effluent: 80 mg/l
Effluent Discharge Point	Lyari River via a discharging channel	
Sewage Treatment	Lift pump + Screen/Grit chamber + UASB + Primary Settling Tank + High Rate Trickling Filter + Final Settling Tank	
Sludge Treatment	Gravity Thickening + Dewatering by Machine (100 %)	
Sludge Use/Disposal	Use and/or disposal at planned green area 15 km north of TP-1	

3) Sewage Treatment Facilities

The dimensions of main facilities of TP-1 are calculated based on the above conditions and are summarized in **Table 83.1.8** and layout of the proposed main facilities is shown in **Figure 83.1.2**.

Table 83.1.8 Summary of the Proposed Main Facilities of TP-1

Facilities	Specifications	Remarks
Pump Facility	Capacity of Pump: 96.8 m^3/m/unit	50% standby
	Number of pump (on duty): 6	
	Number of pump (standby): 2	
	Generator: 1,500 kVA × 2	
Screen Facility	Mechanical Screen	
UASB Reactor	100 m (W) × 78 m (L) × 6 m (D) × 6 tanks	
Primary Settling Tank	33 m in dia. × 2 tanks × 6 trains	
Trickling Filter	42 m in dia. × 6 tanks × 6 trains	High rate type
Final Settling Tank	43 m in dia. × 2 tanks × 6 trains	
Sludge Thickening Tank	18 m in dia. × 8 tanks	
Dewatering Machine	140 kg/m/h × (70 units + 8 units for standby)	Belt press filter (Belt Width: 3 m) 7 hour/day, 6 days/week

For process design for TP-1, refer to **Appendix A83.2**.

(6) Sewage Treatment Plant TP-3

The sewage flowing into TP-3 in 2025 is set forth to be 53 mgd (241,900 m^3/d), same as the existing one, because its site area has no room for its extension.

1) Sewage and Sludge Treatment Processes

As discussed in **Section 8.1**, sewage treatment plant TP-3 will apply Wastewater Stabilization Pond Process consisting of anaerobic ponds followed by facultative ponds, the same as the current one. Sludge will be suctioned from anaerobic ponds by pump and then be dried at drying beds, the same as the current one.

2) Basic Conditions

The facilities of TP-3 are designed based on the conditions as shown in **Table 83.1.9**.

Table 83.1.9 Basic Conditions for TP-3 Design

Item	Basic Conditions	
Location	At mouth of Lyari, Mauripur, Keamari Town	
Area of Site	221 ha (owned by KW&SB)	
Design Sewage Flow	53 mgd (241,900 m^3/d)	
Treatment Capacity	Number of Trains Capacity per Train: Total Capacity:	6 Vary with train 54 mgd (245,000 m^3/d)
Design Sewage Quality	BOD	Influent: 600 mg/l Effluent: 80 mg/l
Effluent Discharge Point	Arabian Sea (Swamp Area of Karachi Bay)	
Sewage Treatment	Lift pump + Screen/Grit chamber + Anaerobic Pond + Facultative Pond	
Sludge Treatment	Drying Beds (8.2 ha)	
Sludge Use/Disposal	Use and/or disposal at planned green area 15 km northwest of TP-3	

3) Sewage Treatment Facilities

The dimensions of main facilities of TP-3 are calculated based on the above conditions and are summarized in **Table 83.1.10** and layout of the proposed main facilities is shown in **Figure 83.1.3**.

Table 83.1.10 Summary of the Proposed Main Facilities of TP-3

Facilities	Specifications	Remarks
Main Pump Facility	Capacity of Pump: 127.0 m^3/m/unit	50 % standby
	Number of pump (on duty): 3	
	Number of pump (standby): 1	
	Generator: 1,375 kVA x 1	
Screen Facility	Mechanical Screen	
Secondary Pump Facility	Capacity of Pump: 14.0 m^3/m	50% standby
	Number of pump (on duty): 12	
	Number of pump (standby): 6	
	Generator: 1,375 kVA × 1	
Anaerobic Pond	150 m (W) × 150 m (L) × 2.5 m (D) × 6 trains	
Facultative Pond	150 m (W) × 1,150 m (L) × 1.5 m (D) × 6 trains	Weighted average length
Drying Beds	10.4 ha 140 m (W) × 120 m (L) × 2 beds 180 m (W) × 270 m (L) × 1 bed 180 m (W) × 120 m (L) × 1 bed	

For process design for TP-3, refer to **Appendix A83.2**.

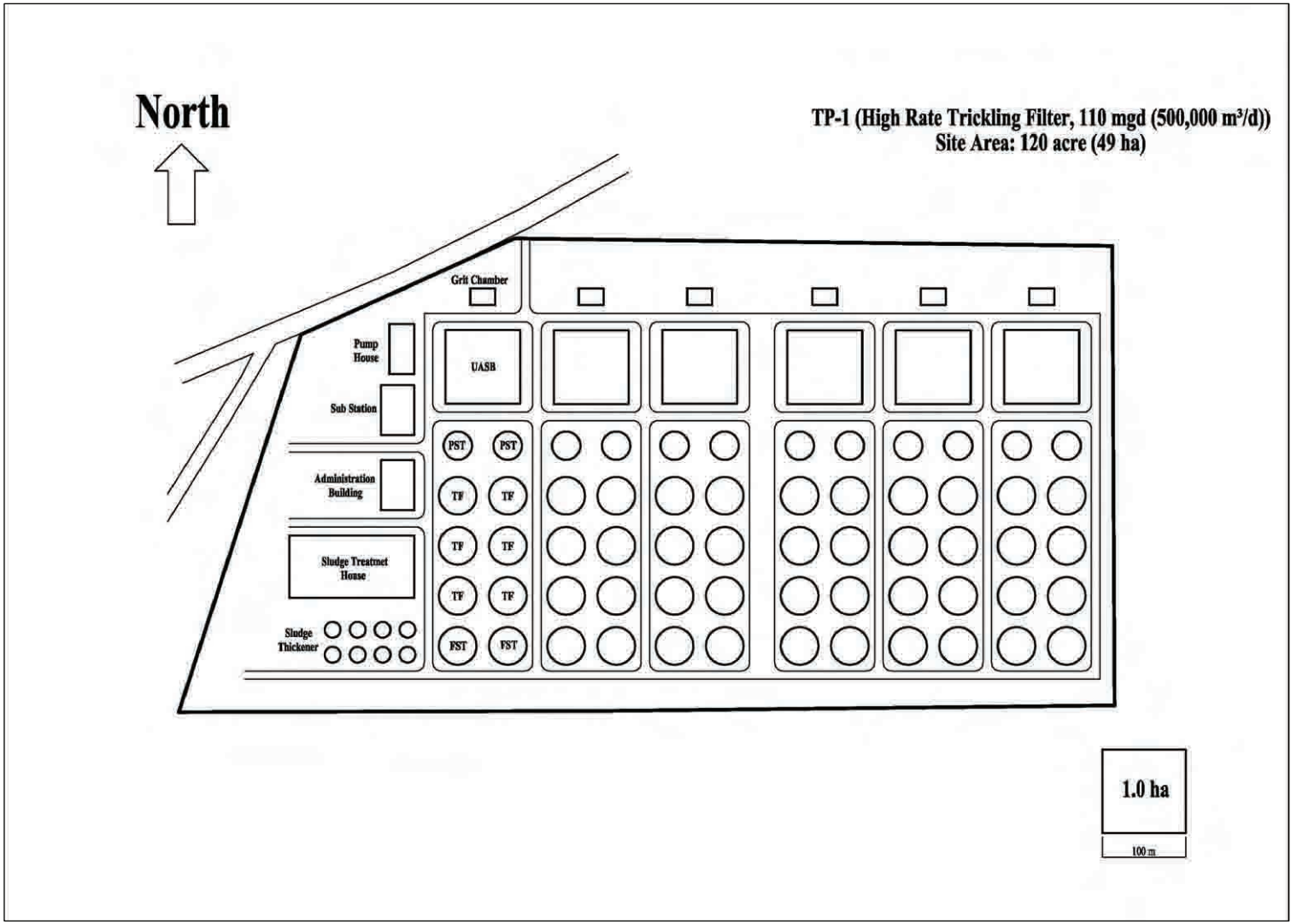

Figure 83.1.2 General Plan of Sewage Treatment Plant TP-1

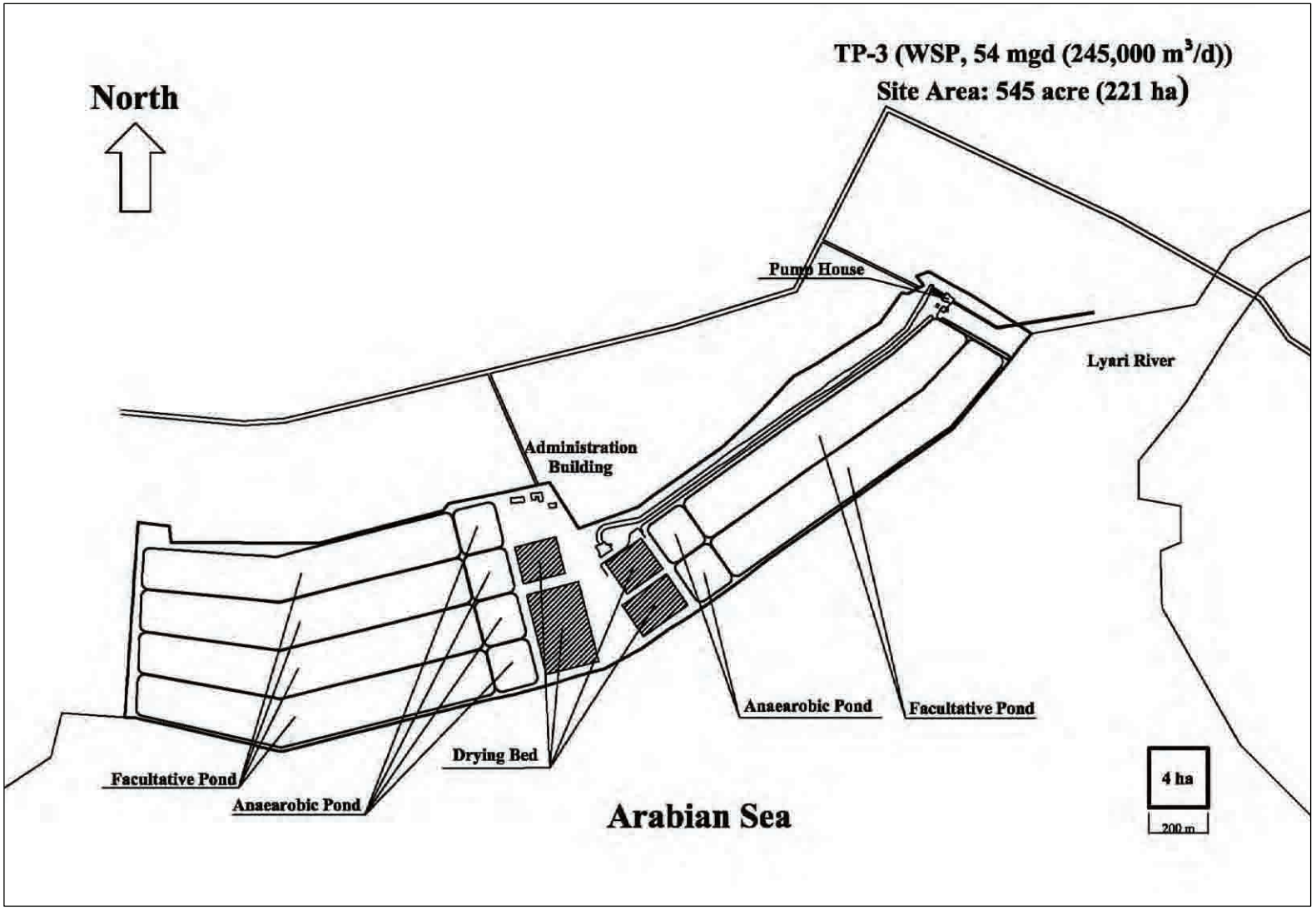

Figure 83.1.3 General Plan of Sewage Treatment Plant TP-3

8.3.2 TP-2 District

(1) General Description

The TP-2 District stretches on both bank sides of Lyari River same as TP-1 and TP-3 District as shown in **Table 83.2.1** and **Figure 83.1.1**.

Table 83.2.1 Overview of TP-2 District

	Relevant Towns	Remarks
Right bank of Lyari River	New Karachi, Gulberg, Gadap	
Left bank of Lyari River	Gulshan-e-Iqbal, Jamshed,	
	Keamari, Saddar, Karachi Cantonment	Clifton PS catchment

Note: Small urbanised parts of Keamari Town and Gadap Town will be included in this district.

The sewage generation in TP-2 District in 2025 will amount to 106 mgd (481,500 m^3/d). Its capacity is 108 mgd (490,000 m^3/d). Covered area, population and sewage generation of TP-2 District are shown in **Table 83.2.2.**

Table 83.2.2 Design Basis of TP-2 District

	District Area (km^2)	Population	Sewage Generation (m^3/d)	Sewage Generation (mgd)
Right Bank Side of Lyari	41.4	2,007,000	145,800	32.1
Left Bank Side of Lyari	59.0	3,006,000	335,700	73.9
Total	100.4	5,013,000	481,500	106.0

(2) Sewer Network / Nallah, Drain

The sewage generated in New Karachi, Gadap, Gulshan-e-Iqbal and Jamshed Town flows into TP-2 through extended stretch of Lyari Interceptor, then lifted up at Iqbal PS to new trunk sewers discharging to TP-2, while the sewage generated in Keamari Town, Saddar Town and Karachi Cantonment flows to Clifton pumping station where the sewage is pumped to TP-2.

Nallahs in Saddar Town currently flowing into Arabian Sea will be intercepted and the intercepted sewage will flow into Clifton Pumping Station. Clifton Pumping Station will convey sewage to TP-2 through pressure main.

At present, TP-2 effluent is discharged to a nearby nallah, but it is needed to construct a pipeline or a channel exclusively for effluent discharge in the future when the flow to TP-2 increases. It is envisaged that the effluent discharge channel will be constructed at the time of first extension of the treatment facilities. The conduit is double box culvert catering for 490,000 m^3/d of average daily flow with the dimension of 2 m by 2 m for each. It will be 3,600 meters long, be directed to the southeast and finally flow into Malir River.

Table 83.2.3 summarizes trunk sewers in TP-2 District.

Table 83.2.3 Outline of Trunk Sewers of TP-2 District

	Diameter / Size (inch / mm)	Length (m)	Remarks
A. Lyari Interceptor (Extension)			
Conduit	84”	9,300	
Sub-total		9,300	
B. New Trunk Sewer (Right bank side of Lyari River)			
Conduit	42” to 66”	16,300	
Sub-total		16,300	
C. New Trunk Sewer (Left bank side of Lyari River)			
Conduit	42” to 66”	14,900	
Box Culvert	3000 × 2000 × 1 and 4000 × 2000 × 1	7,200	
Sub-total		22,100	
D. Effluent Discharging Channel of TP-2			
Box Culvert	2000 × 2000 × 2	3,600	
Sub-total		3,600	
Total		51,300	

For flow calculation of trunk sewers, refer to **Appendix A83.1**.

(3) Branch Sewer and Sub-main Sewer

Table 83.2.4 summarizes branch sewers in TP-2 District. Road length in each town is calculated by multiplying the area of each town by respective road densities. Supposing 97.5% of road length is the length of branch sewers and 4.5% of road length is the length of sub-main sewers, the lengths of branch sewers and sub-main sewers are calculated in each town. Taking coverage rates into account, lengths of existing branch sewers in each town are estimated. If the coverage rate is 80%, branch sewers corresponding to 20% have to be newly constructed. It is supposed that 20% of the existing branch sewers need rehabilitation.

Table 83.2.4 Outline of Branch and Sub-main Sewer of TP-2 District

		Right Bank of Lyari River	Left Bank of Lyari River	Total
Area (km^2)		41.4	59.0	100.4
Road Length (km)		909	1,211	2,120
Branch Sewer (km)	Total	886	1,181	2,067
	Existing	304	664	968
	Rehabilitation (20% of Existing)	61	133	194
	Newly Construct	582	517	1,099
Sub-main Sewer (km)	Newly Construct	41	55	96

(4) Pumping Station

1) Gulberg Pumping Station

Proposed Gulberg Pumping Station should be located near right bank of Lyari River to lift up sewage generated in New Karachi Town and Gadap Town to connection outfall via a 1500 mm diameter pressure main of 1,200 m long. **Table 83.2.5** outlines proposed Gulberg Pumping Station.

Table 83.2.5 Outline of Gulberg Pumping Station

	Design Flow	Description		
Gulberg PS	2.844 m^3/s (170.6 m^3/m) (peak)	Pump	Capacity of Pump	42.7 m^3/m/unit
			Number (on duty)	4
			Number (standby)	2
			Total installed Capacity	256 m^3/m
		Generator	Capacity	750 kVA × 2
		Pressure Main	Diameter	1,500 mm
			Length	1,200 m

2) Clifton Pumping Station

Existing Clifton Pumping Station is located in Saddar Town to convey sewage generated in Saddar Town and Keamari Town. Clifton pumping station is judged to have the sufficient capacity but some rehabilitation is necessary. Also, the pressure main to TP-2 is old and not pressure resistant. It has to be replaced to pressurize the design flow to TP-2 as originally planned.

Design flows to lift by these pumping stations, calculated capacities, requirement of pumps and pressure main for these pumping stations are presented in **Table 83.2.6**.

Table 83.2.6 Outline of Clifton Pumping Station

	Design Flow	Description		
Clifton PS	1.796 m^3/s (107.7 m^3/m) (peak)	Pump	Capacity of Pump	26.9 m^3/m/unit
			Number (on duty)	4
			Number (standby)	2
			Total installed Capacity	162 m^3/m
		Generator	Capacity	500 kVA × 2
		Pressure Main	Diameter	1,200 mm
			Length	4,800 m

(5) Sewage Treatment Plant TP-2

The amount of sewage flowing into TP-2 in 2025 will be 106 mgd (481,500 m^3/d).

It is envisaged that existing facilities of TP-2 will be rehabilitated and functional continuously until 2022. After 2022, these facilities will be demolished due to their life span expiration and new facilities will be constructed.

TP-2 occupies the site area of around 49 ha that enables the construction of the sewage treatment plant with the capacity of 108 mgd (490,000 m^3/d) within the present site area with mechanical dewatering.

1) Sewage and Sludge Treatment Processes

As discussed in **Section 8.1**, TP-2 will apply high rate trickling filter following UASB process as pre-treatment facility to lower high influent BOD concentration. Sludge will be thickened by gravity then be dewatered by machines.

2) Basic Conditions

The facilities of TP-2 are designed based on the conditions as shown in **Table 83.2.7**.

Table 83.2.7 Basic Conditions for TP-2

Item	Basic Conditions	
Location	Jamshed Town	
Area of Site	49 ha (owned by KW&SB)	
Design Sewage Flow	106 mgd (482,000 m^3/d)	
Treatment Capacity	Number of Trains: Capacity per Train: Total Capacity:	8 13.5 mgd/train (61,250 m^3/d/train) 108 mgd (490,000 m^3/d)
Design Sewage Quality	BOD	Influent: 600 mg/l Effluent: 80 mg/l
Effluent Discharge Point	Malir River via a discharging channel	
Sewage Treatment	Lift pump + Screen/Grit chamber + UASB + Primary Settling Tank + High Rate Trickling Filter + Final Settling tank	
Sludge Treatment	Gravity Thickening + Dewatering by Machine (100%)	
Sludge Use/Disposal	Use and/or disposal at planned green area 25 km east-northeast of TP-2	

3) Sewage Treatment Facilities

The dimensions of main facilities of TP-2 are calculated based on the above conditions and are summarized in **Table 83.2.8** and layout of the proposed main facilities is shown in **Figure 83.2.1**.

Table 83.2.8 Summary of the Proposed Main Facilities of TP-2

Facilities	Specifications	Remarks
Pump Facility	Capacity of Pump: 98.5 m^3/m/unit	50% standby
	Number of pump (on duty): 4	
	Number of pump (standby): 2	
	Generator: 1,000 kVA × 2	
Screen Facility	Mechanical Screen	
UASB Reactor	80 m (W) × 71 m (L) × 6 m (D) × 8 tanks	
Primary Settling Tank	28 m in dia. × 2 tanks × 8 trains	
Trickling Filter	36 m in dia. × 6 tanks × 8 trains	High rate type
Final Settling Tank	37 m in dia. × 2 tanks × 8 trains	
Sludge Thickening Tank	18 m in dia. × 8 tanks	
Dewatering Machine	140 kg/m/hr × (68 units + 7 units for standby)	Belt press filter (Belt Width: 3 m) 7 hour/day, 6 days/week

For process design for TP-2, refer to **Appendix A83.2**.

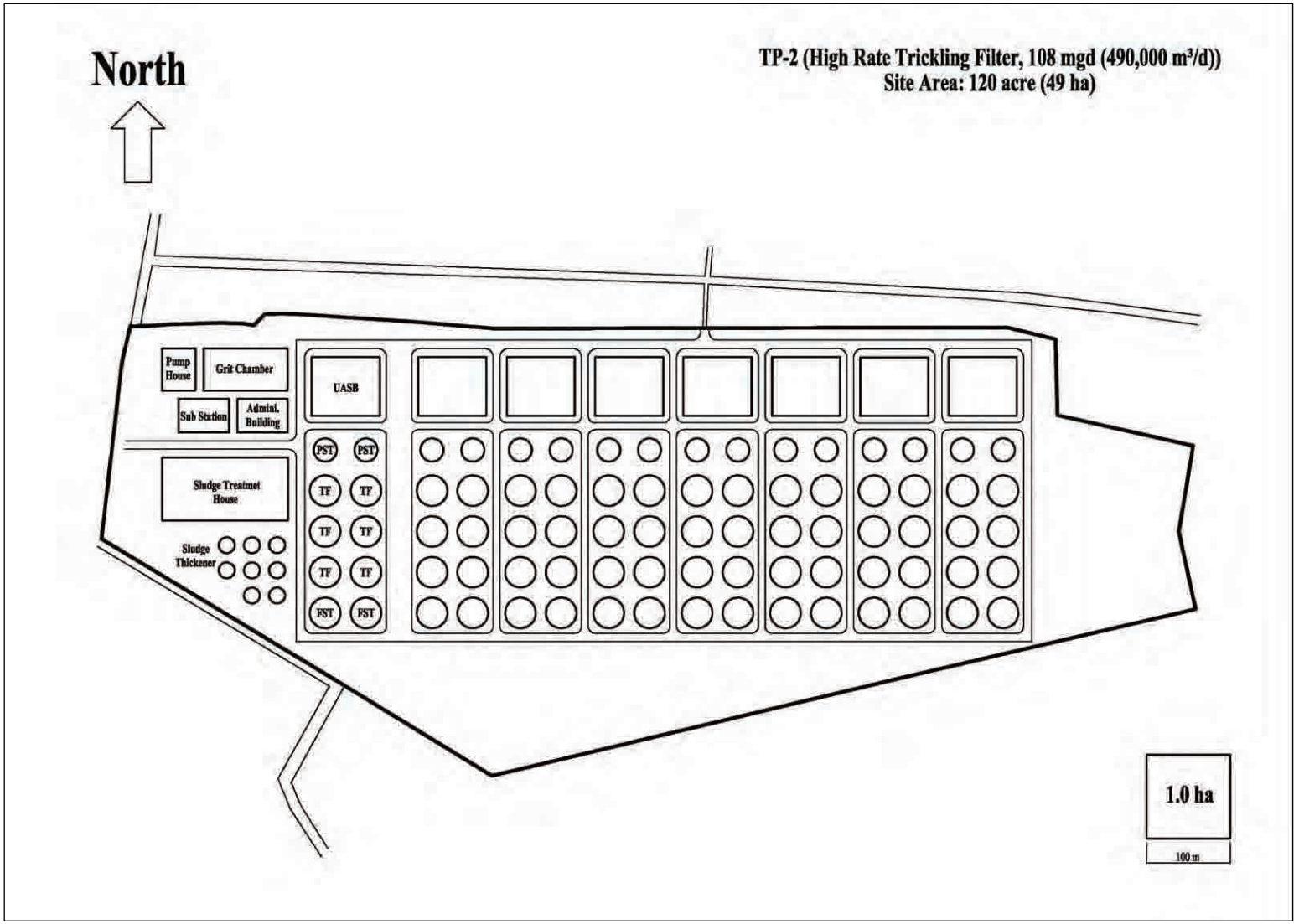

Figure 83.2.1 General Plan of Sewage Treatment Plant TP-2

8.3.3 TP-4 District

(1) General Description

The TP-4 District stretches on both bank sides of Malir River as shown in **Table 83.3.1** and **Figure 83.1.1**.

Table 83.3.1 Overview of TP-4 District

	Relevant Towns	Remarks
Right bank of Malir River	Keamari, Saddar, Clifton Cantonment	Karachi Port PS catchment
	Jamshed, Gulshan-e-Iqbal, Shah Faisal, Malir, Faisal Cantonment, Malir Cantonment	
Left bank of Malir River	Landhi, Korangi, Korangi Creek Cantonment	Korangi PS catchment
	Bin Qasim	Bin Qasim PS catchment

Note: Small urbanised parts of Keamari Town and Bin Qasim Town will be included in this district

The sewage generation in TP-4 District will be 284 mgd (1,288,800 m^3/d) in 2025. Its capacity is 284 mgd (1,290,000 m^3/d).

Covered area, population and sewage generation of TP-4 District are shown in **Table 83.3.2**.

Table 83.3.2 Design Basis of TP-4 District

	District Area (km^2)	Population	Sewage Generation (m^3/d)	Sewage Generation (mgd)
Right Bank Side of Malir	226.1	6,113,000	754,600	166.0
Left Bank Side of Malir	114.1	5,607,000	534,200	117.5
Total	340.2	11,720,000	1,288,800	283.5

(2) Sewer Network / Nallah, Drain

The sewage generated at the upper stream of right bank side of Malir River will flow into Malir Interceptor (right bank side) through Chakor Nallah and other nallahs/drains, cross Malir River and finally flow into TP-4 located at the left bank side of the River. At the same time, the sewage generated at the downstream of right bank side of Malir River flows into Malir Interceptor (right bank side) just before crossing Malir River. Some of the sewage generated in Keamari Town (Karachi Port area) will be lifted up at Karachi Port PS.

Out of the sewage generated at the left bank side of the River, the sewage generated in the northern part of the area will flow into TP-4 through Malir Interceptor (left bank side). The sewage generated in the central part of the area will reach Korangi pumping station where it will be pressurized to Malir Interceptor (left bank side). The sewage generated in the southern part of the area will flow into TP-4 through new trunk sewer and Bin Qasim PS.

Table 83.3.3 summarizes trunk sewers.

Table 83.3.3 Outline of Trunk Sewers of TP-4 District

	Diameter / Size (inch / mm)	Length (m)	Remarks
A. Malir Interceptor (Right bank side)			
Conduit	42" to 66"	7,000	
Box Culvert	2750 × 2000 × 1 to 3500 × 3000 × 2	13,300	
Sub-total		20,300	
B. New Trunk Sewer (Right bank side of Malir River)			
Conduit	42" to 84"	40,000	
Box Culvert	2500 × 2000 × 1 to 3500 × 3000 × 1	6,700	
Sub-total		46,700	
C. Malir Interceptor (Left bank side)			
Conduit	66" to 72"	10,600	
Box Culvert	3500 × 3000 × 1	6,200	
Sub-total		16,800	
D. New Trunk Sewer (Left bank side of Malir River)			
Conduit	42" to 84"	40,400	
Box Culvert	3500 × 2000 × 1	1,600	
Sub-total		42,000	
Total		125,800	

For flow calculation of trunk sewers, refer to **Appendix A83.1**.

(3) Branch Sewer and Sub-main Sewer

Table 83.3.4 outlines branch and sub-main sewers in TP-4 district. Road length in each town is calculated by multiplying the area of each town by respective road densities. Supposing 97.5% of road length is the length of branch sewers and 4.5% of road length is the length of sub-main sewers, the lengths of branch sewers and sub-main sewers are calculated in each town. Taking coverage rates into account, lengths of existing branch sewers in each town are estimated. If the coverage rate is 80%, branch sewers corresponding to 20% have to be newly constructed. It is supposed that 20% of the existing branch sewers need rehabilitation.

Table 83.3.4 Outline of Branch and Sub-main Sewer of TP-4 District

		Right Bank of Malir River	Left Bank of Malir River	Total
Area (km^2)		226.1	114.1	340.2
Road Length (km)		3,390	1,841	5,231
Branch Sewer (km)	Total	3,305	1,795	5,100
	Existing	1,626	641	2,267
	Rehabilitation (20% of Existing)	325	128	453
	Newly Construct	1,679	1,154	2,833
Sub-main Sewer (km)	Newly Construct	153	83	236

(4) Pumping Station

1) Korangi Pumping Station

Existing Korangi Pumping Station located in north-western part of Korangi Town discharges the sewage generated in parts of Korangi Town and Landhi Town into Malir River at present. Its role will be converted to relay pumping station by the target year of 2025 that will pressurize the

sewage to Malir Interceptor (left bank side).
The required capacity of Korangi PS in 2025 is estimated to be 4.817 m^3/s (at peak) that exceeds the present capacity of 0.809 m^3/s and wet sump, pumps and motors have to be equipped as the flow increases. The existing equipment has been remarkably aged and needs to be replaced.

In 2025, the collected sewage at this pumping station should be conveyed via a 2,000 mm diameter pressure main of 1,700 m long to Lyari Interceptor (left bank side).
Table 83.3.5 outlines Korangi Pumping Station

Table 83.3.5 Outline of Korangi Pumping Station

	Design Flow	Description		
Korangi PS	4.817 m^3/s (289.0 m^3/m) (peak)	Pump	Capacity of Pump	72.2 m^3/m/unit
			Number (on duty)	4
			Number (standby)	2
			Total installed Capacity	433 m^3/m
		Generator	Capacity	750 kVA × 2
		Pressure Main	Diameter	2,000 mm
			Length	1,700 m

2) Bin Qasim Pumping Station
Bin Qasim Pumping Station is the one planned in the Master Plan. Bin Qasim Trunk Sewer, also planned in the master Plan along the southern coast of the District, is so long that it will need to lift the sewage before it reaches TP-4.

Design flows considered for these pumping stations, calculated capacities, requirement of pumps and pressure main for these pumping stations are presented in **Table 83.3.6**.

Table 83.3.6 Outline of Bin Qasim Pumping Station

	Design Flow	Description		
Bin Qasim PS	0.999 m^3/s (59.9 m^3/m) (peak)	Pump	Capacity of Pump	22.5 m^3/m/unit
			Number (on duty)	3
			Number (standby)	1
			Total installed Capacity	90 m^3/m
		Generator	Capacity	500 kVA × 1
		Pressure Main	Diameter	900 mm
			Length	400 m

3) Karachi Port Pumping Station
Karachi Port Pumping Station is the one planned in the Master Plan. The sewage of Karachi Port lowland area will be lifted up at this pumping station to the outfall in DHA residential area.

Design flows considered for these pumping stations, calculated capacities, requirement of pumps and pressure main for these pumping stations are presented in **Table 83.3.7**.

Table 83.3.7 Outline of Karachi Port Pumping Station

	Design Flow	Description		
Karachi Port PS	1.106 m^3/s (66.3 m^3/m) (peak)	Pump	Capacity of Pump	24.9 m^3/m/unit
			Number (on duty)	3
			Number (standby)	1
			Total installed Capacity	99 m^3/m
		Generator	Capacity	500 kVA × 1
		Pressure Main	Diameter	1,000 mm
			Length	2,200 m

(5) Sewage Treatment Plant TP-4

TP-4 is a new sewage treatment plant to include in the Master Plan. It will be located at the western bank side of Malir River within Korangi Creek Cantonment. Its site area is around 168 ha. The amount of sewage flowing into TP-4 is estimated to be 1,288,800 m^3/d (284 mgd)

1) Sewage and Sludge Treatment Process

As discussed in **Section 8.1**, TP-4 will apply high rate trickling filter following UASB process as pre-treatment for reduction of high influent BOD concentration. Sludge will be thickened by gravity then be dried at drying beds or dewatered by machine due to land constraint.

2) Basic Conditions

The facilities of TP-4 are designed based on the conditions as shown in **Table 83.3.8**.

Table 83.3.8 Basic Conditions for TP-4

Item	Basic Conditions	
Location	Korangi Creek Cantonment area	
Area of Site	168 ha (owned by CDGK)	
Design Sewage Flow	284 mgd (1,289,000 m^3/d)	
Treatment Capacity	Number of Trains: Capacity per Train: Total Capacity:	16 17.7 mgd/train (80,625 m^3/d/train) 284 mgd (1,290,000 m^3/d)
Design Sewage Quality	BOD	Influent: 600 mg/l, Effluent: 80 mg/l
Effluent Discharge Point	Malir River	
Sewage Treatment	Lift pump + Screen/Grit chamber + UASB + Primary Settling Tank + High Rate Trickling Filter + Final Settling Tank	
Sludge Treatment	Gravity Thickening + Drying Beds (26%) or Dewatering by Machine (74%)	
Sludge Use/Disposal	Use and/or disposal at planned green area 25 km northeast of TP-4	

3) Sewage Treatment Facilities

The dimensions of main facilities of TP-4 are calculated based on the above conditions and are summarized in **Table 82.3.9** and layout of the proposed main facilities is shown in **Figure 83.3.1.**

Table 82.3.9 Summary of the Proposed Main Facilities of TP-4

Facilities	Specifications	Remarks
Pump Facility	Capacity of Pump: 111.9 m^3/m/unit	50% standby
	Number of pump (on duty): 12	
	Number of pump (standby): 6	
	Generator: 2,000 kVA × 4	
Screen Facility	Mechanical Screen	
UASB Reactor	90m (W) × 83m (L) × 6m (D) × 16 tanks	
Primary Settling Tank	33 m in dia. × 2 tanks × 16 trains	
Trickling Filter	42 m in dia. × 6 tanks × 16 trains	High rate type
Final Settling Tank	42 m in dia. × 2 tanks × 16 trains	
Sludge Thickening Tank	18 m in dia. × 20 tanks	
Sludge Drying Beds	Effective area: 27.5 ha	
Dewatering Machine	140 kg/m/hr × (136 units + 14 units for standby)	Belt press filter (Belt Width: 3 m) 7 hour/day, 6 days/week
Sludge Use/Disposal	Use and/or disposal at the planned green area 25 km northeast of TP-4	

For process design of TP-4, refer to **Appendix A83.2**.

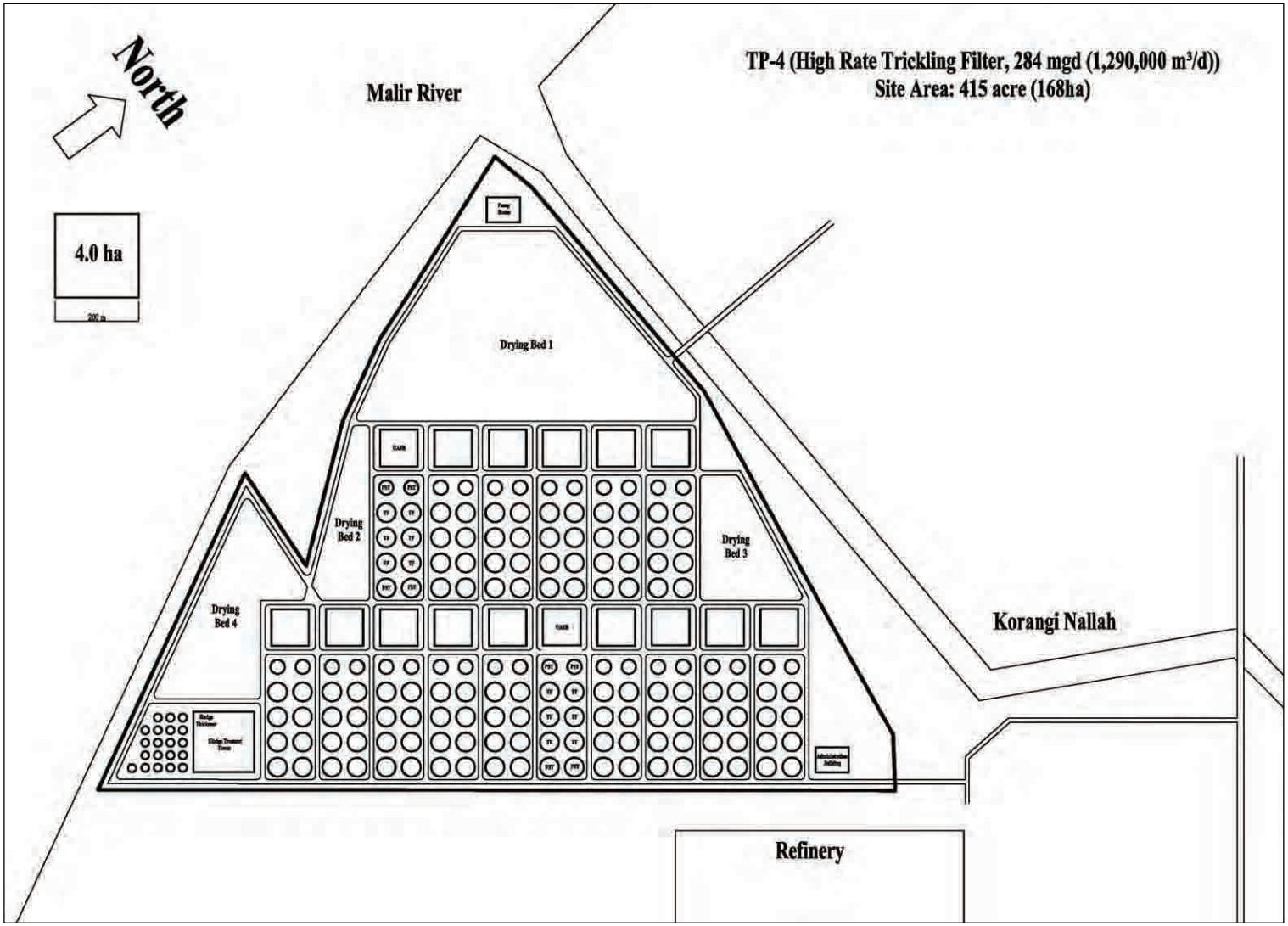

Figure 83.3.1 General Plan of Sewage Treatment Plant TP-4

CHAPTER 9

IMPROVEMENT OF MANAGEMENT SYSTEM

9 IMPROVEMENT OF MANAGEMENT SYSTEM

9.1 INSTITUTIONAL REFORM

Considering the size of the city, population density and the complex nature of its mandated responsibilities, KW&SB has made significant strides in the water and sanitation arena. However, much is still to be done and the role of KW&SB is changing. KW&SB's changing role has been brought about by new priorities set at National and Provincial level with the introduction of new Water, Sanitation and Environmental Policies, Development and Devolution Plans resulting in a major shift in thinking and policy towards a decentralised, people centric and demand responsive approach. This paradigm shift incorporates the principles of:

- Adoption of demand responsive approaches based on involvement, empowerment and full participation in decision making by user groups and beneficiaries
- O&M responsibility by users (beneficiary groups including local bodies, CCB's)
- Shifting the role of government from direct service delivery to that of planning, policy formulation, monitoring and evaluation and partial financial support

The reforms also call for substantial institutional development with regard to services, enhancement of technical and managerial capacity, appropriate forms of public-private partnership, private sector participation, use of information systems etc., to achieve sustainability. Additionally, pricing mechanisms to discourage excessive water use, reduction of leakage and UFW, reuse and recycling of sewage, rainwater harvesting etc; as well as a customer centric approach are advocated.

A diagnostic of the key issues affecting KW&SB are presented in **Table 91.1.1**. These were considered during the 'organisation review' conducted during the first and second phases of the JICA Study and have therefore influenced the recommendations, models and strategies in the Master Plan.

Based on the above, it will be necessary for KW&SB to take a more holistic view of the 'water business' in Karachi and to consider the interactions and influences of the various stakeholders that impact KW&SB's operation. These will determine the key 'business drivers' that will need to be developed to ensure that KW&SB meet business and service objectives now and in the future. The aspects described above, therefore, will provide the impetus for reforms.

Based on the above, a summary of the 'key issues' affecting KW&SB can be presented pictorially in **Figure 91.1.1**.

Table 91.1.1 Key Issues Requiring Intervention

Business Activity	Key Issues
Institutional Arrangements	Insufficient sector agency coordination/cooperation Insufficient community coordination/involvement Lack of an 'Integrated Water Resource Management' (IWRM) approach
Utility Management	Lack of adequate regulation (Water Bye Laws) Lack of monitoring/enforcement of existing regulation Insufficient capacity (HR/management expertise) Lack of capacity (IS/IT/workflow systems) Lack of strategy, policy, process development Lack of Process and Performance Management (example UFW reduction, energy and process chemicals efficiency, plant utilisation, labour efficiency, billing/revenue efficiency etc.) Insufficient project management skills and tools for control
Community Participation/Management	Community participation not an accepted approach No formal structural arrangements for dealing with user/beneficiary groups such as NGO's, CCB's
Spatial Planning and Demographic	Fast growth of population – demand outstrips supply Poor compliance with mandated supply coverage
Resources	Insufficient funds/financing to meet current/future demands for services Lack of project and financial control measures Tariffs not based on full cost recovery Poor billing/revenue practices and performance Insufficient pricing mechanisms to regulate/conserve water Lack of sustainable practices/care for the environment/regulatory enforcement
Political Interference	Lack of financial and management autonomy Political influence on infrastructure projects and priorities and day-to-day management activities
Socio-Economics	Low and irregular incomes of a large part of the customer base, resulting in low capacity to pay for services Debt/disconnection policy not addressing underlying problems
Communication, Information and Education	Limited communications, consultation, involvement and public relations activities Lack of awareness campaigns/outreach programmes Low public enlightenment to report problems, water use efficiency and bill settlement (especially Local Bodies)
Operation & Maintenance and Service Provision	Contaminated/depleting (usable/accessible) water sources Low service levels/insufficient water supply and lack of sanitation services, insufficient infrastructure to meet demand Poor quality of water delivered High levels of leakage and NRW Lack of O&M strategy and planning Lack of planned preventative maintenance and supply chain management

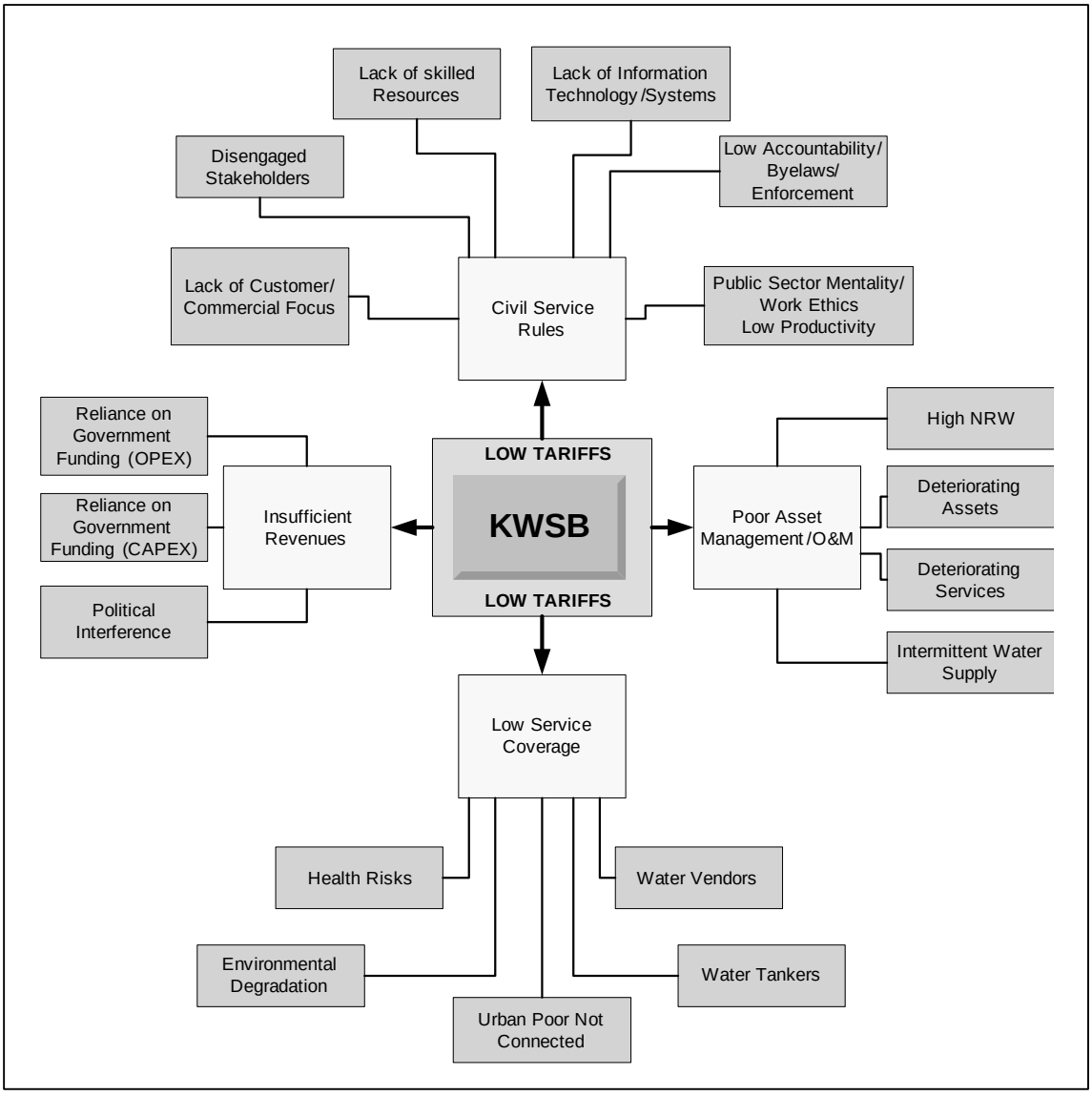

Figure 91.1.1 Problems in a 'Nutshell'

9.1.1 Strengths and Weaknesses of Current Institutional Arrangements

Based on the foregoing and on discussions with senior GOS officials and KW&SB staff as well as a review of documentation relating to current organisation arrangements, practices and procedures, the following organisation strengths and weaknesses have been identified.

Strengths

KW&SB's workforce and management are technically competent and capable of delivering operational and service improvements. Staff are generally well experienced and exhibit a degree of personal motivation despite obvious constraints brought about by limitations in organisational development, customer and operational systems and budgets. Managers are generally enthusiastic about the organisation and many have significant experience within the sector. Staff members are loyal to the organisation and many are knowledgeable about the processes in which they are involved. Financial support continues to be provided to KW&SB from the GOS despite disappointing operational and commercial performance.

Weaknesses

Potential weaknesses with recommendations for mitigation are detailed in **Table 91.1.2**.

Table 91.1.2 Organisational Weakness with Recommendations for Mitigation

Symptom	Recommendations for Mitigation
Lack of clearly defined strategic intent and how this links into individual, team and departmental performance.	Review the strategic intent, vision and mission statement and share these with the entire workforce. This includes the need to prepare and share a KW&SB-wide Corporate Business Plan. Performance targets should be set and measures put in place so that individual and departmental performance supports corporate objectives.
Lack of clearly defined Corporate Strategies.	Define corporate needs and prepare/share strategies with entire workforce. This includes the need for a strategy for asset planning/asset management and development/ asset acquisition; HRD, Customer Services development, etc.
Lack of clearly defined corporate policies and departmental business plans.	Define and share company wide and departmental policies and business plans with appropriate strategies and objectives to enable future improvements.
Lack of clearly defined Business Strategies (operations, customer, commercial, systems, people etc.)	Define departmental strategies, set and agree goals, key performance indicators, measures and action plans for continuous improvement.
There are no clearly defined mechanisms for 'performance managing' the business	Set up a system of performance management that establishes goals and measures for individuals, teams, departments and KW&SB as a whole. This should be a dynamic system that should change as the organisation develops over time.
The use of technology for future development of the business is not well understood or defined.	Prepare IT/Systems strategies that will meet the future corporate business and operational needs.
There are skill gaps in the organisation – human resource development, performance management, regulatory compliance, customer services, communications, corporate and strategic planning, risk management, contingency planning, systems development, community relations and health and safety.	Identify the gaps, train and/or recruit skilled personnel to fill them.
There is no effective job management or work planning system.	Introduce a Job Management System to give better control and information.
Systems for asset management/maintenance are not standardised across functions or departments and the use of computer software or systems to aid asset management/maintenance are not established.	Introduce appropriate technology for the effective management and maintenance of company assets.
Business critical processes are not well defined or 'owned'. For example, Agency Coordination/Government Liaison, Regulatory Compliance, Customer Services, Commercial management, Systems Development, HRD, H&S, Water Quality Management, Supply Chain Management, Operations & Maintenance Management etc.	Define, map and disseminate process routines. Assign key processes to owners or champions. Define and share key policies, strategies and procedures within each process area.
Work routines are generally not recorded to agreed quality standards and a process for sharing best practice is not established.	Codify work practices capturing best practice. Set up training and procedures to ensure the routines are adhered to. Encourage sharing of best practice on a formal basis by service level agreements across process boundaries.
Management information is inadequate and KW&SB struggles to provide any meaningful data to assist with the management of the organisation.	Establish the needs, design and introduce a meaningful MIS. Train staff in the use of the system.
KW&SB have aspirations to improve customer	All employees should be encouraged to 'think customer',

Symptom	Recommendations for Mitigation
services, however, does not demonstrate a commitment to being a customer service driven organisation.	internal and external. Structures need to be geared towards providing customer focus. Recording rather than solving complaints is not enough. Training on customer awareness and customer care should be provided to all existing and new employees.
Customer communication routes require development, including customer feedback.	Develop and agree a customer communications strategy to ensure customers are aware of services, performance against standards and opportunities for feedback. This will enable KW&SB to tailor services to meet changing customer perceptions.
Indications are that KW&SB are not fully utilising Human Resources in terms of efficiency levels as well as numbers of staff employed.	Implement new policies and procedures for staff appraisals, training, development and transfers. Introduce a system of 'succession planning' to ensure the organisation is 'equipped' with competent future leaders.
KW&SB has an aging workforce many of whom have worked for the organisation for many years. Ability to transfer knowledge is being lost.	The age profile will adjust if older employees are released and a programme of recruiting graduates and technicians is introduced. Ensure routines are in place for capture and transfer of knowledge. Ensure a system of equitable career progression based on ability to do the job as well as seniority.
Communications within KW&SB could be improved. There appears to be no mechanism for corporate messages to be cascaded throughout the organisation or for employees to give feedback.	Introduce a fully integrated communication strategy, including written communications, management and team meetings, toolbox talks etc. Feed back loops must be introduced to ensure the views of the workforce are known.
The culture within KW&SB is reactive rather than proactive.	Improve the planning processes and encourage managers and employees to consider the longer term and encourage initiatives for change.
H&S is not well understood or managed.	Assign responsibility for and set up a central H&S support function to ensure compliance with legislation and best practice. Ensure safe systems of work are introduced and that staff are well trained.

Whilst there appears to be a significant number of issues requiring consideration, with the right support from KW&SB's senior management team, each issue creates an opportunity for improvement and therefore, the aspects described above provides the 'imperative for change'. Based on the above, a summary of the 'key solutions' can be presented pictorially in **Figure 91.1.2**.

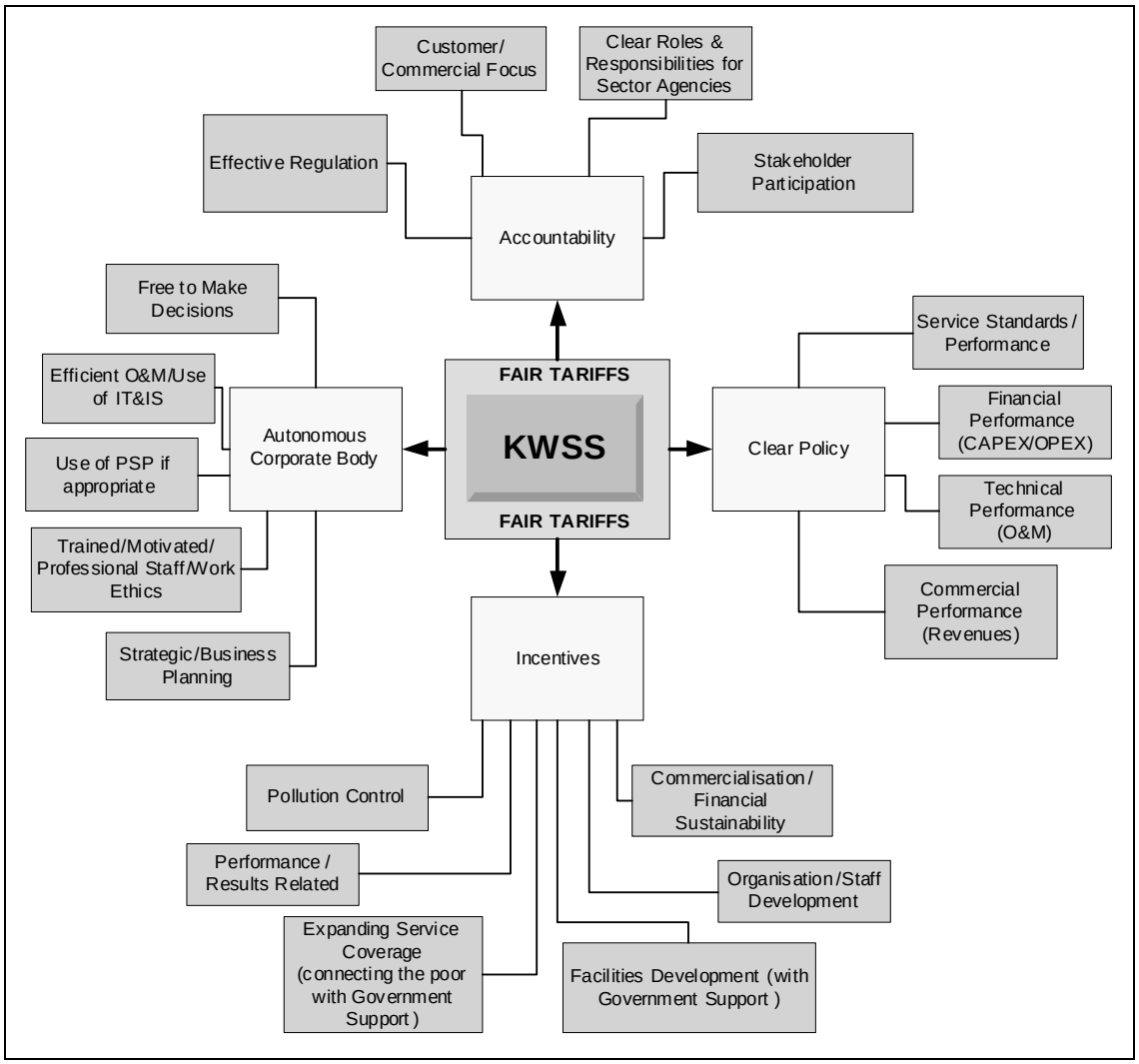

Figure 91.1.2 Solutions in a 'Nutshell'

9.1.2 Formulation of a Long - Term Improvement Plan

Based on discussions it is evident that KW&SB are seeking to become a professional, well-managed, financially autonomous institution which enjoys the high trust and confidence of customers. As a market-based enterprise, KW&SB will want to be responsive to customer demands and have a competent, dynamic and motivated staff. Achieving this will require that strategies are in place for "institutional reforms" as well as "infrastructure improvements".

On this basis, the Master Plan clearly focuses on three distinct aspects:

a) Water supply systems development; concentrating on improving existing water distribution networks (DNI: Distribution Network Improvement)
b) Sewage treatment and sewerage systems development; concentrating on improving and extending existing facilities) and,
c) Institutional reforms; It is this aspect that forms the basis of this section

9.1.3 The Imperative for Change

Based on the organisation review conducted during phases 1 and 2 of the study, it is evident that a 'business as usual' approach is not sustainable. This view is shared by others, including the GOS, KW&SB, and JICA, as well as the WSP and ADB (who have had interaction with KW&SB and CDGK regarding reforms).

The following key sector issues prevail in Karachi:

- Management arrangements for the water and sewerage sector are fragmented
- There is weak cooperation among sector agencies
- The sector is not financially self-sufficient
- There is strong resistance to raising tariffs
- Accounting rules and financial management processes are not consistent with good commercial practice
- There is insufficient focus on asset management/O&M
- There is a lack of customer and commercial focus
- Performance is constrained by civil service rules and work ethics
- There is a lack of strategic and business planning
- There is a lack of regulation and accountability

Based on the above it is clear that KW&SB must embark on a 'change management' or 'reforms programme' that **transforms** the organisation into a customer responsive, professional and commercially viable business. This calls for:

- Institutional and capacity building interventions to develop new skills, competencies, management arrangements, and new ways of working (improved processes and procedures for running the 'business')
- Business and commercial skills, strategic and business planning, with a clear focus on performance management and long term sustainability
- Involvement and consultation with users/communities with a clear focus on customer service provision and access to services for all
- Separation of roles and responsibilities ensuring that 'policy', 'ownership', 'service provision' and 'regulation' are clearly defined and understood

In this context, commercialisation does not equal private sector participation or privatisation. This view has been reinforced quite clearly during discussions held with senior level KW&SB and GOS officials. Rather, it involves implementing 'sound' business principles and practices at all levels of sector management and service delivery.

9.1.4 Reform Examples

There are a number of reform examples in Pakistan, however, little of this relates to the water sector. Reforms with respect to privatisation, deregulation and liberalisation is not a new concept; the government has been pursuing these options enthusiastically since the late 1980's with mixed success. Early on (in the cement sector) it became evident that due to the lack of competition, privatisation created monopolistic practices in terms of price hiking or price fixing by forming cartels which forced the government to create a national Monopoly Control Authority (MCA).

In the electricity sector, private power generators were allowed to start projects in the late 1980's and early 1990's before the National Electric Power Regulatory Authority (NEPRA) was in place. Apart from the banking sector which appears to be well regulated, it would appear that regulatory bodies of other industry sectors [the Pakistan Telecommunications Authority (PTA), the Oil and Gas Regulatory Authority (OGRA) and the Pakistan Electronic Media Regulatory Authority (PEMRA)], are inadequately funded or resourced or have insufficient powers and

capabilities to effectively protect customer interests.

Despite various constraints the Sui Southern Gas Company Limited (SSGS) appears to be a 'shining example' of successful corporatisation in Sindh. SSGS was floated as a Limited Company with 70% ownership by the government and operates (profitably) under commercial principles free from civil service rules and regulations but in compliance with relevant Pakistan Company Law. Whilst they have a representational (imposed government officials) as well as a skills based board, the 'Chief Executive & Managing Director' is able to plan, run and control the organisation on sound commercial principles without undue 'interference' although understandably there will be influence in strategic decisions by the government. We are advocating corporatisation for KW&SB in an attempt to allow them sufficient autonomy to operate under commercial principles, however, this will not work unless effective regulation is in place that clearly defines the roles and responsibilities of the various 'actors'.

In service delivery, as well as in education, health, water/sewerage provision and solid waste management, it would appear that the government are doing little to ensure regulation in a systematic manner. In the water/sewerage sector, therefore, it would appear at least for the time being, that the sector will continue to be effectively 'self regulating' despite the current arrangements of policy pronouncement (water, sanitation and environmental policies), and limited resources and powers afforded to sector agencies such as the Pakistan Environmental Council, the Pakistan Environmental Protection Agency and the Sindh Environmental Protection Agency.

The examples of international practice are shown in **Appendix A91.1**. It is not intended to be an exhaustive list or suggestion of 'best practice', but is intended to illustrate some of the options for institutional reforms already implemented in other parts of the world.

9.1.5 Reform Options

During the Phase 2 stage, the JICA Study team evaluated the four reform options as depicted in **Figure 91.5.1**. After careful evaluation of advantages and disadvantages of each reform option, Option II-A was finally recommended by the JICA Study in its Interim Report dated July 2007. **Table 91.5.1** provides and analysis of some of the key advantages and disadvantages of the four options.

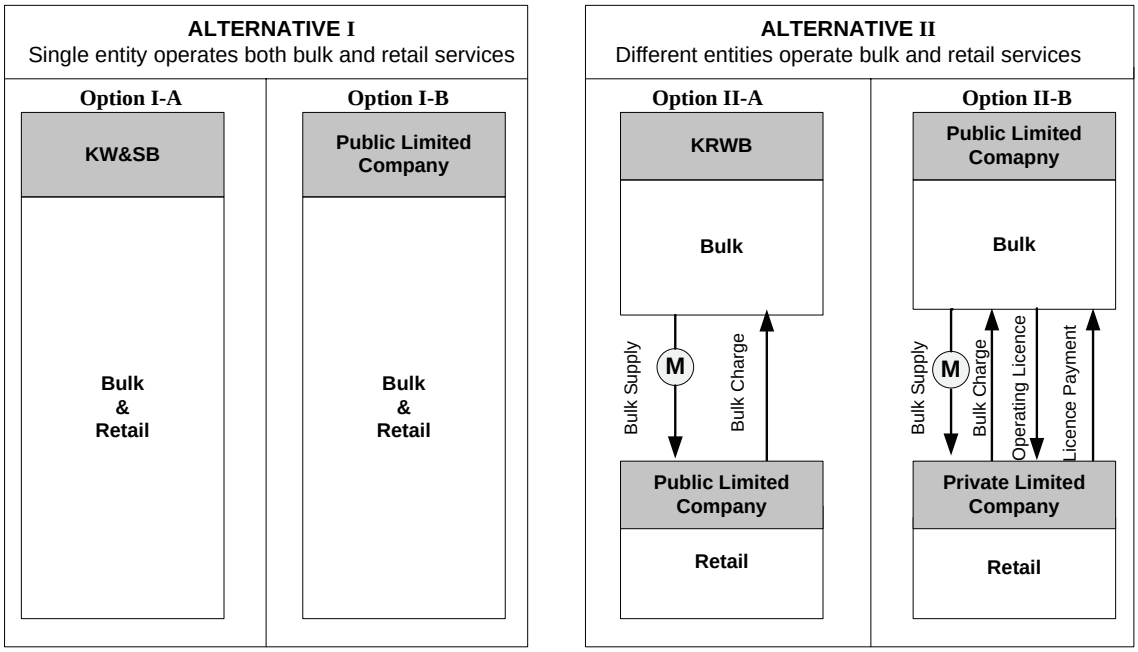

Figure 91.5.1 Alternative Reform Options

Table 91.5.1 Advantages/Disadvantages Associated with Each Reform Option

Reform Option	Advantage	Disadvantage
I-A: Internal Reforms. Bulk and retail services with single entity	▪ Politically less contentious ▪ Less resistance to change from staff ▪ Provides opportunity for business process improvements ▪ Provides opportunity for institutional and capacity building improvements ▪ Improved services through zoning	▪ Lack of role separation ▪ Political interference in day to day operations ▪ KW&SB not free to make management/investment decisions ▪ Reliance on Government subsidies ▪ Politicised tariffs ▪ Lack of managerial/technical/commercial skills ▪ Bulk and retail services with same entity ▪ Institutional strengthening and capacity building interventions take time and may have limited success
I-B: Bulk and retail services with single entity. Corporatised bulk supplier with retail services through zonal Business Units	▪ Separation of roles with clear lines of responsibility for policy, regulation and service provision ▪ Corporate body free to manage on commercial principles ▪ Business units introduces internal competition	▪ Corporatisation may be contentious with staff and/or government ▪ Corporatisation requires a new ordinance and 'articles of association' ▪ Bulk and retail services with same entity ▪ Complicates tariffs and subsidies in balancing the need for full cost recovery in retail services as well as a contribution to recovery of bulk supply assets, whilst ensuring affordability for all for 'essential use'
II-A: Bulk and retail split. Retail services through zonal Corporate Entities	▪ Provides opportunity for business process improvements ▪ Provides opportunity for institutional and capacity building improvements ▪ Improved services through zoning ▪ Separation of roles for policy,	▪ Corporatisation of retail services may be contentious with staff and/or government ▪ Corporatisation requires a new ordinance and 'articles of association'

Reform Option	Advantage	Disadvantage
	regulation and service provision ▪ Bulk and retail services with different entities ▪ Corporatised service providers free to operate within license agreement ▪ Corporatised entities introduces external competition ▪ Financial sustainability for retail service providers working to commercial principles based on full cost recover for improved services	
II-B: Bulk and retail split. Retail services through zonal Private Utilities	▪ Bulk and retail services with different entities ▪ Private utilities free to manage within license agreement ▪ Private utilities introduces external competition ▪ Financial sustainability for retail service providers working to commercial principles based on full cost recover for improved services	▪ Limited separation of roles with policy setting, laws and regulations retained by the Public Authority ▪ Public Authority set-up ties in CDGK with day to day operations ▪ Privatisation of retail services may be contentious with staff and/or government

Option II-A envisages that in the long run the responsibility for providing retail services (water supply and sewerage) would be transferred from KW&SB to 'corporatised' entities on a zone-by-zone basis. Once this process has been completed, KW&SB would be responsible for the management and operation of only the regional bulk water supply system, and, as such, it would need to be renamed , for example, as 'Karachi Regional Water Board (KRWB) as shown in **Figure 91.5.2**. It is envisaged that water supply and sewerage services in Karachi at that time would be managed and operated by three independent public limited companies established in each of the three independent retail service zones. These companies will implement Distribution Network Improvements (DNI) to substantially improve the quality of water supply and sewerage services in their respective retail service zones. Option II-A is described in more details in **Section 9.1.6**.

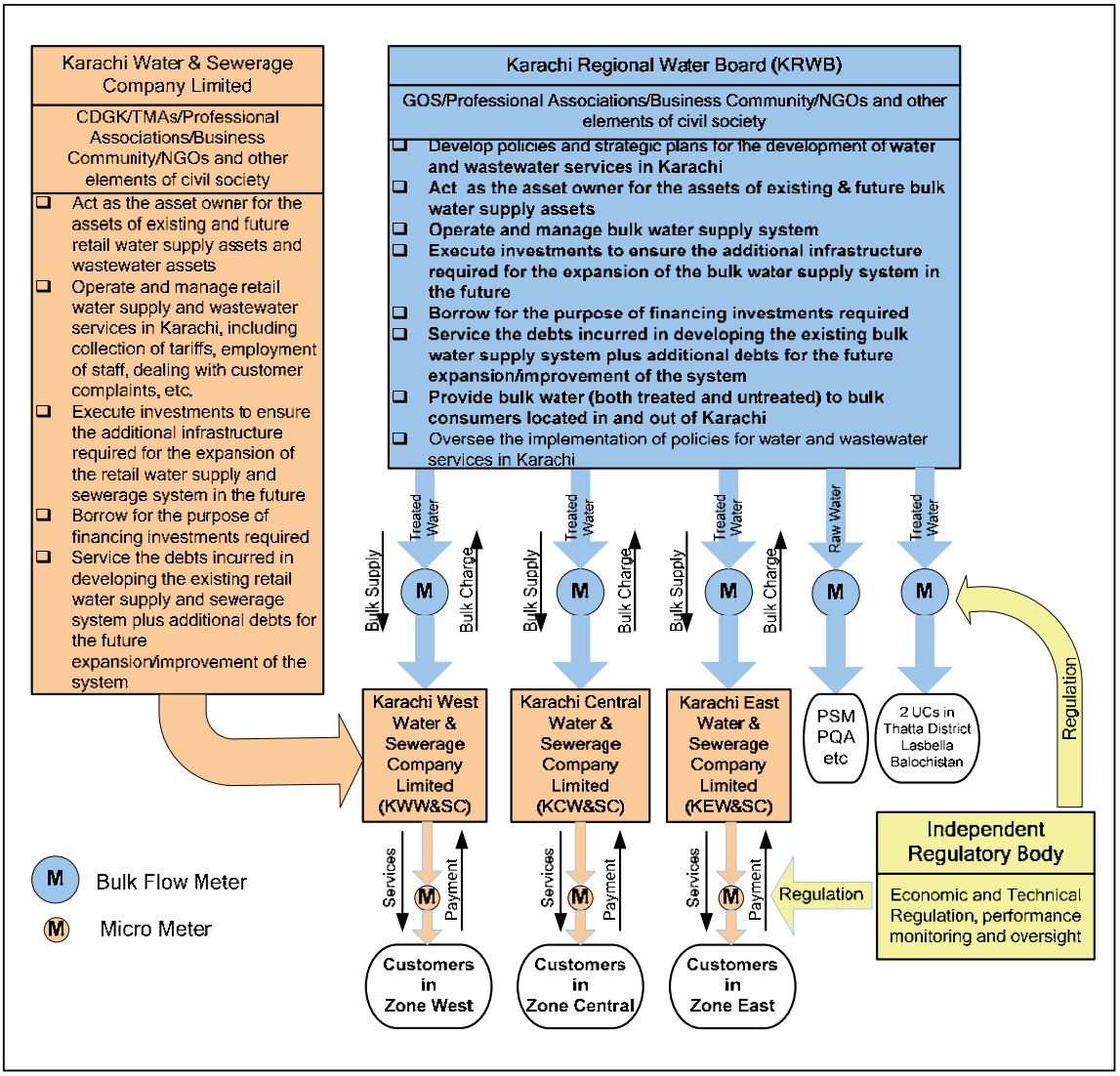

Figure 91.5.2 Details of Option II-A

9.1.6 Institutional Reforms Suggested by JICA Study

In the past, large capital investment works were implemented mostly for the purpose of developing large bulk supply schemes to bring water from distant water sources to Karachi. This has created a huge backlog of replacement, reinforcement and extension in the water distribution system. As a result, many water distribution pipes in the system have already been undersized and deteriorated, and the current levels of leakage and non-revenue water in the distribution system are unacceptably high. In most parts of the urban areas, residents are obliged to spend money on ground-level water reservoirs, suction/booster pumps, roof-top storage tanks, and water filters, and even then water must be boiled prior to drinking. While the basic cost of piped water in Karachi may be cheap, the indirect costs associated with its use are unreasonably high. Many households are compelled to use secondary sources of water such as shallow wells or tanker supplies just to meet their basic needs. In the light of the poor water supply situation, many residents in Karachi have a very negative impression of KW&SB and the service it provides and are therefore reluctant to pay water charges.

It is only if customers are satisfied with the quality of the service they receive that they find themselves willing to pay for the service. The water awareness survey conducted as part of the

JICA study indicated that many households were willing to pay higher charges for a reliable supply of good quality water. With regard to the actual supply of water, the clear targets for the improved quality of the service can be summarized as follows:

- satisfy the customers' water demands so that they no longer need to utilize secondary sources (such as shallow wells and tanker supplies)
- water should be of a potable standard (this would make filtering and boiling of water unnecessary) and be aesthetically pleasing
- water should be supplied at an adequate pressure (this would make the use of suction/booster pumps and roof-top storage tanks unnecessary)
- water should be available on a 24-hour continuous basis to keep the supply system always full of water and under pressure to avoid both contamination and excessive air entrainment (this would make the use of ground-level water reservoirs unnecessary)

These improvements can only be attained through the implementation of Distribution Network Improvements (DNI). DNI will embrace the rehabilitation of water trunk mains and distribution network and the refurbishment of service connections including installation of revenue meters. Where necessary, it will also include improvements to the existing sewerage system. Since DNI would require huge investments and more than 10 years to complete it across all areas of Karachi, it can only be implemented on an area-by-area basis in a progressive way. In the short to medium term, the costs associated with DNI will have to be recovered from the tariffs charged to customers. It is therefore recommended that customers in areas where DNI has already been completed (and receiving an improved service under which they are guaranteed that water will be available for 24 hours per day on a regular basis) would pay a water charge that is some multiple of the current level of water charges, whereas customers in areas where DNI has not been completed (and continuously receiving the current level of service with intermittent supply) would continue to pay the current level of water charges. This dual pricing structure is necessary: (a) to generate the revenues in the short to medium term that will be needed to service the loans taken to finance DNI (and thereby to implement DNI on a financially sustainable basis); (b) to provide a strong incentive for the efficient use of water in areas where DNI has been completed (and customers are receiving an improved service); and (c) to avoid creating an impression that an improvement in service in one neighbourhood is at the expense of the level of service in other neighbourhoods.

KW&SB has suffered severely from political interference. On the other hand, local governments such as GOS, CDGK, TMAs, and UCs have legitimate roles in the shaping of policies for water and sanitation sector in the region, including the adjustment of tariffs. The source of the problem is that KW&SB has been expected to act both as the local governments' agent in developing and delivering these policies and as the operator of services with managerial and technical functions. This promotes a culture of interference in the day-to-day management of services and in the technical execution of projects. To address this problem it is proposed that policy and representative functions should be separated from the operation of services. It is obvious that any new institutional arrangements have to provide the service operator with a much greater degree of insulation from political interference.

Any attempt to implement institutional reforms is likely to fail if it is not accompanied by a discernible improvement in the quality of the service (through implementation of DNI). Similarly, DNI will not be able to produce satisfactory results if it is implemented within the existing institutional framework (without institutional reforms). Thus, institutional reform and DNI (improvements in service quality) are the two inseparably intertwined elements that will need to be implemented simultaneously. Implementing only one of theses two is likely to fail.

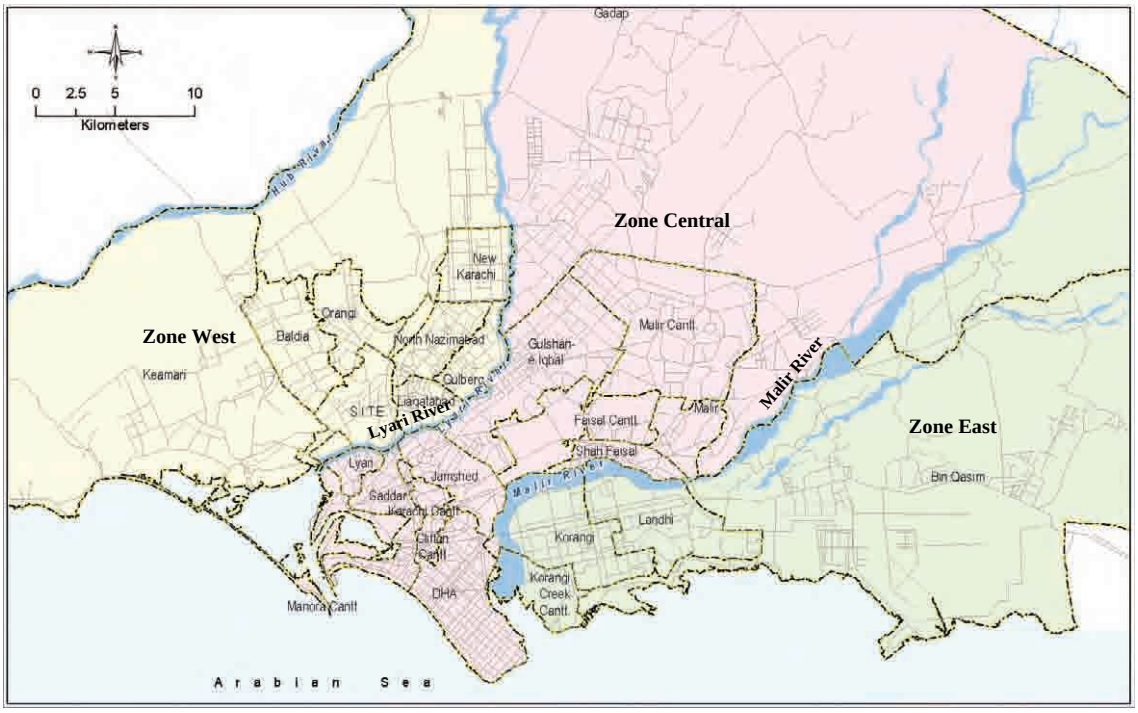

Figure 91.6.1 Three Independent Retail Service Zones

JICA Study proposes that the Karachi city be divided into three independent retail service zones by the Lyari and Malir Rivers (see **Figure 91.6.1**), and that in the long run the responsibilities for providing retail services (water supply and sewerage services) should gradually be transferred from KW&SB to 'corporatised' retail entities on a zone-by-zone basis as shown in **Figure 91.6.2**. The first stage of this reform process will take place in Zone West in early 2011 whilst at this point in time KW&SB will still retain responsibilities for bulk supply from the Kinjhar Lake to Karachi and for operation of retail services within Zone Central and Zone East. The Zone West retail entity will make improvements to the retail services within the Zone West through implementation of DNI in the zone.

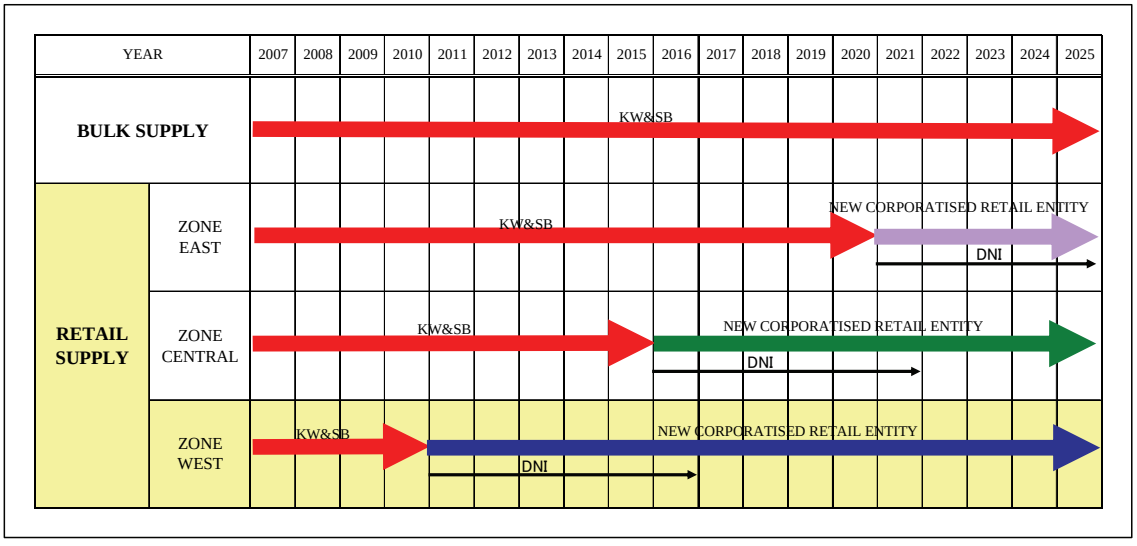

Figure 91.6.2 Transfer of Responsibility for Retail Services

Being an independent corporatised organisation, the Zone West retail entity would be able to perform free from civil service rules and develop its own rules and work ethics for how it does

business. They will include rules for hiring and firing workers, adjusting wage structures, adopting performance-related payments and disciplining workers for poor performance or offering rewards and promotions based on good performance.

The Zone West retail entity would be established as a 'Public Limited Company (PLC)' under the provisions of the Companies Ordinance 1984. The PLC will purchase treated water from KW&SB in bulk and distribute it to all retail and bulk customers (both residential and non-residential) within Zone West. They will also be accountable for collection, transportation and treatment of sewage generated in Zone West. The PLC would take responsibility for all financial and technical aspects of the operation and management of water supply and sewerage services within Zone West including the collection of tariffs, employment of staff, dealing with customer complaints, etc. The scope of retail service that will be managed by the new service provider is broadly described as follows:

(i) Purchase bulk treated water from KW&SB and distribute it to all residential and non-residential customers in Zone West including large users such as industries, governmental institutions/organizations, cantonments, commercial entities (hotels, restaurants, hospitals, etc.) currently on a bulk supply arrangement with KW&SB

(ii) Collect sewage generated in Zone West (and also sewage transferred by KW&SB from outside Zone West) and ensure that sewage is properly treated before being discharged into natural water bodies.

(iii) Operate and maintain water supply and sewerage system within Zone West, which among others include the following infrastructure.

(Water Supply)

- Water Trunk Mains
- Trunk Distribution Mains
- Distribution Network Mains
- Distribution Pumping Stations
- Service Connections

(Sewerage)

- Service Connections
- Sewage Collection Network
- Trunk Sewers and Interceptors
- Sewage Pumping Stations
- Sewage Treatment Plants

(iv) Make extensions and improvements to the existing water supply and sewerage system in Zone West

(v) Collect water supply and sewerage charges from customers to recover the reasonable costs of providing services that are prudently and efficiently incurred

(vi) Enhance public hygiene and the preservation of the environment by supplying safe water that complies with the recommendations of the WHO Guidelines for Drinking Water and by ensuring that sewage is treated properly to such an extent that effluents from treatment plants comply with the requirements of the NEQS.

It is suggested that the majority of the PLC's shares would initially be held by CDGK and TMA's that fall within Zone West. As such, the reform is in line with the on-going process of "Devolution". Other stakeholders in Zone West such as large industries, cantonments, organizations representing civil society, private companies and a trust representing the interests of the company's employees would gradually be included as part of the shareholders as the financial performance of the PLC improves in future.

The objective of the PLC would be to undertake the operation of water supply and sewerage services in Zone West in accordance with high commercial and professional standards and without external interference in the day-to-day management of the services. There would be

no political representation on the Board of the PLC and the articles of association and shareholders' agreement would specify that members of the Board should be selected on the basis of their commercial, professional, managerial and/or technical qualifications and experience.

JICA Study proposes that an independent Regulatory Board (RB) should be formed for economic and technical regulation of water supply and sewerage services in Zone West (see **Figure 91.6.3**). The RB should have the obligation to ensure that the new retail entity in Zone West is able to recover the reasonable financial and economic costs of providing water supply and sewerage services in Zone West. For this purpose, it will define a formula for setting tariffs that reflect the reasonable costs of providing the services to ensure that expenditures are prudently and efficiently incurred. It will also ensure that the formula is properly applied and implemented. The GOS and other local governments will have the power to intervene to limit tariff increases for reasons of regional policy but will be required to compensate the retail entity in such cases. The RB would be responsible for ensuring that the poor and lower income groups are protected from any unacceptable distributional impacts of tariff increases that might fall on them. Where services are provided free of charge the retail entity must be compensated by the relevant local body responsible for social welfare services. The Zone West retail entity would pay a regulatory charge from out of its gross water supply and sewerage revenues to cover the costs of the Regulatory Board.

The RB would monitor the performance of the Zone West retail entity against the prescribed service standards and will also act as 'Ombudsman' in dealing with customer complaints and related issues of customer service. It would also be responsible for setting out and enforcing 'Water Supply and Sewerage Services Regulations' which define clearly the statutory rights and obligations of both the Zone West retail entity and its customers in delivering and receiving the services.

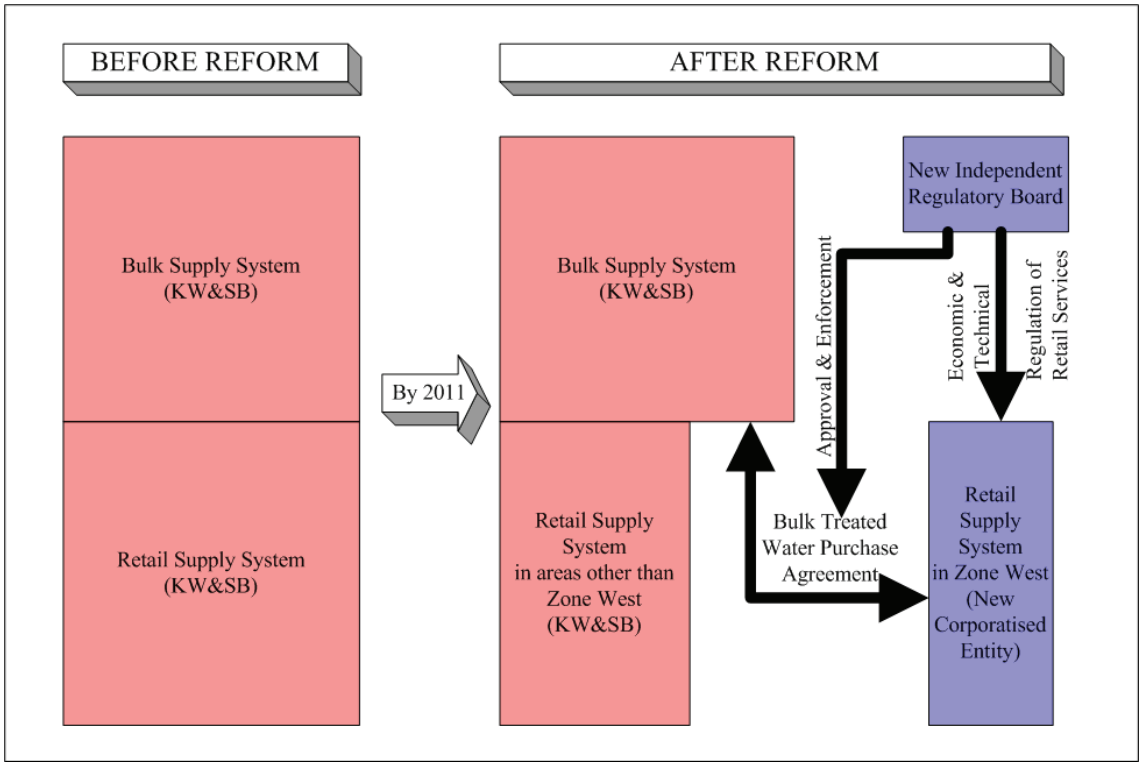

Figure 91.6.3 Institutional Reform Suggested by JICA Study

It should be noted that the 'JICA Study Team' are primarily concerned with the identification of possible reform options and therefore has sought to provide an outline of suggested reforms in principle at this stage. It is expected that detailed studies related to the suggested reforms will be carried out jointly by the Water and Sanitation Program (WSP) and the ADB assisted 'Karachi Mega City Sustainable Development Program (KMCSDP)'.

In order to put this reform (corporatisation) into effect, separate studies will need to be conducted:

- To draft amendments to relevant laws, ordinances and/or regulations that are necessary to enable KW&SB to relinquish responsibility for provision of retail services (water supply and sewerage) in Zone West
- To draft articles of association and shareholders agreement of the Zone West retail entity
- To develop a tariff structure which would be applied in areas where DNI has already been completed, and which, while providing adequate protection for the poor and a strong incentive for efficient use of water, ensure that the Zone West retail entity is able to recover the reasonable costs of providing the services including debt service on loans borrowed for financing DNI.
- To establish a mechanism for the transfer of KW&SB's employees currently engaged in provision of retail services in Zone West to the Zone West retail entity, including transfer of employees' pension rights, severance funds, etc.
- To establish a mechanism to determine the condition of retail assets and for the valuation and transfer of retail assets to the Zone West retail entity
- To establish a mechanism for dealing with the liabilities and receivables associated with the retail assets and customer base transferred to the Zone West retail entity
- To establish an independent Regulatory Board for economic and technical regulation of the water supply and sewerage services
- To draft 'Bulk Treated Water Purchase Agreement' between KW&SB and the Zone West retail entity

It is expected that the reform process would be put into effect through the 'Reform Committees' that have already been established under WSP's initiatives, which would take responsibility for ensuring the progressive implementation of reforms in close coordination with the Local Support Unit (LSU)-CDGK of the ADB assisted KMCSDP.

9.2 IMPROVEMENT OF FINANCIAL MANAGEMENT SYSTEM

A situation assessment of the current financial management practices and performance was carried out during the first phase of the study. Shortfalls were identified through the analysis of financial information and the diagnosis of financial statements. An outline of the key findings with recommendations for improvement can be summarised as follows:

9.2.1 Electricity Charges

Electricity charges are the largest expenditure item among direct costs of water supply and sewerage system operated by KW&SB. It accounted for Rs.1.64 billion or 57% of the total direct operating cost in the fiscal year 2004-05. Thus, this charge is the most serious component to lift water production cost. As a matter of fact, it is an essential cost for KW&SB to convey water source from Indus River. Therefore, the electricity expense is a key issue for KW&SB to reduce the total expenditure. KW&SB is using three kinds of energy sources for power machines in pump stations and plants. They are electricity, city gas and diesel. Among them, the electric power is the overwhelming expenses, because of its convenience. KW&SB is purchasing energy as power source at the following average prices at present.

Table 92.1.1 Comparison of Energy Sources in Unit Prices at KW&SB

Energy Source	Average Purchasing Price	Price per MMBTU	Price per 1000kcal
Electricity	Rs 6.04 per kWh	Rs 1,770	Rs 7.02
City Gas	Rs 10.70 per m^3	Rs 325	Rs 1.29
Diesel	Rs 37.70 per litre	Rs 1,040	Rs 4.13

Remark: Energy contents were set as 860 kcal/kWh of electricity, 8,300 kcal/m^3 of gas and 9,130kcal/l of diesel.

As shown in **Table 92.1.1**, the price of electricity is the highest of Rs.1,770 per MMBTU among the above energy sources. Gas is only Rs.325 per MMBTU or 18% of electricity. Diesel, however, is Rs.1,040 per MMBTU or 59% of electricity, so it is not cheap enough as energy source. Although the gas cost is much cheaper than electricity, it usually costs more to convert into power because of comparatively expensive power-driven machines by gas in general. It is said that natural gas is regarded as promising energy source in the country. It might be a good opportunity to utilise natural gas for power source in KW&SB.

In order to save energy costs and ensure an uninterrupted power supply, KW&SB currently plan to develop a power generation plant on a Build-Own-Operate-Transfer (BOOT) basis at the following locations.

- Dhabeji Pumping Station - 35 MW (in Progress)
- NEK - 10 MW
- Hub - 5 MW

In addition, KW&SB puts forth an effort to search useful new energy sources in Karachi. In developed countries, electricity bulk users procure electric power from neighbouring large factories which generate superabundant power based on excess generation capacity. That utilisation creates another social order issue in power market. It might be necessary to prepare relevant laws.

Natural energy sources are quite attractive energy sources in all countries. In particular, solar energy, wind power, hydro-power, etc. are considered as important and useful energy sources. Some of utilisation technology, however, is still under development and so its installation costs much as compared with existing fossil energy utilisation in general. In the long run, the agencies concerned can consider and discuss the possibility of natural energy utilisation, referring the natural climate conditions in Karachi.

9.2.2 Financial Charges

Financial charge is also serious component for high water production cost. It accounted for Rs.1.18 billion, which was the second largest expense in the expenditure items in the fiscal year 2004-05. Moreover, a part of interests within due time was not included in the financial charge and carried forward to the following year. That is reckoned in “accrued financial charges” in the B/S of the current year. In 2004-05, this amount was as follows: Rs.170 million as accrued financial charges of long-term foreign loans and Rs.1,063 million as that of short-term foreign loans, although the latter charges must be paid within a year. Eventually, the total financial charges aggregated to Rs.2,416 million at the end of the fiscal year. This would obviously be proof of heavy burden for financial management.

In order to avoid this condition, KW&SB has to procure high grant-element loans from donor countries as official development assistance (ODA). Incidentally, the ODA loan is defined as its grant element is more than 25%. For example, a grant element of the loan number SF-1001Pak by ADB was calculated at 27%, so it is narrowly classified as ODA loan. Since that of the loan number of PK-P40 by JBIC was calculated at 52%, it is also perceived as ODA. On the other hand, the loan number of 1987 by IDA was calculated at minus 4.8%, it might not

be considered as ODA loan. In addition to interest charges, every loan lender levies some other charges like commitment charges and service charges.

Table 92.2.1 Grant Element of Agreed Loans

Loan Number	Lending Agency	Amount of Loan (million)	Interest Rate (%)	Repayment Period (Yrs)	Grace Period (Yrs)	Grant Element*1
1987-Pak	IDA	SDR 163.5	11.0	25.0	5	-4.8%
SF-1001Pak	ADB	SDR 39.9	7.0	35.0	10	26.8%
PK-P40	JBIC	¥10,300.0	2.6	20.5	5	51.9%

Remark: The details of the loans above and other loans are tabulated in **Table 35.2.2**.
Note: *1 Discounted at 10%.

Yet, KW&SB can not receive ODAs directly from donors as bi-lateral from foreign countries or multi-lateral loans from international financial organisations. In general, it receives ODA loans through the federal government as two-step loan. Therefore, the federal government is only one agency to contact for negotiation with foreign donors.

Pakistan has already borrowed considerable amount of loans from various countries and organisations. As a result, its debt-service ratio (DSR), a kind of country risk assessment factor of financing, has been at almost the serious level. As shown in **Table 92.2.2**, the DSRs for the recent five years were in the neighbourhood of 20% which is the critical level.

Table 92.2.2 Debt Service Ratio

Item	2000	2001	2002	2003	2004
Debt Service	2,854	2,995	2,850	3,040	4,285
Export of Goods & Service	11,312	12,164	15,943	18,980	20,242
DSR	25.2%	24.6%	17.9%	16.0%	21.2%

(Unit: US$ Million in lines 2 & 3)
Source: Global Development Finance, Country Tables 2006, March 2006, World Bank

9.2.3 Compensation of Labour

Compensation for workers of KW&SB is also an essential cost component for operation of water supply and sewerage services. It accounted for Rs.874 million or 30% of the direct expenditure in 2004-05. In the same year, the number of workers in KW&SB was recorded as 8,180 in total. Among them, around 4,600 workers are engaged in water supply services. Since KW&SB supplied 351 mgd of water in the same year, the number of employees over daily water supplied was calculated as 13.1 persons per one million gallons per day. This figure indicates almost double the average rate in Japan. Thus, this cost item must still have plenty of room for improvement and cost saving through enhancement of labour productivity.

In order to enhance labour productivity, KW&SB should standardise their daily routine of operation and maintenance (O&M) and sales activities. The close investigation of the present daily routine works and the in-depth analysis of their works would need to be conducted. The analysis results must be reflected to a work manual as standard work steps. The respective section chiefs must manage thoroughly their workers in conformity with the standard work schedule.

9.2.4 Accumulated Deficit

The profit and loss (P/L) table as of the end of 2004-05 indicated the accumulated deficit of Rs.10.4 billion. It is around four times of the annual sales in the same fiscal year. This was a result of the accumulation of deficits during the recent four years. During these years,

KW&SB recorded a constant ordinary loss of more than Rs.2 billion. In other words, KW&SB has spent almost double the amount of its sales.

Moreover, the balance sheet (B/S) shows the accumulated financial charges in both the long-term and short-term foreign loans. Their figures were Rs.10.3 billion and Rs.3.0 billion, respectively. Their total comes to Rs.13.3 billion as of the end of 2004-05. This amount is more than the accumulated deficit and nearly equal to the outstanding of the principal (Rs.14.5 billion of the long-term foreign loans) in the same year. This is obviously another accumulated deficit. KW&SB might be able to get rid of some portions of these huge deficits by means of making disposition of hidden assets, such as undervalued real estates or securities. Although the B/S does not indicate these hidden assets, it could be potential financial sources if any are available.

9.2.5 Capitalisation

Water supply and sewerage service is one of process industry. The characteristics of process industry are of a high capital intensity of production, so the industries pour enormous sums into plant and equipment. Accordingly, they have large equity capital for investment. The capital adequacy ratio, i.e., equity capital over the sum of equity and liabilities, of Japanese water supply enterprises is around 53% as an average of 49 water supply enterprises serving more than 300,000 consumers.

In the case of KW&SB in the year 2004-05, its capital adequacy ratio was around 10% only. If the grant-in-aid is added into the equity, the capital would increase to Rs.17.5 billion, so the ratio is calculated at 47%. However, these capitals were withdrawn to be allocated to the accumulated deficit of Rs.10.4 billion. These grants were given mainly by GOS in recent years. In the year 2004-05 particularly, the “Greater 100 MGD Water Supply Project (K-III)” contributed the major grant portion to KW&SB. The insufficient equity obliges KW&SB to resort to external financial sources like loans and debts. It makes KW&SB to impede its management safety. It would be necessary to substantially increase its equity capital instead of increasing long-term debts.

9.2.6 Cost Recovery

The huge deficits in recent years mainly come from small operating revenue and large operating expenditure. In the year 2004-05, the total revenue was Rs.2,653 million, comprising Rs.2,232 million from water supply service and Rs.421 million from sewerage service. On the other hand, the total expenditure was Rs.3,896 million for operation, comprising Rs.3,069 million for water supply operation, Rs.537 million for sewerage operation and Rs.290 million for administration. In addition, the current financial charges were Rs.1,183 million. Furthermore, the accrued financial charges in the B/S were Rs.1,233 million as outstanding financial charges in the same year.

In 2004-05, the volume of water distributed to consumers was estimated at 128.1 billion. The volume of sewage collected was estimated at 89.7 billion gallons per annum. On the basis of these data, their unit values are calculated as shown in **Table 92.6.1** below. The common costs, which do not belong to operation activities, distributed proportional to the respective total expenditures.

Table 92.6.1 Unit Prices and Unit Costs of Water and Sewerage: 2004/05

Unit Value	Water	Sewerage
Unit Price	17.4	4.7
Unit Cost		
Unit Cost Based on Operation Expenditures	26.4	6.6
Unit Cost Based on Common Expenditures*1	16.0	4.0
Unit Cost	42.4	10.6

Remark: Including current and accrued financial charges

As shown in the table, the unit prices of both water and sewerage were 66% and 71% of unit costs based on operation expenditures. They were also down to 41% and 44% of unit costs based on the total expenditures. The difference between unit price and cost was quite large. It would not be impossible for KW&SB to improve their financial management without rectifying this situation. Moreover, approximately 20% of the sale revenue became to the accrued income and is reckoned up to account receivable, named as debtors (consumer's balance). This is another serious problem for the financial management.

From the point of financial management, cost recovery is the most fundamental policy for business enterprise. The cost recovery policy is an important principal for solving the financial problems and warrants further investigation.

9.2.7 Building a Sound Basis for Financial Management

Based on the above it is evident that a number of fundamental changes are necessary to improve the financial performance and thus the financial sustainability of KW&SB.

Assuming the principle of corporatisation, KW&SB will need to develop further financial management and control skills and expertise to manage the organisation on sound commercial principles. Accordingly, KW&SB will need to develop business planning practices as well as new, sound accounting and budgeting procedures and formats to ensure effective financial management, control and sustainability. This will include the need for sound computerised financial application software and computer systems; a 'Financial Information System' (FIS). Where financial staff are placed at operational sites or 'town offices', systems will need to be 'networked' to ensure access to and security of finances and financial information. KW&SB will need to invest in this as well as other systems to improve financial as well as operational performance. Taking SSGC as an example, they have invested heavily in "ORACLE Enterprise Resource Planning"; a systems suite that integrates application across all business processes including finance, human resources, operations, project planning, etc.

An asset revaluation exercise will also have to be undertaken to establish a complete list and value of current assets for effective planning and depreciation. Based on the above, it is likely that intensive staff training will be required to raise the level of financial management and control throughout all levels of the organization, including technical, field and accounting staff.

KW&SB will also need to develop and use a number of relevant key financial performance indicators to monitor performance at the centre as well as within the zonal "business units" or "service provider organisations" depending on how the organisation is reformed in future.

9.2.8 The Need for Financial Self-sufficiency

Financial self-sufficiency will afford KW&SB:

- Freedom in financial management with discretion to decide how to use the funds generated from services provided. KW&SB will have to work within the limits of the constraints of financial capacity that revenues bring
- Incentives to improve overall financial performance through efficiency savings (reducing operational expenditure through optimisation of business and operational processes)
- Incentives to increase revenues through improved service delivery and customer services (improving commercial billing and revenue practices and focussing on the reduction of NRW)

9.2.9 Achieving Financial Self-sufficiency

It is recognised that the provision of water and sanitation services has both socio-economic and financial dimensions; however, whilst these may be essential services for all regardless of social and financial standing, service providers will need sufficient financial incentive through cost recovery mechanisms (tariffs and revenues) to sustain a viable business.

In the long term, financial self-sufficiency means that revenues received (mainly from water and sanitation services sales) are able to cover the direct and indirect operating expenses, indirect costs, debt service and capital expenditure.

KW&SB's aim will be to achieve financial self-sufficiency in the future; not least, because this will afford them 'independence' from government influence and 'interference' in day to day operations. Corporatisation will be a good way to achieve this through affording the organisation more freedom for financial management. As discussed previously, this will bring with it the prerequisite for effective regulation to be in place.

9.2.10 Use of Financial Indicators

In future KW&SB's FIS will need to be capable of providing managers with timely and vital financial information relevant to their responsibilities within the organisation. This can be provided either by 'cost centre', functional department or 'business unit'. Relevant financial reports and key performance indicators and/or 'financial ratios' will also need to be measured and tracked to provide internal information as well as satisfy external reporting needs.

One of the major purpose of compiling the financial statements; Balance Sheet, Income Statement, and Cash Flow Statement, is to assess the financial condition of KW&SB. More emphasis should be placed on financial performance through the analysis of financial indicators. These are calculated from the information contained within the financial statements and are designed to show the relationship between various components of the entity's financial statements.

There are a number of useful indicators such as; Liquidity ('current ratio', 'gearing ratio'), Profitability ('operating ratio', 'return on assets', 'unit production costs', 'unit price'), Solvency ('debt to equity ratio'), Efficiency ('NRW ratio', 'facility utilisation ratio') Productivity ('staff per 1000 connections' 'Accounted for Water per employee'), Current Asset Management Capability ('collection efficiency', 'accounts receivable turnover ratio') etc. KW&SB will need to focus on performance measurement in this way in order to measure financial performance and to enable comparison with other organisations (benchmarking). This will enable KW&SB to not only track performance but will provide a 'tool' for performance improvements generally by tackling the areas of concern identified by the various indicators.

9.3 REDUCTION OF NON−REVENUE WATER

9.3.1 General

It is important to have a clear understanding of the internationally recognised definition of Non-Revenue Water (NRW) which is comprised of several components as shown in the following **Table 93.1.1**.

Table 93.1.1 Definition of Non-revenue Water

<table>
<tr><td rowspan="9">System Input Volume</td><td rowspan="2">Authorised Consumption</td><td>Billed Authorised Consumption</td><td>Billed Metered Consumption (including water exported)</td><td rowspan="2">Revenue Water</td></tr>
<tr><td></td><td>Billed Un metered Consumption</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Unbilled Authorised Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="7">Non-revenue Water (NRW)</td></tr>
<tr><td>Unbilled Un metered Consumption</td></tr>
<tr><td rowspan="5">Water Losses</td><td rowspan="2">Apparent Losses</td><td>Unauthorised Consumption</td></tr>
<tr><td>Metering Inaccuracies</td></tr>
<tr><td rowspan="3">Real Losses (UFW)</td><td>Leakage on Transmission and/or Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to point of Customer metering</td></tr>
</table>

Source: IWA "Best Practice" Water Balance and Terminology

As can be seen, water losses are divided into Real and Apparent Losses and Real Losses represent Unaccounted for Water (UFW). When combined with Unbilled Authorised Consumption (metered & un-metered) this equates to the total Non-revenue Water (NRW), that is water put into the system for which no payment is received.

There is often confusion and disagreement on UFW/NRW percentages because of lack of understanding of the definitions. For example, in the Mott McDonald Draft final Report Executive Summary dated April 1996; overall "leakage" in the trunk, secondary and tertiary mains was estimated to be 30% of system input. This is not the total UFW (water loss) which must include leakage/overflows from storage tanks, unauthorised consumption and metering inaccuracies.

In the absence of system-input metering and retail supply metering the UFW percentage can only be a reasonable estimate, based on the Mott McDonald detailed analysis of pipeline losses and adjusted for the deterioration of the system over 10 years and for unauthorised consumption, and metering inaccuracies. This report uses a reasonable estimate of 35% for UFW.

The following sections examine each component, review the relevant laws and regulations, examine the management system, and develop an Action Plan for reduction of NRW.

9.3.2 Reduction of Leakage in Trunk Mains

There are over 200 km of trunk water mains varying in diameter from 18" to 72", the most widely used material being pre-stressed reinforced cement concrete (PRCC) pipes. In 1996 it was assessed that 40% of the overall pipelines leakage occurred in the trunk main system. Lack of metering prevented accurate measurements but leakage results were obtained from extensive investigations by consultants.

From the inception of the K-III scheme to augment supplies by 100 mgd it was planned to maximize the benefits by reducing trunk main water losses. In May 2006 a contract was

entered into between KW&SB and M/s MM Pakistan (Pvt.) Ltd. for Engineering Services for "Rehabilitation & Strengthening of Water Supply System under KIII Project"

The scope of works includes developing system mapping and a database in map form to show comprehensive details of the water system and to develop an equitable water distribution plan for Karachi. The physical works relate to trunk mains and reservoirs and are divided into two groups:

- Group A: System rehabilitation with extensive repairs to leaking joints including strengthening of the water supply system and rehabilitation work related to reservoirs
- Group B: Installation of flow measuring meters and flow control valves to regulate the water supply system. This includes flow meters at outlets to water treatment works, reservoirs, bulk water pumping stations and distribution pumping stations

The project contains 10 contract packages, 4 of which will shortly be awarded. These contracts are for strengthening of joints externally/internally on weak segments of trunk mains, replacement of part of old Dhadeji PRCC rising main, providing a new gravity main to Orangi town and Rehabilitation of University Reservoir. As of May 2007, 5 more contracts were awaiting KW&SB approval prior to inviting tenders. The last contract under preparation is for flow meters, pressure reducing and other control valves.

The System Mapping & Data Base work has commenced for the production of digital maps (scale 1:2000) to show full details of KW&SB's water supply facilities. The project which will rehabilitate about 50km of trunk mains and 2 reservoirs, provide a system data base and, as an extra, provide a new gravity main for additional water supplies to Orangi town, is expected to last about another 15 months at an estimated cost of Rs 2.2 billion. These rehabilitation works should reduce leakage and result in a reduction of UFW.

9.3.3 Reduction of Leakage in the Distribution System

The water distribution network comprises about 4,850 km of pipelines of which about 65% is asbestos cement pipes and 26% cast iron. Much of the system is old and in very poor condition. KW&SB regulate supplies to sub-zones by opening and closing feeder valves from the trunk mains and regulating the hours of operation of distribution pumping stations. Almost all "retail" (un-metered) consumers (consumers other than bulk metered supplies) are subjected to intermittent water supply.

Leakage within the secondary mains between the trunk mains and the distribution system is estimated to be 20% with the remaining 40% of overall pipeline losses occurring in the distribution system. There is no overall specific strategy, plan or department to deal with leakage; this task falls to the SEs of the 18 towns, under the direction of the appropriate Zone CE.

Substantial water losses and leakage occur due to the following:

- An aging network lacking maintenance and repair
- No planned leakage control system
- Poor workmanship and materials used for pipe and joint repairs. It is said that lack of funds prevents the purchase of spare pipe, repair collars etc. The current practice of using rubber tubing and cement rendered plastic for repairs has become the accepted norm of KW&SB.
- Poor workmanship and materials for connections carried out by the consumer (rarely the declared registered plumber) which are largely unsupervised by KW&SB staff
- Household water systems comprising ground and overhead tanks and an electric pump usually directly connected to the distribution pipe cause large losses due to leakage and

overflows which go unchecked because there is no volume charge

To reinforce this view we quote from the ADB "DRAFT Karachi Sustainable Mega City Water & Wastewater Roadmap", May 2007, as follows:
"The KW&SB distribution system is in very poor condition. It suffers from high leakage, contamination, and provides an average of only 3 hours supply per day. The distribution pipes and service connections are dilapidated and leak heavily. This is the biggest technical problem faced by the KW&SB. Considerable investment is needed to rehabilitate the distribution system and bring it to a level where it can provide potable 24/7 water supply. This investment will involve data gathering and pilot implementation of technical solutions, replacement and rehabilitation of distribution mains and service connections, implementation of District Metering Areas (DMAs), and customer metering to monitor the situation."

ADB will support improvements to the distribution system in accordance with the following:

- A rolling program of Distribution Network Improvements (DNI) on a zone-by-zone basis designed to significantly reduce system losses and progressively move towards achieving 24/7 supply.
- Improving the water distribution system is an immediate investment need. Distribution System Data Gathering and Pilot Improvements projects would lay the basis for future distribution improvement projects. This would involve investments in information gathering equipment such as bulk and customer meters and trialling distribution improvements (for instance, pressurizing a small zone for 24 hours and doing a rapid leak detection and repair program)."

It is understood that this project could be implemented as an extension to the current Rehabilitation & Strengthening of Water Supply System under KIII Project.

9.3.4 Reduction of Apparent Losses

(1) Unauthorised Consumption

While there are no reliable figures, and there is little information on this matter there are thought to be many illegal connections. Many services are known to have more than one connection to tap pipelines to maximise the time they have water. It is also known that illegal connections have been made to the trunk/secondary mains system as these pipelines are always full. Supplies to large Katchi Abadis are generally poor due to the distance from the distribution system and very long, above ground, illegal connections to the nearest pipeline are clearly visible.

Little is done to disconnect illegal connections. The law is rarely, if ever, enforced by those charged with these duties and there is known to be a degree of political and other interference.

(2) Metering Inaccuracies

Due to the fact that about 1 million "retail" consumers are not metered, inaccuracies in meters and meter reading is confined to about 5,000 bulk metered connections. These bulk meters are located on the off takes from trunk or secondary mains which are pressurised 24 hours a day and it is said that meters generally record accurately. Any recording problems may be resolved by the meter workshop department which is equipped to repair and calibrate these bulk supply meters.

9.3.5 Laws and Regulations Relating to NRW

The Laws governing KW&SB appear to be unclear to a number of stakeholders. The Karachi Water & Sewerage Board Act of 24th April 1996 provides for the establishment of a Board for supply of water and disposal of sewerage in the Karachi Division.

The Managing Director (Chief Executive of the Board) is appointed by government (government being defined as the Government of Sindh). The powers of the Board include the following in relation to NRW:

1) Sanction in the manner on payment of fees as may be prescribed by regulations
   a) Water connections.
   b) Water supply to tankers.
   c) Sewerage connection.
2) Levy, collect or recover rates, charges or fees for water supply and sewerage services, including arrears thereof.
3) Have the power to reduce, suspend or disconnect the water supply in the event of contravention of the provisions of this Act or regulations.
4) Have the power to impose surcharge, not exceeding double the amount due, if rates, charges or fees for water supply or sewerage service or the arrears thereof are not paid within the time fixed by the Board.
5) Make regulations with the approval of the Government.
6) Regulate, control or inspect water connections, sewer lines and service lines including internal fittings.
7) Prepare and submit to Government schedule of water and sewerage tariff, rates, charges or fees to be levied by it.
8) Government shall, sanction with or without modification schedule of water and sewerage tariff, rates, charges or fees to be levied for the supply of water and maintenance of sewerage service within ninety days of its submission
9) Government may give aid or make grant to the Board.
10) The Board shall be responsible for bulk production of potable water and its distribution in accordance with the provision of this Act.
11) Subject to the provision of this act and the rules of Board, with the approval of the Government, make regulations for carrying out the purposes of this Act.
12) In particular and without prejudice to the generality of the foregoing powers, such regulations may provide for:
    a) Procedure for applying for water and sewerage connections including payment of fees for making application in this behalf.
    b) Regulation, control or inspection of private houses, water connections, service lines including internal fittings.
    c) Procedures for levying collecting rates, fees or charges for water supply and sewerage service and imposing surcharge in case of any default made in payment thereof.

The Sindh Local Government Ordinance 2001 devolved political power and decentralised administrative and financial authority to local government, in this case the CDGK comprising 18 Town Municipal Administrations and 178 Union Councils. KW&SB are administered through an Executive District Office (EDO) of CDGK. There is provision in the Ordinance for further decentralisation to towns in a city district. The definition of government in this Ordinance is again the GOS.

Hence Regulations are made by the Board of KW&SB with the approval of the Government of Sindh (GOS), for example the Revised Schedule for Water Supply & Sewerage Services published in the Sindh Government Gazette 1st October 2001 (Tariff)

In 2006, in terms of clause 6 (i) (c) of the KW&SB Act of 1996 the Chairman issued New Connection & Service Charges. This clause allows the chairman to act on behalf of the Board in any emergency for ratification by the Board at its next meeting. Presumably this clause was used because the Board never meets.

It appears therefore that in the devolution process KW&SB are a "Water & Sanitation Agency" functioning under CDGK. The Chairman is the CDGK Nazim with an MD acting as the Chief Executive of the Board. The composition of the Board was changed post devolution and presumably the Chairman, MD and all other board members were appointed by GOS. It is not known why the Board has ceased to function since 2001. It is not known if regulations were ever issued under the act to state when the board should meet, but failing such regulation the Chairman shall direct when meetings are held.

Whereas the board has powers on management of the system, water and sewerage tariff, rates, charges or fees to be levied for the supply of water and maintenance of sewerage service must be sanctioned by GOS.

There is a certain degree of confusion as to the responsibilities of KW&SB following the devolution from GOS to CDGK. Due to the involvement of TMA Nazims at ground roots level there are those who think water and sewerage services are a function of the TMAs. In the JICA Study Team Water Awareness Survey only 30% of Katchi Abadi residents were aware that KW&SB is the service provider.

Regarding Regulations, the items for which these are required are listed in the 1996 Act, and have been produced by KW&SB with approval by GOS as necessary (for example, the revised tariff was published in the Sindh Government Gazette). However, new regulations governing Water Connections and Connection Services, produced by internal memorandum in 2006 were not published although it is said that they were discussed with other stakeholders. Regulations regarding disconnection for non-payment are shown on the reverse side of the monthly bill. It would appear that By Laws have not been produced or revised for decades.

9.3.6 Distribution Network Improvement (DNI)

It is the considered opinion of this JICA Study Team that a substantial improvement to water service quality can be achieved by significantly reducing leakage and other water losses and introducing metered supplies with a volumetric tariff to all consumers. This view is shared by ADB in its Draft Karachi Sustainable Mega City Water & Wastewater Roadmap, May 2007.

Pilot projects are planned for Distribution Network Improvement (DNI) and KW&SB have accepted this principle as the way forward. It is also interesting to note that about 85% of households interviewed in the Water Awareness Survey support the introduction of domestic water meters. For the implementation of DNI's, efficient systems need to be developed for the reduction of non-revenue water including the reduction of physical water losses (UFW) which together with other initiatives will reduce overall NRW, these include:

- Proper repair to leakage points using appropriate materials and developing a skilled labour force and/or replacing pipes that are beyond repair
- Proper installation of new connections, water meters, accurate meter reading, calibration, repair and replacement of meters
- Water loss monitoring, identification of leaks and repair
- An accurate customer database and an efficient and effective billing and collection system
- A Consumers Service Centre for information as well as complaint resolution

- Elimination of illegal and unauthorised connections
- Efficient water use

9.3.7 Management System

The current management system for the reduction of UFW is weak and there is a need for strengthening the management system with the aim of reducing the amount of non-revenue water through water losses. This must be looked at in the overall context of the introduction of corporate reforms in the proposed ADB study as part of ADB's technical assistance for capacity building within CDGK, linked to future loans for the Karachi Mega City Development Project.

The ADB study is a follow on from the findings of the World Bank and Swiss Development Corporation for evolving a long term corporate strategy for KW&SB for structural changes, management accountability and organisational changes to eventually achieve full cost recovery whilst meeting the needs of customers and other stakeholders.

Management reform requires strengthening of the management system and is linked to institutional reforms to improve service provision by KW&SB. At a World Bank sponsored workshop held in February 2005 the core message was "fixing water and sanitation service delivery is not about fixing the pipes – it is about fixing the institutions that fix those pipes".

KW&SB has already embarked on a number of reforms and two additional vice chairmen have recently been appointed to facilitate and expedite the overall working and ongoing process of reform in KW&SB. There are many areas to be tackled and consideration has not yet been given to the reduction of real and apparent water losses (UFW).

The response by KW&SB to the problem of water losses, and in particular leakage, has been poor over the years. With the disbanding of the Distribution and Leakage Units there is no centralised system to control the work that should be carried out at Town level where lack of human and financial resources compounds an already bad situation.

The workshop referred to above noted the following:

- Technical staff lack professional knowledge and skill
- Lack of capability of staff below Assistant Executive Engineer (AEE)
- There is a need for a Resource Facility to train technical manpower below AEE (operational efficiency would assist in reducing NRW resulting from leakage).

A new NRW department will require an improved performance of the personnel at head office and zone level as KW&SB moves to a commercially oriented and competent organisation. In addition to capacity building and training, new staff and/or graduate trainees with appropriate qualifications will be required where expertise is limited.

The responsibility for water losses must ultimately be assigned to the "asset owners", i.e. the managers and operators of the network at zone level, with overall responsibility being assigned to a dedicated NRW department which will take responsibility for the reduction of water losses (and revenue losses).

9.3.8 Action Plan for Reduction of NRW

The current contracts to rehabilitate and strengthen the trunk mains (K-III project) to reduce water losses (UFW) should improve availability of water and provide a platform for further improvement to the trunk main system. Management of water losses will be improved if

KW&SB involve themselves in these projects. Furthermore, ADB have an interest in trunk mains and according to the "DRAFT Karachi Sustainable Mega City Water & Wastewater Roadmap" dated May 2007, ADB state that the K-III project is only being utilised to 40% of its capacity of 100 mgd. Current KW&SB works will bring an additional 40 mgd on stream and ADB will support the transmission expansion to bring the final 20 mgd to the KW&SB's customers at an estimated cost of Rs 1.2 billion (US$ 20 million) in their First Tranche Subprojects. The works comprise:

- Provision of approximately 20 km of 48" dia. and 36" dia. water transmission main from Pipri Treatment Plant to Korangi Industrial Area
- Provision of approximately 25 km of 36" dia. water transmission main from Pipri Treatment Plant to Malir Town

The Rehabilitation & Strengthening of Trunk Mains (K-III) project should be extended to cover the remaining 150 km of existing trunk mains to reduce water losses.

Regarding losses in the distribution system, as stated previously ADB are also interested in this urgent matter which requires considerable investment over a long period of time. Recently, a Local Support Unit (LSU) was established within CDGK to execute services and works included under the project. In February 2007 an Invitation for Expression of Interest (EOI) was advertised for a "Study on Water Balance and Equitable Distribution in Karachi". The study is to be completed in four months and the components comprise:

- Evaluating total inflows into the system and to each town in Karachi; actual and billed consumption; water losses and its components, preparing a water balance strategy
- Assessing problems in the distribution network within towns, including pressure and quality problems, and an equitable and efficient distribution system for Karachi in the short and medium term
- Recommending possible investment interventions based on the final analyses

This study will pave the way for future distribution improvement projects. A Distribution Network Improvement (DNI) Programme is included in the ADB first tranche subprojects leading to a rolling programme of DNI improvement on a zone by zone basis to significantly reduce losses and progressively move towards a 24 hour supply.

With regard to leakage within the distribution system, at connections and from household water systems, the DNI pilot projects will provide a platform to launch an overall NRW reduction plan. The pilot projects will provide data, experience and knowledge to develop a NRW unit thereby strengthening management capacity to reduce and control water losses and refine revenue collection systems. At zone level the DNI pilot projects will provide the opportunity to:

- Transfer knowledge and technology through training and active participation of KW&SB staff in the pilot projects
- Carry out training to broaden the understanding of the components of NRW and how to mitigate their effects
- Carry out training on the use of leak detection equipment

Illegal connections must be reduced; they should first be traced and listed by the zonal staff. Action should then be taken in accordance with the regulations; the connection legalised; checked for compliance; and placed on the register. This will become a serious issue when domestic consumers are metered, and the law must be strictly enforced on defaulters.

The more serious transgression of connecting to secondary and trunk mains should be met with the full force of the law as a lesson to those involved in this mal-practice. Politics must not be allowed to interfere.

With the onset of universal metering, a new facility will be required for the calibration, repair and replacement of domestic meters in addition to a modernised bulk meter facility requiring capacity building in this area.
The law relating to KW&SB as the Water & Sanitation Authority under CDGK should be revisited to ensure compatibility between the 1996 Act and the Sindh Government Ordinance of 2001. The public need to be made aware of the powers and duties of KW&SB and its relationship to TMAs in the context of service provision.

Regulations need to be simplified and reproduced in book form for water connection service charges, sanctioning of water connections, payment default etc. all in accordance with item 12) in **Section 9.3.5** above. The internal memoranda relating to service charges and connections, although described as "simplified" and "consumer friendly" are both 10 pages in length with a bewildering array of instructions and number of copies to KW&SB personnel.

In addition Regulations need to be modernised and extended, particularly in view of the intended metering of retail consumers, to cover:

- Ownership of service connection pipe and responsibility for meter maintenance
- Materials & workmanship for service connections (including pipe tapping)
- Location and installation of water meters
- Meter reading, disconnection policy, meter repair and testing
- Procedures for KW&SB inspection & approval of new service connections
- KW&SB rights to oblige consumers not to waste water

The By Laws need to be examined for compliance with all other laws and regulations particularly the GOS Ordinance 2001 and the regulations issued in 2006, and re-written as necessary.

A significant increase in the availability of water could be achieved by replacing and refurbishing the distribution network, resulting in cost effective use of existing bulk water. Universal metering, efficient and effective billing would rationalise water usage, so too would reducing the number of illegal connections. However, regardless of the overall increase in availability of water to consumers by these initiatives, major new sources need to be developed in parallel.

Timescales for the short term, medium term and long term goals for the reduction of NRW are given in the following **Figure 93.8.1.**

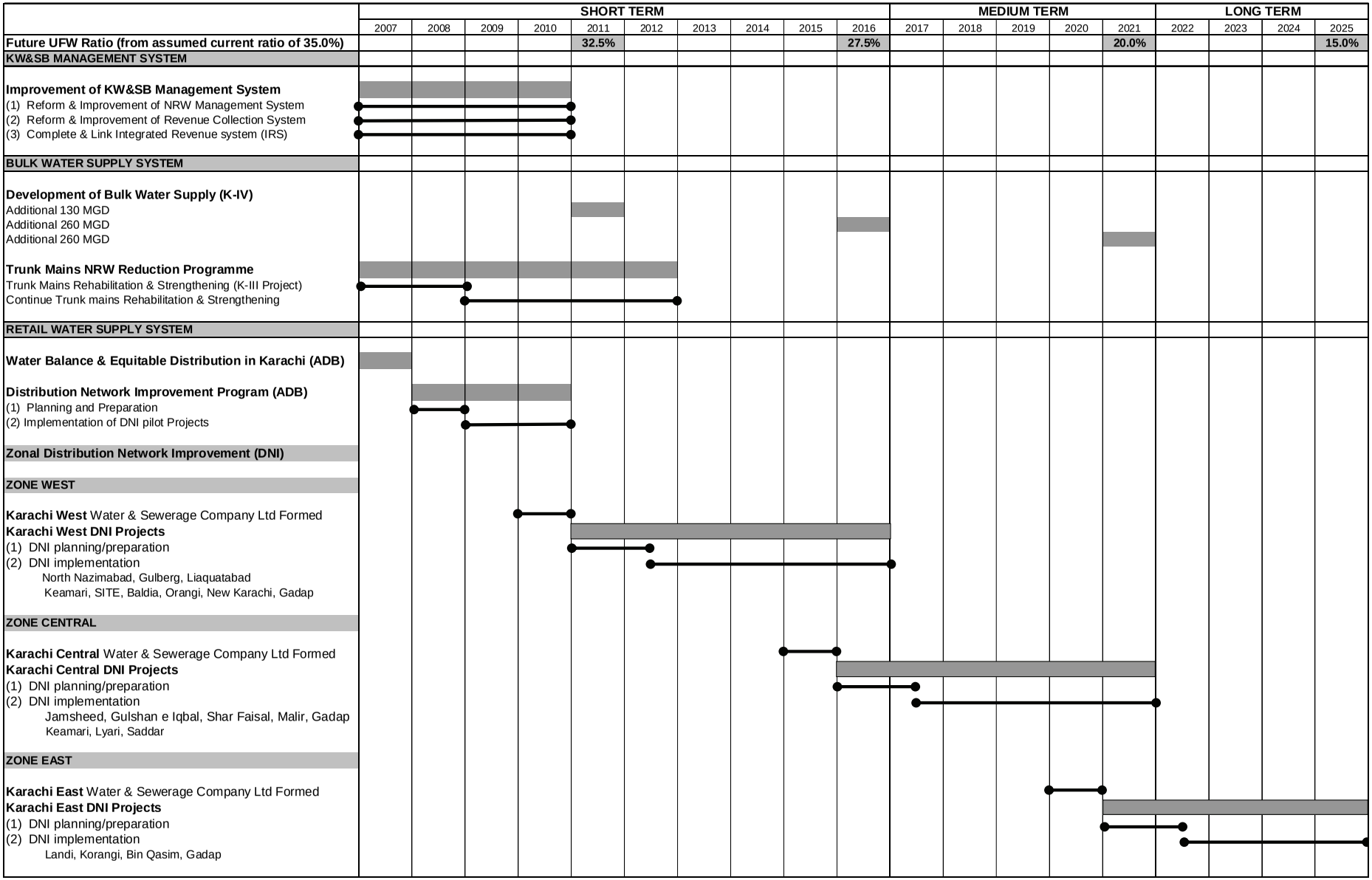

Figure 93.8.1 Timescales for Reduction of NRW

9.4 IMPROVEMENT OF REVENUE COLLECTION SYSTEM

9.4.1 General

The key to a successful water & sewerage service provider is to have the capacity to manage an efficient revenue collection system. Without adequate financial resources, water & sewerage service providers have little chance of sustaining proper operation and maintenance and expand for the future. In the case of KW&SB it has had major problems in its revenue collection system to finance O&M, with poor revenue recovery and mounting arrears. To review this situation all of the components of non-revenue water relating to authorised consumption are examined in this section. These are then related to plans for the improvement of the management system and subsequently the improvement of revenue collection.

9.4.2 Unbilled Authorised Consumption (Metered)

KW&SB does not at present use domestic metering. Metered supplies (referred to as bulk supplies) are confined to government departments, large industrial complexes and other large consumers including housing development areas with their own distribution systems, commercial high rise buildings, hotels etc.

At the end of 2006, KW&SB restructured the meter consumer cell placing it under the supervision of the Superintendent Engineer (SE) Bulk Water Supply together with the meter workshop department. Engineers and revenue officers were allocated to the new structure which also splits the industrial consumers into two zones. This is part of the recent KW&SB initiative to reform the organisation.

The SE would deal with administrative matters whilst technical matters would still be referred directly to the Chief Revenue Officer (CRO). This change has had little or no effect on improving billing and collection.

Bulk supplies are extremely important in terms of revenue since bulk supplies should generate about 1.5 times the revenue for water and sewerage charges of the “retail” domestic consumers. It is therefore extremely important that the approximately 5,000 connections record accurately, are read accurately, billed monthly and monitored closely in regard to payment. The accuracy of the data base for the register of bulk consumers is not known, but this would be an easy task for KW&SB to verify and upgrade as necessary.

The bulk metered supply department has a staff of 73 of which 25 are assigned to meter reading and bill delivery (average of about 200 meter readings/bill deliveries per person per month). There are no reported problems with meters which are said to be generally accurate, repaired, calibrated or replaced as necessary subject to the availability of replacement meters.

9.4.3 Unbilled Authorised Consumption (Un-metered)

The un-metered or “retail” category forms the majority of KW&SB consumers. KW&SB charge a monthly rate for domestic consumers in accordance with the size of the property. It is estimated that approximately 90% of households have a piped water connection (Socio Economic Survey Report-2005, Karachi City Profile V-1.0 / January 25 2006).

However, this does not imply that this number of connections is actually registered on the KW&SB data base. Considering the number of registered household connections which total about 1 million, it seems likely that many households with a piped water connection are not registered with KW&SB, even allowing for the bulk supplies to housing areas in DHA and cantonments.

It had been anticipated that the number of retail consumers on the data base would rise to 1.2 million by June 2007 after the introduction of the computerised integrated revenue system but this has not materialised. Clearly, KW&SB must commence a programme to update the register.

Another important factor in this category is bill delivery. There is anecdotal evidence to suggest that bill delivery may be a major problem. Complaints registered in the IRS centre contain a high number referring to non-delivery of the monthly bill. Considering the fact that only those consumers willing to pay the bill will complain a large problem is indicated.

It is to be noted that the monthly bill deliveries to "retail" consumers is carried out by the same number of personnel who previously delivered the bills annually. The revenue section has a staff of about 900, including bill deliverers, but the actual number of personnel delivering bills is not known. Bill delivery in some areas, particularly in Kachi Abadis is sometimes assisted by staff from the TMAs.

Regarding poor bill deliveries, in the large Katchi Abadis it is thought that up to 20% of bills being printed and sent for distribution are simply not being delivered. This is said to be due mainly to confusion of addresses in the Katchi Abadis (gas, electricity and town registration use different reference numbers). Also many bills are simply ignored because the recipients are illiterate.

9.4.4 Unbilled Authorised Consumption (Tankers)

A recent study by KW&SB states that prior to 1999 KW&SB was responsible for the operation of hydrants for road tanker supplies. When the Hub source failed the tanker service was transferred to the Pakistan Rangers as part of the "Water Crises Management". Pakistan Rangers would now prefer the operation to be taken over by KW&SB.

These tankers are a common sight in Karachi with an estimated 13,750 to 15,390 trips per day adding to the traffic volume delivering an estimated 15-20 mgd daily with a value of about Rs. 1 million/day according to KW&SB. It is estimated that about 25% of tanker deliveries are gratis, and there is a list showing the areas supplied and the approximate number of tanker trips. However, the criteria for selecting consumers for gratis tanker water supply are not clear.

This has been a very large source of authorised consumption for many years from which no revenue is derived and KW&SB are aware that a tanker "mafia" exists conniving with groups in both the private sector and staff of KW&SB to create artificial shortages and enhance profits at the expense of the consumers. In addition it is known that there are illegal tankers and hydrants. Hydrant supplies to tankers were not metered and revenue was lost by the operation of both legal and illegal tankers.

Water Tankers are currently still operated under the control of the Rangers from the existing hydrants but a completely new arrangement is being implemented and planned to be in operation by the end of June 2007. Under the new arrangement, Tanker supplies will be under the control of the City Nazim who has assigned Tanker operations to the Town Nazims for O&M by the TMAs. The rationale is that the Town Nazims are aware of the needs for tanker supplies through the UC Nazims.

The 1996 Act sanctions KW&SB on payment of fees for water supply to tankers which should be prescribed by regulations. Revenue should therefore accrue to KW&SB. However this system of operation by TMAs has been adopted and is allowed under GOS legal notification

No.SOVIII/KW&SB/2(41)/2002 whereby The KW&SB Act of 1996 may be amended to ensure the smooth implementation of the Sindh Local Government Ordinance, and CDGK may assign work to the TMAs. Whereas it would be preferable for KW&SB to run this operation, this system has been adopted. The intended arrangement is:

- KW&SB finance the construction of metered hydrants
- TMAs pay the full cost of operation & maintenance of the hydrants
- TMAs appoint Tanker operators by a tender process
- Tanker operators will charge domestic and commercial customers for delivery
- At the discretion of the TMAs, water will be provided free of charge to the poor and needy who lack a piped water supply

New metered hydrants have been constructed by KW&SB; hydrants have been completed in 15 towns (except SITE, Baldia, Orangi). These 15 towns should be operational by 15th June, and deliveries will be made within the town borders.

The 3 towns of SITE, Baldia and Orangi have the highest ratios of Katchi Abadis which have very poor piped water supplies. Large water tanks located in the towns are filled from the tankers and water is collected by bucket or hand pump. There are about 35 locations where water can be drawn free of charge.

Hydrants can not be located in these towns and all three towns will be supplied by a hydrant located close to the Hub Filtration Plant, which should be in service by the end of June 2007.

It remains to be seen how successful this operation will be under the new arrangement, but it seems unlikely that KW&SB will derive any direct revenue from tanker supplies. At least this service will be metered, more accurate figures of water supplied will be known, and there is an opportunity to reduce malpractice.

9.4.5 Non-payment of Billed Authorised Consumption

Billed Authorised Consumption is supposed to represent the total revenue of KW&SB for the provision of water & sewerage services. However, much of the revenue remains uncollected because of non-payment of bills, further aggravating the amount of non-revenue water. The KW&SB bill has charges for water, sewerage, conservancy and fire. The revenue for water & sewerage services is retained by KW&SB but the other charges are passed on to the TMAs. The collection situation is examined below:

(1) Metered Consumption (Bulk Water)

As stated previously metered supplies are confined to government departments, large industrial complexes and other large consumers including housing development areas with their own distribution systems, commercial high rise buildings, hotels etc. The extent of commercial losses due to incorrect billing or an incomplete database is not known.

However, Information is now being made available to the Revenue Department of KW&SB through the IRS/MIS system and results from May 2007 are summarised in **Table 94.5.1**.

Table 94.5.1 Monthly Billing & Collection for Bulk Consumers (May 2007)

	No. of Bills	Water Amount × Rs 1,000	Sewerage Amount × Rs 1,000	Arrears Water & Sewerage (Rs × 1,000)
Billed	4,995	194,474	48,730	7,395,644
Collected	2,067	72,928	21,745	N/A
Percentage	41.4%	37.5%	44.6%	N/A

Source: KW&SB Revenue Department

As can be seen, the collection rate for the month of May 2007 is unacceptably low considering the generally good supply conditions in the bulk supply system and the consumers' ability to pay. When the full year figures become available after June a more accurate assessment should be made.

The Revenue Department of KW&SB analyse all non-residential details and a list of consumers with arrears of more than Rs 50,000 goes to the Deputy Zonal Directors for action.

Clearly the full benefits of the recently introduced Integrated Revenue System, which rapidly provides accurate information on payment of current bills and arrears will not be realised until KW&SB institutes an integrated approach to act on the information provided and a monitoring system to assess the effectiveness of their efforts.

KW&SB are aware that a good collection rate from bulk consumers would go a long way towards eventual O&M cost recovery. According to figures supplied by KW&SB to ADB if all of the bulk water consumption was billed and collected it could generate an additional Rs 1.5 billion per annum.

(2) Un-metered Consumption (Retail Water)

A similar situation to the bulk supply exists for retail water in that non-payment of bills is a common occurrence. To illustrate this point a summary of the May 2007 monthly billing figures is given in **Table 94.5.2**.

Table 94.5.2 Monthly Billing & Collection for Town Retail Consumers (May 2007)

	No. of Bills	Monthly Water Amount x Rs 1,000	Monthly Sewerage Amount x Rs 1,000	Water Arrears Amount x Rs 1,000	Sewerage Arrears Amount x Rs 1,000
Zone I					
Billed	176,358	8,327	2,815	53,581	16,650
Collected	24,125	1,337	484	2,528	1,019
Percentage	13.7%	16.1%	17.2%	4.7%	6.1%
Zone II (A)					
Billed	178,386	17,894	5,241	53,581	16,650
Collected	26,452	4,105	1,216	2,528	1,020
Percentage	14.8%	22.9%	23.2%	4.7%	6.1%
Zone II (B)					
Billed	274,306	23,006	7,104	99,037	29,417
Collected	88,658	9,673	3,074	9,306	2,866
Percentage	32.3%	42.0%	43.3%	9.4%	9.7%
Zone III					
Billed	333,778	18,709	6,291	95,493	29,019
Collected	88,109	6,079	2,092	7,729	2,914
Percentage	26.4%	32.5%	33.3%	8.1%	10.0%
Total					
Billed	962,828	67,936	21,451	301,692	91,736
Collected	227,344	21,194	6,866	22,091	7,819
Percentage	23.6%	31.2%	32.0%	7.3%	8.5%

Source: KW&SB Revenue Department

An analysis of the these monthly results shows that overall a mere 23.6% of the bills printed and

delivered to the KW&SB offices for distribution to the consumers were actually paid; 31.2% of the monthly water billing was recovered (32% for sewerage) and 6.7% of the arrears were paid (8.2% for sewerage).
It had been hoped that a combination of monthly billing introduced for "retail" consumers in July 2006 with the inclusion in the bill of 5% of arrears and the imposition of a 10% surcharge on unpaid amounts would lead to a rapid improvement in the collection rate. Although there were some early gains when the monthly billing system was introduced there has been no significant improvement.

However the reason for non-payment of bills is not simply a matter of introducing a computerised monthly billing system. The system of bill delivery to the consumers does not work efficiently, the level of service is so poor that consumers see no reason to pay, and disconnection of supply and other punishments have proved unworkable.

There was little or no evidence of a problem of affordability in the Water Awareness Survey, clearly a major problem is willingness to pay. Much depends on the quality of service as illustrated by the Leakage Survey in Landhi Town where there is a very poor supply (only 8% of consumers pay their May 2007 bill). Another fact emerging from the Water Awareness Survey is that 60% of those questioned on none payment said simply that they did not receive a bill. The new complaints management system has a high proportion of complaints that the bill was not received.

In addition, more than half of the retail consumers interviewed said that they are not satisfied with the quantity & quality of water, and the billing & information system. 75% are not satisfied with the way KW&SB handle complaints and 70% do not trust KW&SB officials.

9.4.6 Billing & Collection System

In June 2006 KW&SB awarded a 5 year contract to Millennium Systems & Consultants (Pvt) Ltd. (MSCL) for the printing of bills and other services at a cost of Rs 4 per bill comprising:

- Printing of Consumers monthly Bills for both retail and bulk
- Develop & Implement application software for billing related complaints management
- Develop & Implement application software for billing related MIS
- Data Entry of changes in billing Database
- Correlate KW&SB Billing Database with Citibank
- Establish a Billing Complaints Centre at premises provided by KW&SB
- Establish a Software Development Centre for developing application software for KW&SB

The Integrated Revenue System (IRS) has been implemented in two phases:

- Printing of all bills on a monthly basis. This phase was completed in August 2006 for the printing of the July 2006 bills
- Implementation of Billing System, Complaint Management System (CMS), Collection System and other support systems. Implementation of the sub-systems commenced in December 2006

The MSCL facility is located in the recently refurbished Revenue Secretariat in the KW&SB office complex at 9th mile Karsaz, Shara-e-Faisal which also services the newly established Consumers Service Centre (CSC), the CRO and his supporting departments, and the Bulk Transmission departments concerned with billing & collection of bulk metered supplies. MSCL have a staff of 26 including 10 for the two shift telephone complaints centre currently open from 0900 hrs to 2200 hrs.

Bills are produced monthly for about 1 million retail (domestic un-metered) consumers and about 5,000 bulk metered consumers. The bills are for water, sewerage, conservancy and fire and include 5% of the arrears for payment each month with a surcharge of 10% for non-payment. Monthly bills are printed at a separate facility, boxed for collection by KW&SB staff for distribution from the KW&SB Town offices. Bulk consumer bills are delivered by the meter readers, retails bills are delivered by revenue staff at the town offices. There is known to be a problem with bill delivery due to confusion over addresses and lack of personnel.

MSCL have established the Software Development Centre and printing of monthly bills has been fully developed by MSCL together with data entry for changes in the data base; the development and implementation of application software for billing related MIS and billing related complaints management. The current extent of the IRS-MIS system is shown in **Table 94.6.1**.

Table 94.6.1 IRS-MIS Reports

Billing System Reports
Retail Demand Reports Zone/Town/UC/Quarterly Demand Report Monthly Retail Demand Analysis Collection Reports Town/Quarter collection Reports Town Collection through Banks/NADRA Town wise Collection (Current+Arrears) Yearly/Monthly/Town wise Collection Report Break up of collection for Incentive Purposes Printing Reports Bill Printing Volume Statistics Date wise Duplicate/Special bills Printing Report Town/UC Consumer Performance Report Employee with Greater than 1 consumer ID
Bulk Demand Reports Town/Sector wise Demand Report Collection Reports Town/Sector wise Bulk collection Report Yearly/monthly Sector wise collection Bill Printing Reports Bill Printing Volume Statistics Date wise Duplicate/Specials bills Printing Report Town/Sector wise Consumer Performance Reports Date wise Month wise
Payment Bank Banch wise Collection Town wise Demand v/s Collection Processing Data wise Collection Retail Payments Bulk Payments

The payment system is very high-tech and includes payment through mobile ‘phones, credit cards and cheques but also caters for the 65% of population who don’t have bank accounts with cash payments at banks or conveniently located NADRA kiosks. The aim was to increase the number of registered retail consumers to 1.2 million by the end of the first year of operation (June 2007), but this has not materialised.

Payment may be made through 550 branches of 9 banks, all payments being consolidated daily through Citibank who pass the information on to MSCL on CD with about a 2 day time lag. An

immediate improvement would be for the 9 banks to send the information directly to the IRS centre. In November 2006, KW&SB signed an accord with NADRA for payment of bills through their system of Kiosks. Currently this service is available at 66 kiosks and will be extended to all 178 UCs in the future. All bills include the sum of Rs 8 to cover the bank charges. This needs to be looked at with inclusion of payments through NADRA.

The Billing Complaints Centre, run and staffed by MSCL, is fully operational and now receives 150-200 calls per day since the telephone number was printed on the front of the January 2007 bills. Complaints are not confined to billing but to any aspect of KW&SB's service provision. Billing complaints are normally resolved very quickly at the centre. For all types of complaints, MSCL has developed the software in close cooperation with the revenue staff of KW&SB. The Complaint Management System includes a tracking system to complaint resolution. None bill related complaints are handled by the zone directors. The CMS reports are shown in **Table 94.6.2**.

Table 94.6.2 IRS-MIS Complaints Management System (CMS) Reports

Complaints Management System Reports
Complaints Registered as of "Date"
Status wise Complaints
By Town
By Department
By Action Owner
By complaint type
Analysis by Complaint Status
Complaint Type Aging Analysis of Open complaints

A review of the current Aging Analysis shows that 4,190 (70%) out of 5,979 complaints had not been resolved after one month.

KW&SB has recently set up 7 Customer Service Centres which receive a CD of the monthly bills and can produce duplicate bills for consumers who do not receive their bill. The IRS in the MSCL facility is connected to the CSC in the building to provide data for the printing of duplicate bills. The CMS is also connected but not being used.

9.4.7 Consumers Service Centres

A Consumers Service Centre (CSC) has been opened in the Revenue Secretariat at the KW&SB main office complex at 9th mile Karzas. As stated above it is able to produce duplicate bills for consumers who have not received their bill. About 1,000 persons per month currently use this service and there is a NADRA kiosk in the office for payment of the bill.

The centre also receives and registers complaints, including about 25 complaints per day passed on from the MD's secretariat located in an adjacent building. All these complaints are written up in an Inward Register, transferred to the computer for printed summaries to go to the Chairman, Vice Chairman, Additional Vice Chairmen and the MD of KW&SB. The Executive Engineers at the 18 towns are contacted for complaint resolution which is tracked.

In addition to this CSC at the KW&SB Main Office on 9th Mile Karsaz, there are 6 other Consumers Service Centres using the same complaints system and can issue duplicate bills. These are located at:

- Jamsheed (Located in the Tax Office)
- Gulshan e Iqbal (Located in the office of the Deputy director Taxes)
- North Nazimabad (Located in the Tax Office)
- Liaquatabad (Located in the KMC Supermarket)

- New Karachi town (Located in the Office of the Town Nazim)
- Gulshan e Iqbal (Located at the KW&SB Head Office)

All offices can issue duplicate bills and register complaints for transmission to the relevant Town offices. The offices computer hardware is old and needs to be replaced. The 5 offices in Jamsheed, Gulshan e Iqbal, North Nazimabad, Liaquatabad, and New Karachi town are located in the Revenue Office of the KW&SB Town offices. These "tax" offices are remote from the Town SE's offices.

A Request for Proposals (RFP) has been prepared to link the 7 CSCs to the IRS centre. IT equipment needs to be procured and connectivity between the CSCs and the IRS central system through LAN/WAN at the Revenue Secretariat. The RFP may be used for inviting proposals for procurement of the required IT equipment and Networking Services. This will enable all the centres to be linked by computer to the Integrated Revenue System (IRS) at the KW&SB Revenue Secretariat which will enable the monthly billing data to be received direct. In addition the complaints procedure will be computerised for integration in the central Complaint Management System (CMS) which will include a tracking system up to complaint resolution.

Recently CDGK commenced a project to set up Call Centres at the KW&SB Revenue Secretariat and at the KW&SB offices in all 18 Towns. These Call Centres are intended to handle complaints on all matters related to CDGK, not just water & sewerage. It is not intended to link this complaints system to CMS developed by MSCL. A transmission mast has been erected and a networking box installed at the KW&SB Secretariat, and computers, printers, scanners and UPSs are to be installed at all Towns. Clearly there is need to review this project at least with regard to linking the KW&SB related complaints to the CMS which is already operational.

9.4.8 Management System

Improvement of the management system for billing & revenue collection is a vital and urgent task. KW&SB has major problems in its revenue collection system to finance O&M, with poor revenue recovery and mounting arrears

Recent interventions appear to have had limited success in terms of improved revenue collection. Despite changes to the management of the bulk supply the payment of bills and revenue collection remains unacceptably low. The split to 5 administrative zones does not show any significant change to the revenue stream, and the full benefits of the recently introduced Integrated Revenue System (IRS) and Complaints Management System (CMS) will not be realised until KW&SB institutes an integrated approach to act on the information provided and a monitoring system to assess the effectiveness of their efforts.

The imminent management changes to the water tanker service must be closely monitored and its success or otherwise evaluated. Currently it would appear that tanker water will remain as non-revenue water, estimated to be 3% of supply, which appears to be a lost opportunity for NRW reduction and increase in revenue.

KW&SB would be well advised to urgently add the following to its internal reforms:

- Review and revise the bill delivery system
- Update the Register of Consumers

KW&SB is a typical bureaucratic government entity, with antiquated IT equipment, and a long serving staff steeped in tradition, inward rather than outward looking, constrained by civil service rules and regulations and subjected to both internal and external political pressure. Due to poor information and planning KW&SB has been unable to stay in tune with its customer base, control

water and revenue losses and respond rapidly to customer requests and complaints. Clearly institutional and management improvements must be made if revenue collection is to improve. An integrated improvement programme would develop an agreed institutional arrangement for KW&SB to operate along commercial lines together with reorganisation into area based management zones. For the Revenue Section this will require a change of mindset in the existing long serving staff, the introduction of professionals in finance and administration, and staff training in IT.

With the introduction of the latest technology and data management (IRS-MIS) KW&SB must not miss the opportunity to train its own revenue staff for strengthening of its management capacity. Strengthening is also required for the new CSCs requiring both IT skills training and training for dealing with complaint management. The 6 CSC offices should be linked to the IRS and CMS system at the KW&SB IRS centre. To this end, a Request for Proposals (RFP) is given in **Appendix A94.1**.

The introduction of the CDGK Call Centres for complaints on all aspects of CDGKs operations is a welcome addition. However, there is currently no intended connection to the KW&SB complaints management system. Integrated systems linked to the IRS-MIS are highly desirable and this connection should be explored. This is likely to be covered by the forthcoming ADB study of the "IT Platform for Asset Maintenance and Operations Management".

The need for education of consumers and dialogue with other stakeholders including NGO's, business and community leaders etc. has long been an outstanding issue. If KW&SB is to become an autonomous commercially oriented service provider there will be a need for management strengthening to establish an effective communications unit for improved communication and responsiveness to customer needs from senior management through its Public Relations Department and the newly established CSCs.

9.5 ESTABLISHMENT OF SUSTAINABLE DATA MANAGEMENT

A Geographic Information System (GIS) is generally defined as a computer based technology used to collect, store, manipulate, analyse and display geographically referenced data. GIS links spatial data to non-spatial attribute data. One of the main strengths of GIS is the capability to overlay information in different thematic layers, revealing complex spatial relationships between physical, social, and economic variables.

GIS has wide applicability in municipality, utility, or government agency. In developed countries, water and wastewater utilities are increasingly adopting GIS to perform day-to-day operation, maintenance, data management and customer service. Utilities can also use GIS for demand analysis, facility expansion planning, and network design based on hydraulic modelling and infrastructure management. KW&SB should develop its own GIS system according to their requirements.

9.5.1 GIS for Asset / Facility Management

Considering the existing problems in the operation and maintenance of water supply and sewerage facilities in Karachi, GIS applications for asset/facility management is the most important and basic requirements of the GIS development for KW&SB. GIS-based asset/facility management will increase the efficiency of renewal, expansion and disposal of the facilities as well as operation and maintenance.

In Karachi, many Katchi Abadis are located along the major rivers, Nalas, railway lines and

other natural drainage networks. Many of KW&SB reserved lands are located in these areas and encroached illegally. KW&SB's networks of water supply and sewerage face similar situation of illegal connection and tapping of water supplies resulting in substantial system losses. The Land & Estate Department of KW&SB intends to develop a GIS-based asset management system for the management of KW&SB lands and encroachments.

Automated facility management based on GIS usually manipulates and manages facility information (spatial locations and facility attribute data) and provide a comprehensive inventory process for pipelines, structures, and other manmade improvements. Facility management is an essential base of operation, maintenance, customer service, management of pipeline construction and future expansion planning in water and wastewater services. A GIS-based facility management system could also locate underground utilities correctly for new construction projects to significantly reduce construction change orders, construction costs and incidence.

Usually GIS-based facility management systems use a simplified representation of actual objects (e.g. a road can be represented as a line): it lacks the graphical design functionality of CAD. However, GIS can be supplemented by linking to as-built CAD drawings to provide its users with more accurate and detailed information as needed (e.g. for engineering purposes).

9.5.2 Ongoing Facility Mapping for the Study

At the beginning of this JICA Study, it was quite difficult to understand the configuration of the main water supply pipelines and sewers in Karachi because facilities maps consisting all the existing main water supply pipes or sewers of the 18 towns are not available with KW&SB. In most cases, only superintending engineers, who are managing each town's water supply and sewerage system or the bulk water supply system, keep facility maps/sketches of their areas in hard copy of different scales and styles. Therefore, prior to the preparation of the Master Plan, it was required to collect facility maps from KW&SB's offices of each town and to put the collected information onto the same base map to understand the existing water supply and sewerage systems in Karachi.

Facility mapping can be done in many ways. Base map and mapping software to be used vary depending on the required accuracy of mapping and applications of mapped products. For the preparation of the Master Plan, GIS-based mapping with high accuracy is unnecessary. Instead, CAD-based or simple mapping software-based facility mapping on a general city guide map of Karachi could be used for the purpose. However, JICA Study Team adopted GIS-based facility mapping using high resolution Quick Bird satellite imageries (0.6m resolution) for build-up areas and SPOT imageries (2.5m resolution) for surrounding rural areas as the foundation of its base map to achieve the following objectives:

1) To prepare accurate maps of existing major facilities for the planning of future facility improvements.
2) To support the sampling area selection and random sampling within the selected areas in the household survey (see **Section 4.2** Water Awareness Survey) with high resolution satellite imageries.
3) To provide KW&SB a basis for their future GIS development

JICA Study team have already carried out the GIS-based facility mapping in the following steps using 'ESRI's ArcGIS' software.

1) Evaluation of required base map
2) Acquisition of high resolution satellite imageries
3) Image processing and geo-referencing of the satellite imageries to use them as the foundation of base map

4) Digitisation of basic topographic futures such as roads and rivers from the satellite imageries as part of the base map.
5) Collection of existing facility maps and drawings from KW&SB's offices.
6) Scanning of the collected maps and drawings
7) Digitisation of the scanned maps and drawings into GIS layers
8) Rectification of the digitised information with the help of KW&SB's engineers using the satellite imageries.

In Karachi, many of main water supply pipelines and sewers had not been properly mapped with scale even as hard copy facility maps before the Study. Understandings of many facilities' locations stayed only in KW&SB's engineers' minds. The high resolution satellite imageries of 0.6m resolution was required as medium to extract the knowledge of the engineers on the existing pipelines and to locate them properly onto a map. These imageries had successfully helped KW&SB engineers of the 18 towns to locate their facilities in GIS. The facility locations digitised from the scanned maps were also rectified by a number of KW&SB engineers using high resolution satellite imageries. By November 2007, the JICA Study team have completed digitisation and rectification processes on the following information and infrastructure.

a) topographic information such as roads, rivers, canals, railways
b) administrative boundaries of CDGK, 18 TMAs and 178 UCs
c) the entire Bulk Water Supply System from the Kinjhar Lake to Karachi
d) 405 km trunk distribution pipes
e) 643 km distribution mains (10 inches and larger in diameter)
f) 325 km trunk sewers (18 inches and larger in diameter)
g) water distribution pumping stations
h) sewage treatment plants and pumping stations

The facility maps created using the GIS software have been used by the JICA Study team for the analysis of existing systems and the planning of future development as well as for the presentations of the Master Plan.

9.5.3 Future GIS Development in KW&SB

The establishment of GIS department within KW&SB has been discussed with KW&SB. One of the concerns of the establishment is the sustainability of the GIS system after the completion of the JICA Study. Since September 2007, JICA Study team have been providing on-the-job training for two officials nominated by KW&SB. These officials have been seconded to the JICA Study Team on a full time basis and have been working on the digitisation of small diameter distribution mains on a town-by-town basis. They will be able to continue the work even after the completion of the JICA Study. In the meantime, the JICA Study team have suggested that KW&SB should establish a 'GIS Department' and develop its GIS system on a stage-by-stage basis corresponding to the changes in the actual needs. The stage-by-stage development is proposed to avoid over-investments in early stages.

It is recommended that initially KW&SB should use the GIS system only for producing facility maps. It is strongly recommended that KW&SB should build up its GIS system using the same base map as has been used by the JICA Study Team. Otherwise, KW&SB will waste resources and will also face great difficulties in reconciling spatial data accuracy and consistency of collected data.

The management of the GIS system requires the continuous updates of facility data. In order to maintain the sustainability of the GIS system, it is recommended that KW&SB should not contract out the management of the GIS system to local consultants.

The stage-by-stage development of the GIS and GIS Department in KW&SB includes four stages, Preparation Stage, Initial Stage, Transitional Stage and Advanced Stage. Preparation Stage of KW&SB's GIS is already ongoing within the JICA Study team. After handing over of the GIS by the JICA Study team, KW&SB should proceed with the rest of stages by itself.

The tasks involved in each stage are presented below. In Transitional Stage, it is recommended that KW&SB should review this stage-by-stage GIS development plan considering changes in GIS requirements, the technical maturity of in-house GIS staff, and the availability of financial resources.

1) Preparation Stage (with JICA Study team): 2006-2007
   - Base map development from the satellite imageries and existing maps (roads, rivers, town boundaries, UC boundaries, etc.)
   - Creation of contour map
   - Mapping of existing major facilities (main water lines, sewers, pumping stations)
   - Mapping of planned facilities

2) Initial Stage (start with few KW&SB's in-house GIS staff): 2008-2010
   - Enhancement of base map accuracy and location adjustment of entered data
   - Entering existing water distribution pipes and sewers of small diameters
   - Deciding the attribute data to be collected for each type of facilities
   - Entering attribute data to the digitised water supply and sewer lines and other facilities
   - Defining topology of water supply and sewer lines as networks
   - Entering KW&SB's reserved lands including location of water reservoirs and distribution pumping stations.
   - Entering the information regarding encroachment on the KW&SB's reserved lands.

3) Transitional Stage (with standard GIS functions): 2011-2014
   - Update and improvement of existing facility data through extensive field surveys
   - Recording leakages and repair works for facility improvement
   - Land management for legal process regarding encroachment on KW&SB's lands
   - Trial development of consumer database and detailed distribution network for the distribution network improvement pilot project
   - Review of the GIS development plan

1) Advanced Stage (with specialized GIS software or program customisation): 2015-2025
   - Updating of facility GIS data and linking as-built drawings to the GIS
   - Development of costumer database using digitised housing plots to improve revenue collection and complain handling
   - Application of GIS for water distribution control, etc.
   - Maximizing the use of the established GIS for effective facility management and revenue collection.

It is envisaged that the high resolution imageries along with the GIS data developed will be transferred from the JICA Study team to KW&SB. The least-required resources for the initial stage of GIS development within KW&SB are shown in **Table 95.3.1**.

Table 95.3.1 Human Resources, Software, Hardware Required for the Initial Stage

Category	Items	Number	Required Experience, Specifications, etc.
Human Resources	GIS Manager	1	experience with GIS development planning, facility management, image processing, etc.
	GIS Operator	2	experience with geo-referencing and digitisation, etc.
	Office Assistant/System Technician	1	management of appointments with engineers, maintenance of the system, etc.
Hardware	High Performance PC	1	for image processing, etc. (3.2GHz dual core processor, 4GB RAM, Two SCSI HDs of 146GB, Graphic Card of 256MB)
	Middle Performance PC	2	for Digitisation, etc. (2.8GHz CPU, 1.5GB RAM, SATA HD of 200GB, Graphic Card of 256MB)
	Low Performance PC	1	for distraction work, etc.
	Colour Printer	1	A3 size ink jet
Software	ESRI ArcInfo	1	for geo-referencing and spatial analysis, etc.
	ESRI ArcView	2	for digitisation, inquiring and printing
	ERDAS Imagine	1	for image processing
	Standard Software	4	MS Windows, MS Office, Norton Anti Virus

During Initial Stage, KW&SB will need only two or three qualified in-house staff who could possibly be fulfilled from local GIS specialists having experiences with JICA Study team to ensure smooth transfer of the GIS data and required skills to KW&SB. Large-scale fieldwork, such as facility location data collection using GPS, can be outsourced to local consultants. However, once in-house GIS staff understands basics of GIS development, field works can be directly managed by in-house GIS staff by hiring field surveyors and providing them with necessary equipment such as GPS. Direct management by in-house GIS staff is more preferable in terms of capacity development and reducing expenses.

Large size scanner and plotter are also required for map digitisation and printing. In Initial Stage, however, KW&SB may use local printing shops for the scanning and printing of large size maps and drawings.

The absolute horizontal accuracy of the base map prepared by the JICA Study team is about 20 m in urban areas (Map scale of 1:40,000) and more than 20 m in the surrounding rural areas. In Initial Stage, the accuracy of the base map would have to be enhanced by re-rectifying the satellite imageries with accurate ground control points. For facility management, the base map will need to have about 1m of horizontal accuracy (Map scale of 1:1200). Considering DGPS available from survey companies in Karachi and the potential of the acquired 0.6m high resolution satellite imagery, the horizontal accuracy of 1m is achievable.

The locations of facilities already entered into the GIS need to be adjusted once the accuracy of the base map is enhanced. The accuracy enhancement has to be done before digitising distribution pipelines and sewer of small sizes because small pipes are normally laid in narrow streets where post location adjustment is very difficult.

The largest task in Initial Stage is the digitisation of small water distribution and sewerage pipes. First, the drawings or sketches of the small pipes have to be collected from KW&SB's town offices for digitisation. Then, the location and attributes of the digitised pipelines have to be rectified with KW&SB's engineers or felid workers on satellite imageries as already done for larger size pipelines during Preparation Stage. This is a continuous work and may take many years to complete in case of a large city like Karachi.

The proposed DNI pilot project should include the development of trial GIS-based customer database covering the relatively small target areas of the pilot project. It would be important to

examine the effectiveness and feasibility of customer database development at this stage before going into full-scale development of GIS-based customer database in Advanced Stage of GIS development. The feasibility of integrating the GIS-based customer database and the linking to the KW&SB's billing system should also be explored in this stage.

Advanced Stage requires software development to enhance the utilization of entered facility and customer data. For example, ESRI's ArcFM is the software specialized in facility management, which can be used for the KW&SB's GIS. Standard ArcGIS software is also covering various functions which can be used for facility management or other GIS applications for water supply and sewerage. Moreover, latest ArcGIS support program-interface customisation using Visual Basic, which is a user friendly program language. Since off-the-shelf GIS software is developing very fast, it is important to re-evaluate required GIS software and software customisation before going into Advanced Stage.

9.6 IMPROVEMENT OF CUSTOMER SERVICES

KW&SB do not have a clear customer mandate describing the levels of services to be provided and the responsibilities of customers to pay bills, settle arrears and to comply with regulations with respect to illegal connections, tampering with supplies, etc.

KW&SB does not conduct regular customer surveys to ensure that all customers who receive a supply are registered on the billing database. Whilst there is evidence of illegal connections and 'stealing' of water on a large scale, audits are not systematically conducted. Opinion surveys are not used to improve service shortfalls.

Currently monthly billing is practiced (previously annually). In an attempt to increase revenues, current bills include a portion of outstanding arrears and an interest charge for outstanding debt. This is a good approach to revenue management as monthly billing makes the charges more affordable and allows customers to budget their outgoings; however, it remains to be seen to what extent this approach has on reducing receivables and improving collection rates.

Current legislation allows KW&SB to set tariffs and charges with approval from Government, however, it would appear that the current tariff has remained largely unchanged since 1998. Based on initial analysis it is evident that this is not based on 'full cost recovery' and therefore coupled with the current poor billing and revenue recovery performance, revenues are not sufficient to fund KW&SB's operation.

Apart from 'bulk' (metered) customers, there is no metering of consumption and therefore the opportunity to base charges on actual consumption is being missed. Metering is accepted as the most appropriate method of charging and allows charging mechanisms to limit water wastage through applying block tariff pricing, with increased charges for consumption beyond essential use. This would also allow a fair system of subsidy/cross subsidy for those less able to pay.

KW&SB has segregated responsibility for the management and billing of bulk supplies from retail supply billing. The 'bulk meter unit' (reporting to CE (BT)) is responsible for meter reading and meter maintenance and has indirect responsibility for bulk billing ('key accounts') which has been established as a separate unit under the CRO. The 'key accounts' team has subdivided responsibility into customer groups such as 'commercial', 'industrial' and 'Local Bodies' to ensure regular and prompt payment. This warrants future consideration and investment in order to improve collection rates; for example, the key accounts group should be

in regular and close liaison with key customers with respect to technical matters as well as commercial matters.

The practice of billing or 'taxing' customers who do not have a water supply or sewerage connection or those that are not officially registered but receive a supply needs clarification. It is estimated that 70-80% of customers in certain categories either do not pay or have large arrears, not least the bulk customers, a number of which are government organisations. This is currently being tackled by KW&SB, however, the issue of ensuring 100% billing is a larger issues that warrants further investment and study.

Due to lack of training in the customer services arena staff are not well placed to provide improved services, as the required 'skill sets' are not well developed. This is becoming increasingly pressing as KW&SB have now established 7 "Consumer Service Centres" (CSC) with a plan to increase this to 100 centres, as well as contracting out telephone complaints handling for which KW&SB should be setting and monitoring service and performance standards.

KW&SB does not have a 'Customer Service Strategy' or service policy in place. Consequently, customer service practices and standards vary within and across Regions and are highly dependent on local management attitudes towards customer service provision. KW&SB will therefore need to consider introduction of a strategy that clearly details the organisation's strategic intent with regard to customer services. This should state short and long term service aspirations and service standards to be applied across the customer base.

Responsibility for key customer activities is fragmented, for example, contact management; head of the CSC at the 9th Mile complex reports to the MD, whilst the new contact centre operated by 'Millennium Consultants' reports to the CRO via Director (Billing). The current set-up does not allow for clear ownership of the whole process from initial contact through to satisfactory resolution. There are no documented procedures relating to contact management and complaints statistics or analysis is not used as a means of eliminating route causes of problems.

9.6.1 Effective Provision and Management of Customer Services

Effective provision of customer services will require that KW&SB is organised in such a way that focuses on service delivery. Viewed as a 'key process', customer services will be an 'enabler' to business success through integration with other key corporate processes such as operations and other support activities including finance, systems, HR management, strategic and business planning etc. Accordingly, rather than looking at improving services in isolation, KW&SB will need to consider a more holistic approach as depicted in **Figure 96.1.1**.

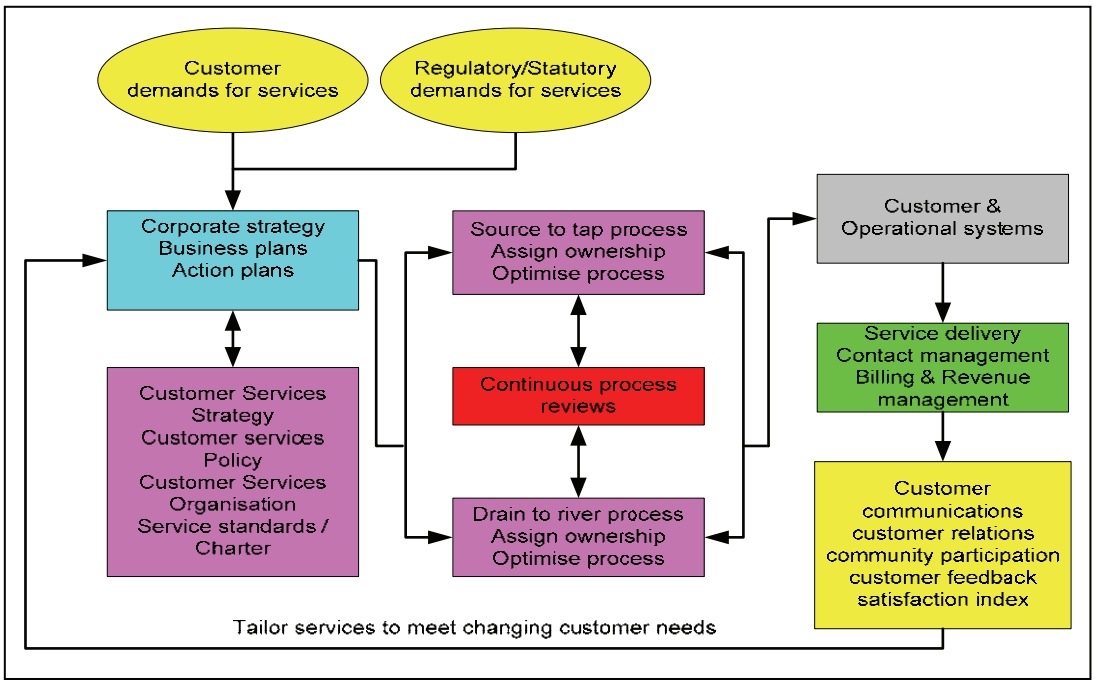

Figure 96.1.1 Customer Model

Based on the recent drive to improve revenue collection it is evident that KW&SB have recognised the paramount importance that good customer service practices has on the success of the organisation. Control of the revenue stream is vital to long-term financial sustainability and proper, responsible control of revenue through accurate metering and billing followed by responsive collection will ensure that KW&SB's financial position is sufficiently healthy to sustain growth and investment in future. In addition, timely response to customer service inquiries and requests (as well as complaints handling) is essential in building public confidence and support of the utility's management.

In order to highlight the importance of "Customer Services" and ensure that it receives the highest priority across the business, KW&SB will need to consider implementing a 'Customer Focus Programme'. The programme would be designed to focus on all 'customer facing activities' including contact management, billing and revenue collection, meter reading and meter management as well as customer and community relations.

This program will need to detail the agreed service standards to be applied by KW&SB (built around customer needs and values) and should seek to integrate the functional and process areas as shown in **Figure 96.1.2**. A fundamental part of this program involves consulting with customers to ensure they are provided with the opportunity for feedback and a say in how services are provided. KW&SB should continue therefore with the plan to establish further CSC's or 'Walk in Centres' (one in each town as a minimum).

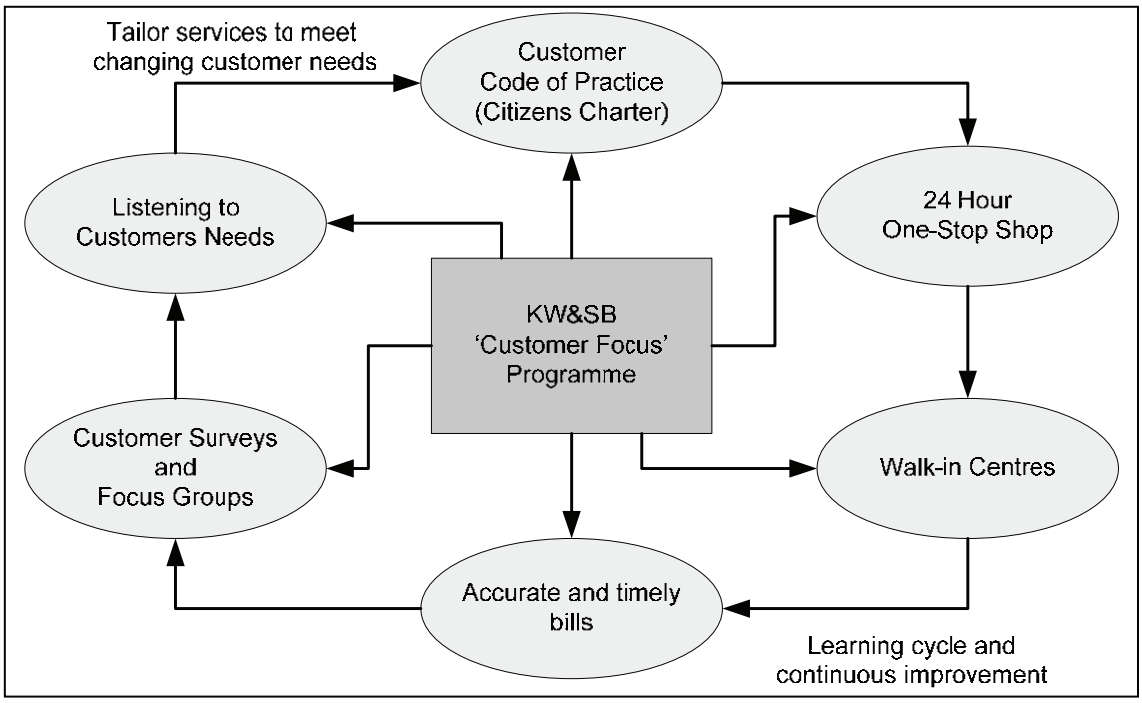

Figure 96.1.2 Customer Focus Programme

9.6.2 Organisation Design

KW&SB recognises that people are key to their success and that creating the right culture is fundamental to delivering service excellence. In this respect, customer service training should be provided to all staff. Recruiting, developing, and retaining the right people with the skills and behaviours to deliver excellent customer service will also be an essential part of enhancing customer satisfaction. A customer culture, vision and values will need to be developed that is visible in the work environment. Staff will need to be supported with quality procedures and the 'tools to do the job'.

Organizational Model

KW&SB's goal will be to provide a seamless service from 'source to tap'. This can be achieved by centralising the key customer processes, managed at 'the centre' without losing sight of the importance of local service provision within the Regions. KW&SB should therefore maintain a network of regional Walk in Centres with clear accountability to the Centre.

The Key functions at the centre would be as follows:

- Customer Relations - call centre, special accounts, customer correspondence, and complaints management
- Meter Services - meter testing and calibration, large meter replacement, planning and coordination of new meter installations, planning and coordination of meter replacement program
- Revenue Management - account administration, planning and coordination of meter reading, bill review and adjustment, payment processing, credit management, legal, contract management (3rd party service providers), and revenue maximization
- Performance and Planning – analysis of management information, performance management reporting, business plan development, monitoring of business plan delivery, coordination and communication of change activity

The Walk in Centres should offer local customer contact and payment facilities; although much of this activity will be centralized over time as business processes and customer behaviours change. Field based staff involved in meter reading, meter installation, meter replacement, investigation of high bill complaints, and turning on/off customer supplies would also be located in the regions, although the work planning and scheduling associated with these activities would be managed from the Centre.

9.6.3 Commercial and Customer Contact System

KW&SB are relying on third parties to provide customer database management, bill printing and some contact management (complaints handling) activities. In order to maintain 'ownership' of customer data, KW&SB should ensure that customer systems are developed that ensure sound financial performance whilst at the same time provide staff with the information they need to provide excellent service. In future, this will require the continued development of the systems provided by MSCL to ensure full integration of customer related activities that will provide staff with reliable, efficient, and instantaneous access to customer accounts, water system status, and other resources for ensuring customer satisfaction.

(1) Revenue Management

Whilst billing services are being provided by MSCL, KW&SB will want to ensure that customers are provided with clear, accurate bills in the most efficient and cost-effective way available. As such KW&SB will need to ensure that existing outsourcing/service provision arrangements are closely monitored in accordance with the contract to ensure compliance with performance standards.

a) Billing

The billing system is one of the key business systems as it covers the process from metering through to collection, and provides supporting information on previous queries, details of payment history etc. KW&SB (through MSCL where appropriate) will want to ensure that data held within the billing system is both accurate and up-to-date so as to facilitate correct billing and therefore should ensure that:

- Any changes to billing practices are introduced in a controlled, progressive manner with a clear plan of action with regard to communication and training to ensure that employees and customers alike are aware of new and/or amended policies and procedures
- Clear, concise bills that are easy to read and understand are designed with customer input to help reduce customer inquiries/complaints and prevent delays in bill payment
- "Right first time" bills are produced, minimizing cancellations and unnecessary customer contacts thereby reducing the need for debt recovery
- Procedures to ensure that changes of property ownership are completed with both ends of the chain captured to verify dates of ownership to minimize the "moved in yesterday" syndrome
- Periodic cross-referencing of the customer database is conducted with third party databases to identify customer gaps
- Meter readers and other field staff are encouraged (incentivised) to report potential illegal connections and other sources of unbilled usage via a dedicated internal hot-line.
- Fieldwork turn-around times are managed to minimise accounts awaiting work completion
- Key Account Liaison staff monitor high-volume commercial accounts, and other key accounts, and provide personalised services to these customers; focussing on additional revenue generation and water meter accuracy

b) Revenue Collection

KW&SB will want to maximise revenues at optimum cost and with a minimum of bad debt write-off. This will require development of a robust credit management policy and procedures which are clearly documented and communicated to all employees and customers, and which are applied without exception.

KW&SB (through third party arrangements for revenue collection where appropriate) will want to ensure:

- A pro-active approach to collection by actively chase outstanding debt
- Prioritised actions and interventions are taken based on materiality e.g. bill value
- All collection activities are carried out in a fair and reasonable manner
- Flexible payment terms are offered to those less able to pay
- Collection/credit management processes are reviewed regularly to identify potential improvements and enhancements
- Introduction of new payment options where of benefit to both customers and the business
- Bill payment strategies that actively promote cost-effective and convenient payment methods, such as automated bank drafts, payment at ATM's etc.
- That customer payments are processed and deposited without unnecessary delay
- The Call Centre and the Walk in Centres which will provide one of the main opportunities for influencing customer behaviour are provided with scripts and processes to ensure opportunities for managing credit risk are handled on a consistent basis

(2) Contact Management

KW&SB's goal will be to provide customers with a courteous, informed, and prompt response to their enquiries. The resolution of customers' problems at first contact will be key to achieving this objective and will require that staff (through MSCL where appropriate) have the proper tools, training, and management systems and programs to help them serve customers.

Customer-facing staff should have rapid access to all information necessary to resolve enquiries in a timely fashion, and to the complete satisfaction of the customer wherever possible. All customer contacts should be logged to ensure that a complete record of contacts is available for future reference and analysis. Customer Service staff should work closely with Field Service personnel across the entire operational area to enable customer's problems to be investigated and rectified promptly.

Currently MSCL try to resolve billing queries at first point of contact and record/pass on operational complaints for resolution by KW&SB staff. Further training is required to ensure that both billing and operational enquiries can be resolved at 'first point of contact'.

Contact management training can be provided effectively through developing and introducing a reference or training manual. The manual would contain all relevant procedures, details of policies relating to billing and collection/operational matters, and also key facts sheets with information about subjects such as water quality, current rates, water conservation, as well as answers to frequently asked questions. The manual should be regularly updated and supplemented with daily briefings on planned water supply interruptions, construction projects, or other activities that could impact customers. This could be provided as an "electronic bulletin board" on the current application developed and used by MSCL in the call centre.

a) Complaints Management

KW&SB will need to adopt a focused, pro-active approach to complaints handling. To ensure that procedures are followed, timescales are met, and that standards of response are satisfactory,

responsibility for complaint management should be assigned to dedicated teams who are trained to handle, track, progress chase, and monitor complaints.

All complaints should be recorded and coded as such to allow accurate information to be produced about the volume and nature of complaints received, and about response times to resolve them. This information should be used for the purposes of monitoring performance against the agreed standards and also for identifying trends in complaint volumes/types.

b) Call Centres

KW&SB will need to consider a number of call centre options available to them. Best practice suggests a single call centre acting as a 'single point of contact' on a 24-hour, 365-day basis is most effective for the consistent handling of both routine and emergency contacts. However, this requires major investment in and integration of systems. For ease of contact, there will be just one Customer Service telephone number that would be publicised widely.

Robust communication links, supported by efficient and effective systems, will need to be developed to facilitate the "one-stop shop" concept and to ensure that, as far as possible, customers experience a seamless service.

Customers will be able to contact the Call Centre to query and settle bills, make payment arrangements, and secure connection or termination of services. They will also be able to report operational problems and request advice or assistance on technical matters.

c) Walk in Centres

KW&SB should push ahead with the strategy to introduce 'Walk in Centres' at each of the 18 towns. KW&SB (through MSCL) are currently putting together plans to provide systems and communications links at 7 office locations. Walk in Centres should provide customers with the opportunity to interact with KW&SB face to face in convenient locations and in this way will play a key role within local communities as information and service providers.

Customers should be able to visit the Centres to set up contracts for water/sewerage services, pay their bills, resolve any questions about their accounts, request technical assistance, register complaints, and pick up information leaflets.

d) Customer Correspondence

Customers should be able to contact KW&SB by letter, fax, and email, with all correspondence logged on the system. KW&SB may wish to consider establishing a central Customer Correspondence team to ensure that incoming Customer Services mail is correctly sorted, logged, and distributed. Where appropriate they will investigate and respond to customer enquiries and complaints direct. If investigation or action is required by other departments, the correspondence team will track and monitor progress to ensure a prompt and full response to the customer. A key part of the Correspondence Team's activity will be to monitor and analyse customer correspondence on a regular basis to identify and eliminate problems, highlight potential areas for improvement, and reduce unnecessary contacts.

9.6.4 Customer Relations

KW&SB will need to develop a "Communications Strategy" that addresses the need to provide customers with clear concise information about services, for example; routine day to day operational information such as advance notification of interruptions to supply, or public education information, such as advice on water conservation.

The strategy may include the development of a range of customer information leaflets available

at the Walk in Centres or distributed with the bills as part of specific awareness campaigns focusing on topical issues. For example; an annual or semi-annual customer newsletter could be used to provide information about KW&SB's progress, about new services, and about forthcoming events. It could also contain articles on water related topics, such as advice about water conservation, water hygiene practices etc.

With the view of improving awareness and company image, KW&SB could also consider a regular programme of "open services", 'road shows', talks and presentations to the general public, community groups and businesses. Additionally as part of KW&SB's website strategy, customers should be able to obtain basic billing and operational information, for example, a guide to rates, what to do if you spot a leak, advice on saving water, etc.

(1) Interruptions to Service

On occasions interruptions to services will be necessary to allow improvements to the network. KW&SB should aim to provide customers with a minimum of 24 to 48 hours notice of any planned interruption to the service. In the event of unplanned interruptions; as a result of a burst pipe for example, KW&SB should aim to inform customers and relevant stakeholders as soon as possible of the loss of supply and advise them on when services will be restored. This notification could take any of the following forms depending on the extent of the problem and the number of customers affected: hand-delivered notice, verbal notice from Field Service personnel, loud-hailed message, radio broadcast etc.

(2) Public Education and Outreach Programme

The cornerstone of the 'Communications Strategy' should be a "Public Outreach Programme" that would focus on the following four main areas of interest:

- Role and responsibilities of KW&SB: what services are provided, processes involved in supplying potable water and treating sewage, cost of providing water and sewerage services and standards to be met in terms of service delivery, water quality, etc.
- Customer Service/Billing and Collection: how to enquire or complain, what are the current rates, how is the bill calculated, how are meters read, what payment methods/payment plans are available, what happens if you don't pay, etc.
- Water quality: how safe is the water to drink, how can you prevent contamination of the supply, how to get the quality tested, etc.
- Water conservation: why conserve water (financial and environmental benefits), how to save water in the home, water management in buildings (urinal controls, cistern displacement devices, grey water recycling in schools, offices, etc)

(3) Customer feedback and consultation

KW&SB will want to maximise the use of customer feedback and consult with customers about current and future standards of service. In this way KW&SB would be able to monitor actual performance, measure the effectiveness of any changes implemented, and anticipate future requirements. In addition, consulting with customers will help KW&SB to establish a direct relationship with customers and to demonstrate that customers' opinions are valued. Not all customers have the same level of expectations and requirements. Customer surveys will help KW&SB to identify and prioritise the elements and levels of service required by different customer types.

KW&SB may want to consider establishing "Regional Citizens Advisory Councils" composed of a cross section of the customer base. Establishing an ongoing dialogue with customers will be of benefit and the creation of Citizens Advisory Councils will provide useful forums for sharing information and ideas, create an atmosphere of openness, and ensure that KW&SB remain focused on customer issues.

The Councils would be made up of volunteer customers who would meet with KW&SB

representatives on a regular basis to discuss customer-related issues/initiatives. For example, the Councils could review new/revised customer literature, advise on proposed service improvements, provide a customer perspective on future legislative or policy changes, etc. Working in partnership with different sectors of the community in this way will undoubtedly help KW&SB to identify how they can offer further assistance or respond more appropriately to their needs, thereby enhancing customer satisfaction.

KW&SB may also wish to consider introducing customer suggestion boxes that will be posted at the Walk in Centres. Similarly an electronic suggestion box could be linked to KW&SB website so that those customers with access to the Internet could email their suggestions for service improvements.

9.7 REVIEW OF LAWS AND REGULATIONS

9.7.1 The Legislative and Administrative Framework

According to the Constitution of Pakistan, water is a Provincial subject and the responsibility for water related issues rests with the Ministry of Water and Power (MWP). Within the Ministry, exists the 'Water Wing' (WAPDA) to discharge its water related responsibilities. For water related matters, the MWP coordinates efforts primarily between WAPDA, the Indus River System Authority (IRSA), the Federal Food Commission (FFC), as well as other Federal Ministries and Provincial Irrigation and Agriculture Departments amongst others.

The relevant legislation in force includes the WAPDA Act, 1958; The Environmental Protection Act (EPA), 1997 and the IRSA Act, 1992 amongst others; whilst at a more local level the Sindh Local Government Ordnance (SLGO), 2001 and the KW&SB Act, 1996 run in parallel. Whilst the SLGO, 2001 gives general powers for the provision of water and sanitation services, the KW&SB Act, 1996, provides a more detailed account of specific technical and administrative responsibilities and powers vested in KW&SB as an 'autonomous' body. Also in force are the KW&SB APT Rules, 1987, the KW&SB Efficiency and Discipline Rules, 1987 and the KW&SB Delegation of Powers, 1991 amongst others. Some of these will have been superseded following devolution as the Government of Sindh (GOS) have issued a number of rules and regulations for local government departments. These include 'Local Fund Budget Rules, 2001'; 'TMA/UA, APT Rules, 2001'; 'Contract Rules, 2001', 'TMA Rules of Business, 2002', 'Conduct of Business Rules, 2001' amongst others.

More recently the Government of Pakistan (GOP) have issued the 'National Environmental Policy, 2005'; the 'National Drinking Water Policy, 2006' and the draft 'National Sanitation Policy, 2006. In response to national policy, the GOS have issued the draft 'Sindh Water Supply Policy, 2006' and the draft 'Solid Waste & Sanitation Policy, 2006'. With the advent of these recent policies it may be prudent for the GOS to consider introduction of a unified provincial 'Water Law' that seeks to eliminate the overlaps and anomalies by combining, clarifying and simplifying the plethora of existing Acts. Whilst the policies act as 'guiding principles', the water laws would need to clearly define roles and responsibilities for all 'actors' involved to ensure an 'integrated approach' to water resource management (IWRM), including the standards required for the supply of safe drinking water and disposal of waste water with due care for the environment.

Devolution of water and sanitation services (W&SS) from the Provincial Government of Sindh to the City District Government of Karachi (CDGK) was enacted as a result of the Sindh Local Government Ordnance (SLGO), 2001. This was effected by setting up a 'Water & Sanitation Department' (CDGK) headed by an 'Executive District Officer' (EDO). Along with other 'departmental heads' (responsible for provision of services such as Health, Education,

Agriculture, Transport, etc.,) the 'EDO Water & Sanitation' is responsible to the CDGK and the people of Karachi via a system of Town Municipal Administration (TMA) and Union Councils (UC's). Due to the size of the city and considering the "essential services" nature of W&SS, it was decided to retain KW&SB as the 'executing agency' for W&SS. As such the KW&SB Act, 1996 was not revoked when the SLGO, 2001 came into force. To maintain effective W&SS at a local level, KW&SB have recently re-organised its Divisional offices in line with the 18 Towns and within 3 hydraulic zones. The current KW&SB organisation structure with key functional responsibilities is shown at **Chapter 9** of progress report No.1.

In accordance with SLGO, 2001; of which Sections 52 and 182 are particularly relevant, KW&SB are responsible for water and sanitation (drainage, sewerage and sewage treatment) services for Karachi. KW&SB are also responsible for bulk supply of water to various agencies including 'Cantonments', such as the Defence Housing Authority (DHA), the Sindh Industrial Trading Estate (SITE), the Karachi Port Trust (KPT) and other major organisations/agencies. These organisations/agencies are responsible for onward distribution of water and collection/disposal of sewage. There has been much discussion regarding KW&SB taking ownership of the water and sanitation infrastructure within these areas and for provision of services, however, due to poor asset condition, this is yet to be agreed.

Working alongside KW&SB is the 'Sindh Katchi Abadis Authority' (SKAA), various Non-Governmental Organisations (NGO's) and 'City Community Boards' (CCB's) with the aim of improving W&SS and ensuring that all areas and communities throughout Karachi are represented. The idea of CCB's or 'beneficiary groups' taking an active role in the O&M of local schemes has been slow 'getting off the ground'.

Responsibility for compliance with 'drinking water standards', safe disposal of sewage and for compliance with environmental legislation/standards is placed on KW&SB, however, the fragmented nature and responsibility for W&SS provision as described above does not 'sit well' with this. KW&SB currently follow and are subject to compliance with the World Health Organisation (WHO), 1971 International Drinking Water Standards and the EPA Standards, for water quality and effluent quality, however, due to lack of effective independent monitoring or 'policing', KW&SB are effectively 'self regulating'.

Whilst KW&SB constitute an autonomous body, in carrying out its duties, KW&SB interact with a number of CDGK departments having either advisory, political, administrative or sanctioning powers over their financial and operational activities. In this event, KW&SB have little 'autonomous freedom' and therefore, essentially continue to operate as an executing agency with a number of financial and operational constraints placed on them coupled with a high level of political interference in day to day operations at local (Town and Council) level. KW&SB is governed by a board of directors of which the M.D KW&SB is a member and the City Nazim is the Chairman. Other board members include representation from private industry as well as government bodies. It is understood that whilst formal board meeting are conducted infrequently, The M.D consults on a regular basis with the Chairman of the board and other related CDGK and GOS departments regarding approval/processing of major development projects, approval of budgets, funding, financing, loan repayment, tariff adjustments, water quality/effluent standards compliance etc.

In conclusion, overall, there is sufficient legislation and policy pronouncement already in place, however, the motivation, coordination, resources, participation of beneficiaries and institutional capacity to effectively implement them appear to be sorely missing. Additionally, there would appear to be overlaps and lack of clarity in responsibilities for interrelated agencies and a lot of the legislation is very prescriptive and 'over-specified' which enforces strict bureaucratic routines and stifles the development of new ways of working. Therefore, with the concept of

making KW&SB more 'accountable', there is a need for new legislation (or Water Byelaws) that more clearly defines what KW&SB can and cannot do in relation to fulfilling their constituted responsibilities for the provision of water and sanitation services. This will include raising finances, cost recovery mechanisms (tariff setting), service standards, management of human resources, asset O&M, asset creation/disposal etc.

9.7.2 The Need for Consolidated and Appropriate Water Byelaws

The formulation of a new and appropriate 'Water Law' or 'Water Byelaws', to compliment current legislation is required. This warrants a more detailed study and analysis which could be taken up by ADB as part of their ongoing support to the GOS. In principle, the outline is provided in **Table 97.2.1** as a guideline for implementation of a consolidated and appropriate water law or byelaws which highlights the key requirements to be considered:

Table 97.2.1 Guidelines for New Water Byelaws

CHAPTER	SECTION	AREA TO BE COVERED
DEFINITIONS & INTERPRETATIONS		Definitions and interpretations
BYELAWS & LEVELS OF SERVICE	APPLICATION OF BYELAWS AND LEVELS OF SERVICE	Application of byelaws and levels of service
	TARIFFS, RATES AND CHARGES	Prescribed tariffs and charges for services Determination of tariffs Subsidies
	APPLICATION for SERVICES	Application for water services Application for sewerage services Special arrangements for services
	PAYMENT	Payment of deposits Payment for services provided
	ACCOUNTS	Account queries Appeals against findings of authority Arrears Payment plans
	TERMINATION AND LIMITATION OF USE	Limitation/purposes of use Discontinuation of services Interruption of services Restoration of services
	GENERAL PROVISIONS	Responsibility to comply with byelaws Unauthorised use of services Compliance with notices and documents Power of entry and inspection Damage to water supply schemes Pollution of water supply schemes Liabilities and compensation Offences and penalties
WATER SUPPLY SERVICES	CONNECTION TO WATER SUPPLY SCHEME	Provision of connection pipe Location of connection pipe Water connection for single property Water connection for multiple users Interconnection between premises Disconnection of connection pipe
	COMMUNAL WATER SERVICES	Access to stand post/spot sources
	TEMPORARY SUPPLIES	Emergency supplies Hydrant supplies Tanker supplies
	STANDARDS AND CONDITIONS OF SUPPLY	Quantity, quality and pressure General conditions of supply
	MEASUREMENT OF SERVICES	Measuring the quantity of water supplied Estimated consumption Defective measurement devices Customer side water losses

CHAPTER	SECTION	AREA TO BE COVERED
	INSTALLATIONS	Approval of installations Provision and maintenance of installations Authorised material specifications
	POLLUTION, RESTRICTIONS AND WASTEFUL USE	Responsibilities for preventing contamination Water restrictions imposed from time to time Water conservation methods Water quality sampling and testing
SEWERAGE SERVICES	STANDARDS & GENERAL PROVISIONS	Standards Objections to discharge to sewer network
	ON-SITE SANITATION	Application for infrastructure Service charges
	SEWAGE DISPOSAL	Provision of connecting sewer Connection to sewers Connections for single property Connections for multiple users Interconnection between premises
	INDUSTRIAL EFFLUENT	Application for disposal of industrial effluent Unauthorised discharges Quality standards Consequences of non-compliance
	QUANTITY OF DISCHARGE	Basis of measurement of domestic discharge Basis of measurement of industrial discharge
	INSTALLATIONS	Drains in streets or public places Construction standards by authority or approved provider Maintenance of facilities Pre-treatment facilities Protection from floodwater ingress

9.8 HUMAN RESOURCE DEVELOPMENT

9.8.1 Gaining Consensus on Human Resource Management and Development Needs

A senior management strategic workshop was held on 06 February 2007 with the aim of involving KW&SB in the development of the institutional aspects of the Master Plan, specifically with respect to 'Human Resource Management' (HRM) and 'Human Resource Development' (HRD) activities. The aim of the workshop was to enable a forum where senior KW&SB managers could express ideas and concerns in an open and honest environment with the idea of developing new ways of working that would transform KW&SB into a customer focused efficient and commercially sustainable professional Organisation.

The key findings as described below have influenced the development of the Master Plan.

(1) Consensus of HRM needs

- A professional HRM set-up should be established that sets policy and guidance for good HRM practices and procedures. This cannot be devolved to departmental managers
- Promotions should be based on performance and merit as well as the ability to do the job. This should include skills, 'values and behaviours', experience and qualifications as well as seniority
- Job transfers should be based on merit and the need to develop skills for the good of the individual and organisation alike. Avoid political appointments
- Investment in office facilities and equipment such as computers, desks and even stationary is required for staff to feel valued, part of the organisation, and motivated to work in a 'business like' environment
- If staff are officiating higher graded roles for extended periods they should be promoted and rewarded accordingly

- Managers should be free to take 'ownership' of problems and to make decisions based on delegated powers and authority without the need to refer even minor decisions to superiors. Managers should be 'free to manage' without fear of retribution to eliminate the current feeling of low moral and low esteem. Enthusiasm and creativity is being 'stifled' by the current management style and approach
- Job evaluation and job design should go hand in hand with rewards and recognition based on job size, responsibility for budgets, staff, resources etc.

(2) Consensus of HRD needs

- Professional in-house training facilities with organized training based on individual as well as departmental needs should be established with sufficient funds for effective operation. Induction training and vocational training are just as important as technical and on the job training.
- Learn from good practices in other well run organizations; scholarships, study tours and other methods could be used to build staff knowledge and capacity
- Career and succession planning should be based on organisation as well as individual needs. Staff should be supported in developing training needs for career progression and promotions should be based on 'the best person for the job' principle
- Job descriptions with clear roles and responsibilities are required so that staff are aware of what is expected of them and how their performance will be measured
- A professional, open and honest 'performance appraisal system' should be introduced that clearly defines goals, targets, training and development needs to improve individual performance

9.8.2 HRM and HRD Situation Assessment

A situation assessment of HRM and HRD aspects was conducted during the first phase of the JICA study. This can be summarised as follows:

The organisation does not have well defined policies or procedures in place for manpower planning, recruitment, performance management/improvement, motivation, succession planning, human resource development or training amongst other key activities.

Like other government establishments, KW&SB are bound by various civil service rules and regulation 'imposed' from time to time. This has influenced the current civil service 'values and behaviours' and is largely the cause of low morale and lack of motivation and enthusiasm prevalent throughout the organisation. Many employees have long service with KW&SB, turnover of staff has been negligible (apart from retirement) and recruitment has effectively been put on hold for the past few years. The practice of promoting staff based almost entirely on seniority rather than on 'ability to do the job' does little to encourage the development of sustainable policies and processes for improved performance. At the same time valuable experience and knowledge is being lost as routines are not in place to capture and transfer knowledge.

The current policy of internal transfers and promotions from within the organisation and no external recruitment (until most recently, whereby graduate engineers are currently being recruited) despite some obvious skill gaps is becoming more and more evident, not least due to the need to introduce new systems and technologies etc. to improve business, commercial and operational performance.

The current organisational structure is a traditional functional hierarchy. It does not provide the most efficient or effective way of organising the business. The present arrangement reinforces functional 'silo' mentality where each department or function invariably operates in

isolation to other departments with little coordination or teamwork across processes or lines of responsibility. This type of set-up potentially exacerbates bureaucracy, inhibits information flow and communications, prevents the sharing of best practice and stifles teamwork, creativity and initiative.

Due to the need for Systems and Process improvements, most of the functional departments within KW&SB are 'reactive' in nature with little time to assume a more 'pro-active' approach. The current set-up does not encourage communication and as a result the sharing of ideas and learning is limited. When operating through functional lines of control, it is difficult to prevent inefficient practices developing as each department tends to be 'inward looking'. This type of functional arrangement can often result in employees not being aware of 'wider' corporate issues.

KW&SB's low level of automation, particularly in the administrative field has led to labour intensive manual practices involving a large number of employees performing clerical, administrative or menial tasks compared to those performing skilled or technical/managerial tasks.

The industrial relations climate is poor which means that change initiatives are often stifled due to union opposition or intransigence. As water is highly politicised, local councillors and political parties are reluctant to 'rock the boat' or upset the 'steady state' by introducing or forcing through radical changes or reforms. This limits KW&SB's ability to initiate change within their own organisation, which in turn stifles initiative and enthusiasm for change.

(1) Process ownership

There is no central coordinating role at policy level dealing with HRM. Based on recent changes to the KW&SB organisation structure (June 2006), the Chief Administrative Officer (CAO) does not hold functional responsibility for HRD or Training activities. The CAO primarily holds administrative responsibility for HRM and Training activities. Responsibility for the Training function rests with the DMD (Planning & Design).

There is no longer a central coordinating role at policy level dealing with HRD. This has been devolved to the respective CE's and CO's to manage capacity building and enhancement of human resources within their areas of responsibility. KW&SB will need to take care that the lack of a central HRD Department with competent staff to deliver training and development activities, does not dilute their development efforts.

(2) Building Staff Capacity

Programmes for building staff capacity should be aimed at developing technical competencies, process competencies and managerial competencies to ensure efficient operation of all aspects of the business. Currently, apart from a variety of basic skills training courses, skills are developed by means of on-the-job training.

KW&SB can gain significant improvements in business and staff performance by enhancing and aligning skill levels with the stated needs of the business. This will require considerable investment in assessing competencies and tailoring training and development needs of each employee throughout the organisation to meet agreed individual, departmental and corporate objectives. This would lead to the need for introducing a "corporate training and development plan", which will require continuous monitoring and development.

KW&SB do not have a formal training policy or documentation regarding the training and development needs of individuals or KW&SB as a whole. However, both internal and external training is provided as funds allow. It is recommended that all training in future is based on

individual and departmental development needs and should be targeted and prioritised, rather than be made available to those who have time to attend.

The quality and success of training imparted is not measured or monitored. We recommend introduction of a system that measures the effectiveness of training delivered and the effects of training on the trainee's performance. Currently, KW&SB do not have a formal policy on career development or a career development and progression planning process, although criteria is well established for promotions and job transfers.

Little emphasis is given to training, development and promotional prospects of those lower down the organisation, for example clerical staff or labourers. The system of promoting to vacant positions based on seniority 'leaves them behind'. Equal emphasis and opportunities for further development and enhancement should be open to all employees. The ultimate aim of a career development programme is to enhance the future performance of the organisation itself through the development and advancement of its employees. It is recommended that individuals take responsibility for their own careers, by introduction of a training and development framework designed to allow all grades and disciplines equal opportunity for advancement.

(3) Managing Performance

KW&SB do not have a system in place for formally setting or communicating corporate, departmental or personal performance targets/key performance indicators and performance measures are not formally set or monitored. 'Job descriptions' are not widely used and therefore, key tasks and priorities and how these are measured are not always clearly understood. For KW&SB to be a successful service organisation, employees must know what is expected of them and to have the opportunity to learn new skills to improve their contribution to the 'Business'.

A system for sharing corporate objectives has not been developed and therefore, it is not clear how departmental or functional objectives are set and measured to ensure that these contribute to wider corporate goals. Similarly a system for sharing departmental objectives has not been developed and therefore it is not clear how individual's objectives contribute to wider departmental objectives.

The current system of 'rewards and recognition' (terms and conditions) does not relate to performance and therefore good performance goes largely 'unrecognised' and poor performance goes largely 'un-checked'.

No or little feedback is given to individuals regarding their performance; consequently, training or future development needs are not formally discussed, agreed or documented.

9.8.3 The Imperative for Change

The current reforms and commercialisation agenda is presenting a number of challenges to KW&SB, including the need to ensure that there are appropriate arrangements in place for effective human resources management and development with the idea of transforming KW&SB into a customer focused efficient and commercially sustainable professional organisation. It is recognized that this cannot be achieved by running the organisation on a 'business as usual' approach; a fundamental shift away from current business principles will require a new approach to human resource management (HRM) and human resource development (HRD).

(1) The Need for HR Policies

HR policies ensure that everyone is treated fairly and consistently and that their contributions to the success of KW&SB are appropriately recognised and rewarded. All employees should be fully aware of what is expected of them and what they, in return, should expect from KW&SB. HR Policies summarise the Organisation's responsibility to individuals and their responsibility to the Organisation.

The Policies

Detailed HR policies and procedures will need to be developed and preferably be contained in an "Employee Handbook", which would also require development. The HR policies/procedures should be readily accessible to all employees and KW&SB will need to take responsibility for facilitating understanding through training where appropriate.

a) Recruitment & Selection

KW&SB should have a non discriminatory policy to recruit and promote on merit as well as seniority, regardless of sex, pregnancy, trade union membership, sexual orientation, race, disability, age or religion. Wherever possible, existing employees should have an opportunity to apply for vacancy/promotion opportunities. KW&SB will need to clearly define recruitment and selection procedures/techniques which support this policy, and for training recruiters. All newly appointed employees should be integrated into their new role through a supervised induction programme and therefore be given appropriate support and guidance until they are fully competent to do the job.

b) Development and Training

Through performance management processes KW&SB will aims to ensure that all employees know what is expected of them and possess the necessary skills, knowledge, values and experience to achieve the highest level of performance of which they are capable. Wherever possible, KW&SB will undertake to provide development opportunities, such as study for qualifications, secondments, project work and undertaking other challenging roles.

c) Reward and Motivation

KW&SB's aim is to reward with fair and competitive salary and benefit packages. All elements of reward will need to be designed to support the achievement of desired behaviour, values and standards as well as high performance and continuous improvement/development. Reward procedures and mechanisms will need to be accessible and transparent. KW&SB will also recognise that pay/benefits are only one element of reward, and that personal development, recognition and celebration of achievement are also equally significant.

d) Equity, Diversity and Dignity at Work

KW&SB's employment policies will need to be based on the principles of equality and diversity, this being in the belief that the elimination of unfair discrimination in the workplace contributes to productivity and performance as it allows people's talents to be most effectively utilised. KW&SB will also need to commit to ensuring the dignity at work and fair treatment of all, and that procedures are in place for resolving any grievance or harassment issue which staff may have in connection with their employment.

e) Conduct and Capability

KW&SB will need to ensure that there is a strong management framework and key principles to support people at work. The purpose of the policy is to allow managers to deal effectively with staff and colleagues when their conduct, performance or attendance falls below acceptable standards. KW&SB will need to provide guidance and rules under which people can operate effectively, and through which the organisation can ensure compliance with relevant employment laws.

f) Job Security and Pensions

KW&SB will need to provide an equitable pension scheme for all employees. Where individuals are affected by changes to their role or their personal/health circumstances, all reasonable steps are taken to enable them to stay with the organisation. This may be through discussing possible solutions to enable them to continue in their role, adjusting working hours/patterns, or helping find a new role within or outside the Authority. As a responsible employer, there will also be a need to have in place policies which support a reasonable work-life balance. KW&SB should also aim to implement a 'Health and Safety Policy' which will set out the approach to managing 'Occupational Health and Safety' of all employees.

g) Communications, Information and Consultation

KW&SB should encourage an open and honest culture, and to ensure that all employees are regularly updated with what is happening in all areas of the business, and that consultation takes place as appropriate. Two way and face-to-face communication is essential, giving everyone the opportunity to ask questions and have a voice in decision making. KW&SB should also encourage a 'no-blame' culture, so that all can have their say without fear of reprisal or discrimination. Accordingly, KW&SB will need to put in place channels of communication (direct and indirect) and feedback, as well as making sure that communication is timely and inclusive. KW&SB will recognise and work with registered trade unions and put in place appropriate collective bargaining arrangements as necessary.

(2) The Need for Improved HRD Methods

The management of human resources is integral to business success. People are at the heart of the organisation and effective business, operations and customer services performance is closely linked to having a well-trained and committed work force in place. It is evident that the workforce and management in KW&SB are technically competent and capable of delivering the services required, however, there are opportunities for KW&SB to capitalise on these inherent skills by introducing more effective systems and strategies.

KW&SB will need to improve on their HRD approach in order to 'add value' to the training efforts currently provided, by **'professionalising'** the functioning of the Human Resource Department and by 'building' capacity of the staff engaged in delivering HRD and Training services. The HR Department will need to be developed to take a more proactive role by providing overall direction and strategy for HRD and Training activities and by providing support to 'line managers' responsible for the key business processes described earlier. This approach will ensure that line managers take a more active role in staff development issues whilst at the same time ensure that employee needs and expectations are adequately managed.