S4 MASTER PLAN

S4.1 WATER DEMAND FORECAST

S4.1.1 Population

(1) Past Trend of Population Growth

Karachi City conducted population censuses in 1961, 1972, 1981 and 1998. **Table S41.1.1** shows past population and actual annual population growth rates of Karachi City.

Table S41.1.1 Past Population and Annual Population Growth Rate

	1961	1972	1981	1998
Population (×1000)	1,912.6	3,498.6	5,395.4	11,335
Annual Growth Rate		5.5%	4.8%	4.5%

Note: 1) 1961, 1972 and 1981: Karachi Development Plan 2000, June 1991
2) 1998: Adjusted by Karachi Strategic Development Plan 2020 (August 2007) based on 1998 census data of 9.96 million.

(2) Future Population

Karachi Strategic Development Plan 2020 (KSDP – 2020) issued in August 2007 projected the future population in Karachi as shown in **Table S41.1.2** and **Figure S41.1.1**. The JICA Study adopted this population projection based on the agreement made in the steering committee held on 2nd October 2006. The future land use plan in Karachi proposed in KSDP – 2020, as well as the future population projection, was also referred to in preparing water supply and sewerage master plan in this study.

Table S41.1.2 Future Population of Karachi

	1998	2005	2010	2015	2020	2025
Population (×1000) *	11,335	15,120	18,529	22,594	27,550	32,506
Growth Rate		4.20%	4.15%	4.05%	4.05%	3.36%

*: 1) 1998 to 2020: Projected by KSDP - 2020 (August 2007) 2) 2025: Projected by JICA Study

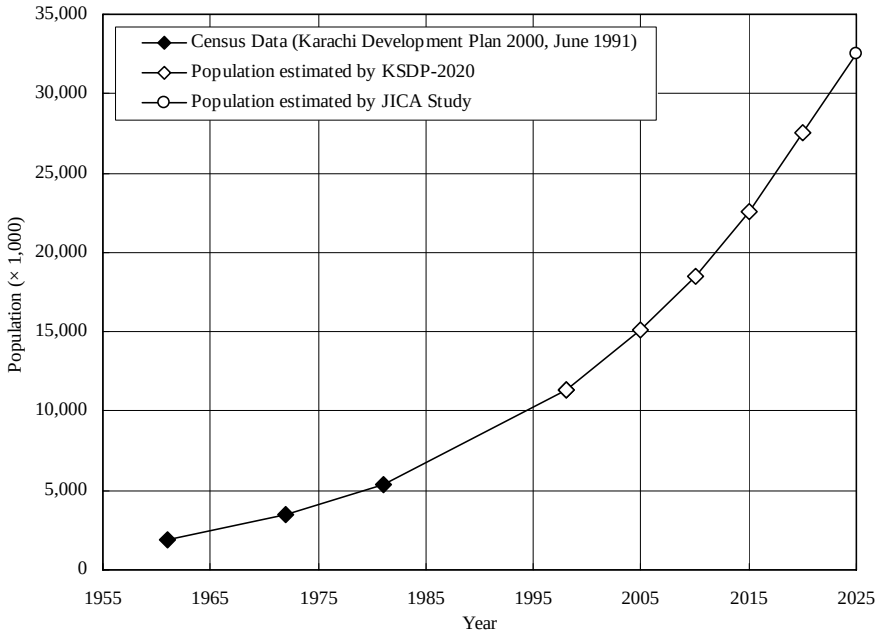


Figure S41.1.1 Population of Karachi

S4.1.2 Water Demand

(1) Basis of the Future Water Demand Forecast

1) Per Capita Bulk Water Demand

The present water supply system of Karachi City has a bulk (raw) water supply capacity of 600 mgd as shown in **Table S41.2.1**. This figure does not include the bulk supply of bulk water from Gujjo Headworks to Pakistan Steel Mills and Port Qasim Authority which have their own bulk water transmission facilities (canals and pumping stations) and filtration plants. As of the end of year 2006, KW&SB actually supplies bulk water of about 630 mgd, which exceeds the capacity of 600 mgd.

Table S41.2.1 Bulk Water Supply Capacity

Bulk Water System	Capacity	Actual Supply
GK System	280 mgd	300 mgd
Haleji System	20 mgd	30 mgd
K-II System	100 mgd	120 mgd
K-III System	100 mgd	100 mgd
Dumlottee Wells	20 mgd	0 mgd
Hub System	80 mgd	80 mgd
Total	600 mgd	630 mgd

source: KW&SB

Therefore, per capita bulk water demand in 2006 can be calculated by dividing actual supply amount of 630 mgd by the population in 2006 of 15.8 million as follows:

$$\frac{630 \text{ mgd}}{15.8 \text{ million}} = 39.9 \text{ gallons/capita/day (181.3 lpcd)}$$

At present KW&SB supplies bulk water of about 40 gallons per capita per day (gpcd) or 181 litres per capita per day (lpcd) for the water supply system in Karachi. This JICA study proposed that 40 gpcd should also be adopted for bulk water demand for the year 2025. Although the bulk water demand of 40 gpcd in 2025 is as much as the present demand (as of 2006) shown above, domestic per capita water consumption will increase because of the reduction of technical water losses (UFW) and expected water-saving efforts of non-domestic consumers.

2) Service Ratio

Considering the socio-economic survey conducted in Karachi Strategic Development Plan 2020 (Socio Economic Survey Report – 2005, Karachi City Profile, V-1.0/January 25, 2006) and our survey which was conducted mainly at Katchi Abadis during the period of basic study in 2006, JICA study has adopted 90% as the current average service ratio in Karachi in 2005. Considering the average groundwater withdrawal of about 30 mgd (Feasibility Study to explore Groundwater Sources in Karachi District, KW&SB, 2004), only 5 % to 10 % of the population in Karachi currently have access to groundwater other than the KW&SB water. Consequently about 90 % of the population is using the KW&SB water because there is no alternative bulk source in Karachi other than the KW&SB water and groundwater. The service ratio in Karachi is assumed to increase gradually from the current 90% to 100% by 2015.

3) Non-Domestic Water Consumption

Non-domestic water consumption accounts for about 40% of the total water consumption in Karachi. In the future, however, this proportion is expected to decrease gradually to about 35% in 2025 as a result of water conservation efforts such as recycling and reuse of wastewater and introduction of desalination systems by large industrial and commercial consumers.

4) Technical Water Losses (UFW)

The current UFW in the transmission and distribution systems from filtration plants to

customers was reported to be 25% to 35% of the total water supply capacity. It is assumed that through the implementation of the Distribution Network Improvements (DNI) during the next 20 years, UFW will be reduced to 15 % by 2025.

(2) Future Water Demand

Table S41.2.2 shows the target figures proposed for preparing the water supply master plan, regarding service ratio, non-domestic consumption ratio and technical water loss (UFW).

Table S41.2.2 Target of Future Service ratio, Non-domestic Consumption Ratio and Water Loss (UFW) Ratio

Year	2005	2010	2015	2020	2025
Service Ratio	90.0%	95.0%	100.0%	100.0%	100.0%
Non-domestic Consumption Ratio	40.0%	39.6%	38.3%	36.8%	34.8%
Technical Loss (UFW)	35.0%	33.0%	28.5%	21.5%	15.0%

Based on **Table S41.2.2**, the future water demand was calculated as shown in **Table S41.2.3** and **Figure S41.2.1**.

Table S41.2.3 Future Water Demand

		unit	2005	2010	2015	2020	2025
a	Population	× million	15.120	18.529	22.594	27.550	32.506
b	Per Capita Bulk Water Demand	gpcd	40.0	40.0	40.0	40.0	40.0
c	Bulk Water Demand: a × b	mgd	604.8	741.1	903.8	1,102.0	1,300.3
d	Bulk Water Loss	%	10.0%	10.0%	10.0%	10.0%	10.0%
e	Water Demand: c / (1+d)	mgd	549.8	673.8	821.6	1,001.8	1,182.0
f	Water Loss (UFW)	%	35.0%	33.0%	28.5%	21.5%	15.0%
g	Total Supply to Customers: e × (1-f)	mgd	357.4	451.4	587.4	786.4	1,004.7
h	Ratio of Domestic Consumption	%	60.0%	60.4%	61.7%	63.2%	65.2%
i	Domestic Consumption: g × h	mgd	214.4	272.6	362.3	497.3	655.3
j	Non-domestic Consumption: g × (1-h)	mgd	143.0	178.8	225.1	289.1	349.5
k	Service Ratio	%	90.0%	95.0%	100%	100%	100%
l	Served Population: a × k	× million	13.608	17.602	22.594	27.550	32.506
m	Per Capita Consumption: i / l	lpcd	71.6	70.4	72.9	82.1	91.6

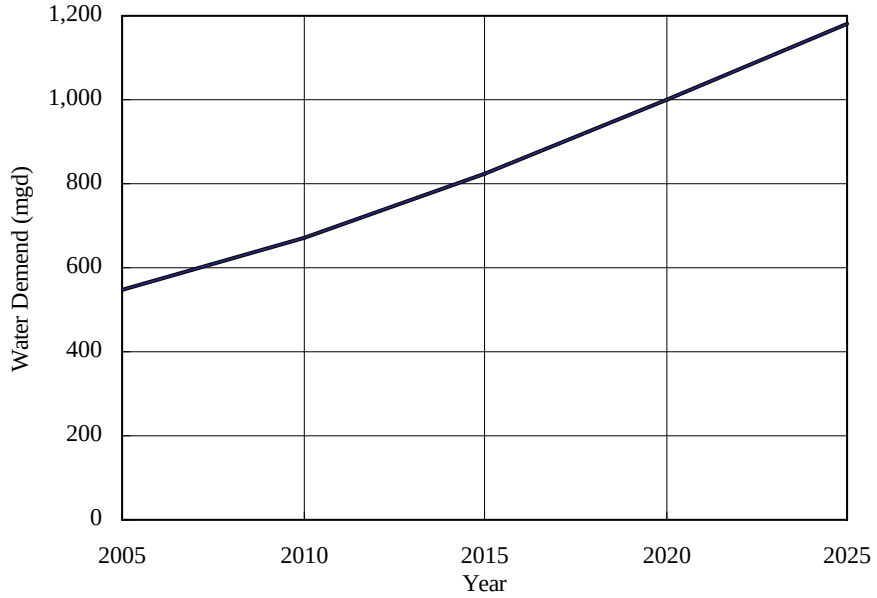


Figure S41.2.1 Future Water Demand

S4.2 WATER SUPPLY MASTER PLAN

S4.2.1 Planning Assumptions

This section discusses the planning assumptions, based upon which our master plan for the water supply system in Karachi has been formulated.

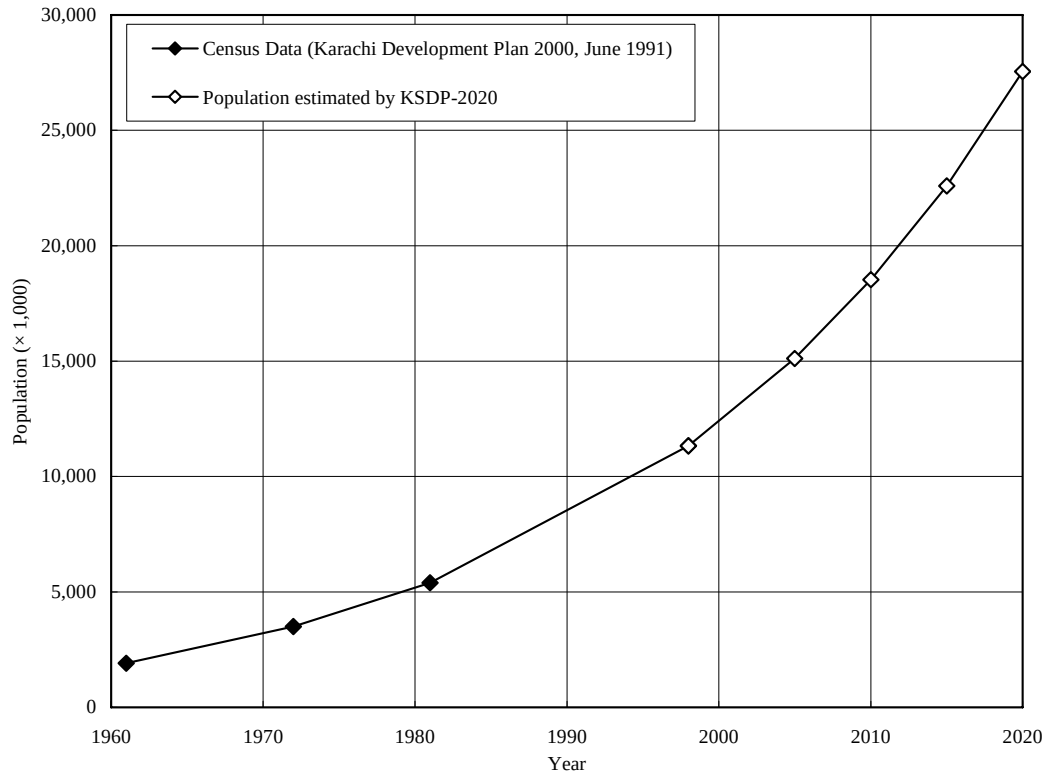
(1) Population and Development Patterns

In August 2007, CDGK issued the final report on Karachi Strategic Development Plan 2020 (Final Report, August 2007). This report indicated that the total population of Karachi was 15.2 million in 2005 and it would increase to 27.5 million in 2020. The report also predicted that more than 45% of the projected population increase during the 15 years from 2005 to 2020 would occur in the three towns located on the outskirts of Karachi City, namely Keamari, Gadap and Bin Qasim whereas the other 55% would occur in the remaining 15 towns. This was based on the perception that during the next 15 years significant developments would take place on the outskirts of the city in particular in the southern part of Gadap Town. **Figure S42.1.1** shows the population projections made in the Karachi Strategic Development Plan 2020 (Final Report, August 2007). **Figure S42.1.2** illustrates the future land use envisaged by the same plan.

Karachi's total population was 15.2 million in 2005 and it would increase to 27.5 million in 2020.

We believe that the Karachi Strategic Development Plan 2020 (KSDP-2020), once it is approved and authenticated by higher authorities, will serve as a guiding principle, based on which all infrastructure development schemes for all public service sectors, such as water supply, sewerage, solid waste disposal, electricity, gas, telecommunication and roads will be developed. For this reason, we decided to develop a water supply and sewerage master plan for Karachi based on the population projection, future land use patterns and other basic data provided in the KSDP-2020 (Final Report, August 2007).

It has been predicted that 45% of the population increase during the 15 years from 2005 to 2020 would occur in the three towns located on the outskirts of the Karachi City, namely Keamari, Gadap and Bin Qasim while the other 55% would occur in the remaining 15 towns.



Year	1981	1998	2005	2010	2015	2020
Population (1,000)	5,395.4	11,335	15,120	18,529	22,594	27,550
Average Annual Growth Rate (%)		4.46%	4.20%	4.15%	4.05%	4.05%

Figure S42.1.1 Population Projection in KSDP-2020 (Final Report - August 2007)

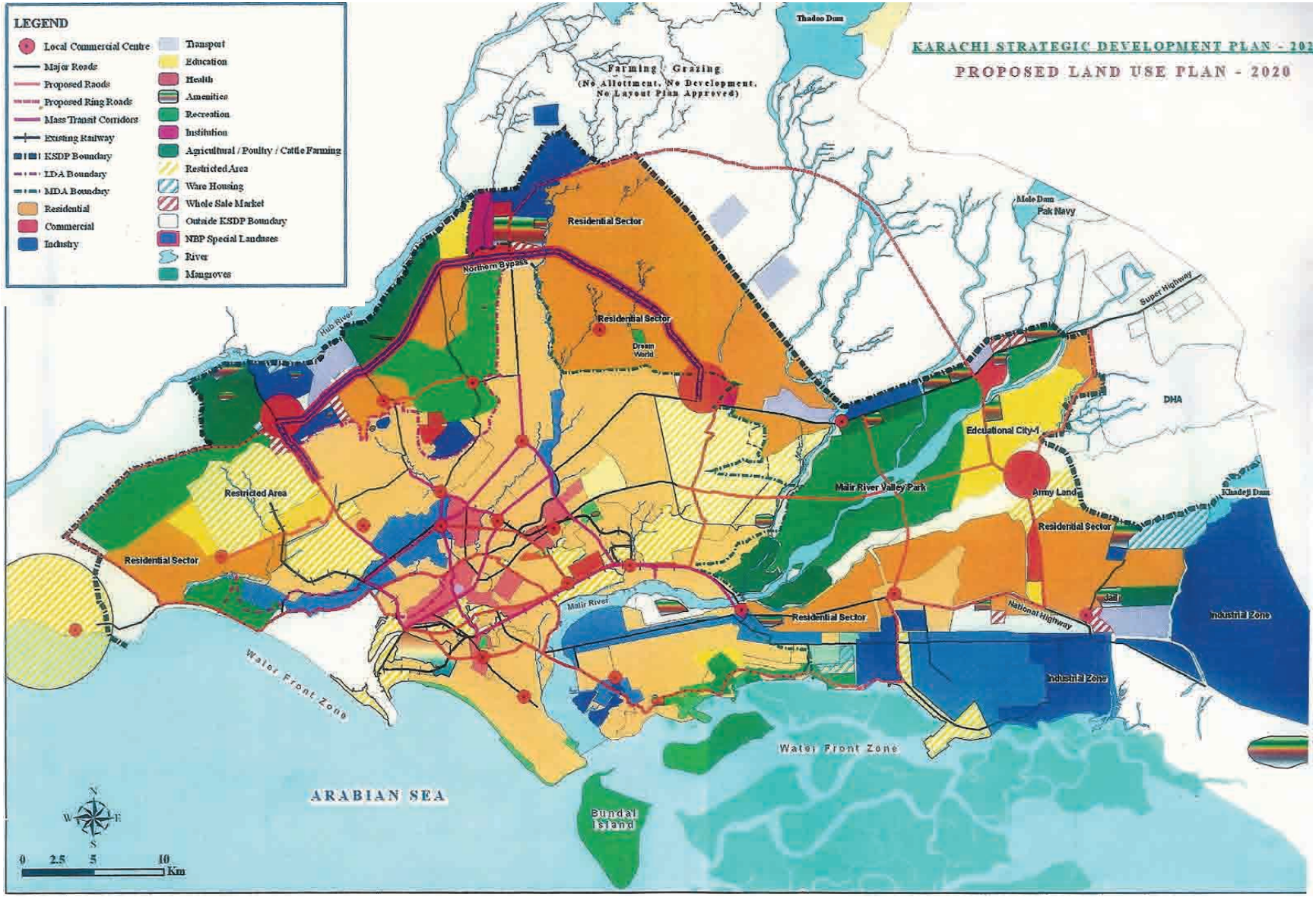


Figure S42.1.2 Land Use Plan proposed in KSDP- 2020 (Final Report - August 2007)

(2) Water Sources

Despite the significant population increase envisaged by the KSDP-2020 (Final Report-August 2007), there has been no definite plan for increasing the capacity of water sources to meet the increasing water demand. In this respect, the KSDP-2020 has proposed the use of several modern technologies to increase the water supply capacity. They include the construction of sea water desalination plants, reuse of effluents from sewage treatment plants for recharging groundwater aquifers, and the development of dual water supply systems and dual sewerage systems. However, most of these technologies are not considered financially viable both at present and in the foreseeable future.

In the light of the immense size of the water demand in the city, there is no doubt that the Indus River will continue to remain as the only viable water source for Karachi in the foreseeable future. This view was first indicated by the 1985 water supply master plan study for Karachi conducted by Sir M. MacDonald and Partners (principal consultant) and Associated Consulting Engineers (local associated consultant). The study made a review of all potential water sources in the Karachi region, which included the Indus River and other surface water and groundwater sources, seawater desalination, and the indirect reuse of treated sewage effluents for the recharge of aquifers and substitution of existing non-potable uses. As a result, the study indicated that the Indus River and desalination are the only two sources that could technically meet a large water demand in Karachi. The study also indicated that the cost of desalination for the foreseeable future was prohibitive and that desalination should therefore be considered as a last resort. The study then concluded that the Indus River was the only viable water source for Karachi.

This view was endorsed by a special committee formulated by GOS in 2002. The committee, which was comprised of representatives from the Planning and Development Department of GOS, Irrigation and Power Department of GOS, and Karachi Water & Sewerage Board (KW&SB), prepared a report on long term water supply plan for Karachi up to the year 2025. The committee submitted the report to the Central Development Working Party (CDWP) on November 14, 2002, which was evaluating the PC-I of the scheme "Assured Water Supply for Karachi – upgrading Kinjhar Lake System" at that time. In summary, the report provided the following major findings and recommendations.

(Findings)

- The existing allocation of 1,200 cusecs from the Indus River would be fully utilized in 2005 with completion of the 100 mgd K-III project. The population of Karachi was ever growing and additional requirement up to the year 2025 was estimated to be another 1,200 cusecs thus the total requirement would be 2,400 cusecs.
- The present scheme for assuring a water supply for Karachi is considered as Phase-I. This phase is to cater for short-term assured water for Karachi City up to the year 2005. Phase-II of this scheme would be required for long-term requirement of water supply in Karachi beyond 2005 and up to 2025.

(Recommendations)

- To meet the growing water demand of Karachi the water allocation for Karachi up to 2025 may be increased by another 1,200 cusecs raising the total allocation to 2,400 cusecs by the Government under a national cause without affecting the water supply quota of Thatta District for agriculture purposes. Once additional allocation was allowed then a 2-stage study programme for system expansion would have to be initiated.
- Stage-I: Study by the Irrigation and Power Department of GOS for increasing capacity in the system from the KB Feeder Upper up to the Kinjhar Lake without affecting the stability of the Kotri Barrage.
- Stage-II: Feasibility study by KW&SB in consultation with the Irrigation and Power

Department of GOS for determining the most economically viable, technically feasible and secure route to bring additional 1,200 cusecs of water from the Kinjhar Lake to Karachi.

Based on the committee's recommendations, CDGK requested the GOP to grant an additional quota of 1,200 cusecs (650 mgd) from the Indus River to meet the future water demand of the Karachi City. Furthermore, KW&SB since October 2005 has been conducting the K-IV Study, the main objective of which is to recommend on the most economical and technically viable route for conveying additional 1,200 cusecs of Indus water from the Kinjhar Lake to Karachi. The study examined several alternative routes and recommended the most economical route as a result of the comparison of capital and annual operating costs to be required for each alternative. Further, the study also identified the sites for construction of three water treatment plants each having an ultimate treatment capacity of 260 mgd, 260 mgd and 130 mgd. **Figure S42.1.3** shows the locations of the raw water conveyance route and three water treatment plants proposed by the study. In January 2008, President Pervez Musharaff while presiding at the 'foundation stone unveiling ceremony' of the 'Corridor Project' at Governor's House assured the Federal Government's supports towards the implementation of the K-IV Project.

In developing a water supply master plan for Karachi, the JICA Study assumed that Karachi would be granted an additional quota of 1,200 cusecs from the Indus River and a total of 2,400 cusecs of Indus River water would be made available at the Kinjhar Lake for extraction by KW&SB. This is based on our strong belief that if this additional quota is not granted, then there will be no such a large population increase or significant developments in Karachi as have been envisaged by the KSDP-2020 (Final Report-August 2007).

Karachi would be granted an additional quota of 1,200 cusecs from the Indus River and a total of 2,400 cusecs of Indus River water would be made available at the Kinjhar Lake for abstraction by KW&SB. If this additional quota is not granted, then there will be no such a large population increase or significant developments in Karachi as have been envisaged by the KSDP-2020 (Final Report - January 2007).

The Department of Irrigation and Power of GOS is currently responsible for the operation and maintenance of the Kotri Barrage, KB Feeder Upper and Kinjhar Lake while KW&SB's responsibility for the operation and maintenance of the bulk water supply system starts from the KG Canal that withdraws the impounded water of the Kinjhar Lake. It is likely that this demarcation of responsibilities will remain unchanged in the future, and as such, it is assumed that any infrastructure development required for enabling KW&SB to withdraw additional 1,200 cusecs from the Kinjhar Lake would be planned, designed and implemented by GOS and that GOS would also be responsible for the operation and maintenance of such additional infrastructure. Instead, it is assumed that KW&SB would pay GOS a raw water charge at the rate of Rs.0.5 per 1,000 gallons (Rs.0.11 per m^3) to compensate GOS for part of the costs incurred with respect to the construction, operation and maintenance of such infrastructure.

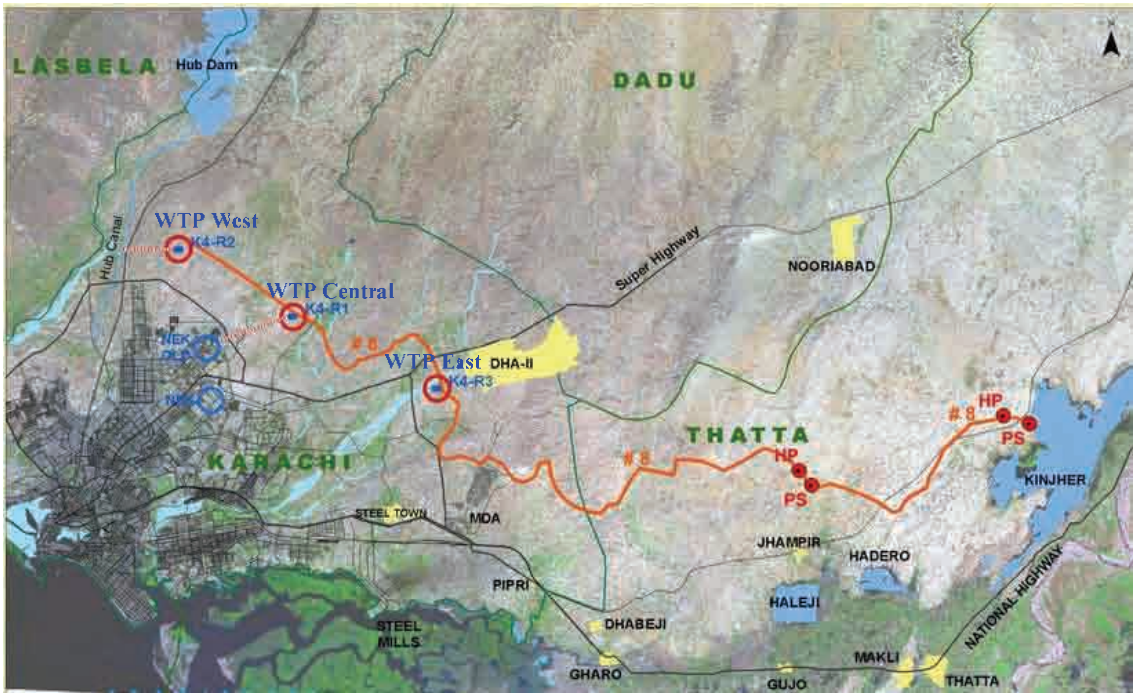


Figure S42.1.3 K-IV Project (Source: K-IV Project Executive Summary, OSMANI May 2007)

S4.2.2 Basic Policies, Goals and Strategies

This section discusses the following basic policies adopted for the formulation of the water supply master plan.

- Demand Management Approaches
- Separation of Bulk and Retail Supplies
- Zone-wise Management of Retail Supply
- Implementation of Distribution Network Improvement (DNI) on a Financially Sustainable Basis

Basic Policies Adopted for the Formulation of the Water Supply Master Plan

(1) Demand Management Approaches
(2) Separation of Bulk and Retail Supplies
(3) Zone-wise Management of Retail Supply
(4) Implementation of DNI on a Financially Sustainable Basis

(1) Demand Management Approaches

KSDP-2020 estimated that Karachi had a total population of 15.2 million in 2005 and also projected that the total population would increase to 27.5 million by 2020. It is envisaged from this projection that Karachi's total population could reach 32.0 million in 2025, which is almost double of the present total population. On the other hand, the possible increase in the capacity of water sources over the same period is estimated to be only 1,200 cusecs (650 mgd) as discussed in **Section S4.2.1**, which is less than the capacity of existing water sources i.e.720 mgd. These observations suggest that Karachi will continuously be subjected to severe water constraints over the planning horizon of 2025.

Our observations suggest that Karachi will continuously be subjected to severe water constraints over the planning horizon of 2025.

Karachi is located in the arid region where annual precipitation is as small as 200 mm. There is no prospective surface or underground water source available within or in the vicinity of the

city which can be developed in a large scale to cater for the enormous water demand of the mega city. It is therefore extremely important to ensure that **'Demand Management Approaches'** are implemented in order to provide both general public and business entities with strong incentives to voluntarily restrict their water consumption for essential purposes only. There should be a consensus reached by all stakeholders that making future water supply development plans based on unconstrained water demands is not a proper approach in the case of Karachi.

There should be a consensus reached by all stakeholders that making future water supply development plans based on unconstrained water demands is not a proper approach in the case of Karachi.

The central part of the demand management approaches will be the introduction of measured supplies with a volumetric charging system whereby all retail and bulk customers will be charged based on their actual consumption. This will be further reinforced by the introduction of a new water tariff structure which will provide both domestic and non-domestic customers with strong incentives for efficient use of water. Tariffs will be structured to differentiate essential water needs from non-essential water needs. A low tariff would be applied to essential water needs while those who consume beyond essential needs should be severely penalized. Minimizing leakage, wastage and illegal connections will also constitute the core part of the demand management approaches.

(1) Demand Management

Goals

All consumers in the city including government and business entities are being highly conscious about water conservation and voluntarily restrict their consumption for essential purposes only.

Strategies

- **Introduction of measured supplies with a volumetric charging system whereby all retail and bulk customers will be charged based on their actual consumption**
- **Introduction of a new water tariff structure which will provide both domestic and non-domestic customers with strong incentives for efficient use of water**
- **Implementation of efficient meter reading, billing and collection**
- **Minimizing leakage, wastage and illegal connections**
- **Implementation of mass media campaigns for enhancing consumers' awareness on water conservation**
- **Mandatory use of water-saving equipment and devices in newly constructed houses and buildings such as low-volume toilets, low-flow showerheads, water faucets with flow restrictors or aerators.**
- **Subsidizing large-scale commercial and industrial users part of their investment costs for water conservation including internal recycling of used water.**

(2) Separation of Bulk and Retail Supplies

KW&SB is currently supplying water to the entire Karachi District and two union councils in the Thatta District of the Sindh Province. In the near future, KW&SB is also expected to supply treated water to the Lasbela District of the Balochistan Province. This demonstrates that KW&SB is playing a role of the regional bulk water supplier.

Under the Pakistani constitution, water is a provincial subject. However, GOP also performs a number of functions and responsibilities in the water sector, mostly relating to inter-provincial matters. The water supply to Balochistan under the K-III project is a good example of this. Because of the inclusion of the supply to Balochistan, the K-III project was given a status of an inter-provincial project and the entire project cost was subsidized by GOP. Both GOP and GOS have legitimate roles in shaping of policies and strategies for the water and sanitation sector in the region. It is obvious that the bulk water supplies to the Thatta and Lasbela Districts are the consequence of these policies and strategies. However, it should be noted that these policies and strategies often conflict with sound business and commercial principles.

Development of a new bulk water supply scheme to bring water from the Indus River to Karachi requires a large-scale investment which would inevitably exceed the financial capability of the service provider. Thus, part of the investment cost would have to be subsidized either by GOP or GOS. The reality is that in the past the entire capital costs required for the development of the bulk water supply system were subsidized either by GOP or GOS. The cost required for operation and maintenance of the bulk water supply system is also significantly large because of the long distances covered by the system. All these considerations lead to a conclusion that managing the bulk water supply system on a full cost recovery basis would not be feasible - at least within the planning horizon of 2025. On the contrary, retail water supply in Karachi can be managed on a full cost recovery basis with sound business and commercial principles. This is why we recommend the separation of bulk and retail supplies. **Figure S42.2.1** demonstrates the basic concept of the proposed separation.

Managing the bulk water supply system on a full cost recovery basis would not be feasible – at least within the planning horizon of 2025. On the contrary, retail water supply in Karachi can be managed on a full cost recovery basis with sound business and commercial principles. This is why we recommend that in the long run bulk and retail supplies should be managed and operated by different organizations.

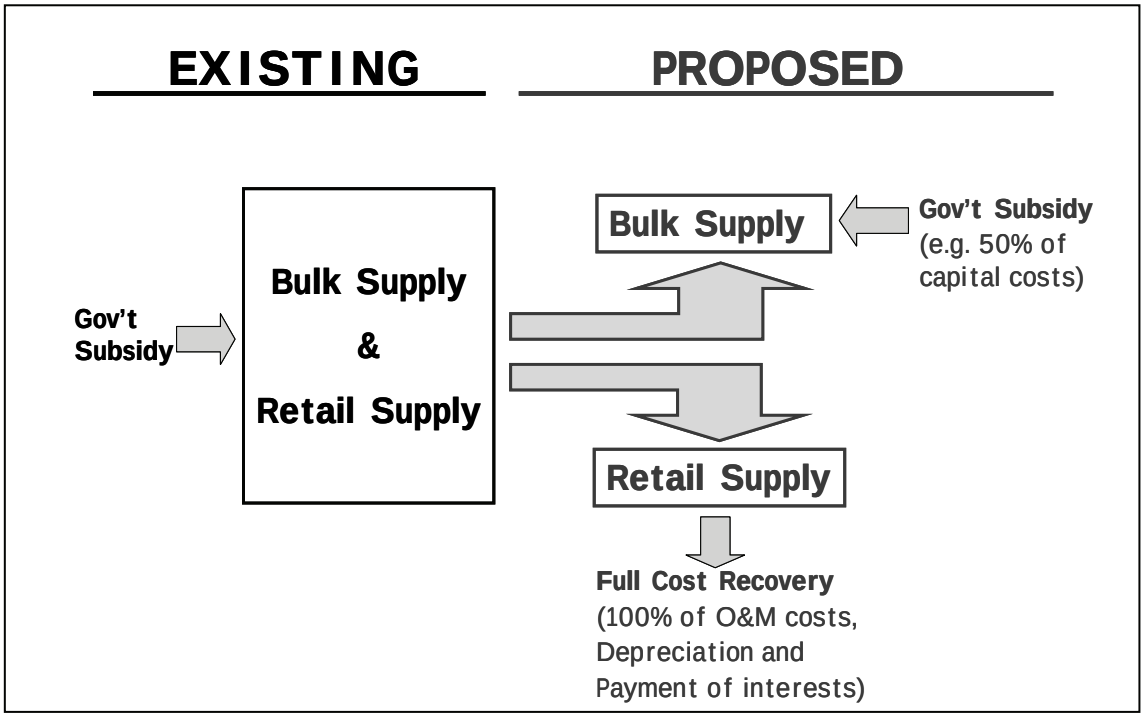


Figure S42.2.1 Separation of Bulk and Retail Supplies

The ultimate objective of the proposed separation is to enable the retail supplier to provide customer-focused, efficient water supply and sewerage services on a financially sustainable basis. This requires the insulation of the retail supplier from external interference in the micromanagement aspects of its operation, including the employment of staff, disciplining workers of poor performance, offering rewards and promotions based on good performance, handling of payment defaulters and illegal/unauthorized connections, recovery of arrears, etc. Experience indicates that as long as retail suppliers are dependent on government subsidies they will remain vulnerable to political interference in the day-to-day management of the services and in the technical execution of projects.

The ultimate objective of the proposed separation is to enable the retail supplier to provide customer-focused, efficient water supply and sewerage services to its customers.

This requires the insulation of the retail supplier from external interference in the micromanagement aspects of its operation.

Experience indicates that as long as retail suppliers are dependent on government subsidies, they will remain vulnerable to political interference in the day-to-day management of services and in the technical execution of projects.

(2) Separation of Bulk and Retail Supplies

Goals

An institutional framework is in place whereby a competent retail supplier (or suppliers) can provide water supply and sewerage services on a full cost recovery basis with sound business and commercial principles.

Strategies

- **All stakeholders agree to the separation of the bulk and retail supplies.**
- **Conduct a separate study to identify necessary changes to existing laws, ordinances and regulations and draft detailed legal provisions to put the separation into effect.**
- **Propose such changes for approval of legislators.**

(3) Zone-wise Management of Retail Supply

KW&SB has divided the entire Karachi City into five distribution zones, namely Zone I, Zone II-A, Zone II-B, Zone III-A and Zone III-B. This division was made for administrative purposes only, and from the hydraulic point of view each zone is not completely separated from others. **Figure S42.2.2** shows the locations of the existing five distribution zones. Zone I straddles the Malir River, and so do Zone II-A and Zone II-B the Lyari River. Zone III-A straddles both rivers. Retail service in each distribution zone is managed by a Zonal Chief Engineer. However, bulk customers in the zone such as cantonments, DHA, PSM, PQA and industries do not fall under his responsibility; they fall under the responsibility of the bulk transmission department. The same department is also responsible for operation and maintenance of water trunk mains that are passing through these distribution zones.

KSDP-2020 (Final Report-August 2007) proposed that the water and wastewater services in Karachi should be managed and operated by each town. This however would not be a feasible

option at least in the foreseeable future because of (a) the complexity of the existing water distribution system in which one water trunk main is supplying a number of towns whereas many towns are supplied by more than one water trunk main, and (b) the significant economic disparities between towns, making it difficult for some towns (such as Orangi, Baldia and Lyari) to cross-subsidize tariffs from the rich to the poor because of their weak revenue bases.

We propose that Karachi should be divided into three distinct hydraulic zones each separated from the others by two major rivers in Karachi i.e. Malir and Lyari Rivers. The rationale is that there is only a limited number of exiting water mains and sewer pipes that have been laid across these rivers and they can easily be located for installation of isolation valves or bulk flow meters. Further, separation of hydraulic zones by rivers would allow for more prudent approaches for planning of the sewerage system than by the administrative boundaries of the towns. **Figure S42.2.3** shows the locations of the proposed three hydraulic zones.

Karachi should be divided into three distinct hydraulic zones by the two major rivers in Karachi i.e. Malir and Lyari Rivers.

The size of the city is too large for a single retail entity to manage and operate water supply and sewerage services efficiently. It is therefore recommended that water supply and sewerage services in each hydraulic zone be managed and operated by an independent organization. Each organization will be responsible for operation and management of water supply and sewerage services within its own hydraulic zone, including the operation and maintenance of water trunk mains, leakage and NRW reduction, collection of tariffs, employment of staff and dealing with customer complaints. It will purchase treated water in bulk from the bulk supplier at the immediate downstream of filtration plants, service reservoirs, or pumping stations as the case may be, and distribute it through water trunk mains into various towns located within its hydraulic zone. The organization will also be accountable for collection, transportation and proper treatment of sewage generated in its hydraulic zone. Its revenue base would include not only retail consumers but also bulk consumers such as cantonments, DHA, and other industrial, commercial and governmental entities within the zone. Tariffs would be different from one zone to another reflecting the actual revenue requirements of each zone, providing they obtain prior approval of an independent regulatory body.

The size of the city is too large for a single retail entity to manage and operate water supply and sewerage services efficiently. It is therefore recommended that water supply and sewerage services in each hydraulic zone should be managed and operated by an independent organization.

The advantages of having zone-wise management will be as follows:

- Each organization will be held directly accountable for the quality of the services it provides including the levels of leakage and NRW occurring in its zone
- Water supply and sewerage services can be managed and operated on a competitive basis in which each organization's performance will be evaluated on the basis of common performance indicators (PIs)
- Increase the ease with which equitable distribution can be attained
- Increase the ease with which both technical and non-technical losses can be monitored and reduced. Each zone will be further divided into a number of leakage/NRW control districts, which can be hydraulically isolated whenever necessary to monitor or control leakage and NRW.
- Increase the ease with which customer focused approaches can be implemented. For example, the time required to respond to customers' problems/complaints can be shortened.

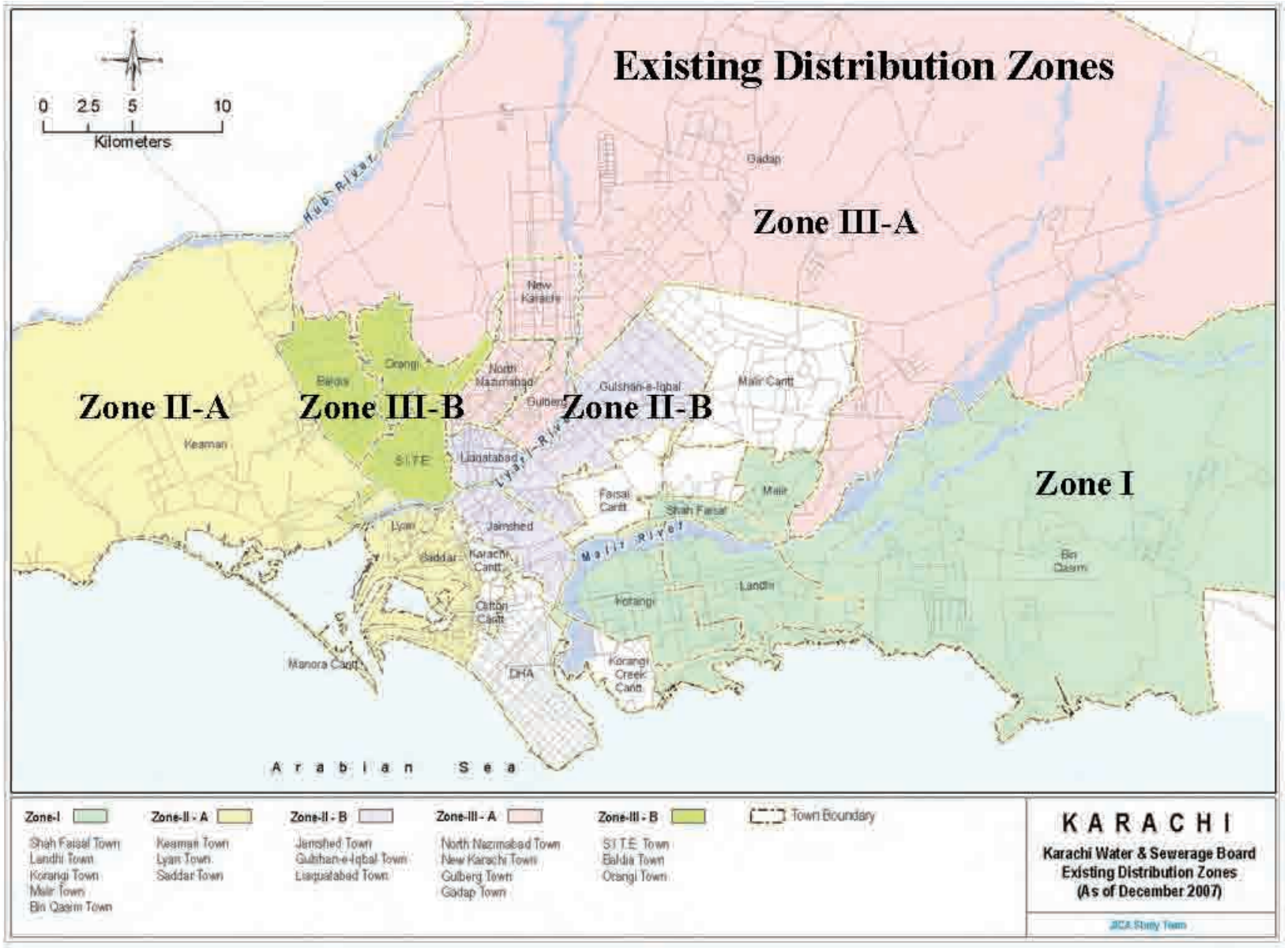


Figure S42.2.2 Existing Distribution Zones

Figure S42.2.3 Proposed Hydraulic Zones

(3) Zone-wise Management of Retail Supply

Goals

Retail entities provide efficient water supply and sewerage services to their customers on a competitive basis and with accountability. This relates not only to the quantity and quality of water supplied but also to the improved efficiency in revenue collection, system maintenance, and response to customer problems/complaints.

Strategies

- **All stakeholders agree to the zone-wise management of water supply and sewerage services.**
- **Conduct a separate study to identify necessary changes to existing laws, ordinances and regulations and draft detailed legal provisions to put the proposed zone-wise management into effect.**
- **Propose such changes for approval of legislators.**

(4) Implementation of DNI on a Financially Sustainable Basis

Assessment of the existing water supply conditions in **Section S3.5.1** revealed that:

- While the basic cost of piped water in Karachi may be cheap, the indirect costs associated with its use are unreasonably high;
- The overall picture is that there are many more urgent problems in the water distribution system than in the bulk water supply system;
- 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;
- Many problems have either directly or indirectly emanated from KW&SB's financial constraints; and
- A substantial improvement to water service quality is the only way to break the 'vicious circle' as depicted in **Figure S35.1.1**.

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.

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). The existing water distribution net work 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. Many pipelines in the system have already been undersized and deteriorated, and the current levels of leakage and non-revenue water are unacceptably high. 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 of timeframe 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. This is necessary to implement DNI on a financially sustainable basis.

DNI 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. This is necessary to implement DNI on a financially sustainable basis.

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 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.

Customers in areas where DNI has already been completed would pay a water charge that is some multiple of the current level of water charges. On the other hand, customers in areas where DNI has not been completed 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 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.

The current level of sewerage service charge is well below the level that would be necessary to ensure cost recovery in the medium and longer term, i.e. including the costs of building or extending the sewer network. With the introduction of a measured water supply, the current approach, whereby the charge for sewerage service is a proportion (25%) of the charge for clean water supply, will have the effect of linking the sewerage charge directly to the volume of clean water supplied. As such it will be in line with international practice. However, the 25% premium for sewerage service is certainly not sufficient to cover the costs of operating and maintaining the sewer network and sewage treatment plants. We suggest that this should be

increased to 50% of the charge for clean water supply once the quality of sewerage service has been improved. The evidence from the water awareness survey mentioned above suggested that the priority need of the public with respect to the sewerage service is the smooth, uninterrupted removal of sullage and excreta from their home and their vicinity. For this reason, we recommend that DNI should also include improvements to the existing sewage system wherever it is found necessary. Meanwhile, customers in areas where the sewage system has already been improved through DNI would pay a sewerage service charge that is 50% of the charge for the improved service level of clean water supply which, as has been stated above, is already some multiple of the current level of water charges. In contrast, customers in areas where the sewage system has not been improved would continue to pay the current level of sewerage service charge, which is 25% of the charge for clean water supply.

DNI should include improvements to the existing sewage system wherever it is found necessary.

Meanwhile, customers in areas where the sewage system has already been improved through DNI would pay a sewerage service charge that is 50% of the charge for the improved service level of clean water supply, which is already some multiple of the current level of water charges. In contrast, customers in areas where the sewerage system has not been improved would continue to pay the current level of sewerage service charge, which is 25% of the charge for clean water supply.

The examination of the financial statements of KW&SB of recent years shows an extremely worrying trend as regards its short term financial positions. Over recent years, KW&SB has continuously been operating in deficit. The annual deficit ranges from Rs.2,000 to 2,700 million (US$33.3 to 45.0 million) as shown in **Table S42.2.1** below. **Figure S42.2.4** illustrates these deficits as compared with annual revenues. At the end of the fiscal year 2004/05, the accumulated deficit totalled to Rs. 10,435 million (US$173.9 million). These deficits have eventually been subsidised by GOP and GOS.

Table S42.2.1 Accumulated Deficit of KW&SB Rs.million

Fiscal Year	2000/01	2001/02	2002/03	2003/04	2004/05
Profit/Loss of the Fiscal Year	-820.70	-2,029.65	-2,693.09	-2,536.39	-2,358.71
Accumulated Surplus/Deficit at start of Fiscal Year	3.00	-817.70	-2,847.36	-5,540.44	-8,076.83
Accumulated Surplus/Deficit at end of Fiscal Year	-817.70	-2,847.36	-5,540.44	-8,076.83	-10,435.54

Source: Profit and Loss Statements, KW&SB

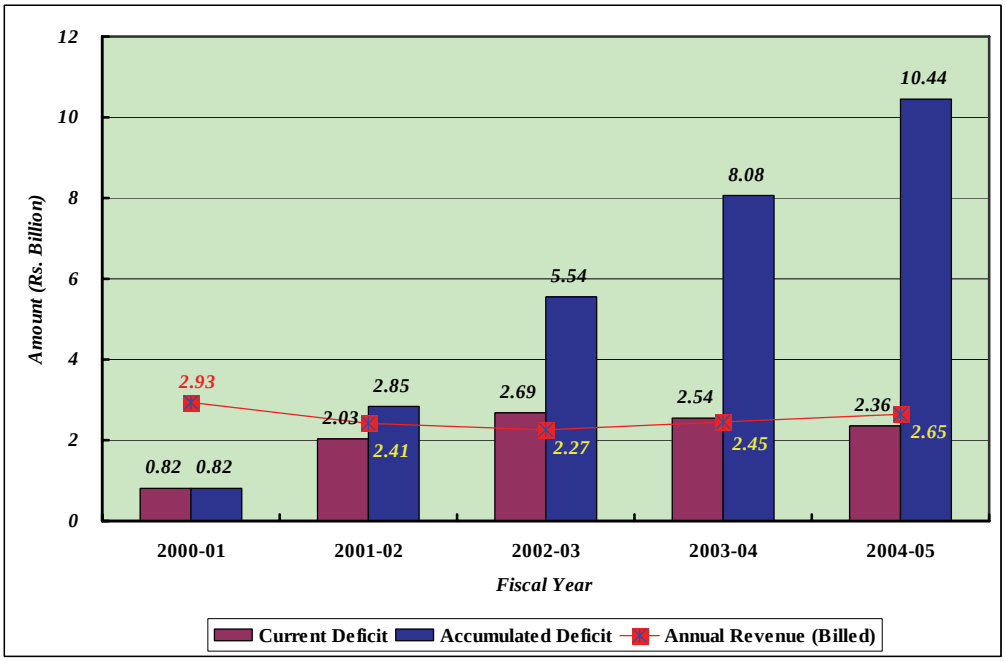


Figure S42.2.4 Revenues and Deficits of KW&SB

This demonstrates that KW&SB is not financially capable of taking new loans for the implementation of DNI. DNI will involve not only physical improvement works; it will also include improvements to many institutional aspects, such as the introduction of a dual pricing system, elimination of illegal and unauthorised connections, and the strict enforcement of laws on payment defaulters. As such, it is very likely that the implementation of DNI would face severe political interference if it is financed by Government subsidies. It is therefore necessary to create a new institutional framework, whereby DNI can be implemented on a loan financing basis without any Government subsidies.

(4) Implementation of DNI on a Financially Sustainable Basis

Goals

In the short to medium term, retail entities will generate the revenues sufficient to service the loans taken to finance DNI (and thereby implement DNI on a financially sustainable basis).

Strategies

- **Implement DNI on an area-by-area basis in a progressive way.**
- **Introduce a dual pricing structure in which customers in areas where DNI has already been completed (and receiving an improved level of service) would pay a water charge that is some multiple of the current level of water charges.**
- **Include improvements to the sewerage system in the scope of DNI.**
- **Increase the level of sewerage service charge to 50% of the charge for clean water supply in areas where an improvement to the sewerage system has already been made.**
- **Create a new institutional framework whereby DNI can be implemented on a loan financing basis without any Government subsidies.**

S4.2.3 System Development Plan

To meet the increasing water demand in Karachi, the water supply capacity of the filtration plants will be expanded in three stages. Under Stage I the capacity will be expanded by 130 mgd to meet the water demand in year 2016 (the target year of Stage I). Stage II will also increase the total capacity by 260 mgd to satisfy the projected water demand in year 2021 (the target year of Stage II). Stage III will increase the supply capacity by 260 mgd to a total of 1,270 mgd which will be able to cater for the water demand up to year 2025 (the target year of Stage III and the master plan). The stage-wise expansion of the water supply capacity is shown in **Figure S42.3.1**.

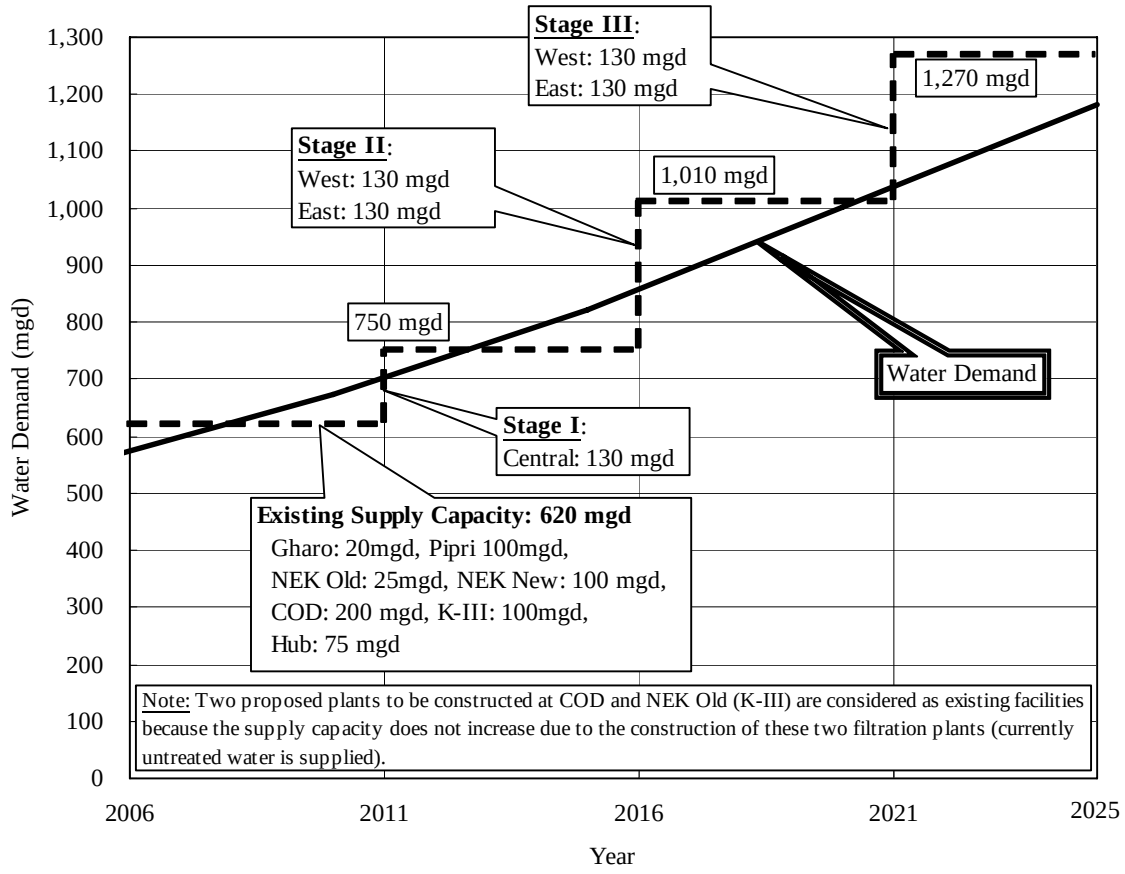


Figure S42.3.1 Stage-wise Development Plan for the Target Year of 2025

S4.2.4 Proposed Water Supply System

The water supply master plan covers the 18 towns, DHA and Cantonments in Karachi City. The master plan was developed based on the planning assumptions, policies and strategies discussed in **Sections S4.2.1** and **S4.2.2**. The plan is conceived to deliver substantial improvements to the existing water distribution system while also increasing the water supply capacity and providing new water transmission and distribution infrastructure.

The water supply master plan will enable KW&SB to meet future water demand and provide continuous and equitable water supply for its customers by 2025. In order to improve the quality of the water supply service, priority was given in the water supply master plan to the implementation of Distribution Network Improvement (DNI) which includes the replacement of the existing distribution network mains and service connection pipes, and installation of water meters at all service connections.

As a result of our study on the institutional reform of the water supply and sewerage sector it is proposed that the retail supply should be separated from the bulk supply. In addition, considering the magnitude of the future water supply system and topographical features of Karachi City, the same study also recommends the zone-wise management of the retail supply where water supply area will be divided into 3 zones (Zone West, Zone Central and Zone East) by two main rivers flowing through Karachi City, namely Lyari River and Malir River and each zone will be managed and operated by an independent organization or by a different business unit of the same organization.

Water supply plan for each zone was formulated based on the following policies:

- eliminating the use of several existing bulk pumping stations and a large number of small size distribution pumping stations for energy cost saving,
- supplying water to customers by gravity as much as possible, and
- keeping minimum dynamic water pressure of 10 m in distribution network system.

Tables S42.4.1 and **S42.4.2** present a summary of improvement works included in the master plan for the Karachi Water Supply System. **Table S42.4.1** shows the components for bulk water supply system by stages and **Table S42.4.2** shows the components of retail water supply system by zones. **Figure S42.4.1** depicts the proposed Karachi Water Supply System in 2025.

Table S42.4.1 Components of Bulk Water Supply System

Facility		Proposed				Rehabilitation / Replacement
	Stage	Stage I	Stage II	Stage III	Total	
	Target Year	2016	2021	2025		
	Construction	2009-2011	2014-2016	2019-2021		
Bulk Water Canal/Conduit		260 mgd	260 mgd	260 mgd	780 mgd	620 mgd
Bulk Pumping Station		2 P/Ss: 3.9MW, 7.1 MW	2 P/Ss: 7.8MW, 14.2 MW	2 P/Ss: 7.8MW, 14.2 MW	6 P/Ss	15 P/Ss
Filtration Plant		3 F/Ps: 315 mgd	2 F/Ps: 260 mgd	2 F/Ps: 260 mgd	5 F/Ps: 835 mgd	6 F/Ps: 435 mgd
		K-III: 100 COD: 85 K-IV(C): 130	K-IV(W): 130 K-IV(E): 130	K-IV(W): 130 K-IV(E): 130	K-III: 100 COD: 85 K-IV(W): 260 K-IV(C): 130 K-IV(E): 260	Gharo: 20 Pipri: 100 COD: 115 NEK Old: 25 NEK New: 100 Hub: 75
Transmission Pumping Station		3 P/Ss (2 P/Ss)	2 nos. (4 P/Ss)	2 nos. (6 P/Ss)	7 P/Ss	2 P/Ss
Transmission Main		32 km	53 km	44 km	129 km	17 km
Distribution Reservoir		2 nos. (7 nos.)	4 nos. (2 nos.)	2 nos. (6 nos.)	8 nos.	6 nos. (8 nos.)
Distribution Pumping Station		-	-	3 P/Ss	3 P/Ss	-

Note: Numbers in parenthesis are only expansion of capacity.

Table S42.4.2 Components of Retail Water Supply System

Facility	Zone	Proposed				Rehabilitation/ Replacement			
		West	Central	East	Total	West	Central	East	Total
Trunk Distribution Main (km)		406	364	152	922	273	259	153	685
Distribution Network Main (km)		2,539	3,152	2,349	8,041	3,751	4,208	1,220	9,179
	by DNI	-	-	-	-	2,578	3,069	681	6,329
	by other than DNI	-	-	-	-	1,173	1,139	539	2,850
Service Connection (×1,000)		454	564	420	1,438	1,119	900	378	2,398
	by DNI	-	-	-		553	784	283	1,620
	by other than DNI	-	-	-		566	116	95	778

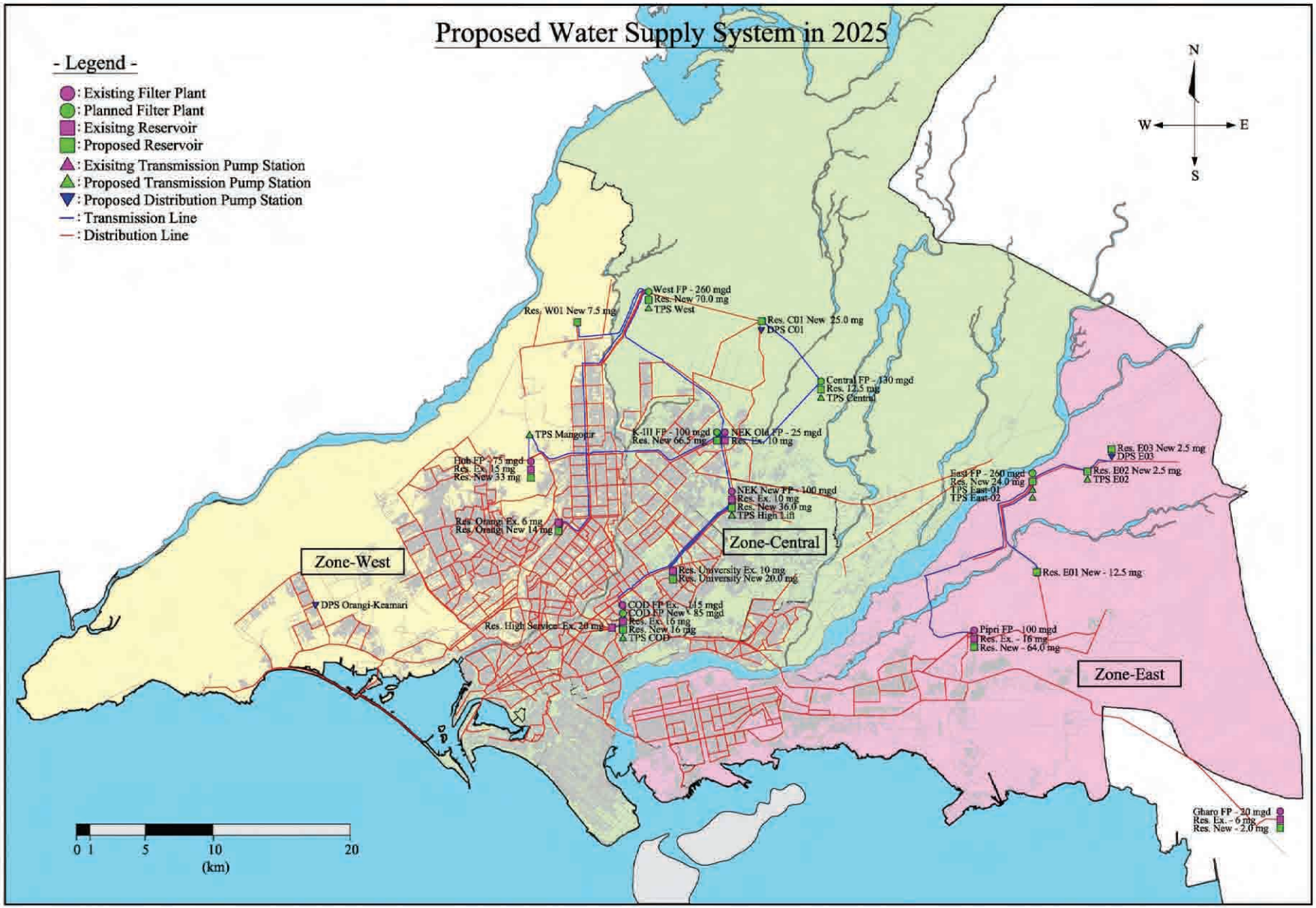


Figure S42.4.1 Proposed Water Supply System in 2025

S4.3 SEWERAGE MASTER PLAN

Sewerage system consists of sewage collection and its treatment. Sewage collection contributes to improved living environment by getting rid of generated sewage from living environment and sewage treatment to improved water qualities in public water bodies by treating collected sewage to permissible level. Specifically, the influent with BOD concentration of 600 mg/l is treated to the effluent with BOD concentration of 80 mg/l, and about 87% of BOD is removed, which improves the water quality of public water bodies. Hence, sewerage system is inevitable for better living and water environment. **Table S43.1.1** shows effluent standard for any wastewater flowing into sewage treatment plants and for any wastewater being discharged to public water bodies. Wastewaters including industrial ones being discharged to sewage treatment plants have to comply with the effluent standard shown in **Table S43.1.1**. Sindh Government is supposed to monitor water qualities of industrial wastewaters flowing into sewage treatment plants.

Table S43.1.1 Environmental Quality Standard (NEQS)

Parameter	Unit	Standards	
		Into Inland Water	Into sewage treatment plant
BOD (5 days at 20 degrees C)	mg/l	80	250
COD_{Cr}	mg/l	150	400
Total Suspended Solids	mg/l	200	400
Faecal Coliforms	MPN/100ml	Not applicable	Not applicable

Source: PEPC (Pakistan Environmental Protection Council)

S4.3.1 Fundamentals

The fundamentals in preparing sewerage master plan are as follows.

- To make full use of existing facilities by their rehabilitation and extension.
- To promptly get rid of generated sewage from living environment.
- To treat collected sewage to meet NEQS (National Environmental Quality Standard) with the effluent BOD of less than 80 mg/l.

Target year of Master Plan is 2025 when the population will be 32.5 million people with the generated sewage of 693 mgd (3.15 million m^3/d). The population in inner 15 towns will be 25.6 million for the area of 586 km^2 while that in outer three towns will be 6.9 million for the area of 2,366 km^2. The sewage generation will be 552 mgd (2.51 million m^3/d) in inner 15 towns and that in outer three towns will be 141 mgd (0.64 million m^3/d).

The Master Plan deals with inner 15 towns because necessary information such as road planning and site availability for sewage treatment plants is not sufficient. Further, EIRR of sewerage projects including and excluding outer three towns based on rough cost estimate revealed that the former is 3.8% and the latter 6.7%, respectively.

Appropriate treatment process will be selected taking into account required effluent qualities as well as full use of existing facilities.

Among three existing sewage treatment plants, TP-1 and TP-2 adopt high rate trickling filter process, while TP-3 adopts stabilization pond system consisting of anaerobic and facultative ponds. The same processes will be adopted for respective plants in MP but some pretreatment might be required for high rate trickling filter process due to the high estimated influent BOD of 600 mg/l.

Influent BOD for the existing three sewage treatment plants is designed to be either 385 or 365 mg/l, while the actual ones are observed to be in the range between 300 and 370 mg/l which is nearly the same as design value. In the Master Plan preparation, BOD loading per capita per day was calculated to be 50 g/capita/d applying influent BOD concentration and per capita sewage generation of 123 to 145 lpcd. BOD concentration of non domestic wastewater is supposed to be 250 mg/l complying with NEQS. Influent BOD concentration in the Master Plan is calculated to be 600 mg/l as follows by dividing total BOD loading contained in the influent by the whole sewage generation in 2025. (Refer to **Tables 81.2.5** and **81.2.8** in the Main Report.)

BOD Loading (Domestic): 50 g/capita-day × 25,581,942 person = 1,279,000 kg/d
BOD Loading (Non-domestic): 250 mg/l × 826,264 m^3/d = 207,000 kg/d
Total BOD Loading: 1,486,000 kg/d
Sewage amount: 2,508,000 m^3/d
BOD concentration: 1,486,000 kg/d / 2,508,000 m^3/d= 592 mg/l ≒ 600mg/l

Table S43.1.2 summarizes influent and effluent BOD concentrations of these processes.

Table S43.1.2 Influent/Effluent BOD of Each Process

Name of process	Influent BOD to the process (mg/l)	Effluent BOD from the process (mg/l)	BOD removal efficiency at the process (%)
UASB	600	300	50
High rate trickling filter	300	80	74
Anaerobic pond	600	300	50
Facultative pond	300	80	74

At present, sludges are dewatered at sludge drying bed at three existing treatment plants. The same will be adopted at extended and new plant(s) as much as possible within site area availability. If the condition is not met, mechanical dewatering will be partly introduced.

S4.3.2 Alternative Study

Table S43.2.1 compares three alternatives from various viewpoints. Alternative 1 shown in **Figure S43.2.1** is arranged so that no additional sewage treatment plant is required except for TP-4 and energy saving processes such as trickling filter process and waste stabilization pond process are adopted.

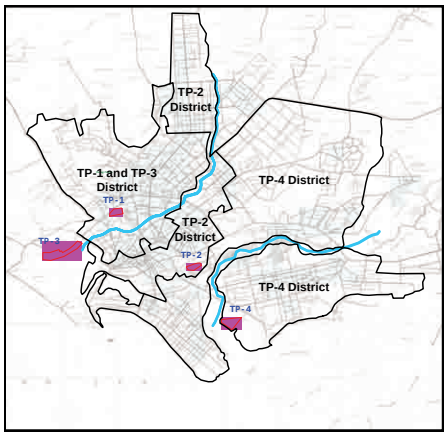


Figure S43.2.1 Schematic of Alt. 1

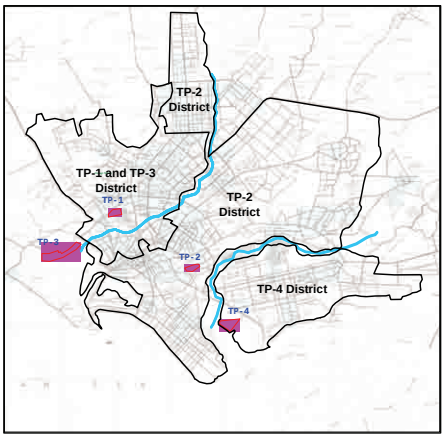


Figure S43.2.2 Schematic of Alt. 2

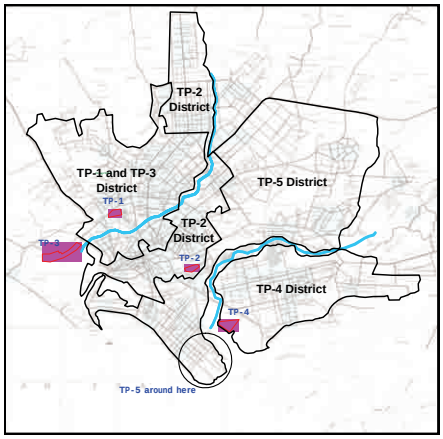


Figure S43.2.3 Schematic of Alt. 3

Alternatives 2 and 3 shown in **Figures S43.2.2** and **S43.2.3**, respectively, are both modified Alternative 1 and the difference between these two is how to divert the flow exceeding TP-2 capacity to other sewer districts.

In Alternative 2, excessive flow is treated at TP-2 by adopting activated sludge process. On the other hand, alternative 3 diverts some flow to new TP-5 whose site is located in DHA area where the land acquisition for the treatment plant is expected to be considerably difficult. Comparing these three alternatives, it is judged that the Alternative 1 is the most viable one from technical, financial and environmental viewpoints.

Table S43.2.1 Comparison of Three Alternatives

	Alternative 1 (Recommended)	Alternative 2	Alternative 3
Layout of Sewer District	TP-1/3 District: Southern part of right bank side of Lyari River and part of the area of between two rivers TP-2 District: Northern part of right bank side of Lyari River and western part of the area between two rivers TP-4 District: Northeastern and southern parts of the right bank side of Malir River and left bank side of Malir River	TP-1/3 District: Same as Alternative 1 TP-2 District: Northern part of right bank side of Lyari River and most of the area between two rivers TP-4 District: Left bank side of Malir River	TP-1/3 District: Same as Alternative 1 TP-2 District: Same as Alternative 1 TP-4 District: Same as Alternative 2 TP-5: Northeastern and southern parts of the area between two rivers
Treatment Process And Capacity	TP-1: UASB+HRTF, 110 mgd (500,000m^3/d) TP-2: UASB+HRTF, 108 mgd (490,000m^3/d) TP-3: AP+FP, 54 mgd (245,000 m^3/d) TP-4: UASB+HRTF, 284 mgd (1,290,000m^3/d)	TP-1: UASB+HRTF, 110 mgd (500,000m^3/d) TP-2: UASB+ASP, 273 mgd (1,240,000m^3/d) TP-3: AP+FP, 54 mgd (245,000 m^3/d) TP-4: UASB+HRTF, 119 mgd (540,000m^3/d)	TP-1: UASB+HRTF, 110 mgd (500,000m^3/d) TP-2: UASB+HRTF, 108 mgd (490,000m^3/d) TP-3: AP+FP, 54 mgd (245,000 m^3/d) TP-4: UASB+HRTF, 119 mgd (540,000m^3/d) TP-5: UASB+HRTF, 167 mgd (750,000m^3/d)
Technical Evaluation	Malir Interceptor (right bank side) has to cross Malir River. Less energy consuming processes are applied.	Malir Interceptor (right bank side) does not cross Malir River but it has to be connected to TP-2 by pump. TP-2 adopts activated sludge process that requires high energy consumption and skilled operators.	Addition of TP-5 prevents TP-2 from receiving larger flow which result in the adoption of activated sludge process. Malir Interceptor (right bank side) does not cross Malir River.
Social/Environmental Evaluation	No additional land acquisition for sewage treatment plants is required.	No additional land for sewage treatment plants is required. Adoption of activated sludge process for TP-2 might cause sewage flooding at power failure.	Additional land is needed for TP-5 site within DHA area.
Economic Evaluation based on construction and O&M costs for 30 years	NPV: Rs. 61,500 million Its total construction 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.	NPV: Rs. 69,500 million Its NPV is the highest among three alternatives mainly due to high construction and O&M costs for activated sludge process.	NPV: Rs. 61,600 million Its total construction 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	The Alternative is viable judging from technical, economic and environmental viewpoints and is recommended.	The Alternative is not viable from technical, economic and environmental viewpoints.	Its NPV is nearly the same as that of Alternative 1, but the Alternative is not viable since the land acquisition for TP-5 site will hinder the smooth implementation of the project.

S4.3.3 Master Plan

In the target year of 2025, all the areas in inner 15 towns will be sewered, either through rehabilitation of existing sewers or construction of new sewers where no sewer is available at present. Relevant small pumping stations will be implemented, too.

Existing Lyari Interceptor will be extended to New Karachi to convey the sewage generated there down to TP-3. Two new interceptors at the both bank sides of Malir River will be implemented to collect the sewage generated in the upstream area between Lyari and Malir Rivers and in the whole left bank side area of Malir River and to convey it to TP-4.

Three new pumping stations of Gulberg, Bin Qasim and Karachi Port will be constructed to convey the collected sewage to TP-2 (Gulberg) and TP-4 (Bin Qasim and Karachi Port), respectively.

TPs-1 and 2 will be extended to treat the estimated amount of sewage, while TP-3 will have the same capacity as it is because it has no extra site for extension. **Table S43.3.1** summarizes the features of three sewer districts with four sewage treatment plants. **Tables 43.3.2** and **43.3.3** outline sewerage facilities to newly construct and to rehabilitate, respectively. **Figure S43.3.1** shows general plan of sewer districts.

Table S43.3.1 Features of Sewer Districts

	TP-1	**TP-3**	**TP-2**	**TP-4**
District are (km^2)	145.3		100.4	340.2
Population (persons)	8,849,000		5,013,000	11,720,000
Length of branch and sub-main sewers (km)	3,365		2,164	5,336
Length of trunk sewers (km)	44.9		51.3	125.8
Number of main PS	2 (Jamila and Chakiwara)		2 (Gulberg and Clifton)	3 (Korangi, Bin Qasim and Karachi Port)
Location of TP	SITE Town	Keamari Town	Jamshed Town	Korangi Town
TP site area (ha)	49	221	49	168
Owner of land	KW&SB	KW&SB	KW&SB	CDGK
Design sewage flow (m^3/d)	494,400	241,900	482,000	1,289,000
Capacity (m^3/d) (number of trains)	500,000 (6)	245,000 (6)	490,000 (8)	1,290,000 (16)
Influent BOD (mg/l)	600	600	600	600
Effluent BOD (mg/l)	80	80	80	80
Sewage treatment process	UASB + HRTF	WSP (AP + FP)	UASB + HRTF	UASB + HRTF
Sludge treatment process	GT + MD	DB	GT + MD	GT + DB/MD (DB: 26%, MD: 74%)

Note: UASB for Upflow Anaerobic Sludge Blanket, HRTF for High Rate Trickling Filter, AP for Anaerobic Pond, FP for Facultative Pond, GT for Gravity Thickenere, DB for Drying Bed and MD for Mechanical Dewatering

Table S43.3.2 Outline of Sewerage Facilities (to newly construct)

Facilities		To newly construct				Remarks
	Stage	I	II	III	Total	
	Target year	2016	2021	2025		
TP-1 and TP-3 District						
Branch ad Sub main sewers (10-36")		663 km	663 km	530 km	1,856 km	
Trunk sewers (42"-)		39.7 km	5.2 km	0.0 km	44.9 km	
Pumping station		-	-	-	-	
TP-1		250,000m^3/d	167,000m^3/d	83,000m^3/d	500,000m^3/d	
TP-3		-	-	-	-	
TP-2 District						
Branch and Sub main sewers (10-36")		427 km	427 km	341 km	1,195 km	
Trunk sewers (42"-)		19.8 km	25.7 km	5.8 km	51.3 km	
Pumping station		-	Gulberg (170.6 m^3/m)	-	1 PS (170.6 m^3/m)	
TP-2		-	429,000 m^3/d	61,000 m^3/d	490,000 m^3/d	
TP-4 District						
Branch and Sub main sewers (10-36")		1,096 km	1,096 km	877 km	3,069 km	
Trunk sewers (42"-)		37.1 km	73.1 km	15.6 km	125.8 km	
Pumping station			Karachi Port (66.3m^3/m)	Bin Qasim (59.9m^3/m)	2 PS (126.2m^3/m)	
TP-4		484,000m^3/d	564,000m^3/d	242,000m^3/d	1,290,000m^3/d	

Table S43.3.3 Outline of Sewerage Facilities (to rehabilitate)

Facilities		Rehabilitation				Remarks
	Stage	I	II	III	Total	
	Target year	2016	2021	2025		
TP-1 and TP-3 District						
Branch and Sub main sewers (10-36")		232 km	61 km	9 km	302 km	
Pumping station		-	Jamila and Chakiwara (157.9 m^3/m)	-	2 PSs (157.9 m^3/m)	
TP-1		110,000 m^3/d	-	-	-	Mechanical and electrical equipment
TP-3		245,000 m^3/d	-	-	-	Pumping facility
TP-2 District						
Branch and Sub main sewers (10-36")		54 km	133 km	7 km	194 km	
Pumping station		-	Clifton (107.7m^3/m)		1 PS (107.7m^3/m)	
TP-2		-	110,000 m^3/d			
TP-4 District						
Branch and Sub main sewers (10-36")		-	440 km	14 km	454 km	
Pumping station			Korangi (289m^3/m)		1 PS (289m^3/m)	

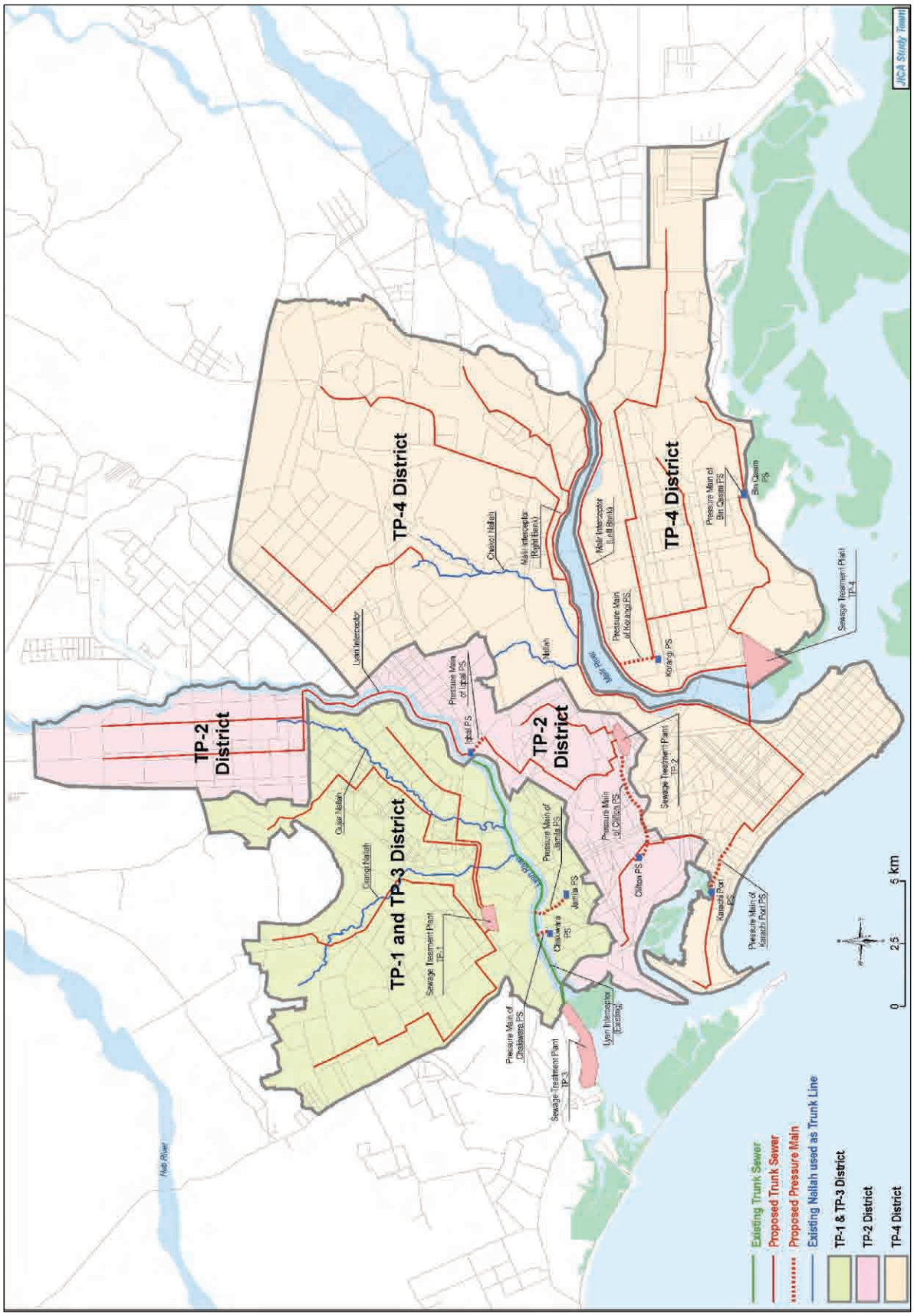


Figure S43.3.1 General Plan of Sewer Districts

S4.4 IMPROVEMENT OF MANAGEMENT SYSTEM

S4.4.1 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.

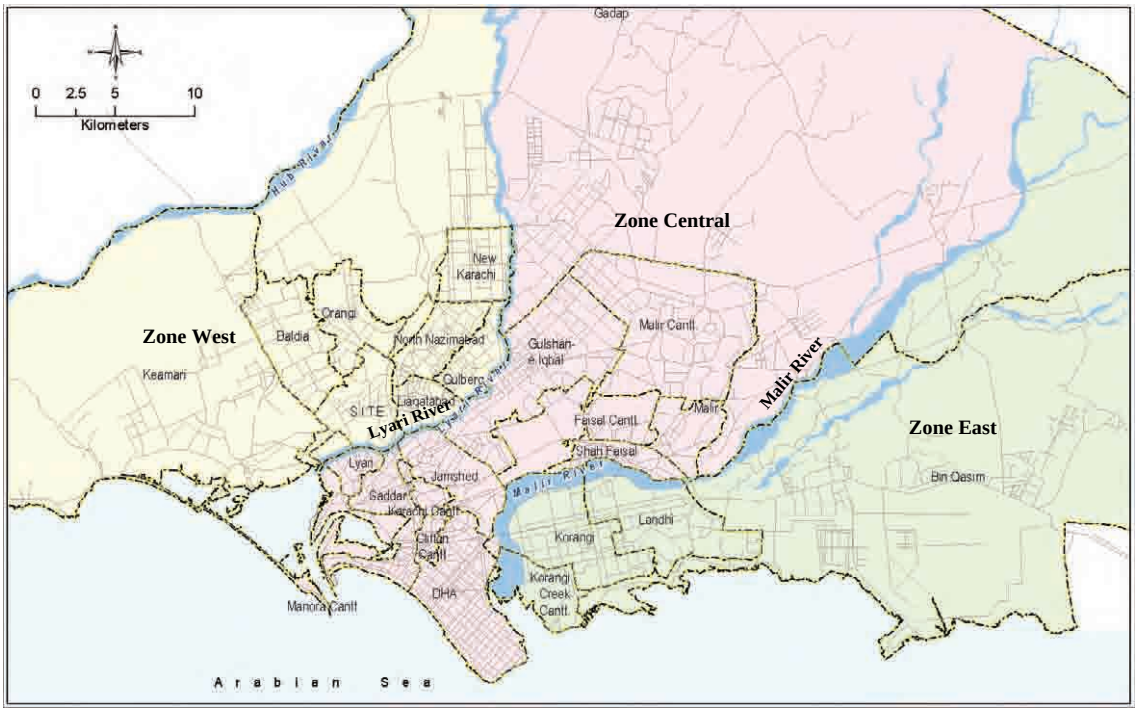


Figure S44.1.1 Three Independent Retail Service Zones

JICA Study proposes that the Karachi city be divided into three independent retail service zones by the Lyari and Malir Rivers (see **Figure S44.1.1**), 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 S44.1.2**. 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.

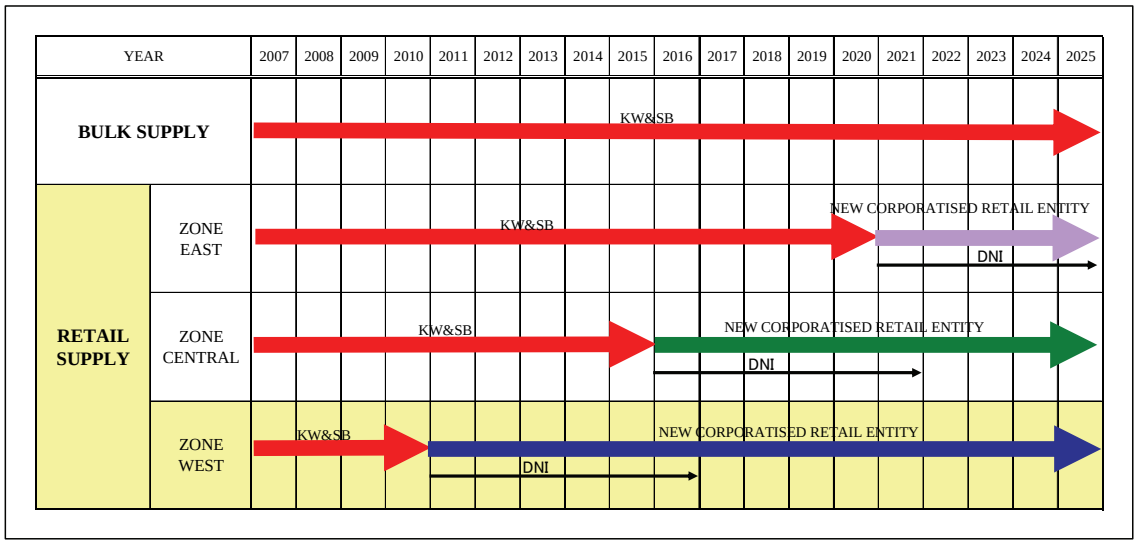


Figure S44.1.2 Transfer of Responsibility for Retail Services

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 bulk customers 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
- Booster 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 S44.1.3**). 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.

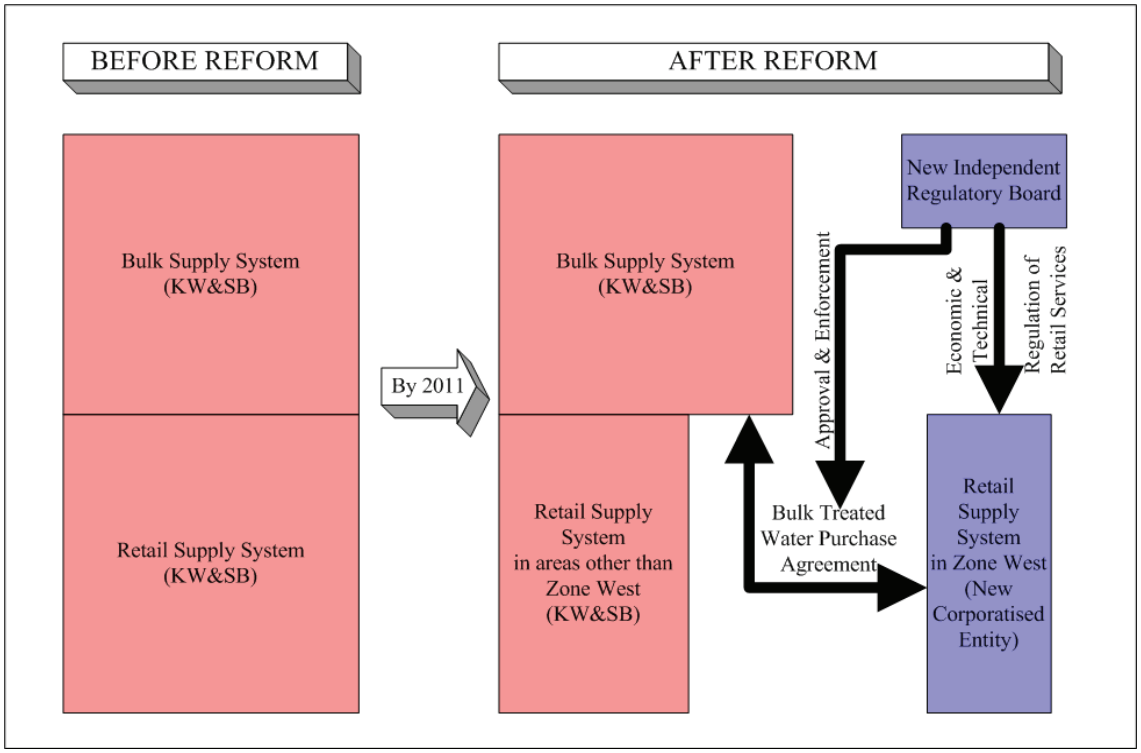


Figure S44.1.3 Institutional Reform Suggested by JICA Study

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.

S4.4.2 Improvement of Financial Management System

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.

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. Relevant financial reports and key performance indicators will 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. 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).

S4.4.3 Reduction of Non-revenue Water

In the absence of system-input metering and retail supply metering the UFW percentage can only be a reasonable estimate. This report uses a reasonable estimate of 35% for UFW.

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. 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

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.

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

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

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 reduce the number of illegal connections.

Timescales for the short term, medium term and long term goals for the reduction of NRW are given in the following **Figure S44.3.1**.

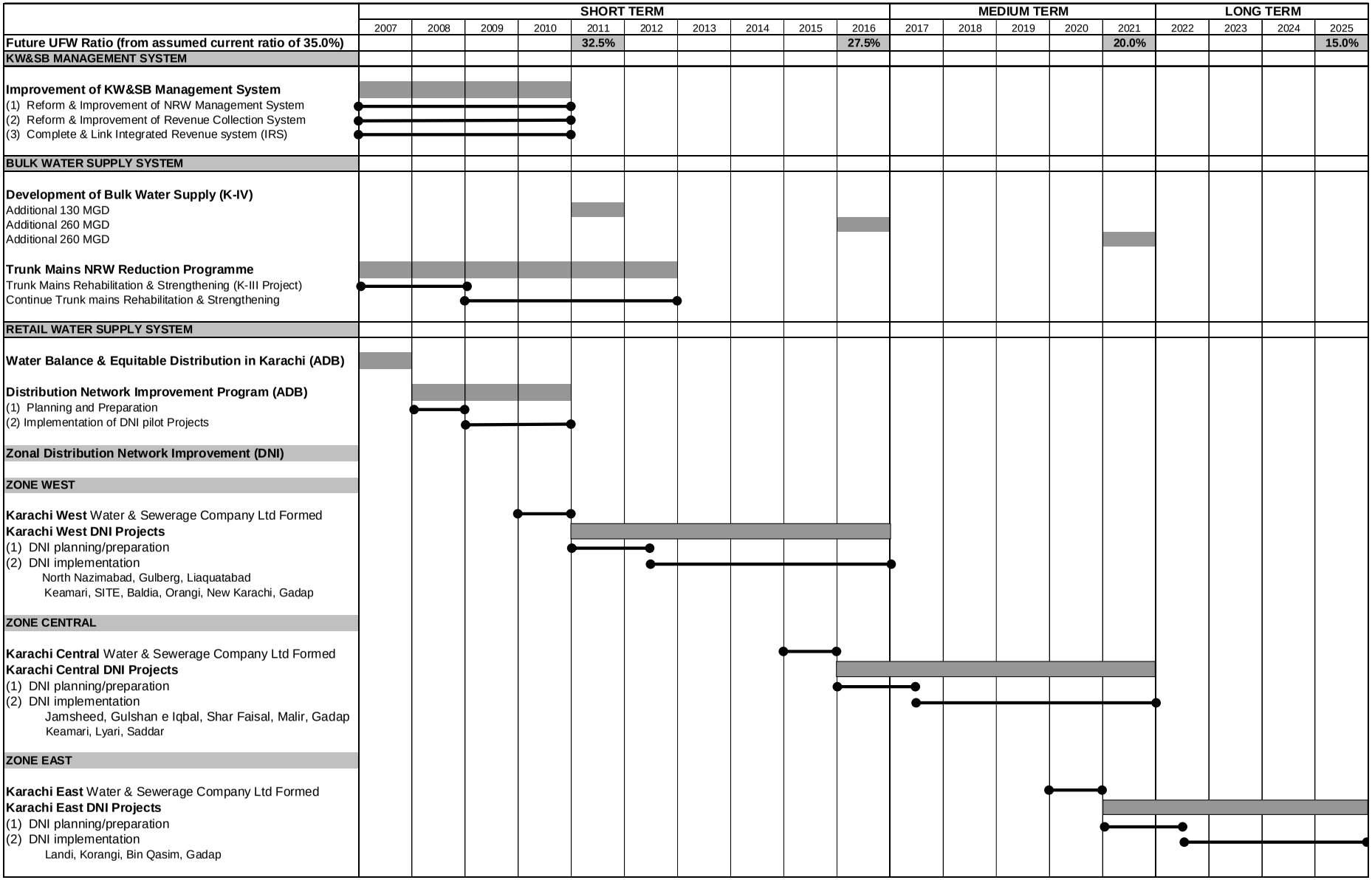


Figure S44.3.1 Timescales for Reduction of NRW

S4.4.4 Improvement of Revenue Collection System

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 with poor revenue recovery and mounting arrears.

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.

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 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 houses 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.

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. 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.

Improvement of the management system for billing & revenue collection is a vital and urgent task. 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. 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

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.

S4.4.5 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.

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 in renewal, expansion and disposal of the facilities as well as operation and maintenance.

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; based on which accurate maps of existing major facilities for the planning of future facility improvements were prepared.

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.

By November 2007, the JICA Study team have completed digitisation and rectification processes on the following information and infrastructure.

- topographic information such as roads, rivers, canals, railways
- administrative boundaries of CDGK, 18 TMAs and 178 UCs
- the entire Bulk Water Supply System from the Kinjhar Lake to Karachi
- 405 km trunk distribution pipes
- 643 km distribution mains 10 inches and larger in diameter
- 325 km trunk sewers 18 inches and larger in diameter
- water distribution pumping stations
- 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.

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 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. 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 also recommended that KW&SB should not contract out the management of the GIS system to local consultants.

The least-required resources for the initial stage of GIS development within KW&SB are shown in **Table S44.5.1**.

Table S44.5.1 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

S4.4.6 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.

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.

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.

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.

With the view of improving awareness and company image, KW&SB could also consider a

regular programme of "open houses", '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.

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.

S4.4.7 Human Resource Development

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.

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.

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.

S4.5 PRELIMINARY COST ESTIMATES AND IMPLEMENTATION SCHEDULES

S4.5.1 CONDITION OF COST ESTIMATE

(1) Construction Cost

The capital costs of the proposed water supply and sewerage projects were estimated based on the data and information provided in the following documents using the conditions and assumptions shown in **Table S45.1.1**.

a) JBIC-financed Karachi Water Supply Improvement Project – Contract Documents
b) K-III Project – Contract Documents
c) Tameer-e-Karachi Project – Trunk Mains Installation Contracts
d) K-IV Project, Greater Karachi Water Supply Scheme, Executive Summary May 2007
e) Greater Karachi Sewerage (S-III) Project – PC-1 Documents
f) Schedule of Rate, Government of Sindh, October 1, 2004
g) Catalogue prices of manufacturers and suppliers

Table S45.1.1 Conditions and Assumptions Used for Estimate

(a)	Base Cost	Current price in 2007
(b)	Engineering Fees	7.5% of (a)
(c)	Physical Contingency	5% of [(a) + (b) + land acquisition cost]
(d)	Price Contingency	1.5% of (c) for F/C component, 6.0% of (c) for L/C component
(e)	Project Administration	1.5% of (d)

(2) Operation and Maintenance Cost

Operation costs comprise personnel costs, electricity costs, diesel fuel costs, chemical costs, sludge disposal costs (sewerage) and other. These costs were estimated based on the total pumping capacity in case of a pumping station and the total treatment capacity in case of a water treatment plant or a sewage treatment plant. Maintenance costs of mechanical and electrical equipments of pumping stations, water treatment plants and sewage treatment plants were calculated based on their construction costs. Maintenance costs of sewers were presumed to depend on the length.

S4.5.2 Cost Estimates

(1) Initial Cost

A summary of the Initial costs for the water supply components and sewerage components are presented in **Table S45.2.1**.and **S45.2.2** respectively. Overall total basic cost (TBC) and total project cost (TPC) including both water supply and sewerage projects are as follow.

Overall TBC: Rs. 319,347 Million
Overall TPC: Rs. 519,894 Million

(2) Operation and Maintenance Cost

A summary of the operation and maintenance cost for the water supply components and sewerage are presented in **Tables S45.2.3** and **S45.2.4,** respectively

Table S45.2.1 Cost Estimate for Water Supply Components (Million Rs.)

		Total	Breakdown	
			F/C	L/C
(A)	Bulk Water Supply		60%	40%
		72,641	43,362	29,279
(B)	Zone West		72%	28%
		52,653	37,691	14,962
(C)	Zone Central		71%	29%
		58,527	41,803	16,724
(D)	Zone East		71%	29%
		30,252	21,541	8,711
Total Base Cost (TBC)			67%	33%
		214,073	144,397	69,676
(E)	Engineering Fees		70%	30%
		16,055	11,238	4,816
(F)	Land Acquisition		0%	100%
		1,547	0	1,547
(G)	Physical Contingency		67%	33%
		11,583	7,781	3,802
Sub-total (TBC+E+F+G)			67%	33%
		243,257	163,416	79,841
(H)	Price Contingency		30%	70%
		80,792	24,052	56,740
Sub-total (TBC+E+F+G+H)			58%	42%
		324,049	187,468	136,581
(I)	Project Administration		0%	100%
		4,861	0	4,861
Total Project Cost (TPC)			57%	43%
		328,910	187,468	141,441

Table S45.2.2 Cost Estimate for Sewerage Components (Million Rs.)

		Total	Breakdown	
			F/C	L/C
(A) Zone West				
	TP-1 and TP-3 District		44%	56%
		24,002	10,532	13,470
	TP-2 District		21%	79%
		4,122	871	3,251
	Sub Total		41%	59%
		28,124	11,403	16,721
(B) Zone Central				
	TP-1 and TP-3 District		44%	56%
		2,563	1,117	1,446
	TP-2 District		52%	48%
		19,101	9,911	9,190
	TP-4 District		23%	77%
		14,861	3,395	11,466
	Sub Total		39%	61%
		36,525	14,423	22,102
(C) Zone East				
	TP-4 District		50%	50%
		40,625	20,147	20,478
	Sub Total		50%	50%
		40,625	20,147	20,478
Total Base Cost (TBC)			44%	56%
		105,274	45,973	59,301
(D)	Engineering Fees		70%	30%
		7,896	5,527	2,369
(E)	Land Acquisition		0%	100%
		18	0	18
(F)	Physical Contingency		45%	55%
		5,660	2,575	3,085
Sub-total (TBC+D+E+F)		0	45%	55%
		118,848	54,075	64,773
(G)	Price Contingency		14%	86%
		69,313	9,477	59,836
Sub-total (TBC+D+E+F+G)			34%	66%
		188,161	63,552	124,609
(H)	Project Administration		0%	100%
		2,823	0	2,823
Total Project Cost (TPC)			33%	67%
		190,984	63,552	127,432

Table S45.2.3 Operation and Maintenance Cost of Water Supply Component

(Million Rs./year)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Bulk Water Supply System (Common)																		
Operation Cost	991	991	991	991	1,437	1,503	1,503	1,503	1,503	2,070	2,211	2,351	2,492	2,524	2,777	2,918	3,059	3,200
Maintenance Cost	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Total	999	999	999	999	1,445	1,511	1,511	1,511	1,511	2,078	2,219	2,360	2,500	2,532	2,785	2,926	3,067	3,208
Bulk Water Supply System (Zone West)																		
Operation Cost	73	73	73	73	73	73	73	73	73	196	197	199	201	203	330	340	350	360
Maintenance Cost	4	4	4	4	8	8	8	8	8	21	21	21	21	21	35	35	35	35
Total	78	78	78	78	81	81	81	81	81	217	218	220	222	224	365	375	385	395
Bulk Water Supply System (Zone Central)																		
Operation Cost	310	310	310	310	627	646	665	683	702	706	711	715	720	724	739	750	761	772
Maintenance Cost	14	14	14	14	41	41	41	41	41	60	60	60	60	60	79	79	79	79
Total	324	324	324	324	668	687	705	724	742	766	770	775	779	784	817	828	839	850
Bulk Water Supply System (Zone East)																		
Operation Cost	354	355	355	355	355	355	355	355	355	481	486	492	497	503	636	646	655	665
Maintenance Cost	8	8	8	8	8	8	8	8	8	16	16	16	16	16	23	23	23	23
Total	362	364	364	364	364	364	364	364	364	497	502	508	513	519	660	669	679	688
Total																		
Operation Cost	1,727	1,729	1,729	1,729	2,493	2,578	2,596	2,615	2,633	3,452	3,605	3,758	3,911	3,954	4,483	4,654	4,825	4,996
Maintenance Cost	35	35	35	35	65	65	65	65	65	105	105	105	105	105	145	145	145	145
Total	1,762	1,764	1,764	1,764	2,557	2,643	2,661	2,680	2,698	3,557	3,710	3,862	4,015	4,058	4,627	4,799	4,970	5,141

Table S45.2.4 Operation and Maintenance Cost of Sewerage Components

(Million Rs./year)

		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Zone West																			
TP-1 and TP-3 District	Operation Cost	9	9	9	9	9	9	32	74	78	145	152	160	179	186	198	209	222	233
	Maintenance Cost	14	14	14	14	14	14	28	51	53	92	95	98	102	105	112	117	127	133
	Sub Total	24	24	24	24	24	24	61	125	131	237	247	258	281	291	309	326	349	366
TP-2 District	Operation Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Maintenance Cost	0	0	0	0	2	2	7	12	12	17	17	17	17	19	22	24	26	29
	Sub Total	0	0	0	0	2	2	7	12	12	17	17	17	17	19	22	24	26	29
Sub Total	Operation Cost	9	9	9	9	9	9	32	74	78	145	152	160	179	186	198	209	222	233
	Maintenance Cost	14	14	14	14	16	16	35	63	66	109	112	114	119	124	134	141	154	161
	Sub Total	24	24	24	24	26	26	67	136	144	254	264	274	298	311	331	350	375	395
Zone Central																			
TP-1 and TP-3 District	Operation Cost	7	7	7	7	8	8	12	12	13	13	14	14	15	15	16	16	17	17
	Maintenance Cost	1	1	1	1	1	1	5	7	8	12	12	13	14	14	15	16	17	18
	Sub Total	8	9	9	9	9	9	16	20	20	25	26	27	28	29	31	32	34	35
TP-2 District	Operation Cost	0	0	0	0	0	0	0	0	0	0	0	0	156	182	202	221	241	261
	Maintenance Cost	0	0	0	0	0	0	0	0	0	0	0	0	44	53	57	65	69	76
	Sub Total	0	0	0	0	0	0	0	0	0	0	0	0	201	235	259	286	309	338
TP-4 District	Operation Cost	0	0	0	0	0	0	0	0	0	0	0	7	8	9	10	10	11	12
	Maintenance Cost	0	0	0	0	13	14	16	17	18	27	36	45	53	62	74	85	96	106
	Sub Total	0	0	0	0	13	14	16	17	18	27	36	51	61	71	84	95	107	118
Sub Total	Operation Cost	7	7	7	7	8	8	12	12	13	13	14	21	179	206	227	248	269	290
	Maintenance Cost	1	1	1	1	14	16	20	25	26	39	48	57	111	129	146	166	181	201
	Sub Total	8	9	9	9	22	24	32	37	39	52	62	78	290	335	373	414	450	491
Zone East																			
TP-4 District	Operation Cost	0	0	0	0	59	64	68	73	77	112	155	201	260	306	363	427	495	553
	Maintenance Cost	0	0	0	0	20	26	27	28	29	45	56	67	85	96	109	127	145	158
	Sub Total	0	0	0	0	78	90	95	100	106	157	211	268	344	402	472	554	639	712
Sub Total	Operation Cost	0	0	0	0	59	64	68	73	77	112	155	201	260	306	363	427	495	553
	Maintenance Cost	0	0	0	0	20	26	27	28	29	45	56	67	85	96	109	127	145	158
	Sub Total	0	0	0	0	78	90	95	100	106	157	211	268	344	402	472	554	639	712
Total																			
Total	Operation Cost	16	17	17	17	76	81	113	158	167	269	321	381	618	699	788	884	985	1,077
	Maintenance Cost	16	16	16	16	50	58	82	115	121	193	216	239	315	349	388	433	480	520
	Sub Total	32	32	32	33	126	139	194	274	288	462	537	620	932	1,048	1,176	1,318	1,464	1,597

S4.5.3 IMPLEMENTATION / DISBURSEMENT SCHEDULE

(1) General

Proposed water supply and sewerage projects are to be implemented during the period between 2008 and 2025. These projects are allocated as follows. The whole implementation is divided into three stages, namely, Stage I (Target year: 2016), Stage II (Target Year: 2021) and Stage III (Target Year: 2025).

(2) Schedule of Water Supply Projects

A summary of implementation schedule of the water supply components is shown in **Table S45.3.1.**

(3) Schedule of Sewerage Projects

A summary of implementation schedule of the sewerage components is shown in **Table S45.3.2**.

Table S45.3.1 Implementation Schedule of Water Supply Projects

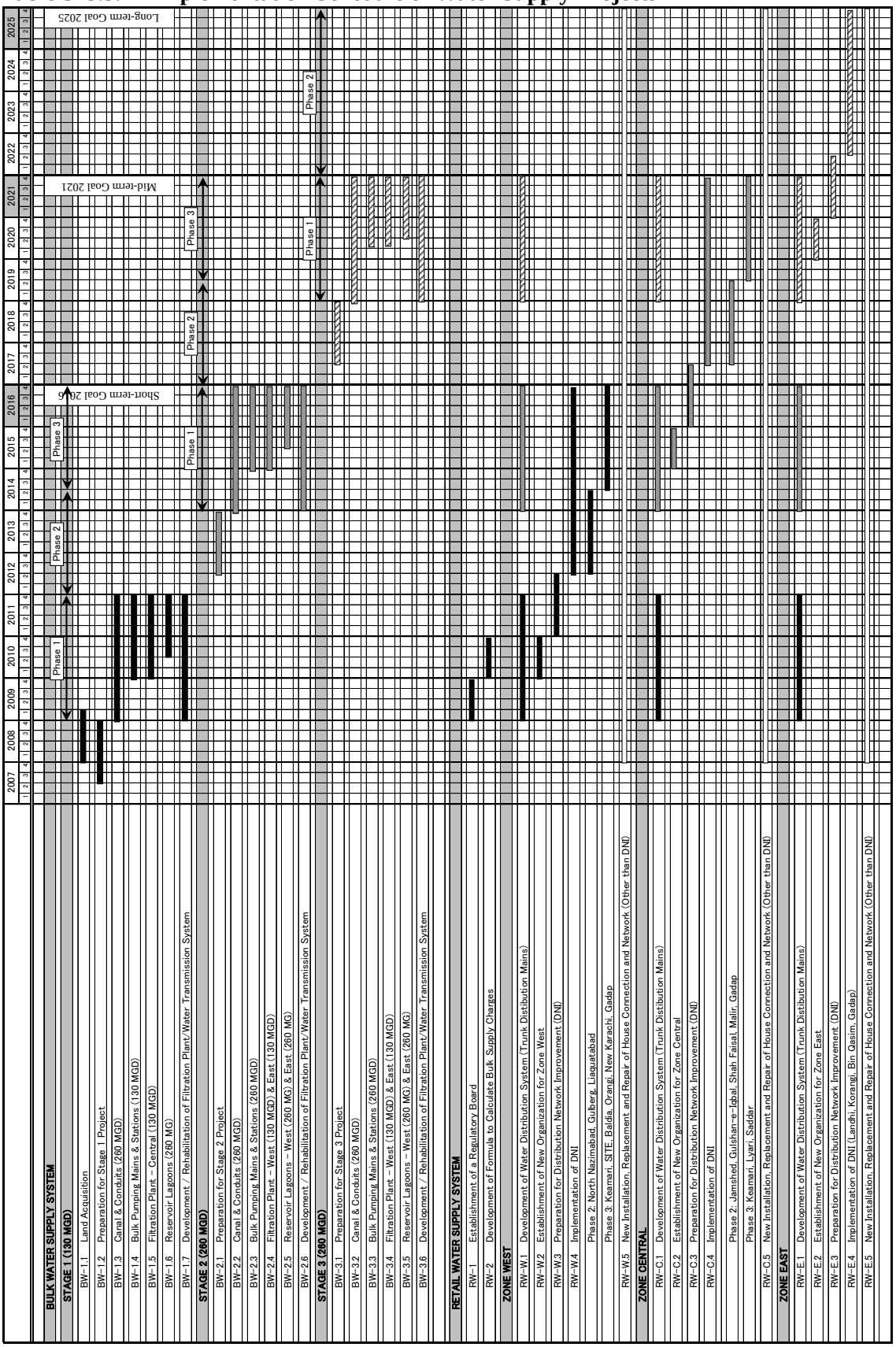
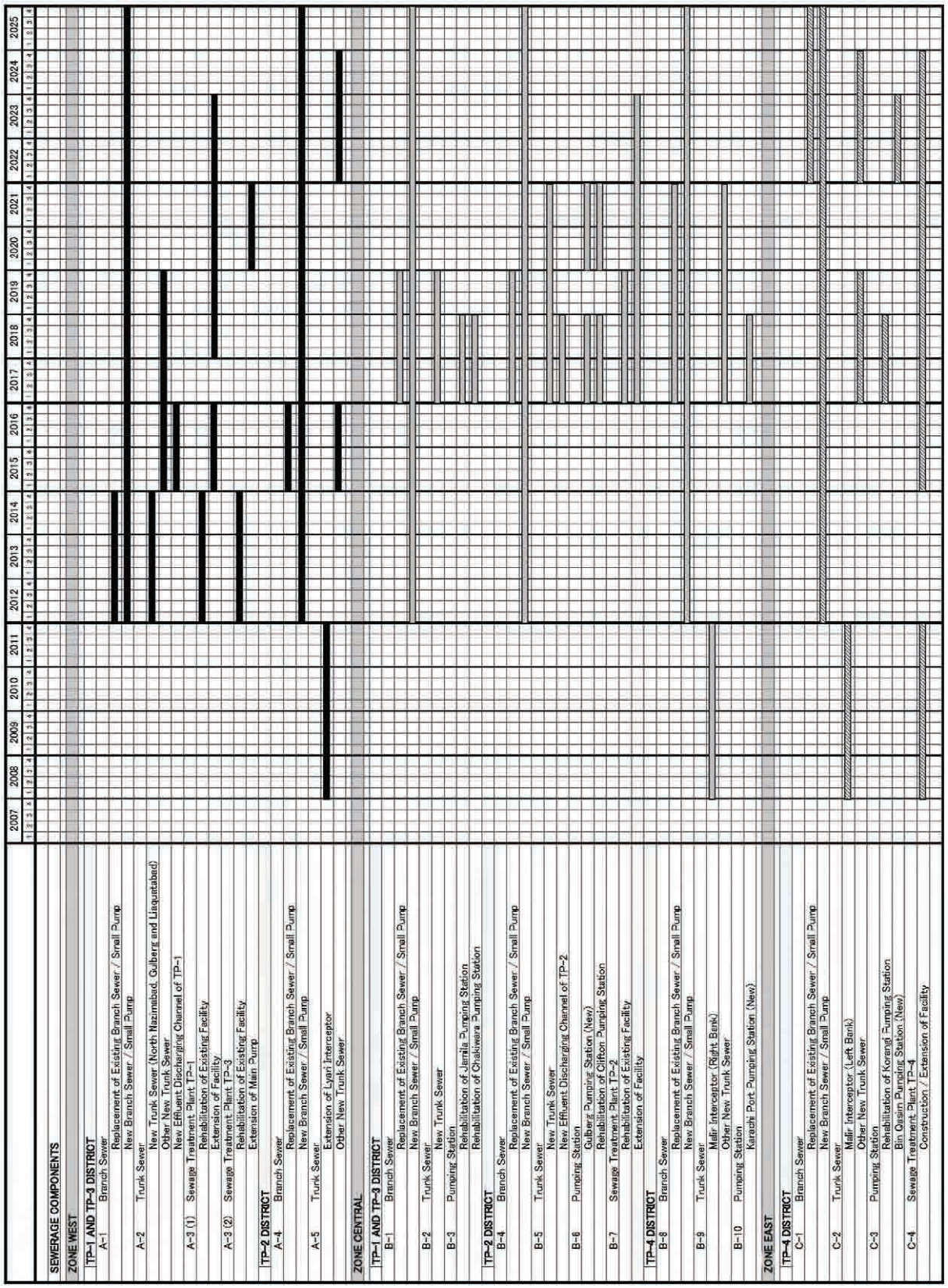


Table S45.3.2 Implementation Schedule of Sewerage Projects



S4.6 EVALUATION OF MASTER PLAN AND SELECTION OF PRIORITY PROJECTS

S4.6.1 Environmental and Social Evaluation of Master Plan

(1) Water Supply System

From environmental and social point of view, the water supply system will improve the living condition, public health, standard of living and contribute to encouraging economic growth. However, the implementation of the Master Plan may cause the environmental and social impacts summarised below, thus the mitigation measures should be taken during both construction and operational stages.

- The land acquisition will be needed for the proposed facilities of distribution reservoirs and pumping stations. The sites for eight distribution reservoirs and three pumping stations were carefully selected and they were planned to be constructed at arid or vacant land. Hence, non-spontaneous resettlement will not occur. KW&SB should acquire the necessary land by strictly complying with the Land Acquisition Act 1894 and National Resettlement Policy to compensate for lost private properties.
- The construction of pipelines such as transmission & distribution mains will cause the serious traffic disturbance within the Karachi City. To mitigate this impact, the schedule of installation of pipelines should be informed in advance, traffic should be controlled and relief road should be proposed.
- The areas that are provided with no water supply or low quality service are watered by tankers operated and managed by Rangers. As the water supply service area will be expanded by Master Plan, it will affect the sales by tankers of Rangers. However, as the water supply facilities will be constructed step by step till 2025, the demand for tankers water supply will not decrease immediately. KW&SB have to consult with them on this matter.

Overall, implementation of proposed water supply system in Master Plan is necessary as water is inevitable for human life. Some impacts will be expected by construction and operation of these facilities but these impacts can be avoided / minimised by taking appropriate mitigation measures and proper operation and maintenance of facilities.

(2) Sewerage System

From environmental and social point of view, the sewerage system will improve the living condition, public health, standard of living, water quality of water bodies such as rivers and sea, and contribute to encouraging economic growth. However, the implementation of the Master Plan may cause the environmental and social impacts summarised below, thus the mitigation measures should be taken during both construction and operational stages.

- The land acquisition will be needed for the proposed facilities of pumping stations and TP-4. The land for TP-4 is already acquired by CDGK and no impact will be expected. Resettlement can be avoidable by carefully selecting the location of pumping stations but their land acquisition is inevitable. KW&SB should acquire the necessary land by strictly complying with the Land Acquisition Act 1894 and National Resettlement Policy to compensate for lost private properties.
- The construction of sewers such as pressure mains and trunk sewers will cause the serious traffic disturbance within the Karachi City. To mitigate this impact, their installation schedule should be informed in advance, traffic should be controlled and relief road should be proposed.
- As a result of sewage treatment, the treated sewage and sludge will be generated. As long as effluent meets the Pakistan's standards, it will not affect the water quality of

receiving water bodies. Rather, it will improve water qualities there. The sludge from the existing TPs is used as soil conditioner and this will be applied to proposed TP-4. If the sludge will be disposed of, it should be done in environmentally sound manner at appropriate location.

- TPs will generally emit odour unless they are properly operated, and odour comes from the sludge handling system such as sludge drying beds. It is the most effective mitigation measure for TPs to be operated and maintained properly. The sludge drying bed should be located away from the residential area as far as possible. It is recommended to set buffer zone to mitigate the impact.

Overall, implementation of proposed sewerage system in Master Plan is necessary since sewage collection and its treatment is inevitable for human life. Some impacts will be expected by construction and operation of these facilities but these impacts can be avoided / minimised by taking appropriate mitigation measures and proper operation and maintenance of facilities.

(3) EIA Requirement at F/S Stage

The EIA report submission is required with the documents of PC-1 which is the application documents for approval of project implementation to ECNEC (Executive Committee of the National Economic Council). The EIA report is not required at the F/S stage. The environmental and social considerations at EIA level will be conducted in F/S stage to assess the impact which may be expected by the implementation of priority project, to propose the mitigation measures and monitoring plan. The report will include the requirements of Pakistan EIA and will be the basis of the EIA report which will be prepared at the time of submitting PC-1 documents by KW&SB.

S4.6.2 Economic Evaluation of Master Plan

(1) Objectives

In the national economy, there are various economic sectors, such as agriculture, industry, transportation, infrastructure, etc. Each sector also has various sub-sectors. Infrastructure structure sector, for instance, includes water, sewerage, waste-disposal, electric power, city gas, telecommunication, etc. The projects of these sub-sectors have proposed to produce their products and services for the people through utilising human resources, natural resources, artificial resources, etc. In these projects, economic evaluation proposes the optimal plan in the fields of utilising resources from the viewpoint of national economy.

(2) Criteria and Assumptions

In the economic evaluation of this study, the following criteria and assumptions are applied for the estimation of economic value and judgement of the proposed projects.

1) Standard conversion factor: 0.88
2) Price level: the end of January 2007
3) Foreign exchange rate: Rs.60.77 per US$1.00; JP¥121.68 per US$1.00; and JP¥2.00 per Rs.1.00
4) Social discount rate: 12% per annum
5) Distribution of the benefit accruing from public health improvement:
   - Water supply 50%
   - Sewerage 20%
   - Waste-disposal 30%
6) Evaluation period: 30 years after the completion of the construction work (2008– 2055)

(3) Water Supply Project

1) Economic Benefits

The tangible economic benefits adopted in this economic evaluation of water supply are listed as follows.

a) Benefits from saving costs of domestic water source procurement
b) Benefits from public health improvement
   - Saving of household medical expenditures
   - Saving of medical treatment expenses and medical institutions
   - Decrease of absence from work due to illness
c) Benefit from saving costs through improvement of non-domestic water supply system
d) Reduction of O&M expenses in the existing water supply system
e) Negative benefits associated with the disuse of:
   - Existing distribution pipes
   - Existing domestic water supply equipment in households
   - Existing well water supply facilities in non-domestic use

The tangible economic benefits mentioned above were quantified based on the data and information presented by concerned persons and agencies. The total economic benefit was estimated as follows. The total benefit was estimated at Rs.75 billion in the target year 2025, although it was minus Rs.3.4 billion in the beginning year 2012 because of large negative benefits. The economic benefits are summarized in **Table S46.2.1**.

Table S46.2.1 Economic Benefits of Water Supply Project (Unit: Rs. Billion)

Benefit Item	2012	2016	2021	2025
1. Domestic Saving Costs	4.81	19.62	44.11	65.19
2. Public Health Improvement	0.92	3.59	7.13	9.65
3. Non-domestic Saving Costs	0.35	1.39	2.92	4.01
4. Reduction of O&M Costs	0.09	0.36	0.78	1.12
5. Negative benefits	-9.59	-6.75	-4.05	-5.32
Total	-3.42	18.20	50.88	74.64

2) Economic Costs

The estimated costs of the proposed project in the market prices were converted into economic value by applying the standard conversion factor to local cost portion. The economic costs are summarized as follows.

a) Capital investment cost: the total construction cost by the target year 2025 was calculated at Rs.237 billion in economic value, against the estimated costs of Rs.329 billion in the market prices.
b) O&M cost: the O&M cost is annually disbursed for the economic life of the proposed project. The O&M cost starts emerging in the beginning year of the distribution network improvement, 2012 and continues to the end of the evaluation in 2055.
c) Replacement cost: In general, the economic life of electrical and mechanical equipment is considered to be 15 years. This equipment has to be replaced every 15 years throughout the evaluation period.

3) Economic Evaluation

The indices of the evaluation are 15.7% in EIRR, Rs.52.0 billion in NPV and 1.39 in B/C. Therefore, the project is viable from an economic point of view because its EIRR is higher than the social discount rate, 12%.

(4) Sewerage Project

1) Economic Benefits

The tangible economic benefits adopted in this economic evaluation of sewerage are listed as follows. The estimated values of the economic benefits are summarized in **Table S46.2.2**.

1) Willingness-to-Pay (WtP) of the beneficiaries from improved environment
   - Quantified at 1% of household income of the beneficiaries in service areas
2) Benefits from public health improvement
   - Saving of household medical expenditures
   - Saving of medical treatment expenses and medical institutions
   - Decrease of absence from work due to illness
3) Benefits of saving costs owing to the elimination of septic tank management
4) Benefits from improved environment by property treating sewage generated by non-domestic water users
5) Reduction of O&M expenses for the existing sewerage system
6) Negative benefits associated with the disuse of:
   - Existing septic tanks
   - Existing sewer pipes

Table S46.2.2 Economic Benefits of Sewerage Project (Unit: Rs. Billion)

Benefit Item	2012	2016	2021	2025
1. WtP of residents	0.57	1.59	3.99	6.54
2. Public Health Improvement	0.27	0.77	2.46	3.76
3. Elimination of septic	0.06	0.16	0.50	0.77
4. Effects of non-domestic users	0.28	0.52	1.93	3.21
5. Reduction of O&M Costs	0.02	0.08	0.50	1.10
6. Negative benefits	-0.01	-0.07	-0.14	-0.18
Total	1.19	3.05	9.24	15.22

2) Economic Costs

The estimated costs of the proposed project in the market prices were converted into economic value by applying the standard conversion factor to local cost portion. The economic costs were summarized as follows.

a) Capital investment cost: the total construction cost by the target year 2025 was calculated at Rs.203 billion in economic value, against the estimated costs of Rs.381 billion in market value.
b) O&M cost: the O&M cost is annually disbursed for the economic life of the proposed project. The O&M cost starts emerging, from the beginning of 2008, when TP-3 starts operation for its service areas. Following that, TP-4 will start its services in 2011. TP-1 will be rehabilitated until 2014, and will stat its services in 2015. Finally, the sewerage system will start to cover the outer three towns in 2017. These O&M costs will continue until the end of the evaluation in 2055.
c) Replacement cost: the economic life of electrical and mechanical equipment is considered to be 15 years in general. This equipment has to be replaced every 15 years throughout the evaluation period.

3) Economic Evaluation

The indices of the economic evaluation are 3.8% in EIRR, minus Rs.30.2 billion in NPV and 0.56 in B/C. Therefore, the project is not viable from an economic point of view because its EIRR is much lower than the social discount rate, 12%.

4) Economic Evaluation of Sewerage System excluding the Outer Three Towns

One of the reasons of the negative viability above was considered as lower cost performance of

the outer three towns in the said sewerage system. Thus, a scheme of the sewerage system excluding the outer three towns is evaluated under the same conditions and assumptions.

The indices of the evaluation are 6.8% in EIRR, minus Rs.14.5 billion in NPV and 0.69 in B/C. Therefore, this sewerage scheme is also not viable from an economic point of view. Since this EIRR becomes higher than that of the original scheme, its economic prospect is better than that of the original case. The EIRR, however, is still lower than 12%, so the implementation of the proposed sewerage master plan alone would be difficult from the viewpoint of economic viability.

(5) Integrated Project

It is said that water supply and sewerage services are inseparably related to each other for the improvement of living environment. It is a known fact that KW&SB has managed these systems together for a long time. Hence, the projects of water supply and sewerage systems are evaluated in combination as an integrated project. Since two alternative plans are considered for the sewerage system, two cases of integrated project are analysed from an economic viewpoint. They are named as (i) the project covering the entire areas of Karachi City (Case 1) and (ii) the project excluding the outer three towns (Case 2).

1) Evaluation of Integrated Project (Case 1)

The evaluation indices of Case 1 are 13.3% in EIRR, Rs.21.4 billion in NPV and 1.11 in B/C. Then, the project of Case 1 is viable from an economic point of view although its EIRR was slightly higher than the social discount rate, owing to the good economic efficiency of the water supply system.

2) Evaluation of Integrated Project (Case 2)

The evaluation indices of Case 2 are 14.2% in EIRR, Rs. 37.1 billion in NPV and 1.20 in B/C. Then, the project of Case 2 is also considered to be viable from an economic point of view because its EIRR is considerably higher than the social discount rate of 12%. This result suggests that the integrated project of Case 2 would be more feasible than that of Case 1.

S4.6.3 Selection of Priority Projects

(1) Identification of Priority Projects

The existing water distribution network has many problems which have resulted in the current low quality of the service in Karachi. Many residents have a very negative impression of KW&SB and the service it provides and are therefore reluctant to pay water charges. As a result, KW&SB faces a very low level of revenue collection and severe financial constraints. It is expected that Distribution Network Improvements (DNI) will be able to address those problems efficiently and effectively and thereby substantially improve the current situation. It is also expected that, with the introduction of a 'dual pricing structure' as discussed in **Section S4.2.2**, it will be possible to implement DNI on a financially sustainable basis while minimizing negative social impacts and potential wastage and misuse of water by residents at the same time. All these considerations led to a conclusion that DNI should be selected as the 'Priority Project' and given a high priority for implementation.

DNI will include the rehabilitation of water trunk mains, trunk distribution mains and distribution network mains, and the refurbishment of service connections including installation of retail supply meters. Where necessary, it will also include improvements to the existing sewerage system. In addition, DNI will also have efficient systems with regard to:

- Developing/maintaining GIS-based accurate customer/asset databases
- Meter reading;
- Meter installation/replacement/repair/calibration;

- Billing based on meter reading;
- Bill collection;
- Receiving customer complaints and feedback and responding accordingly;
- Installing new service connections;
- Minimizing leakage and wastage;
- Removing/regularizing illegal/unauthorized connections;
- Increasing awareness on water conservation;
- Recordkeeping and data collection; and
- Liaison with other utility service authorities.

(2) Location of Priority Projects

Given the immense size of the city and the current poor conditions of the existing distribution network, it would require huge investments and more than 10 years to complete DNI across all urban areas of Karachi. DNI therefore can only be implemented on an area-by-area basis in a progressive way. With respect to the institutional reform, the JICA Study proposes that Karachi should be divided into three independent retail service zones by the Lyari and Malir Rivers (see **Figure S44.1.1**), 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 S44.1.2**. It is also suggested that the first stage of this reform process will take place in Zone West in early 2011, and that the new Zone West retail entity will implement DNI in Zone West.

Zone West encompasses a number of towns which are New Karachi, North Nazimabad, Gulberg, Liaquatabad, S.I.T.E., Orangi, Baldia, Keamari and Gadap. With the exception of Keamari and Gadap, the other towns in Zone West are fully developed urban areas. The JICA Study selected three towns, namely North Nazimabad, Gulberg and Liaquatabad, as the 'priority towns' where DNI should be implemented on a priority basis. This selection was made based on the following criteria.

a) Towns where a stable supply can be maintained

One of the key objectives of DNI is to provide a 24-hour continuous supply at an adequate pressure. The results of our water distribution analysis for Zone West have suggested that Orangi, Baldia and S.I.T.E. should be supplied from the Hub Filtration Plant, while Gadap, New Karachi, North Nazimabad, Gulberg and Liaquatabad from the NEK Old Filtration Plant and Keamari from the COD Filtration Plant. The analysis also indicated that a sufficient water head is available between the NEK Old Filtration Plant and the three towns, namely North Nazimabad, Gulberg and Liaquatabad, and that the water from the filtration plant can therefore gravitate across all areas of these three towns at an adequate pressure. Gadap and New Karachi were excluded from the 'priority towns' because of their relatively high altitudes. It is recommended that DNI in these two towns should be delayed until the completion of a new K-IV water filtration plant (130 mgd) which is proposed to be constructed at a higher elevation to the north of the NEK Old.

A new 100 mgd water filtration plant is proposed to be constructed at the NEK Old under the first tranche of the ADB's US$ 800 million loan. This will increase the total filtration capacity of the plant to 125 mgd which is sufficient to meet the total water demand of the five towns, namely Gadap, New Karachi, North Nazimabad, Gulberg and Liaquatabad until 2016. It was judged from the foregoing assessments that the 'priority towns' would be able to receive a stable supply once DNI is completed in these towns.

b) Towns where 'Ability to Pay' of residents is high

The residents of the three 'priority towns' have a relatively high 'ability to pay' as compared

with the residents of the other towns in Zone West. As such, it is expected that they would agree to pay a water charge that is some multiple of the current level of water charges once they receive an improved service under which they are guaranteed that water will be available for 24 hours per day on a regular basis. This is necessary: (a) to generate the revenues in the short or medium term that will be needed to service the loans taken to finance DNI (and thereby 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.

Figure S46.3.1 shows the location of the three 'priority towns'. **Table S46.3.1** provides some basic features of these towns. The total population in the three towns was approximately 2.4 million in 2005 which was equivalent to 15.8% of the total municipal population in Karachi (15.2 million) or 38% of the total population in Zone West (6.4 million) in the same year.

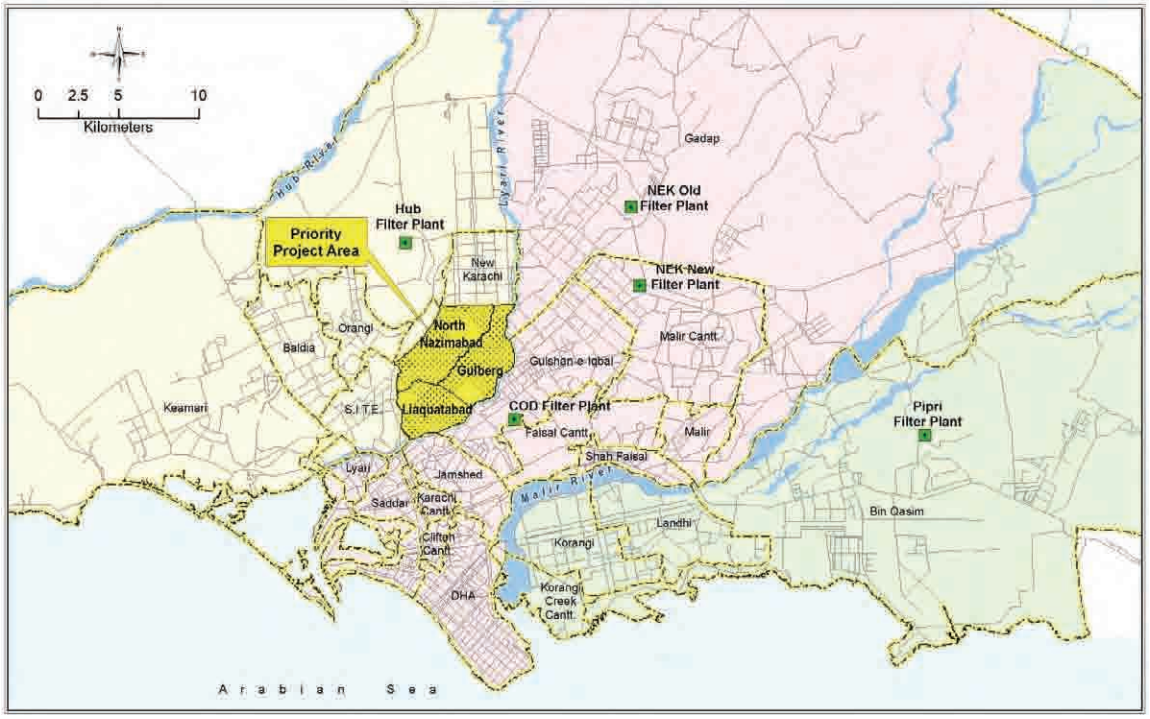


Figure S46.3.1 Location of Three 'Priority Towns'

Table S46.3.1 Basic Features of Three 'Priority Towns'

Town	Area		Population				
	acre*	km^2	2005*	2010	2015	2020*	2025
North Nazimabad	4,127	17	753,423	815,407	889,328	979,450	1,069,572
Gulberg	3,417	14	688,581	745,229	812,788	895,154	977,520
Liaquatabad	2,685	11	985,577	999,095	1,015,211	1,034,860	1,054,509
Total	10,229	42	2,427,581	2,561,741	2,719,342	2,911,484	3,103,626

Source: Figures with *- Karachi Strategic Development Plan 2020 (Final Report, August 2007); other figures-JICA Study Team