12.4 PRELIMINARY DESIGNS OF SEWERAGE PROJECTS

12.4.1 Sewage Collection System

Table 124.1.1 outlines target three towns of the priority project.

Table 124.1.1 Outline of Target Towns

(a) Area

	Area (ha)
North Nazimabad Town	1,670
Gulberg Town	1,380
Liaquatabad Town	1,090
Total	4,140

(b) Population and Sewage Generation

	Population		Sewage Generation upper: mgd lower: m^3/d	
	2016	2025	2016	2025
North Nazimabad Town	907,400	1,069,600	14.6 66,200	20.9 94,800
Gulberg Town	829,300	977,500	13.1 59,600	18.7 85,100
Liaquatabad Town	1,019,100	1,054,500	14.9 67,900	18.8 85,200
Total	2,755,800	3,101,600	42.6 193,700	58.3 265,100

Generally, trunk sewers and sub-main sewers should be designed based of sewage generation of target year of the master plan, because it is almost impossible to increase flow capacity in multiple steps to fit sewage generation. Since existing trunk sewer connecting to sewage treatment plant TP-1 has enough flow capacity for sewage generation in 2016 in downstream stretch near TP-1, the downstream end of proposed trunk sewers is to be connected to the existing trunk sewer in Liaquatabad Town as shown in **Figure 124.1.1.**

Sewage generated in target towns flow into sewage treatment plant TP-1 or TP-3. In 2016, capacity of rehabilitated TP-1, 24.2 mgd or 110,000 m^3/d, is not sufficient for the whole sewage generation of target towns; therefore, sewage from some strips along with Gujjar Nallah or Lyari River should flow into TP-3 through existing Lyari Interceptor laid at the right bank side of Lyari River.

The preliminary design in feasibility study stage was done using the results of levelling survey and detailed street map developed in GIS study.

Figure 124.1.1 shows alignments and size of trunk sewers and sub-main sewers. Outlines of trunk sewers and sub-main sewers are shown in **Table 124.1.2**, and outlines of branch sewers in **Table 124.1.3**. Refer to Appendix **A124.1** for design conditions and results of the preliminary design.

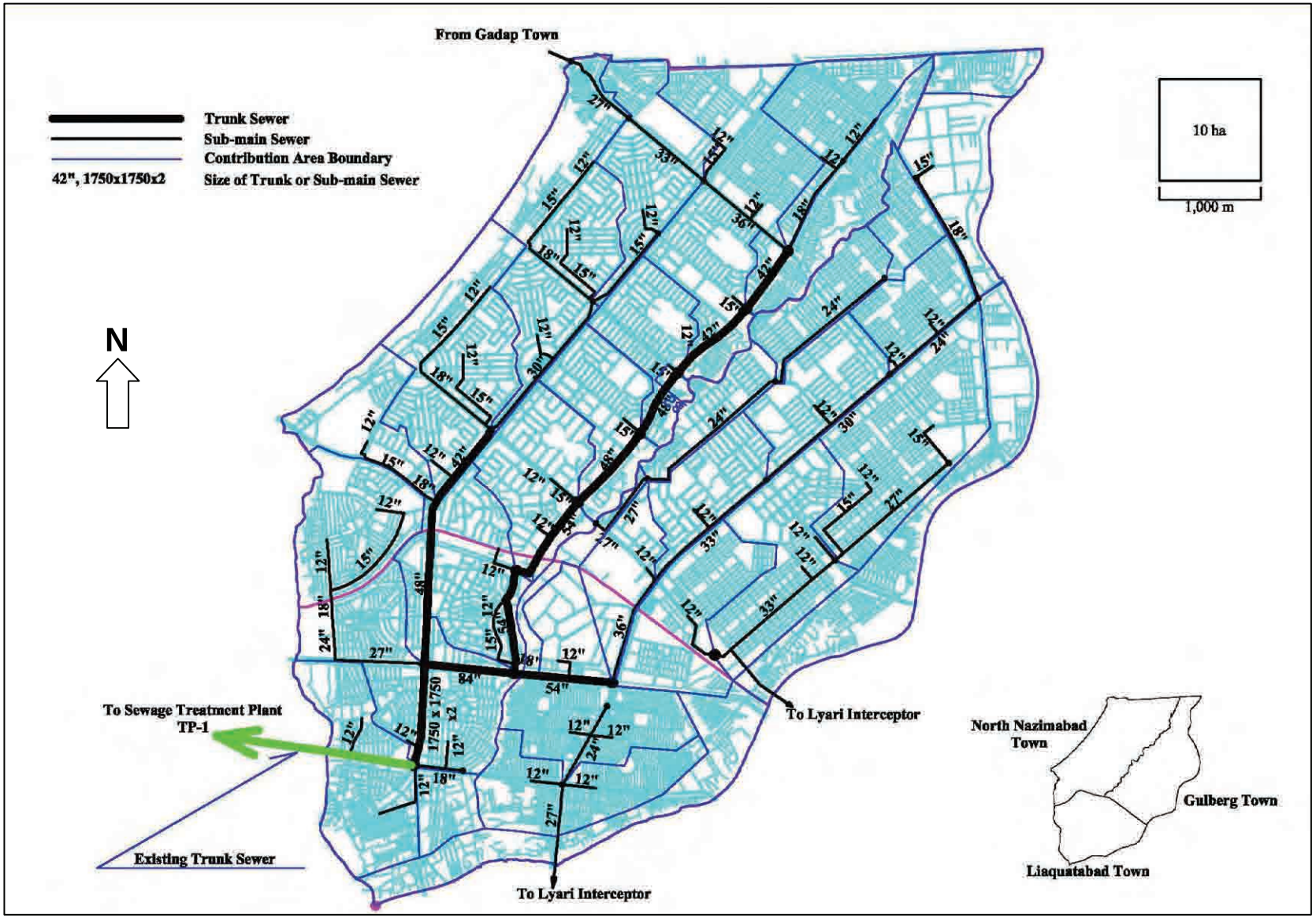

Figure 124.1.1 General Plan of Trunk and Sub-main Sewer

Table 124.1.2 Town-wise Trunk Sewer and Sub-main Sewer Length

Size		Length (m)			
(inch)	(mm)	North Nazimabad	Gulberg	Liaquatabad	Total
Sub-main Sewer					
12	290	3,680	1,540	4,410	9,630
15	370	4,570	1,650	2,000	8,220
18	440	2,790	1,350	1,390	5,530
24	590	0	4,410	1,200	5,610
27	660	820	2,290	1,760	4,870
30	730	1,630	1,600	0	3,230
33	810	970	3,090	0	4,060
36	880	1,080	0	1,130	2,210
Trunk Sewer					
42	1,020	2,460	0	0	2,460
48	1,170	1,630	0	1,610	3,240
54	1,320	990	0	2,040	3,030
84	2,050	0	0	890	890
1750 × 1750 × 2		0	0	1,010	1,010
Total		20,620	15,930	17,440	53,990

Table 124.1.3 Outlines of Branch Sewers

	North Nazimabad	Gulberg	Liaquatabad	Total
(1) Area (ha)	1,670	1,380	1,090	4,140
(2) Road Length (m)	365,500	316,800	301,300	983,600
(3) Branch Sewer Length (m)				
(3-a) Existing Length (m)	321,640	278,790	265,150	865,580
(3-b) Required Length (m)	35,740	30,980	29,460	96,180
Total (m)	357,380	309,770	294,610	961,760
A. Rehabilitation Length (m)	64,330	55,760	53,030	173,120
B. Newly construction Length (m)	35,740	30,980	29,460	96,180
C. Total	100,070	86,740	82,490	269,300

Note:
(1) Area and road length of each town were measured in GIS study.
(2) Total branch sewer length was determined by this preliminary design.
(3) Length of existing branch sewer was estimated to be 90% of total based on the interviews with officers of each town. Hence, the length of branch sewers to newly lay is 10% of the total length of branch sewers.
(4) Rehabilitation length in this project was presumed to 20% of existing length of sewers.

12.4.2 Rehabilitation of Sewage Treatment Plants

(1) Sewage Treatment Plant TP-1

Figure 124.2.1 shows general plan of sewage treatment plant TP-1.

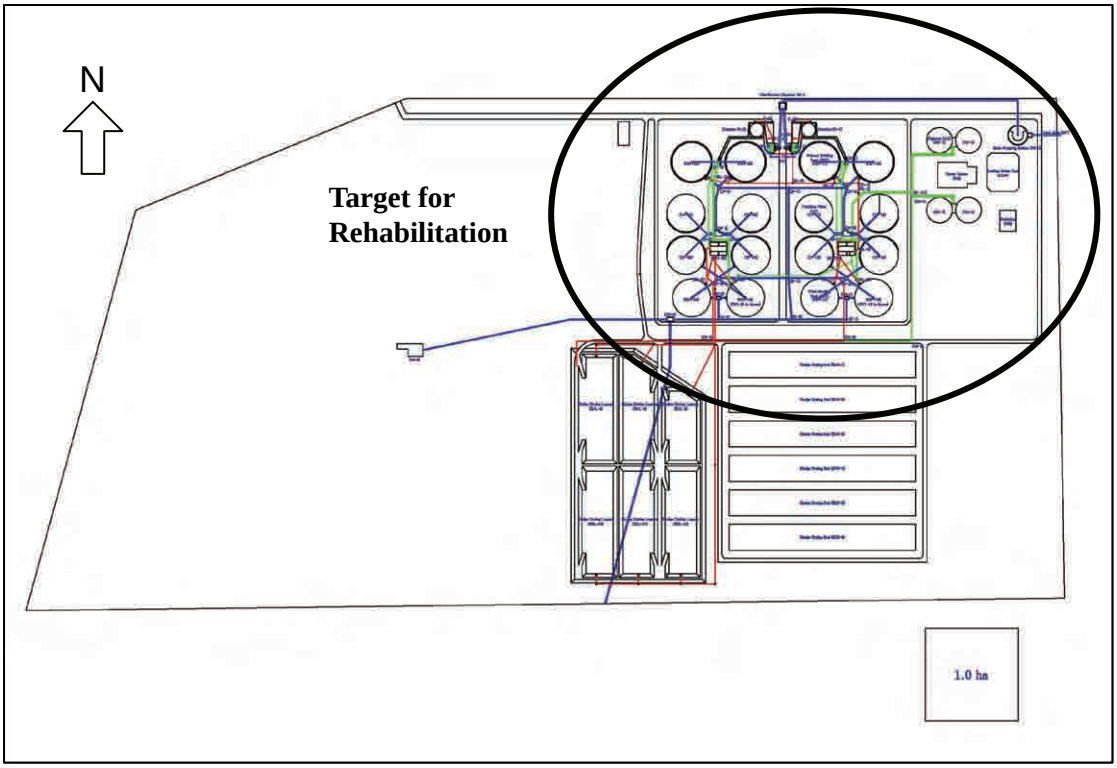

Figure 124.2.1 General Plan of Sewage Treatment Plant TP-1

The scope of rehabilitation for mechanical and electrical work is illustrated in **Figure 124.2.2**. The component of this rehabilitation work is tabulated in **Table 124.2.1** and **Table 124.2.2**.

The details of the rehabilitation work are attached as **Appendix A124.2** to this report.

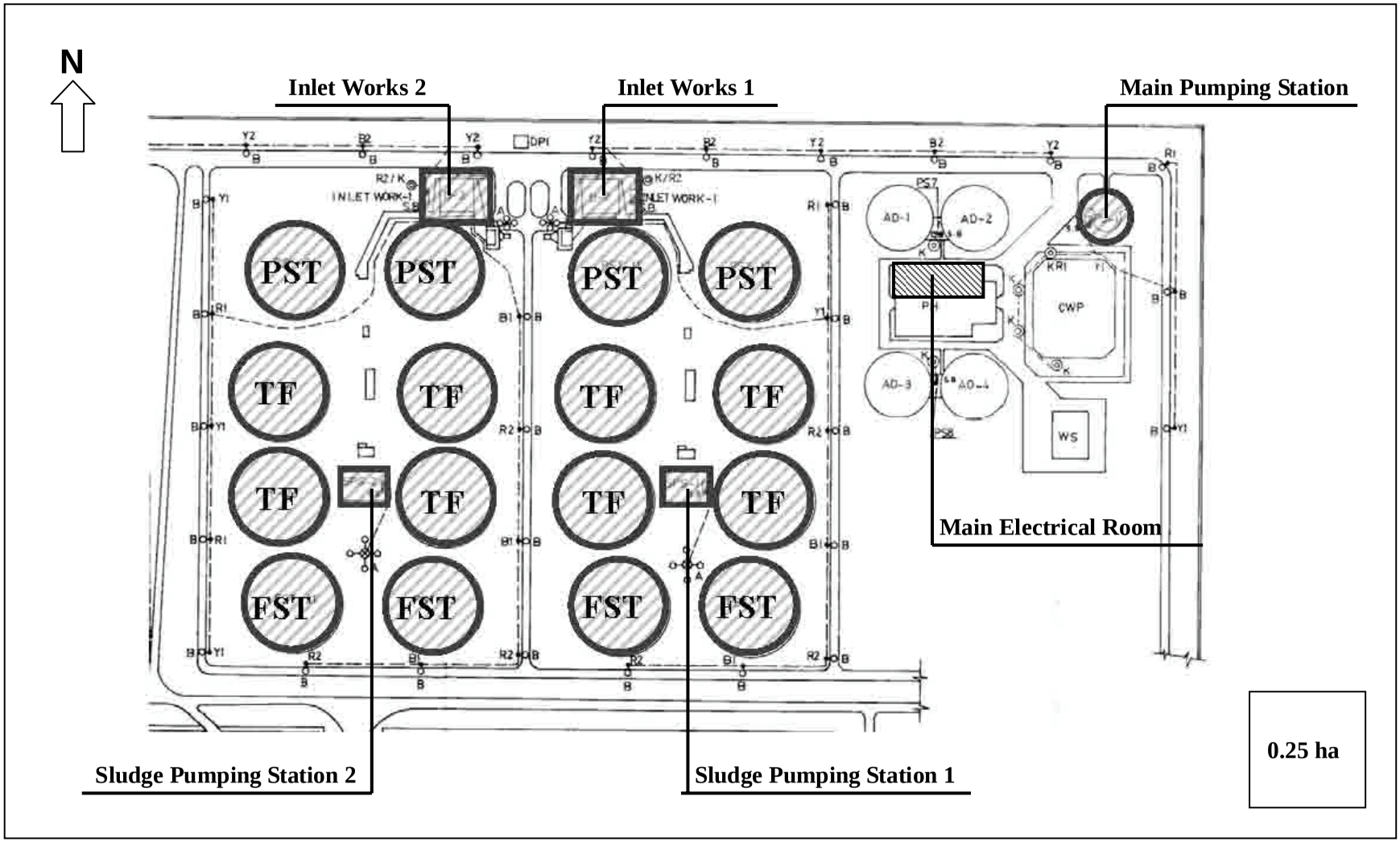

Figure 124.2.2 Scope of Rehabilitation for Mechanical and Electrical Work at TP-1

Table 124.2.1 List of Equipment to Rehabilitate in TP-1

Equipment Name	Specification			Qty
(a) Main Pumping Station				
Main Pump	Multistage Vertical Centrifugal Sewage Pump		400V 3phase 90.00kW	7
	$0.52m^3/s \times 10mH$			
Motor for Bar Screen			400V 3phase 1.50kW	4
Ventilation Fan			400V 3phase 2.20kW	2
Sump Pump	Submersible Pump		400V 3phase 1.50kW	2
(b) Screen, Grit Chamber, Partial Flume (Inlet Works 1&2)				
Motor for Mechanical Screen			400V 3phase 1.50kW	4
Motor for Grit Collector			400V 3phase 3.00kW	2
Motor for Organic Pump			400V 3phase 0.20kW	2
Motor for Grit Separator			400V 3phase 1.50kW	2
(c) Primary Settling Tank				
Sludge Collector for PST	Centre Driven Column Type	42 m in dia	400V 3phase 3.00kW	4
(d) Trickling Filter				
Trickling Filter		41.4 m in dia		8
(e) Final Settling Tank				
Sludge Collector for FST	Centre Driven Column Type	42 m in dia	400V 3phase 3.00kW	4
(f) Sludge Pumping Station No.1 at Train 1				
Humus Sludge Pump	Vertical Centrifugal Sewage Pump $0.04m^3/s \times$ 12.3mH		400V 3phase 11.00kW	2
Lagoon Feed Pump	Vertical Centrifugal Sewage Pump $0.03m^3/s \times$ 20mH		400V 3phase 15.00kW	3
Ventilation Fan			400V 3phase 2.20kW	1
Sump Pump	Submersible Sewage Pump		400V 3phase 1.50kW	2
(g) Sludge Pumping Station No.2 at Train 2				
Humus Sludge Pump	Vertical Centrifugal Sewage Pump $0.04m^3/s \times$ 12.3mH		400V 3phase 11.00kW	2
Pressure Pump	Centrifugal Type, with pressure tank		400V 3phase 2.50kW	1
Ventilation Fan			400V 3phase 2.20kW	1
Sump Pump	Submersible Sewage Pump		400V 3phase 1.50kW	2
(h) Electrical Equipment				
Incoming Panel		Indoor Installation		2
Transformer	1000kVA	Indoor Installation		1
Main Low Voltage Panel		Indoor Installation		1
PF Improvement Panel		Indoor Installation	SC 100kVar ×1	2
PF Improvement Panel		Indoor Installation	SC 125kVar ×1	1
Motor Control Centre	PS-1	Indoor Installation		1
Motor Control Centre	Inlet Works 1	Outdoor Installation		1
Motor Control Centre	Inlet Works 2	Outdoor Installation		1
Motor Control Centre	SPS-1	Indoor Installation		1
Motor Control Centre	SPS-2	Indoor Installation		1
Local Control Switch				55
Generator Set	Diesel Type 750kVA with 4500 Liter Fuel Tank		Indoor Installation	1
Level Meter	Ultrasonic Type	0 to 5m	Outdoor Installation	7
Flow Meter	Ultrasonic Open Channel Type	0 to $3500m^3/h$	Outdoor Installation	2

Table 124.2.2 List of Connecting Pipes in TP-1

	Diameter / Length	Length
Connecting Pipes	100-300mm, 1050mm L= 4,870 m	Connecting inlet works, primary settling tanks, trickling filters and final settling tanks for sewage. Connecting primary/final settling tanks and sludge handling facilities for sludge.

As shown in **Figure 124.2.2**,**Table 124.2.1**, and **Table 124.2.2** major rehabilitation works include;

- replace main pumps with new ones
- replace sludge scrapers of four primary settling tanks and four final settling tanks with new ones
- replace primary effluent sprinklers of eight trickling filters with new ones
- replace sludge withdrawal pipes of four primary settling tanks and four final settling tanks with new ones
- replace pipes connecting treatment facilities for sewage conveyance and sludge conveyance with new ones
- install flow meter
- replace associated electrical equipment with new one

The rehabilitation works will enable TP-1 to treat the flow of 110,000 m^3/d to meet the effluent standard of BOD of less than 80 mg/l.

(2) Sewage Treatment Plant TP-3

Figure 124.2.3 shows general plan of sewage treatment plant TP-3.

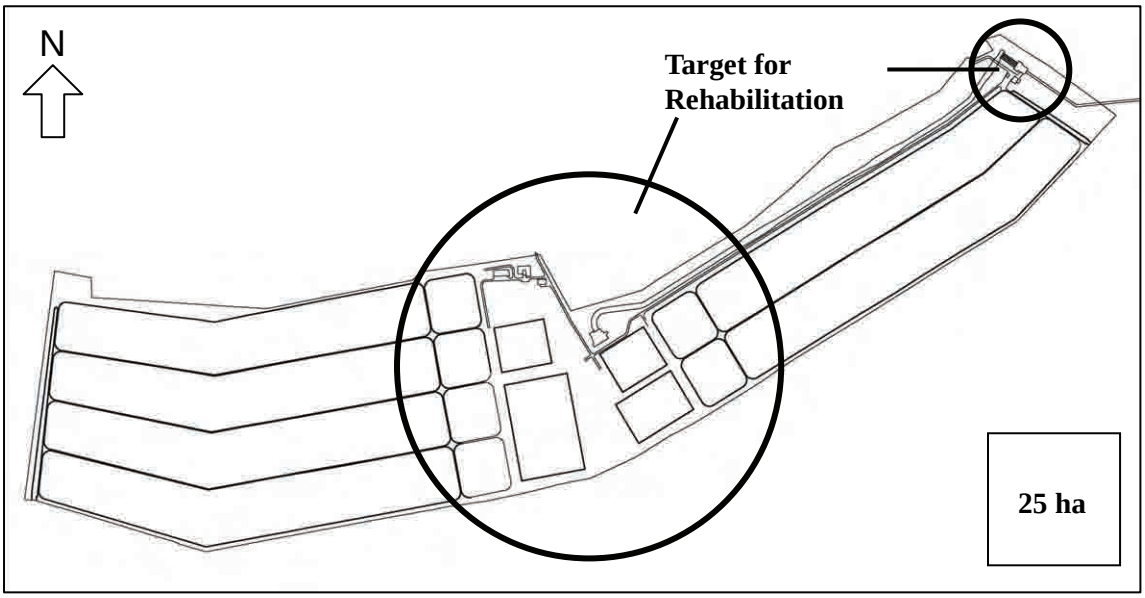

Figure 124.2.3 General Plan of Sewage Treatment Plant TP-3

The scope of rehabilitation for mechanical and electrical work is illustrated in **Figure 124.2.4**. The component of this rehabilitation work is tabulated in **Table 124.2.3**.

The details of the rehabilitation work are attached as **Appendix A124.2.1** to this report.

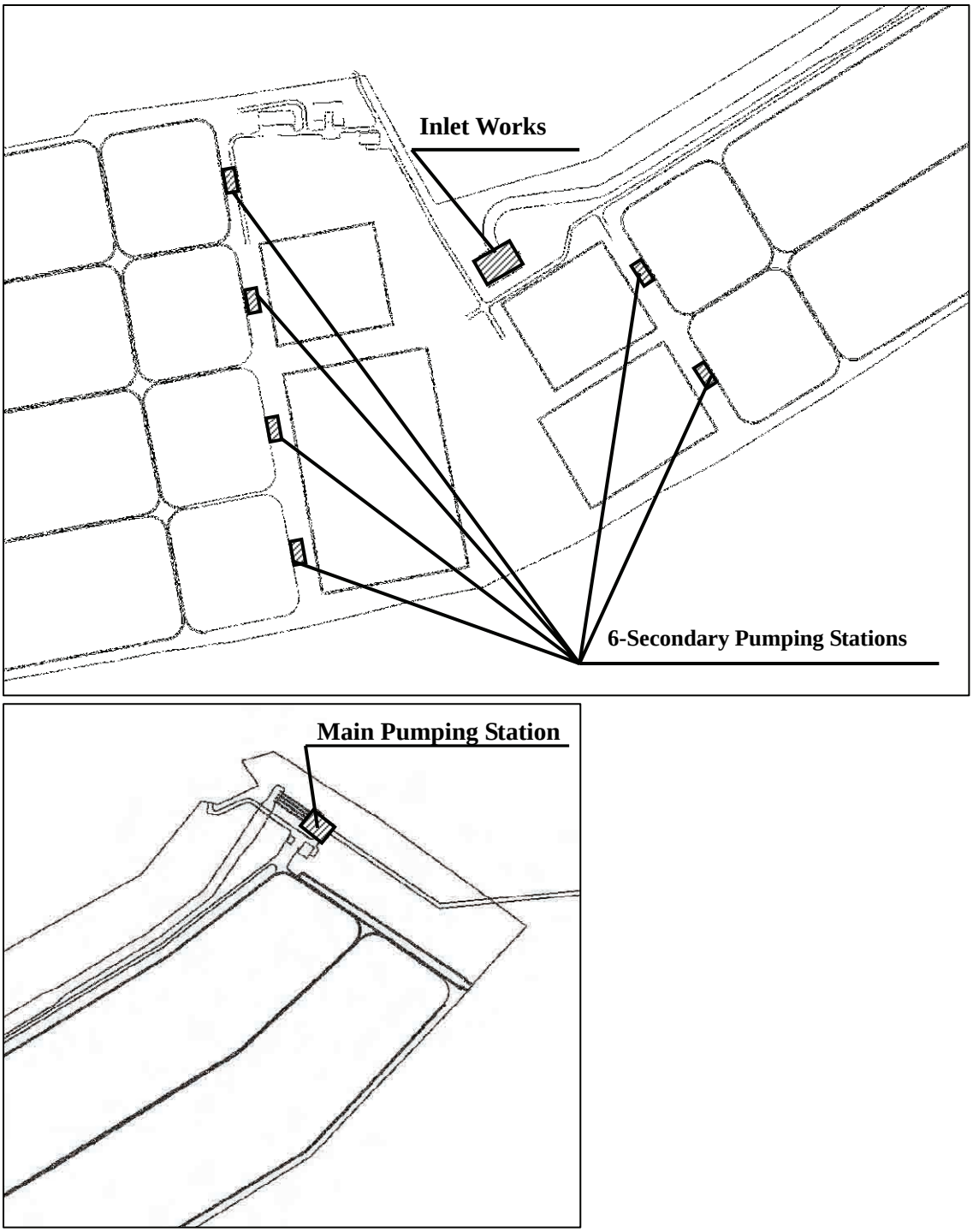

Figure 124.2.4 Scope of Rehabilitation for Mechanical and Electrical Work at TP-3

Table 124.2.3 List of Equipment to Rehabilitate in TP-3

Equipment Name	Specification			Qty
(a) Main Pumping Station				
Motor for Bar Screen			400V 3phase 1.50kW	4
Potable Water Pump	Centrifugal Pump			3
(b) Screen, Grit Chamber (Inlet Works)				
Motor for Mechanical Screen			400V 3phase 1.50kW	5
Motor for Grit Collector			400V 3phase 3.00kW	3
Motor for Organic Pump			400V 3phase 0.20kW	3
Motor for Grit Separator			400V 3phase 1.50kW	3
Potable Water Pump	Centrifugal Pump			2
Drainage Pump	Submersible Sewage Pump			2
(c) Anaerobic Pond				
Secondary Pump	Vertical Sewage Pump $0.83m^3/s \times 7mH$		400V 3phase 75.00kW	18
Ventilation Fan			400V 3phase 2.20kW	6
Sump Pump	Submersible Sewage Pump		400V 3phase 1.50kW	12
(d) Electrical Equipment				
Motor Control Centre	Inlet Works	Indoor Installation		1
Motor Control Centre	SPS	Indoor Installation		6
Local Control Switch				61
Level Meter	Ultrasonic Type	0 to 5m	Outdoor Installation	6
Flow Meter	Ultrasonic Open Channel Type		Outdoor Installation	6

Major rehabilitation works include;
- replacement of 18 submersible pumps with 18 vertical pumps
- construction of six pumping stations with pump sumps where three secondary pumps are installed for each
- installation of flow meter
- replacement of associated electrical equipment with new one

The rehabilitation works will enable TP-3 to treat the flow of 245,000 m^3/d to meet the effluent standard of BOD of less than 80 mg/l.

12.4.3 Implementation Schedule

As engineering services, detail design works will begin in early 2012 followed by construction supervision which will be finalized in mid 2014. Replacement works of mechanical and electrical equipment of two sewage treatment plants of TP-1 and TP-3 and construction works of branch and trunk sewers will commence simultaneously in mid 2012 and will be finalized in mid 2014. **Figure 124.3.1** shows the implementation schedule of these construction works for sewerage priority projects.

No.	Components	Description	Unit	Quantity	Year				
					2012	2013	2014	2015	2016
1	**Engineering Service**								
	Engineering Service	TP-1 and TP-Sewage Treatment Plant, Sewer and Box Culvert	-	-					
2	**TP-1 Sewage Treatment Plant**								
	2.1 Mechanical Equipment								
	a) Main Pumping Station								
	Main Pump	Vertical Centrifugal, 31.2m^3/min 10.0m 90kw	sets	7					
	Electric Winch for Coarse Screen	1,000kg 1.5kw	sets	4					
	Sump Pump	Submerged pump 1.1kw	sets	2					
	b) Screen Chamber	Drive Equipment for Mechanical Rake 1.5kw	sets	4					
	c) Detritor								
	Drive Equipment for Grit Collector Rake	3.0kw	sets	2					
	Organics Return Pump	0.18L/s 1.0m 0.2kw	sets	2					
	Drive Equipment for Grit Removal Rake	1.5kw	sets	2					
	d) Primary Settling Tank	Equipment of Sludge Collector Rake Diameter 42.0m	sets	4					
	e) Trickling Filter	Water Spray Bar Diameter 41.4m	sets	8					
	f) Final Settling Tank	Equipment of Sludge Collector Rake Diameter 42.0m	sets	4					
	g) Sludge Pump Station No.1								
	Humus Sludge Pump	Vertical Centrifugal, 2.4m^3/s 12.3m 11.0kw	sets	2					
	Lagoon Feed Pump	Vertical Centrifugal, 2.0m^3/min 20.0m 15.0kw	sets	3					
	Sump Pump	Submerged Pump 1.5kw	sets	2					
	h) Sludge Pump Station No.2								
	Humus Sludge Pump	Vertical Centrifugal, 2.4m^3/s 12.3m 11.0kw	sets	2					
	Pressure Pump	Horizontal Centrifugal 2.5kw, with Pressure Tank	set	1					
	Sump Pump	Submerged Pump 1.5kw	sets	2					
	2.2 Electrical Equipment								
	Incoming Panel		sets	2					
	Electrical Transformer	1,000kVA	set	1					
	Main Low Voltage Panel		set	1					
	PF Improvement Panel	SC 100kVarxl 2sets, SC125kV arxl 1set	l.s.	1					
	Motor Control Center	PS-1 1set, Inlet Works -1 1set, Inlet Works-2 1set	l.s.	1					
	Motor Control Center	SPS-1 1set, SPS-2 1set	l.s.	1					
	Local Control Switch		sets	55					
	Generator Set	Diesel Type 750kVA 4,500 litter Fuel Tank	set	1					
	Level Meter and Flow Meter	Ultrasonic Type 7sets, Ultrasonic Open Channel Type 2sets	l.s.	1					
	2.3 Internal pipe of Sewage Treatment Plant								
	Chamber of JP5, JP6 to F. Settling Tank	DN 1,050mm	m	70					
	Sludge, Scum and Drain Pipe Line	DN 100 - DN 300mm	m	4,800					
3	**TP-3 Sewage Treatment Plant**								
	3.1 Mechanical Equipment								
	a) Main Pumping Station	Motor for Bar Screen 1.5kw 4sets, Potable Water Pump 3sets	l.s.	1					
	b) Screen Chamber	Drive Equipment for Mechanical Rake 1.5kw	sets	5					
	c) Detritor								
	Drive Equipment for Grit Collector Rake	3.0kw	sets	3					
	Drive Equipment for Grit Removal Rake	1.5kw	sets	3					
	Pump	Organics Return 3sets, Potable Water 2sets, Drainage 2sets	l.s.	1					
	d) Anaerobic Pond								
	Secondary Pump	Vertical Sewage Pump 50m3/min 7m 75kw	sets	18					
	Sump Pump	1.5kw	sets	12					
	3.2 Electrical Equipment								
	Motor Control Center		set	1					
	Motor Control Center	SPS	sets	6					
	Local Control Switch		sets	61					
	Level Meter and Flow Meter	Ultrasonic Type 6sets, Ultrasonic Open Channel Type 6sets	l.s.	1					
	3.3 Pump House for Secondary Pump	W=10.0m L=15.0m H=5.0m	hou.	6					
4	**Sewer and Box Culvert**								
	4.1 Branch Sewer								
	North Nazimabad Town	DN 10 inch	m	100,100					
	Gulberg Town	DN 10 inch	m	86,700					
	Liaquatabad Town	DN 10 inch	m	82,500					
	Total			269,300					
	4.2 Trunk Sewer								
	North Nazimabad Town	DN 12 inch	m	3,680					
		DN 15 inch	m	4,570					
		DN 18 inch	m	2,790					
		DN 27 inch	m	820					
		DN 30 inch	m	1,630					
		DN 33 inch	m	970					
		DN 36 inch	m	1,080					
		DN 42 inch	m	2,460					
		DN 48 inch	m	1,630					
		DN 54 inch	m	990					
	Gulberg Town	DN 12 inch	m	1,540					
		DN 15 inch	m	1,650					
		DN 18 inch	m	1,350					
		DN 24 inch	m	4,410					
		DN 27 inch	m	2,290					
		DN 30 inch	m	1,600					
		DN 33 inch	m	3,090					
	North Nazimabad Town	DN 12 inch	m	4,410					
		DN 15 inch	m	2,000					
		DN 18 inch	m	1,390					
		DN 24 inch	m	1,200					
		DN 27 inch	m	1,760					
		DN 36 inch	m	1,130					
		DN 48 inch	m	1,610					
		DN 54 inch	m	2,040					
		DN 84 inch	m	890					
		1,750x1,750 Box Culvert (Double Culvert)	m	1,010					
	Total			53,990					

Figure 124.3.1 Implementation Schedule of Sewerage System

12.4.4 Plans for Construction and Procurement of Equipment/Materials

(1) Plans for Construction

Plans for construction are prepared based on the implementation schedule. Construction materials are procured according to plan for procurement of equipment/material. In order to obtain high quality outcome of the construction works, plans for construction will include routine quality control, schedule control and safety management. Vibration, noise, liquid and solid wastes that are expected to be generated during the construction works have to be minimized, which will be incorporated in the plans for construction. As a whole, the following items will be taken into account in the preparation of the plans for construction.

Sewage treatment plants of TP-1 and TP-3

Plans for construction have to be prepared by minimizing interrupted operation, since these two plants in operation are to be rehabilitated. TP-3 is close to the sea and salt resistant paint will be used for mechanical equipment.

Trunk and branch sewers

Circular trunk sewers have diameters ranging between 12 and 84 inches and box culvert has the dimension of 1,750 mm by 1,750 mm. Their total length is 54.0 km. Sheet piles and other soil retaining apparatus will be adopted for larger diameter pipe laying and deeper excavation. Branch sewers are defined as those of 10 inches diameter and their total length is 269 km. Replacement of sewers is planned with smooth flow diversion and abandoned sewers are left underground as they are.

As-built drawings

As-built drawings are to be prepared for concrete structures and sewer pipes at the time of construction completion and to be used for operation and maintenance purposes at the later stage.

(2) Procurement of Equipment/Materials

Construction of sewerage facilities requires pumps, mechanical and electrical equipment for sewage treatment, pipes, valves, concrete and reinforcing steel bars. Mechanical and electrical equipment, concrete, reinforcing steel bars and concrete pipes are locally procured. Pumps, cast iron pipes, valves and pumps are to be imported.

Table 124.4.1 Procurement of Equipment and Material for Sewerage System

Item	Description	Procurement
TP-1		
Main Pumping Station	Vertical1 Centrifugal	Overseas
Primary Settling Tank	Equipment of Sludge Collector Rake	Domestic
Trickling Filter	Water Spray Bar	Domestic
Final Settling Tank	Equipment of Sludge Collector Rake	Domestic
Sludge Pump Station No.1	Humus Sludge Pump, Lagoon Feed Pump	Overseas
Sludge Pump Station No.2	Humus Sludge Pump, Pressure Pump	Overseas
Electrical Equipment		Domestic
Pipe	Cast Iron Pipe	Overseas
Valve	Sluice Valve	Overseas
TP-3		
Secondary Pump	Vertical Pump	Overseas
Electrical Equipment		Domestic
Pump House for Secondary Pump	Reinforced Concrete and Concrete Block	Domestic
Trunk Sewer		
84inch	Pre-stressed Reinforced Concrete Pipe	Domestic
72inch less or equal	Reinforced Concrete Pipe	Domestic
Box Culvert	Reinforced Concrete	Domestic
Branch Sewer	Reinforced Concrete Pipe	Domestic

12.4.5 Plans for Operation and Maintenance of Priority Projects

O&M activities and improvement plans for the sewerage facilities are designed to fit in with the priority projects identified during the Feasibility phase; namely the rehabilitation of branch sewers, installation of branch and trunk sewers, as well as rehabilitation of main pumps at TP-1 and secondary pumps at TP-3 and rehabilitation of treatment facilities at TP-1. Improvements to O&M practices are required as part of DNI in line with modern methods to be adopted by the retail entity responsible for sewerage services within Zone West. The priority will be to operate and maintain sewerage facilities to ensure efficient collection and treatment of sewage, safe disposal of sewage sludge and effluent discharge that complies with environmental standards.

For the sewerage facilities within Zone West, DNI is based on the following premise:

- Effective operations and maintenance practices and methods will be employed.
- Effective methods of process control will be employed including the testing of effluents prior to discharge into public water bodies to ensure compliance with environmental legislation in force. This includes the safe disposal of screenings, grit and sludge generated at plants as a result of sewage treatment
- Effective operations management practices will be employed including the need to collect and act on asset data
- Effective maintenance management practices will be deployed including the need to employ a more proactive approach to maintenance such as the use of planned preventive maintenance practices to ensure efficient plant availability and operability
- Modern techniques and tools will be employed to ensure that the sewer networks are regularly cleaned and maintained to prevent sewer blockages and sewage flooding
- High safety standards will be employed to ensure safe installation, maintenance and operation of equipment in potentially explosive atmosphere

Modern techniques and tools will be employed to ensure that the sewerage networks are regularly cleaned and maintained to prevent sewer blockages and sewage flooding.

High safety standards will be employed to ensure safe installation, operation and maintenance of equipment in potentially explosive atmospheres.

Modern O&M methods employed by the Zone West retail entity will include:

- Policy formulation, setting of departmental targets and objectives
- Asset management plans and the recording of asset information
- O&M manuals that clearly state the parameters, procedures, schedules and responsibilities for effective operation of collection and treatment systems
- ‘Planned preventative maintenance’ practices
- H&S policy/manuals and contingency/emergency plans
- Providing and acting on meaningful and timely management information
- The use of information systems and technology for all O&M activities such as computerised maintenance management systems (CMMS) and GIS

In the short to medium term this will require the retail operator to:

- Implement best operating practices and manuals
- Implement safe systems of work
- Improve safety standards at sewage pumping stations (PS’s), sewage treatment plants (TP’s) and the sewer networks
- Upgrade electrical installations at TP’s and PS’s to comply with safety regulations in force
- Provide tools for effective maintenance of PS’s, TP’s and the sewer networks
- Measure the performance of assets and staff

- Record process and asset data and maintain asset records
- Act on process, asset and management information
- Implement proactive maintenance practices
- Enhance skills through training

It is envisaged that in the medium and long term, Regional Control Centres (RCC) will be established for effective control of sewerage facilities. The treatment plants, pumping stations and sewer networks within each region would be monitored and controlled from the RCC's. The RCC's would have a communications link with the Central Control Centre at the service provider's HQ site for monitoring and control purposes. A communications network would provide the communications 'backbone' for purposes of providing management information and telemetry of critical assets and control points such as the PS's.

In order to improve network performance and service standards the retail entity will need to adopt a number of improvements as detailed in the improvement plan shown in **Appendix A124.3**.

(1) Sewage Treatment Plants

After implementation of DNI, the sewage treatment plants, sewage pumping stations and the sewer networks associated with Zone West will be managed by the Zone West retail entity. The retail entity will therefore be responsible for the O&M of TP-1, TP-3 and associated pumping stations.

DNI will be operated on the basis of charging domestic, commercial and bulk customers a sewerage charge set at a fixed % rate of the water charge. This will be determined, agreed upon and monitored by the independent regulator.

Operation and maintenance manuals will be used to document procedures for plant operation and maintenance and will be used for training purposes. This will ensure the deployment of standard operating procedures and practices at each plant.

Training of staff in the use of modern operation and maintenance techniques such as planned preventative maintenance and predictive maintenance techniques, including the hardware, software and technologies employed will be through extensive training programmes for staff transferred to the retail entity from KW&SB.

The sewage treatment plants will be rehabilitated to comply with effluent standard stipulated in NEQS. It is estimated that 62 trained and qualified staff members will be required to comply with efficient operation of the treatment plants . This is based on international best practice and assumes that O&M staff will be responsible for regular 'running' maintenance of the plant and will employ modern O&M techniques. Running maintenance includes regular inspection, oiling and greasing of plant and equipment.

The TP's will be operated on a 24-7 basis and all facilities will be subject to daily and periodic inspection of concrete structures, mechanical and electrical equipment.

Concrete structures include inlet pumping station, grit chambers, primary settling tanks, trickling filters and final settling tanks. Mechanical and electrical equipment include pumps, screens, rakes, grit collectors, scrapers of primary and final settling tanks and sprayers of trickling filters.

Treatment control parameters including influent and effluent qualities will be monitored as a

minimum as well as the following:

- Flow rate
- Water level at the plant inlet, primary settling tanks, final settling tanks, anaerobic and facultative ponds
- Water quality including water temperature, pH, BOD, SS, of the plant influent and effluent
- Sludge layer thickness at the bottom of anaerobic and facultative ponds

Major breakdowns or periodic rehabilitation work to plant and equipment will be through maintenance contracts let to specialist maintenance companies to be selected and certified by the retail entity.

Sewage treatment plants constantly generate grit, screenings and sludges removed from raw sewage, and dried sludge from their treatment processes. Such solid wastes shall be removed from the TP's and properly disposed of or reused.

(2) Sewage Collection System

It is estimated that the length of sewers in the three towns will be approximately 1,018km in 2016. Maintenance of sewers includes three major tasks of regular inspection, cleaning and repairs. Maintenance manuals will be used to document procedures for the maintenance of sewers and will be used for training purposes. This will ensure the deployment of standard operating procedures and practices throughout the sewers located within three towns.

Regular maintenance of sewers will include the need to periodically remove deposits, grit and debris. For larger diameter sewers, it will be necessary to use mechanised sewer cleaning equipment.

The most commonly used mechanized equipment is high-pressure water tankers used with sludge vacuum tankers (or "gully suckers") as illustrated in **Figure 124.5.1**:

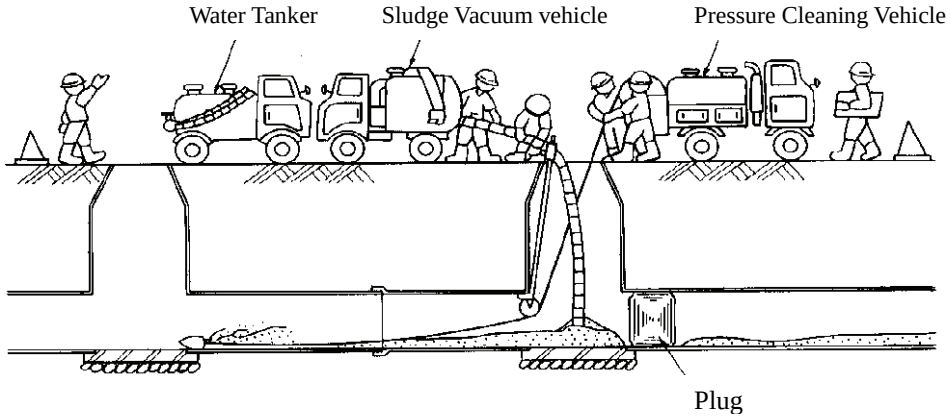

Figure 124.5.1 Mechanized Sewer Cleaning

Where equipment such as sludge vacuum vehicles and jetting machines are available in KW&SB at the time of starting DNI in Zone West it is assumed that the appropriate equipment will be transferred to the new company at that time along with the appropriate staff.

Sewers should be cleaned at least every five years. It is assumed that a sewer cleaning team with mechanised equipment would be able to clean 100m per day. Supposing one team for standby, three teams of six members for each or 18 staff members in total will be in charge of above mentioned maintenance works.

Operation and maintenance manuals will be used to document procedures for branch sewer operation and maintenance and will be used for training purposes. This will ensure the deployment of standard operating procedures and practices throughout the networks located within each town.

Regular operation and maintenance of branch sewers will include the need to regularly remove deposits, grit and debris.
For smaller size sewers, manual cleaning equipment will be deployed extensively such as rodding and swabbing tools, however the use of mechanised equipment would speed up the process in cases where sewers are being cleaned for the first time.

Ten teams of five members for each or 50 staff members in total will be in charge of maintenance works of collection network. Typical manual cleaning equipment such as the Hand Reel Winch type is shown in **Figure 124.5.2**:

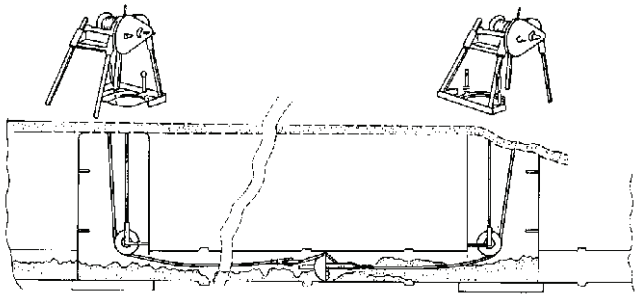

Figure 124.5.2 Manual Sewer Cleaning

The total number of staff members required to inspect and maintain both trunk and branch sewers is 68 including the operation of mechanised and manual cleaning equipment.

A detailed cost benefit analysis will need to be done to determine whether sewer cleaning should be done in-house or contracted out. This warrants further separate study.

If sewer cleaning is conducted in-house, staff transferred to the retail entity from KW&SB will be subject to extensive training in the use of modern operating and maintenance techniques for the regular removal of deposits, grit and debris and for dealing with emergencies such as sewage overflows or sewage flooding, especially where this relates to property flooding.

12.5 PRELIMINARY COST ESTIMATES AND FINANCING PLANS

12.5.1 Preliminary Cost Estimates

(1) Construction Cost

Table 125.1.1 summarizes the construction cost of water supply and sewerage projects. The former is Rs.12,452 million, and the latter is 3,976 million with the total cost of Rs.16,428 million. Refer to **Appendix 125.1** for the details.

Table 125.1.1 Construction Cost of Water Supply and Sewerage Systems

(unit: Rs.thousand)

Water Supply System			Sewerage System			Grand Total
Components	Description	Amount	Components	Description	Amount	
1) Reservoir	Capacity 30mgd	490,860	1) TP-1 Sewage Treatment Plant	Capacity 24mgd Rehabilitation	337,279	
2) Trunk Distribution Main	DN14 - DN100inch L=75,480m	4,605,980	2) TP-3 Sewage Treatment Plant	Capacity 54mgd Rehabilitation	198,685	
4) Flow Meter	DN18 - DN100inch N=17nos.	46,125	3) Branch Sewer	DN10inch L=269,300m	942,550	
5) Distribution Network Main	L=996,100m	2,988,300	4) Trunk Sewer	DN12 - DN84inch, Box Culvert L=53,990m	1,171,080	
6) House Connection	N=228,300nos.	1,035,540	-		-	
Total		9,166,805	Total		2,649,594	11,816,399
Engineering Fee	7.5%	687,510	Engineering Fee	7.5%	198,720	
Land Acquisition		3,680	Land Acquisition		-	
Physical Contingency	5.0%	492,899	Physical Contingency	5.0%	142,416	
Price Contingency	foreign currency1.5% local currency 6.0%	1,916,802	Price Contingency	foreign currency1.5% local currency 6.0%	927,044	
Project Administration	1.5%	184,015	Project Administration	1.5%	58,767	
Total		3,284,906	Total		1,326,947	4,611,853
Grand Total		12,451,711	Grand Total		3,976,541	16,428,252

(2) Operation and Maintenance Cost

1) Water Supply System

Table 125.1.2 shows the operation and maintenance cost for water supply system in the feasibility study area. Bulk water of 84 mgd is purchased from Bulk Water Supply Central. The unit purchasing cost is estimated to be Rs.21/thousand gallons taking into account operation and maintenance costs of Bulk Water Supply Common and Bulk Water Supply Central. Operation cost is estimated for Hub Water Supply System, while maintenance cost is estimated excluding reservoir, trunk distribution main and flow meters associated with Bulk Water Supply Central. Refer to **Appendix 125.1** for the details.

Table 125.1.2 Operation and Maintenance Cost of Water Supply System

Component	Amount (Rs. Million/year)		
Water Supply Project			
Purchased Water Fee			643.8
Trunk distribution main			92.1
Operation Cost		0.0	
Maintenance Cost		92.1	
Distribution Network Main			59.8
Operation Cost		0.0	
Maintenance Cost		59.8	
House connection			68.5
Operation Cost		0.0	
Maintenance Cost		68.5	
Total			864.2

2) Sewerage System

Table 125.1.3 shows the operation and maintenance cost for sewerage system in the feasibility study area. Operation cost is estimated for the necessary expenditure such as personnel cost, utility cost, sludge disposal cost and water quality analysis cost needed to operate two sewage treatment plants of TP-1 and TP-3. Maintenance cost includes those for trunk and branch sewers and mechanical electrical equipment of two sewage treatment plants of TP-1 and TP-3.

Refer to **Appendix 125.1** for the details.

Table 125.1.3 Operation and Maintenance Cost of Sewerage System

Component	Amount (Rs. Million/year)		
Sewerage Project			
Sewage Treatment Plant TP-1	42.5		
Operation Cost		41.1	
Personnel			13.8
Electricity			16.1
Diesel			4.2
Polymer			0
Sludge Disposal			4.2
Laboratory and other			2.8
Maintenance Cost		1.4	
Sewage Treatment Plant TP-3	37.8		
Operation Cost		36.9	
Personnel			9.6
Electricity			18.8
Diesel			4.2
Polymer			0
Sludge Disposal			1.7
Laboratory and other			2.6
Maintenance Cost		0.9	
Cleaning Cost of Branch and Trunk Sewer	9.7		
Sub-total	90.0		
Total	954.2		

12.5.2 Financing Plans

The Zone West retail entity will need to raise funds for the implementation of the Priority Projects. The total project cost is estimated at Rs. 16.4 billion as shown in **Table 125.2.1**. This will provide for the following:

(Water Supply)

- A 30 mg water distribution reservoir,
- 75 km of trunk distribution mains,
- 996 km of distribution network mains, and
- 228,300 service connections including revenue metres.

(Sewerage)

- 269 km of branch sewers
- 54 km of trunk sewers,
- replacement of mechanical and electrical equipment at TP-1, and
- replacement of pumps at TP-3

Table 125.2.1 Summary of Priority Project Cost

Items	Rs. (million)	US$ (million)
Base Costs	11,817	194.4
Water Supply	9,162	150.8
Sewerage	2,650	43.6
Other Costs	4,612	75.9
Engineering Fee	886	14.6
Land Acquisition	4	0.1
Physical Contingency	635	10.4
Price Contingency	2,844	46.8
Project Administration	243	4.0
Total Project Cost	16,429	270.3

Apart from internal financing by Government, there are two prospective external sources of fund which would possibly be used for financing the implementation of the Priority Project. They are ADB and JBIC loans.

(1) ADB Loan

The Asian Development Bank (ADB) fielded an appraisal mission to Pakistan from 21 - 25 January 2008 to conduct loan appraisal of the Karachi Mega City Sustainable Development Program (KMCSDP). The Government of Pakistan (GOP) has requested ADB to provide financing through a 'Multitranche Finance Facility (MFF)' for US$ 800 million over 8 years, for selected infrastructure investments and associated public sector reform and institutional development initiatives in Karachi. The MFF has a maximum utilization period of 10 years, and the 'Periodic Financing Requests (PFRs)' will be converted into separate loans.

The Investment Program under KMCSDP will comprise the following parts:

Part A: Institutional Reform, Implementation Support and Capacity Development.
Part B: Water Supply and Wastewater Management.
Part C: Urban Transport.
Part D: Katchi Abadi Improvement and Low-income Housing.

The Part B Program (Water Supply and Wastewater Management) is intended to help develop effective institutional arrangements for delegated management of water supply and wastewater management by assisting CDGK to (i) establish KW&SB's accountability and commercial freedom, (ii) pilot distribution network improvements in one zone of the water supply network, and (iii) finance improvements in raw water quality and transmission.

The total cost of Karachi's urban sector development plan and strategy is estimated to be equivalent to US$ 8.5 billion over the period 2008 to 2020. The total cost of the Investment Program supported by ADB's MFF, from 2008 through 2015, is expected to be equivalent to US$ 1,135 million, comprising 13.3% of the KSDP-2020 investment requirements.

The GOP has entered into a 'Framework Financing Agreement (FFA)' with ADB for up to US$ 800 million through individual loans. In accordance with the FFA, GOP has submitted the first PFR to ADB in an amount of US$ 210 million. The first PFR in the water sector is expected to amount to US$ 93 million which will finance (i) TA for the establishment of KW&SB's accountability and commercial autonomy, (ii) a pilot distribution network improvement (DNI) scheme in one area of the water supply network; (iii) urgent improvements in the quality and transmission of raw water; and (iv) transaction advice for a management, lease or concession contract (or contracts). It is likely that further investments in distribution network improvement (DNI) will be made in the subsequent tranches.

The total cost of the Program is estimated at US$ 1,135 million of which the identified investment requirements to be funded by ADB under the MFF are estimated at US$ 800 million or 70% of the total Program cost as shown in **Table 125.2.2**.

Table 125.2.2 Details of Program Cost

Source	US$ (million)	Share
ADB Ordinary Capital Resources (OCR)	710	62%
ADB Asian Development Fund (ADF)	90	8%
Government	267	23%
Other sources (including private sector)	68	7%
Total	1,135	100%

Source: ADB

An MFF of up to US$ 800 million equivalent will provide loans for (i) up to an aggregate of

US$ 710 million equivalent from ADB's ordinary capital resources (OCR) under ADB's London interbank offered rate (LIBOR)-based lending facility, and (ii) up to US$ 90 million equivalent in Special Drawing Rights from ADB's Special Fund Resources. Each loan will be extended to finance projects subject to submission of related Periodic Financing Requests (PFRs) by the Government. The Government intends to finance the Program with the submission of four PFRs. The last loan is expected to be executed no later than the estimated project completion date of 30 June 2016. The deadline for submission of the last PFR is expected to be 31 December 2012.

Financing from OCR resources will be subject to interest to be determined in accordance with ADB's LIBOR based lending facility, and commitment charge of 0.75% per annum and other terms and conditions. The Special Funds resources will have a 32-year term including a grace period of 8 years, and with an interest rate of 1.0% per annum during the grace period and 1.5% per annum thereafter.

The borrower of the loan will be GOP. All loans from OCR and the Special Funds will be onlent by GOP to the Government of Sindh (GOS) at the same terms and conditions as those of the ADB loans to the GOP. GOS will bear the foreign exchange risk for all loans. The Finance Department of the GOS will be the Executing Agency (EA).

It is currently expected that about 46% of the US$ 800 million loan (US$ 368 million) will be allocated for Part B: Water Supply and Wastewater Management. Although US$ 93 million has already been allocated for Part B in the first PFR, a large portion of the balance US$ 275 million can be allocated in the subsequent tranches for financing the implementation of the Priority Projects.

(2) JBIC Loan

In the past, JBIC provided a Japanese Yen Loan (L/A No.PK-P40 dated November 22, 1994) for the implementation of the 'Karachi Water Supply Improvement Project'. The project with the major objective of improving the quality of water supplied to Karachi provided for construction of the 100 mgd Manghopir Pumping Station and the 80 mgd Hub Filtration Plant and the capacity expansion by 50 mgd of the Pipri Water Treatment Plant. The JBIC loan amounted to JPY 10.3 billion was a general untied loan carrying 2.6% interest rate and 30 years repayment period including 10 years of grace period.

JBIC loan for the main components of the Priority Projects would be a general untied loan carrying an interest rate of 1.2% with 30 years repayment period including 10 years of grace period. For consulting services, the interest rate will be minimal (0.01%) and the repayment, grace period and conditions for procurement will be the same as those for main components. In addition, an amount equivalent to 0.1% of the total unused loan amount would be levied by JBIC as a commitment charge.

JBIC loan would be able to cover almost the entire project cost shown in **Table 125.2.1** except for the costs associated with land acquisition and project administration.

12.6 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

12.6.1 Background

Environment and social consideration for the Master Plan were already carried out, and the result is shown in **Chapter 11**. According to the results of environment and social consideration, although some adverse impacts on environment and society are expected, it was predicted that adverse impacts could fully be controlled by common mitigation measures.

Consequently, KW&SB and JICA Study Team judged the Master Plan to be category-B based on the JICA EIA Guidelines. From the JICA EIA Guidelines, EIA Study is not essential requirement for the implementation of Category B Project.
In final process of the Master Plan Study, priority project is selected as the Feasibility Study project from the components of the Master Plan. Three towns (North Nazimabad, Gulberg and Liaquatabad Towns) as the priority project area are selected, and the priority project which are mainly distribution network improvement for water supply system and collection network improvement for sewerage system are selected.
In this section, the EIA Study for the priority project is performed. As mentioned above, from the result of environmental and social consideration of the Master Plan, it is concluded that the serious adverse impacts are not generated.
On the other hand, the regulation concerning the EIA of Pakistan requires EIA Study to water supply and sewerage projects with the project cost of Rs. 25 million or more. The project cost of the priority project is **Rs. 16,429 million.** EIA has to be carried out by the time of project implementation, not in Feasibility Study stage.
From the above background, the EIA Study concerning the priority project is not needed to be carried out in the Feasibility Study. However, EIA Study (draft) is conducted in Feasibility Study for the following reasons.

Stakeholder Meetings
In this JICA Study, three stakeholder meetings (in the early Study stage, the Master Plan stage and the Feasibility stage) were planned in consideration of implementation of EIA Study. If it is under ordinary circumstances, the broad opinion acquired in stakeholder meetings is reflected into the priority project plan. Consequently, the priority project can be formulated with more residents involvement.
The first stakeholder meeting was held in September 2006. The second stakeholder meeting was proposed to be held at the end of the Master Plan stage to inform of contents of the Master Plan and result of environmental and social considerations in the Master Plan to the stakeholders. JICA discussed the holding of second stakeholder meeting with KW&SB as the KW&SB should take necessary steps to organise the meeting. As the K-IV project and S-3 Project, the former is under PC-1 process and the latter is under pre-qualification stage of consultants, are included in the M/P, KW&SB was reluctant to disclose the information to the public at this stage. Therefore, the stakeholder meeting to inform of the contents of the Master Plan and results of environmental and social considerations was not held. By postponing the 2nd stakeholder meeting, 3rd meeting is not held yet.

Land Acquisition
There are some components that require land acquisition in the priority project. However, actual location of land to acquire is not determined yet.

The above-mentioned two items are very important when implementing the priority project. Since these items are not determined at present, the EIA Study in the Feasibility Study may not include all the required items. As mentioned above, EIA has to be carried out by the time of project implementation. Prior to EIA report preparation, necessary land has to be located and stakeholder meetings have to be held.
The EIA Report (Draft) in the Feasibility Study is shown in **Appendix A-126.1**, and Main Report includes the following items as a summary of the EIA report.

1) Project Description
   - Components of the Priority Project
   - Justification of the Priority Project
2) Impact Identification and Mitigation Measures
   - Impact Identification and Mitigation Measures
   - Risk Analysis and Mitigation Plan

Monitoring Programme

3) Conclusion

12.6.2 Legal and Administrative Framework

(1) Laws and Regulations

The major laws and regulations related to the environmental and social considerations are as listed below:

a. Pakistan Environmental Protection Ordinance, 1983

The Ordinance for the first time established the Pakistan Environmental Protection Council and the Federal and Provincial Environmental Protection agencies. It also pioneered in Pakistan, the requirement of preparing Environmental Impact Assessment (EIA) reports.

b. Pakistan Environmental Protection Act (PEPA) 1997

The Pakistan Environmental Protection Act 1997 is the most important environmental legislative instrument in Pakistan. This Act aims to provide for the protection, conservation, rehabilitation and improvement of the environment, for the prevention and control of pollution and promotion of sustainable development.

(2) Administrative Framework

a. Pakistan Environmental Protection Council (PEPC)

PEPC was established in 1984 by Pakistan Environmental Protection Ordinance, 1983, headed by Prime Minister and one of the members is Minister of Environment. Its main roles are:

- Co-ordinate and supervise enforcement of the provision of Pakistan Environmental Protection act,
- Approve comprehensive national environmental policies and ensure their implementation,
- Approve the National Environmental Quality Standards.

b. Pakistan Environmental Protection Agency (PEPA)

PEPA exist under the PEPC. PEPA is the regulatory institution entrusted with the functions of administering and enforcing the Act and its rules and regulations. These include:

- Take all necessary measures for the implementation of the national environmental policies,
- Ensure the enforcement of the National Environmental Quality Standards,
- Establish standards for the quality of environment,
- Establish systems and procedures for survey, surveillance, monitoring, measurement, examination, investigation, research, inspection and audit to prevent and control pollution.

c. Environmental Protection Agency of Government Sindh (SEPA)

In each province, Provincial Environmental Protection Agency (Provincial-EPA) is established, and Provincial-EPA is independent from Ministry of Environment and PEPA. Many of the federal agency's functions and powers have already been delegated to the Provincial-EPAs.

The main functions are advising and coordinating with government, semi-government organizations, industries, NGOs, and various development agencies on preventive measures for pollution abatement.

- Coordinating environmental policies and plan,
- Implementing PEPA, 1997 and entering NEQS,
- Rendering advice and assistance on environmental matters to various agencies, and
- Establishment of monitoring system for effluents and emissions.

(3) EIA Procedures

Article 12 of Pakistan Environmental Protection Act 1997 states that no proponent of a project shall commence construction or operation unless he has filed with the Government Agencies designated by Federal Environmental Protection Agency or Provincial Environmental Protection Agencies, as the case may be, or, where the project is likely to cause an adverse environmental effects an environmental impact assessment shall be conducted, and he obtained from the Government Agency approval in respect thereof.

The legal procedures for IEE and EIA are promulgated in July 2000 (The Review of Initial Environmental and Environmental Impact Assessment Regulations, 2000). The regulations define the required procedures for "Policy and procedures for the filing, review and approval of environmental assessment" including responsibilities of EPA and other concerned agencies. (See **Figure 126.2.1**)

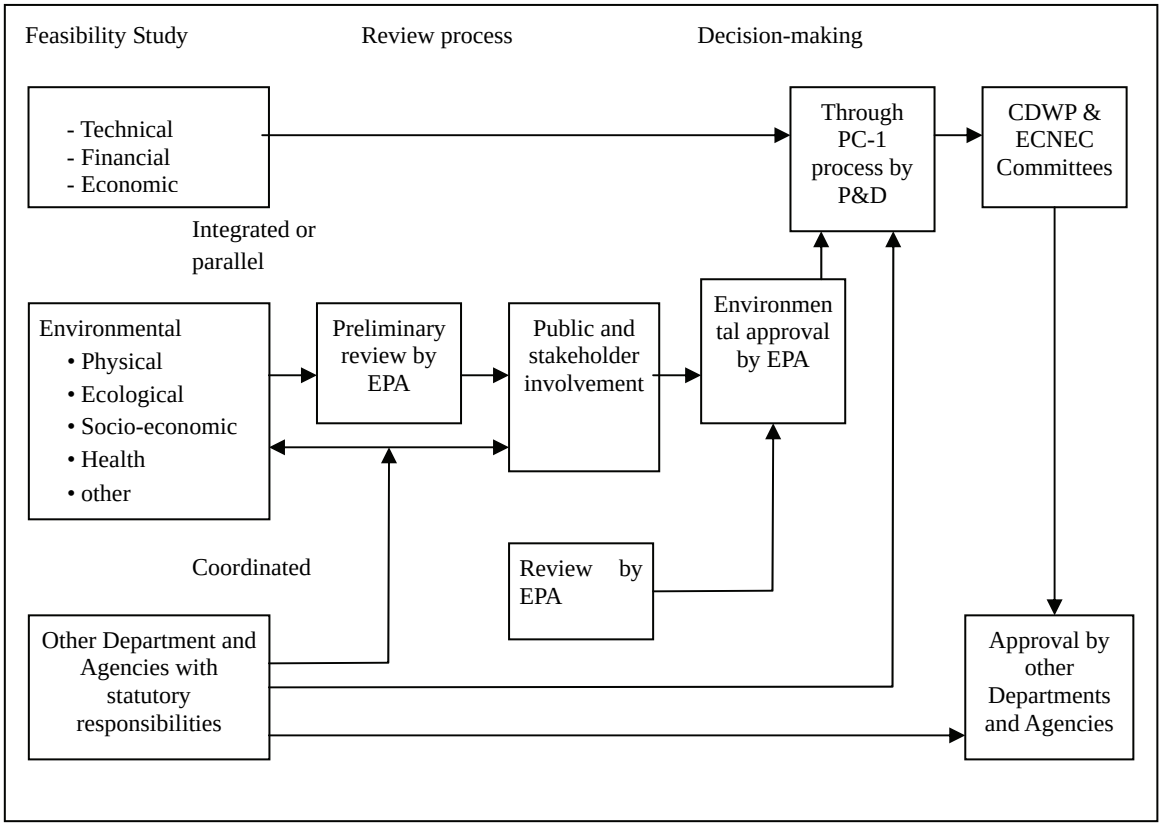

Figure 126.2.1 Decision-making Process

The Guidelines set out the key policy and procedural requirement, including a brief policy statement on the purpose of environmental assessment. The Guidelines also provide schedules of proposals that require either IEE or EIA, which cover:

- Initial environmental report (scoping, alternatives, site selection, format of IEE)
- Assessing impacts (identification, analysis and prediction, baseline data)
- Mitigation and impact management (and preparing an environmental management plan)
- Reporting (drafting style, main features, shortcoming, other forms of presentation)
- Review and decision-making (role, steps, remedial options, checks and balances)
- Monitoring and auditing (systematic follow up, purpose, effective data management)
- Project management (inter-disciplinary teams, programming & budgeting)

This water supply and sewerage project falling under the category specified in schedule II requires to file an EIA with the federal agency, i.e. Environmental Protection Agency, Sindh (EPA-Sindh). The procedures of EIA are as follows:

- ToR for EIA
- Selection of Consultants / Specialists
- Field Visit and Report Preparation
- Submission of the EIA report to the EPA-Sindh with review fee for EIA report
- Confirmation of document submitted by the EPA-Sindh (within 10 working days)
- Advertisement in the newspapers by EPA-Sindh (after 20-25 days of confirmation)
- No objection certificate by the EPA-Sindh (within 90 days of filing)
- Public Hearing (30 days after advertisement)

(4) Information disclosure and stakeholders participation

In principle, information on the environmental assessment is publicly disclosed. The policy of information disclosure and stakeholders participation is described under "Guidelines for Public Consultation, 1997, PEPA" which include:

- Consultation, involvement and participation
- Stakeholders
- Techniques for public consultation (principles, levels of involvement, tools, building trust)
- Effective public consultation (planning, stages of EIA where consultation is appropriate)
- Consensus building and dispute resolution
- Facilitating involvement (including the poor women, building community and NGO capacity)
- Establish committee for the environmental evaluation

(5) Land Acquisition Act and National Resettlement Policy

The acquisition of private properties for public purposes including development projects in Pakistan is governed by the Land Acquisition Act 1894 (LAA). It comprises 55 sections pertaining to area notification and surveys, acquisition, compensation and apportionment, awards and disputes resolution, penalties and exemptions. Section 4 allows preliminary notification for survey, section 6 provides for declaration of intended acquisition, section 8 deals with detailed survey and planning, sections 11 to 15 and 23 to 28 provide for inquiry by the Land Collector into claims and values, and the setting of compensation levels, primarily through interpretation of market value. Sections 16 and 17 provide for compulsory acquisition, while section 18 allows for redress of grievance at the District level Civil Courts and above, if necessary.

Determining the amount of compensation shall take into consideration (i) the market value of the land at the date of the publication of the notification, (ii) the damage sustained by the taking of any standing crops or trees, (iii) the damage sustained by severing the land from his other land, (iv) the damage sustained by reason of the acquisition injuriously affecting his other property, moveable or immoveable in any other manner, or his earning, (v) if the person is compelled to change his residence or place of business in consequence of the acquisition of the land, the reasonable expenses incidental to such change, (vi) the damage resulting from diminution of the profits of the land between the time of the publication of the declaration and the time of the possession of the land. In addition to the market value of the land as above provided, the sum of 15 percent on market value shall be awarded in consideration of the compulsory nature of the acquisition.

LAA has been the most commonly used law for acquisition of land and other properties for development projects. Although it lays down detailed procedures for the acquisition of private

properties for public purposes and their compensation, the LAA dose not cover resettlement and rehabilitation of persons. Therefore, National Resettlement Policy has formulated in 2002 to ensure an equitable and uniform treatment of resettlement issues all over Pakistan. This Policy is applied to all development projects involving adverse social impacts, including land acquisition, loss of assets, income, business etc. The Policy also aims to compensate for the loss of income to those who suffer due to loss of communal property including common assets, productive assets, structures, other fixed assets, income and employment, loss of community networks and services, pasture, water rights, public infrastructure like mosques, shrines, schools, graveyards etc.

The objectives of the Policy are:

- Avoid or minimize adverse social impacts in a project wherever possible and where adverse impacts cannot be avoided, the mitigation measures and resettlement activities should be conceived and executed as development programs and the affected persons be provided opportunity to share the project benefits,
- Project affected persons be provided with sufficient compensation and assistance for lost assets, that will assist them to improve or at least restore their living standards, income earning or production capacity to the pre-project levels,
- Provide a development opportunity to all vulnerable groups. The vulnerable population should receive special assistance to bring them at least to a minimum living standard at per with the pre-project level,
- All population adversely affected by the project should be eligible for sharing the social and economic benefits, envisaged after completion of the project.

(6) Others

Other laws and regulations which may be related to the environment are:

- Air Quality: Statutory Notification S.R.R.742 (1993)
- Noise: The Motor Vehicle Ordinance (1965) and Rules (1965)
- Toxic or Hazardous Substances: The Agricultural Pesticides Ordinance (1971) and Rules (1973)

12.6.3 Baseline of Environmental Data

(1) Physical Environment

1) Topography

Karachi City represents quite a variety of habitats such as the seacoast, islands, sand dunes, swamps, semi-arid regions, cultivated fields, dry streambeds, sandy plains and hillocks. Classified according to physiographic features, Karachi City District can be divided into hilly region, alluvial plain and coastal areas of three broad categories.

The metropolitan area is divided into three regions by two river streams of Lyari and Malir Rivers. Gujjar and Orangi are the main tributaries of the Lyari River while Thaddo and Chakalo are the main tributaries of the Malir River. Among the various physiographic features, low flat-topped parallel hills devoid of vegetation, interspersed with sidespread plains and dry riverbeds are the main topographic characteristics of the city. The highest of the region is 75 m that gradually decreases to 1.5 m above mean sea level towards the coastline.

2) Geology and Geomorphology

Physiographical classification of the area establishes three separate landforms, namely mountain highland, piedmont plain and the valley floor. According to the geological classification, the rocks of the entire region of Karachi and its suburbs, upper valleys of Lyari and Malir rivers are almost exclusively of the tertiary deposit belonging to the most recent geological period. The lower reach of the Lyari basin constitutes post-tertiary alluvial subsoil while the upper reach constitutes boulders and conglomerate. Malir River basin consists of alluvial deposits of

boulders, gravels, sand and clay.

3) Climate

As located on the coast, Karachi tends to have a relatively mild climate, with low average levels of precipitation (approximately 175 mm per year), which classifies the region as arid. The hottest month is May-June with the temperature ranging between 32 ºC and 35 ºC, the winter is relatively mild and with dry minimum temperatures of about 7 ºC. For most parts of the year, the relative humidity in Karachi is high. In the morning it ranges from 53 to 86 % and in the afternoon it ranges between 53 and 81 %. The relative humidity is at a minimum in the months of March to June while it is at highest during the monsoon months of July through September.

Strong coastal winds are the characteristic feature of the region. The wind direction during the southwest monsoon period is dominantly from the northeast and wind intensity is depending on the air pressure of the continent. Mean wind velocity varies from 5.3 miles per hour (m.p.h, 8.5 km/hour) in November to 12.8 m.p.h. (20.4 km/hour) in July. Remarkably strong winds blow mostly from southwest or west from March till October. In the coastal regions, the wind velocities reach up to 25 m.p.h. (40 km / hour).

4) Water Sources

Both surface and ground water sources are available and used in Karachi as water source. The following part describes main sources of surface and ground waters.

a. Surface Water

Kinjar Lake

It is the largest freshwater lake in Pakistan with very extensive reed-beds, particularly in the shallow western and northern parts. The lake is 24 km long by 6 km at its widest, and the maximum depth of the lake is 8 m.

Haleji Lake

It is located at 75 km east of Karachi in the Thatta district. The lake was converted into a reservoir to provide an additional water supply for Karachi in the late 1930's. The lake is about 3 km long and 1.6 km wide with 5-6 m of the maximum depth.

Hub Dam

The other principal source of surface water for Karachi is the Hub Dam. It is located 40 km west of Karachi, on the border between Baluchistan and the Sindh Provinces. It is a large reservoir constructed in 1981 next to the Hub River, on the arid plains north of Karachi.

b. Groundwater

Karachi city falls in a dry and arid zone with scanty and intermittent rainfall with prolonged period of drought. The Karachi District area comprises four (4) basin areas, namely, Malir River Basin, Gadap Basin, Lyari River Basin and Hub River Basin (partial).

The groundwater exists in these basins within the alluvial deposits of Quaternary age and Manchar conglomerate, sandstone, Gaj sandstone, limestone, Nari sandstone and silica sand. Groundwater aquifer is available in different depths of different strata. Semi artesian condition has also been identified in deeper confined aquifers. The depths of aquifers and the water table in Karachi range from 20 feet (6 m) to 300 feet (91 m) below ground surface. The groundwater is recharged mainly by precipitation which falls in the watershed area of the basins. Since the major streams and nallahs are ephemeral in natures, most of the precipitation is lost through surface runoff. Some of this water percolates into the subsoil strata and contributes to recharge of groundwater.

At present, the groundwater is withdrawn from the open wells and tube wells. About 1000 existing dug wells and tube wells are provided with centrifugal or submersible pumps. The average pumping discharge of these wells has been estimated approximately as 80 gallons per minute (363 litre/min) that amounts to a discharge of 53 cusecs (1.5 m^3/sec.) against an

estimated recharge of 91 cusecs (2.6 m^3/sec.). The balance of approximately 38 cusecs (1.1 m^3/sec.) represents a rough assessment of the present potential availability of groundwater sources. This quantity is partly represented in groundwater flows for springs, evaporation, evapo-transpiration and base flows of sub-soil storage. In the past, ground water at Dumlottee location was a major source of water for Karachi. The Khadeji, Thaddo Nallah, Mole tributary are the main sources of recharge to the Malir Basin area. However, gradually with the passage of time and due to excessive lifting of sand from Malir River bed along with extensive use of ground water by farmers, the water table has dropped.

c. Sea Water and Coastal Oceanography

The Karachi coastal zone lies in the north-eastern corner of the Pakistan coast bordering the northern Arabian Sea. The coastal oceanographic features of the Karachi coastal zone are therefore very much under the influence of the oceanographic characteristics of the northern Arabian Sea. The unique oceanographic features of the northern Arabian Sea such as high salinity, low precipitation, high evaporation rates, reversal of sea water circulation during the two monsoon periods, and high primary production rates, prevail all along the coastal and near-shore waters of the Karachi coastal belt. However, due to the small depths of the in-shore and backwaters, certain factors such as turbulence, turbidity, high suspended solids, littoral drift and organic and inorganic pollutants are more pronounced in the coastal waters within the coastal zone of Karachi.

5) Ambient Air Quality

The main sources of ambient air pollution in Karachi are vehicle emissions, waste burning, suspended solid and 'dirty fuels' for production purposes used by small-scale businesses. Air pollution levels in Karachi and other urban centres of Pakistan are extremely high compared with the international standards and are rising every year. According to the Ministry of Environment, 40% of the urban population of Pakistan faces health risks from air pollution.

6) Ambient Noise

Karachi is the hub of industrial and commercial activities in Sindh. In 1994, a survey was done to assess the degree of noise pollution in Karachi. From the results of survey, other forms of vehicular traffic such as motorcycle, three wheelers etc. were the main contributors to high levels of noise pollution in the city. Noise levels varying from 87 to 99db were recorded at the harbour and the vegetable/meat market areas. Even near places such as hospitals high noise levels (81 to 82 db) were recorded. It is felt that rapid urbanization is contributing to increasing levels of ambient noise in the city, particularly sources from various forms of vehicular traffic. Increase in the number of vehicles, traffic jams, lack of maintenance of vehicles, traffic jams all contribute to this growing pollution threat.

(2) Biological Environment

1) Protected Areas and Sensitive Habitats/Reserves

In Pakistan there exists a system of protected areas for the endangered species, habitats, ecosystems, archaeological sites, monuments, buildings and other cultural heritages. Protected areas in Pakistan can be broadly categorized into two groups; namely, ecosystems and archaeological/cultural sites.

Ecosystems include protected areas such as wildlife reserves, national parks, and game reserves. The official classification of notified protected ecosystem in Pakistan is National Park, Wildlife Sanctuary and Game Reserve. In addition, there are protected forests, village forests, and state forests. The main features of a 'National Park' include protection and preservation of scenery, flora, fauna in its natural state and preserving areas of outstanding scenic merit and natural forest. The main features of a 'Wildlife Sanctuary' include areas with undisturbed breeding grounds, prohibited or regulated public areas and areas prohibiting non-exploitation of forests.

2) Bio-diversity – Fauna and Flora

a. Coastal Bio-diversity

The vegetation along the Karachi coast is dominated by mangrove forests. Eight species have been documented with *Avicennia marina* being the most abundant (95%). Dense mangroves are present in the Korangi and Phitti creeks. This ecosystem provides habitat for wildlife of terrestrial and marine origin.

b. Land based vegetation

The characteristic vegetation on the 'Hills' in Karachi are *xerophytic*, growing on the slopes as well as on the hills. Northern and north-eastern sides of the hills show better vegetation growth as compared to the southern and western exposures.

On the 'Alluvial Plain', vegetation consists of deciduous *xerophytic* shrubs, forming open communities.

3) Wetland Resources

Some important wetlands located within and in the vicinity of Karachi city. Main wetlands are descried below.

a. Kinjhar (Kalri) Lake

The site was listed as a 'Wetland of International Importance' under the 'Ramsar Convention', in July 1976, and declared a 'Wildlife Sanctuary', in March 1977 under Section 14 of the Sindh Wildlife Protection Ordinance 1972.

b. Haleji Lake

The area was declared a 'Wildlife Sanctuary' (1,704 ha), in March 1977 under Section 14 of the Sindh Wildlife Protection Ordinance 1972. Haleji Lake Wildlife Sanctuary was listed as a 'Wetland of International Importance', in July 1976.

c. Hadero Lake

The area was declared as a 'Wildlife Sanctuary' (1,321 ha), in March 1977 under Section 14 of the Sindh Wildlife Protection Ordinance 1972.

d. Hub Dam

Hub Dam reservoir is protected within the 'Hub Dam Wildlife Sanctuary' (27,219 ha), established in 1972.

e. Hawks Bay/Sandspit Beaches and adjacent creeks

The site is one of the regions of most important green turtle nesting site.

f. Clifton Beach

Located on the coast south of Karachi City, it is public recreational beach.

g. Korangi and Gharo Creeks

The creeks are located about 20-30 km southeast of Karachi, at the northern extremity of the Indus Delta. The site is a complex of large tidal creeks with extensive mangrove swamps and inter-tidal mudflats.

(3) Socio-cultural Environmental

1) Population

It is now estimated that Karachi's population is approximately 13 million (9.8 million in the 1998 census). Currently an estimated 350,000 persons are added to the population every year. Another estimate puts the increase at 33,000 households annually. The city has nearly 33% of the population of Sindh and 7.5% of the population of Pakistan. In the early period of

Karachi's growth, after the creation of Pakistan, migration played an important role. This trend continued over the years.

2) Land Use and Urban Planning

a. Land

In 1870, the urbanized area of the Karachi District was 13 sq.km, the 1971 census report gives the figure of 289 sq.km, the 1974 Master Plan defined metropolitan Karachi as 349 sq.km and the 1988 Karachi Development Plan gives a figure of 3,520 sq.km. The area of Karachi District is 3,527 sq.km. At the current rate of urban land conversion of about 6,780 acres (27 km2) per year, Karachi will outstrip its present boundaries.

b. Urban Planning

The key urban master planning exercises carried out for Karachi City are briefly discussed below:

The Karachi Development Plan 2000

On the expiry of the 1974-85 Karachi Master Plan periods, the Karachi Development Plan 2000 was initiated by the KDA with UNDP assistance.

Master Plan 2020 for the Development of Karachi

A project for the formulation of a Master Plan 2020 for Karachi City has been completed within the Master Plan Group of Offices (MPGO) of the City District Government Karachi (CDGK).

3) Transport and Traffic

Karachi has 14,854 intra-city buses, all owned by private operators. In addition, it has 513 inter-city buses as well. There are also 13,613 taxis and 23,337 rickshaws in the city. According to the Regional Transport Authority (RTA) figures, 72% of all commuters using buses travel by Karachi's 8,773 mini-buses. Karachi's traffic is the main cause of air and noise pollution in the city.

4) Socio-economic Activities

a. Health

Karachi has a variety of medical facilities. It has all sorts of hospitals, clinics and dispensaries, both in the public and private sectors. However, a vast majority of the population also get treatment from medical practitioners, both qualified and unqualified and by hakims (traditional doctors using herbal medicines).

b. Education

In Karachi, according to the 1981 census, the literacy rate was 57% as compared to 26% in the whole Pakistan. According to a survey conducted by the Applied Economic Research Centre (AERC) in 1987, the literacy rate in the planned areas was 76% and 48.6% in unplanned areas. The Government of Sindh, the City Government and the private sector are the main providers of education in Karachi.

Social indicators representing the whole of Karachi may be misleading since there are major differences between the social indicators for the city's planned areas and Katchi Abadis. There are also major differences in social indicators among low-income settlements themselves. The data also shows that better incomes do not necessarily mean better social indicators.

c. Economy

Karachi is the financial capital of Pakistan; and it has the greatest share of GDP and generates approximately 65% of the national revenue. Karachi has Pakistan's largest port, and it was the federal capital for the first two decades after independence.

Karachi's per capita income is two and a half times that of the national average. In terms of large scale manufacturing industry, for example, Karachi still has a share of around one third in the national value added for the sector. In terms of contribution to the energy sector

(electricity and gas), the transport, communication and storage sector, as well as the wholesale and trade sector, Karachi's contribution in each of these areas is at least 25% of the country's value addition. A high percentage of the population also works in the informal sectors. However, unemployment rate is still over 10% and income disparities are quite prominent. Almost 50% of the population lives in Katchi Abadis with limited access to public utilities and gainful employment opportunities.

5) Solid Waste Management

Karachi does not have a properly functioning garbage management system. Garbage is often dumped in nallahs, open drains and sewer manholes, thus clogging the system, causing sewage overflows and system breakdowns.

Karachi generates about 6,113 tons of solid waste every day. About 5,057 tons is collected and 1,057 tons is not collected. About 10% of this waste is removed at source by housewives and sold to about 15,000 *kabaris* who pick up the waste from households. This solid waste consists of glass, plastic, metal and paper. Another 600 tons of solid waste is collected from *kutchra kundis* and from the streets and markets by waste pickers. This waste consists of paper, rags, plastic, metal objects, glass and bones.

6) Cultural Assets

Karachi has very rich built heritages. Most of them are located in the old city. The heritages consist of residential, public and institutional buildings such as hospitals, municipal offices, courts, prisons, halls, auditoriums, libraries, churches, schools and colleges and warehousing in the port area. Most of these buildings are of the early British period. Many of these heritages have been destroyed, both in the Saddar area and in the old city. Under the Sindh Cultural Heritage (Preservation) Act 1994, a large number of buildings (about 900) have been listed as protected buildings and their demolition is illegal under the Act. There are also a number of cultural sites in and around Karachi which record its long and complex history.

7) Water Rights

The 'Constitution' of Pakistan protects the life of its people and obliges the State to secure the well being of the people and to provide for all the citizens, within the available resources of the country, facilitates for adequate livelihood and basic necessities of life. In 1994, the Supreme Court of Pakistan interpreted the constitutionally protected right to life and dignity to include the right to a healthy environment. Furthermore, the State is urged to promote, with special care, the economic interests of poorer classes or areas. According to the 'Constitution', water is a provincial subject. However, the Government of Pakistan has also to perform a number of functions and responsibilities in the water sector, mostly relating to inter-provincial matters.

8) Industrial Activities

After the creation of Pakistan, the strategy adopted for industrialisation in the Sindh province promoted the creation of planned industrial estates and an engineering base. The first industrial estate established was the Sindh Industrial Trading Estate (S.I.T.E) beyond the Lyari River in Karachi in 1947, which was meant to be the industrial hub of the country, not just Sindh. S.I.T.E. was provided with infrastructure such as water, roads and a sewerage network with the specific condition that it would be used only if the effluent from the factories were treated according to the requirements of the Factory Act 1934. Industrial estates in Landhi (1953), Korangi (1959) and North Karachi Township (early 1970) were established subsequently. About 70% of the total industry of Pakistan is located in Karachi.

Nearly 30 mgd (136,000 m^3/day) of water is being provided to industrial sites located at S.I.T.E, Korangi, Landhi, F.B Area, North Karachi and elsewhere in the city. However, none of the industrial estates in Karachi is served with effluent collection and conveyance system. So the effluents are not collected and conveyed to the KW&SB treatment plants and instead are discharged mostly untreated into the sea via the Malir and Lyari Rivers.

12.6.4 Project Description

The priority project selected three towns of North Nazimabad, Gulberg and Liaquatabad Towns in western zone of Karachi City to improve water supply and sewerage system.

In the selection process of Priority project, the following environmental and social impacts were considered.

- It is possible to acquire construction site for the priority project without resettlement, disappearance of productive green/agricultural and impact to cultural properties.
- It is possible to perform safe and satisfactory water supply service in the whole project area by the priority project.
- Water quality improvement in the public water bodies by the priority project is expected.

The priority project consists of water supply and sewerage systems. Components of the priority project for water supply system are expansion of reservoir and improvement of distribution network. Components of sewerage system consist of collection/conveyance network implementation and replacement of equipment in the two associated sewage treatment plants. Components of the priority project are shown in **Table 126.4.1**.

Table 126.4.1 Components of Priority Project

	Components		Quantity
Water Supply System	Expansion of reservoir (NEK old reservoir)	Capacity (million gallons)	30
	Rehabilitation of Trunk Distribution Mains	Pipe length (m): Diameter (inch):	25,990 16 - 100
	Installation of Trunk Distribution Mains	Pipe length (m): Diameter (inch):	49,490 14 - 64
	Installation of Flow Meter	Flow meter (nos)	17
	Rehabilitation of Distribution Network Mains	Pipe length (m) North Nazimabad Town: Gulberg Town: Liaquatabad Town: Total	 336,600 374,900 284,600 996,100
	Improvements to House Connections	**Water meter only** North Nazimabad Town: Gulberg Town: Liaquatabad Town: Total **Water meter and service pipe** North Nazimabad Town: Gulberg Town: Liaquatabad Town: Total	 8,800 9,200 2,100 20,100 68,600 71,500 68,100 208,200
Sewerage System	Rehabilitation of Collection & Trunk Sewers	Pipe length (m): Pipe diameter (inch): Box culvert (mm)	36,570 15 – 84 1,750 × 1,750
	Rehabilitation of Sewage Treatment Plant (TP-1)	Pumps and other equipment	-
	Rehabilitation of Sewage Treatment Plant (TP-3)	Pumps and other equipment	-

Justification of the Priority Project

Since the priority project is a part of the Master Plan, there is no alternative study about the priority project itself.

Alternative study of the Master Plan for water supply was carried out from two viewpoints of water source and water transmission system, and details are shown in **Chapter 11.1.2**.

Similarly, alternative study for sewerage system was carried out from technical, economic, environmental and social viewpoints, and details are shown in **Chapter 11.1.3**.

If the priority project is not implemented, the current problems will remain unsolved and will be further deteriorated with an increase of population in the future. If the priority project is implemented, the existing problems will be solved.

The existing problems in the project area, and benefits of the implementation of the priority project are shown in **Table126.4.2**.

Table 126.4.2 The Problems and Benefits without/with the Priority Project

The Existing Problems (without Project)	Benefits with the Priority Project
Water Supply System	
• Water supply service level is low. • Actual service hour (the majority of the population only receives water for a few hours supply every 3 to 4 days.) • Since water supply water pressure is low, private storage tank and suction pump are required. • Since water pressure is low, ingress of polluted water to the distribution pipe is expected. • In order to compensate the amount of insufficient water supply, water supply by a tanker is performed. • House connection has many unsuitable facilities because of private responsibility.	• All households receive water supply service. • Service hour is 24 hours a day and seven days a week. • Sufficient water pressure is maintained. Therefore, the private storage tank and the suction pump will be unnecessary. The ingress of polluted water to the distribution pipe is not expected. • All households receive the appropriate water supply service. Consequently, water supply by tanker will be unnecessary. • All of house connection facilities are reconstructed by the priority project.
• The capacity of distribution line is insufficient. • There is very high ratio of leakage and non-revenue water. (Average ratio of leakage: 30 – 35％ in the study area) • It is possible that without the implementation of the DNI leakage could increase to 60 to 70%.	• All households receive water supply service. • Improvement is expected.
• Many residents of Karachi have a very negative impression of KW&SBB and the service it provides and are therefore reluctant to pay water charges. • While the basic cost of piped water in Karachi may be cheap, the indirect costs associated with its use are unreasonably high. • With increase in population, the existing problems are aggravated further.	• Water meter installation and introduction of a meter-charge system • Improvement in the rate of charge collection • A financial improvement is prospective. • Improvement in water-saving consciousness • Improvement is expected.
Sewerage System	
• The existing sewage collection ratio: 90 % • The capacity of collection and conveyance sewer is insufficient.	• The whole quantity of sewage will be collected and the sewage can be conveyed to the sewage treatment plant.
• The existing treatment plants are not functional.	• The treated effluent will meet the effluent water quality standards.

12.6.5 Impact Identification and Mitigation Measures

The first step in EIA is to identify the potentially significant impacts. Various aspects considered in impact identification of the project are as follows:

- Project components
- Project stages
- Impact generating activities
- Type of impact

A matrix table was used to overall identify the impacts. The matrix thus identifies the environmental factors likely to be affected, and the activities responsible for this. The cells, which fall at the junction of an activity and an affected parameter, have been graded as A, B, C and blank. (See **Table 126.5.1**).

The adverse impacts have been classified in two categories, namely construction stage and

operational stage. Impacts during construction stage may be regarded as temporary or short-term whereas those during operation stage are likely to have long-term effects. The environmental impacts have been discussed separately for the construction stage and the operational stage.

Table 126.5.1 Scope Matrix for Project Components

Development Scheme / Environmental Elements			Affected parameters																							
			Social Environment									Natural Environment								Pollution						
			Resettlement	Economic Activity	Traffic/Public Facilities	Split of Communities	Cultural Properties	Water Right/Right of Common	Public Health Condition	Solid Waste	Hazard (Risk)	Topography and Geology	Soil Erosion	Groundwater	Hydrological Situation	Coastal Zone	Flora and Fauna	Meteorology	Landscape	Air Pollution	Water Pollution	Soil Contamination	Noise and Vibration	Ground Subsidence	Offensive Odor
Activities	Water Supply System																									
	Expansion of reservoir (NEK old reservoir)	cs	C		C				C	C									C	C			C			
		os						C											C		C		C			
	Replacement of trunk distribution main	cs		C	B				B	C	B								C	B			B			
		os		B		C															C					
	Installation of trunk distribution main	cs		C	B				B	C	B								C	B			B			
		os		B		C															C					
	Installation of flow meters /Flow control valves	cs		C	B				B	C	B								C	B			B			
		os		B		C															C					
	Installation of distribution main	cs		C	B				B	C	B								C	B			B			
		os		B		C															C					
	Installation of house connection	cs		C	B				B	C	B								C	B			B			
		os		B		C															C					
	Sewerage System																									
	Replacement of existing sewer line	cs		C	B				B	C	B								C	B			B			
		os				C																				
	Installation of new sewer line	cs		C	B				B	C	B								C	B			B			
		os				C																				
	Rehabilitation of Sewage Treatment Plant (TP-1)	cs								C																
		os								C											C		C		C	
	Rehabilitation of Sewage Treatment Plant (TP-3)	cs								C																
		os								C											C		C		C	

Note:
cs: Indicates construction (rehabilitation) stage.
os: Indicates operation stage.

A: Indicates that the development scheme is foreseen to have strong impact on the environmental element.
B: Indicates that the development scheme is foreseen to have some impact on the environmental element.
C: Indicates the impact is not quite sure but minor impact is expected.

Adverse impacts and mitigation measures during construction stage and operation stage are summarized in **Appendix A-126.1**, and items which are important or need explanation are described below.

Expansion of Reservoir (NEK Old Reservoir) - Construction Stage, Water Supply System

Resettlement

Impact:

Expansion of existing reservoir (NEK Old Reservoir) is proposed as the priority project component, and the land acquisition for expansion is needed. In most cases, resettlement and disappearance of productive green/agricultural land may be caused by land acquisition in the urban area and its surrounding area. However, in this case, the field investigation could select appropriate construction site with no possibility of resettlement as follows.

Mitigation Measures:

The NEK Old Reservoir is located in a suburban area of the north side of the Study Area. However, actual location of construction site is not determined yet. The existing boundary of water supply facilities area and an adjoining vacant area are shown in **Figure 126.5.1**.

Land owner of this vacant area is the Sindh Provincial Government, and there is no house and any facilities. If it is possible to acquire the adjoining vacant area for the expansion project site, the level of adverse impacts caused by the land acquisition for the expansion of reservoir is expected to be not significant. The requirement of the land acquisition is shown in **Table 126.5.2**.

Table 126.5.2 The Land Acquisition for the Expansion of Reservoir

Project Component	Capacity of Facility to be Expanded	Area Need to Acquire
Expansion of NEK Old Reservoir	30 million gallons	1.5 ha

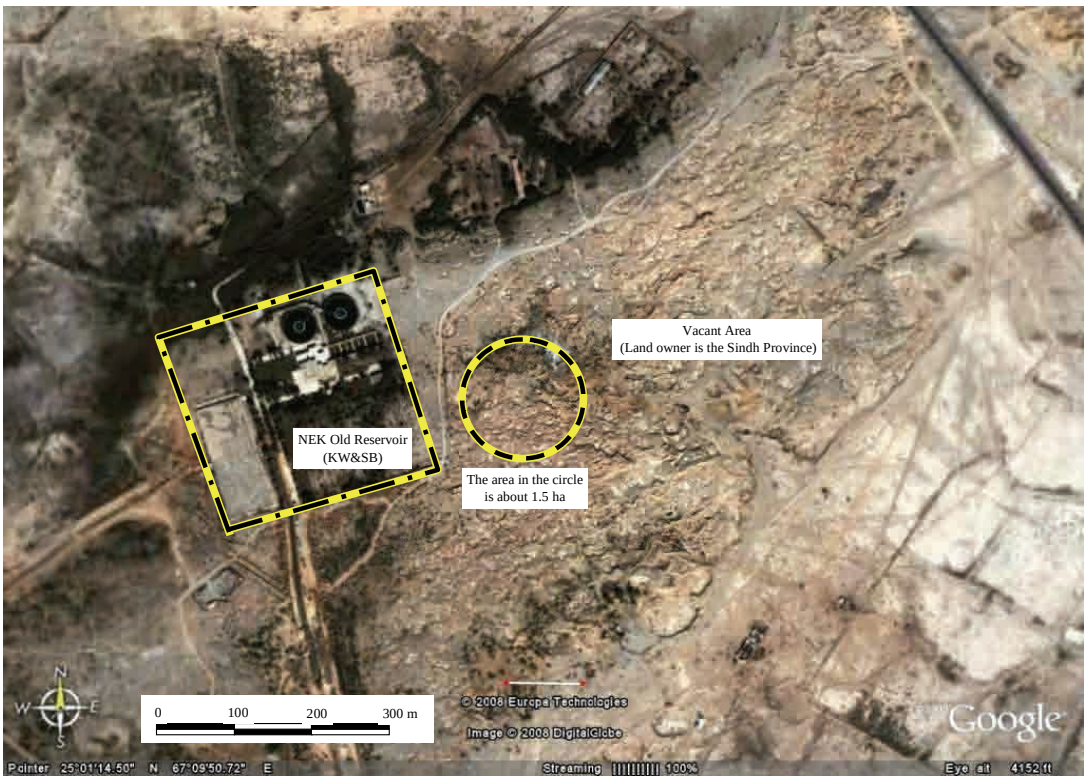

Figure 126.5.1 The Suitable Site for the Expansion of Reservoir

Construction of Distribution Network - Construction Stage, Water Supply System

Construction of distribution network is an integrated combination of the following works:

Replacement of trunk distribution main
Installation of trunk distribution main
Installation of flow meters /Flow control valves
Installation of distribution main and line
Installation of house connection

Traffic/Public Facilities

Impact:

During the construction stage, serious disruptions of vehicular traffic and pedestrian, traffic jams, bottlenecks and blockages to roads will be expected.

During the construction of house connection, water supply may be partly disrupted for a certain period of time.

Mitigation Measures:

These impacts could be mitigated or minimized by the following countermeasures:

- The announcement and public notification concerning the construction of facilities and its schedule before the construction.
- As mitigation measures, during the construction period, watchman or traffic control staff will be deployed at the site to control the traffic, and schedule of the transport of construction material should be controlled.
- Traffic diversion management should be properly implemented to control pedestrian movement.
- Temporary fences with appropriate warning signs should be used to isolate the construction site. Especially, construction sites in the vicinity of schools, mosques and locations of public concentration should be strictly fenced.
- If blockages to roads and other services are unavoidable, such blockage areas should be identified well in advance and circulated to public with appropriate details on maps.
- During the construction stage, the project owner or building constructor should arrange an information desk and a person responsible at the construction site office.
- When construction of house connection is carried out, constructor should inform the related household about preparation of water for drinking and domestic use. If necessary, the project owner should arrange sharing water with neighbours or water service by tankers.

Hazard (Risk)

Impact

- The accident by the unapproved entry to the construction site can be considered.
- It is said that about 50% of the existing distribution line in the Study Area uses an asbestos cement pipe. Respiratory organs illness by asbestos to workers and residents possibly occur by work such as cutting of asbestos cement pipe.

Mitigation Measures (Accident)

- At the time of construction, the safety of public is one of the most important issues. Following combination of the activities increases the risks of accidents (especially local population) during construction stage:
    - Unauthorized access to a construction site
    - Absence of control over access to construction sites
    - Collision with construction vehicles
    - Poor site safety measures and warning system
    - Inadequate site management

  Countermeasures such as fences with appropriate warning signs and personnel assignment against the above-mentioned items should be taken.

Mitigation Measures (Asbestos Cement Pipe)

In principle, the existing distribution line will be abandoned with the present condition. Consequently, the adverse impact at construction sites or move-out processes will be not generated.

When the work such as cutting of asbestos cement pipe is needed, it is required to work with careful attention to the following points.

- Workers wear an anti-dust mask and working clothes, and these equipments is discarded after the end of work.
- In principle, cutting work of the pipe is avoided as much as possible.
- When cutting a pipe, it should be done after pouring water and making pipes wet.
- The scob of cutting is kept in a container with a lid and should be incinerated.
- The construction site forbids entry except the persons concerned.
- When conveyance of an asbestos pipe is needed, it should be packed up with a plastic sheet and scattering of asbestos is prevented.

Replacement of Existing Sewer Line & Installation of New Sewer Line - Construction Stage, Sewerage System

It is desirable to construct sewers and water supply distribution networks simultaneously, which possibly reduces the whole adverse impacts by construction.

Work schedule and sequencing for combined construction works between sewers and water supply distribution networks should be considered. Normally, Sewers will be laid away from the water supply lines and at a greater depth.

Basically, adverse impacts during construction stage in sewage collection network are the same as these of distribution network for water supply except adverse impact concerning Asbestos Cement Pipe. Therefore, the possibility of the adverse impact is predicted concerning the following environmental elements.

Economic activity
Traffic /Public Facilities
Public Health Condition
Solid Waste
Hazard (Risk)
Landscape
Air Pollution
Noise and Vibration

Description of adverse impacts in the above environmental elements for the sewers (replacement of existing sewers and installation of new sewers) is omitted. (For details, refer to **Appendix A-126.1**)

Rehabilitation of Sewage Treatment Plants (TP-1 & TP-3) - Construction Stage, Sewerage System

The rehabilitation of sewage treatment plants is only replacement work of equipment such as pumps, motors, sludge scraper, primary effluent sprinklers and electrical equipment with minor civil works. Therefore, it is expected that adverse impacts in the rehabilitation of sewage treatment plants are not significant to environmental and social aspects.

Solid Waste

Impact:

Solid waste is generated by replacement of equipment such as pumps and electrical equipment.

Mitigation Measures:

The generated solid waste is recyclable and valuable waste such as pumps and iron material.

Expansion of Reservoir (NEK Old Reservoir) - Operation Stage, Water Supply System

Water Right/Right of Common

Impact:

There may be a possible occurrence of adverse impact on the additional water right from the Indus River.

Mitigation Measures:

No additional water intake from Indus River is required till 2025. (For details, refer to **Chapter 3.2**)

Construction of Distribution Networks - Operation Stage, Water Supply System

Economic Activity

Impact:

The household which runs short of water or does not have house connection receives water supply by a tanker that is operated by the Ranger. Therefore, if all the households have connection and sufficient water can be supplied, water supply tankers will become unnecessary and business will be suspended. There might be possible unemployment of Rangers.

Mitigation Measures:

The water supply facilities will be constructed step by step till 2025, and the demand for water supply tankers will not decrease immediately. Moreover, it is expected that the rapid increase in population of Karachi city will increase the necessity for water supply tankers.

Split of Communities

Impact:

An obvious difference will arise in the water supply service level between adjacent towns and the project area by the implementation of this project.

Mitigation Measures:

Neighbouring towns are also included in the sole Master Plan. The opportunity to receive the same water supply service with the project area in the future is obtained. However, project area has a charge system equivalent to water supply service level.

Rehabilitation of Sewage Treatment Plants (TP-1 & TP-3) - Operation Stage, Sewerage System

Offensive Odour

Impact:

Emission of odour is expected from the sewage and sludge treatment processes in the sewage treatment plants.

Mitigation Measures:

Basically, it is expected that if the plants are operated and maintained properly, it is possible to control odour emission to the minimum. In addition, it is expected that adverse impacts will be reduced at the circumference environment of the sewage treatment plant.

The east and west side surroundings of the sewage treatment plant (TP-1) are vacant, and the northern and southern areas are occupied by many factories.

Similarly, the sewage treatment plant (TP-3) is surrounded by factories, container yards and sea area. Therefore, the odour from these sewage treatment plants is not considered to cause the adverse impacts to local residents.

However, the odour monitoring at the boundary of the sewage treatment plants should be carried out. According to the monitoring data, it can be judged that the surrounding environment of the sewage treatment plants met environmental standards. It is recommended to accumulate the relevant data in the future.

Risk Analysis and Mitigation Plan

During the operation stage, attention should be paid to the following aspects as Risk Analysis.

Power supply

One of the main reasons for malfunction of the water supply facilities and the sewage treatment plants is energy shortage. It is suggested that the power generators and fuel storage against emergency be provided to ensure at least minimum services in case of power cuts.

Electrical & Mechanical Equipment Failure

Operational disruption due to electrical & mechanical equipment failures can be avoided by spare parts and stand-by provision available at site. Operation & maintenance instructions and manuals for emergency should be provided with training to the operation staff in the filtration plants and sewage treatment plants.

Water Pollution and Contamination (Water Supply System)

Raw water might be possibly contaminated. Especially, the contamination by substance which has influence on water use and human health should be considered. If such a situation occurs, measures have to be taken such as raw water bypass and operation stop immediately.

These impacts can be mitigated by adopting the following measures:

- Regular water quality monitoring
- Establishment of urgent communication network with the river administrator and related organization.
- Preparation of the operations manual for emergency situation
- Training to the operation staff for the emergency situation

Water Pollution and Contamination (Sewerage System)

The possibility of water pollution and contamination of the sewage at the sewage treatment plant by an accidental industrial wastewater flowing into sewers can be considered. Accidental water quality problems may cause the following problems:

- Malfunction of treatment process
- Non compliance with effluent quality standard
- Influence on the reuse of treated effluent and sludge

These impacts can be mitigated by adopting the following measures:

- Regular water quality monitoring
- Preparation of asset list and its management of factories that possibly emit hazardous wastes
- Establishment of urgent communication network with listed factories and the Environmental Protection Agency (EPA –Sindh and others)
- Preparation of the operation manual for emergency situation
- Training to the operation staff for the emergency situation

Monitoring Programme

The project owner should establish monitoring system to assess the quality of the neighbouring environment after the commissioning of the project. An environmental monitoring programme is important as it provides useful information and helps to:

- Verify the predictions on environmental impacts presented in this study,
- Assist in detecting the development of any unwanted environmental situation, and thus,

provides opportunities for adopting appropriate control measures.

Monitoring plan for Water supply system

The sampling and water quality analysis of raw water and distributed water will be carried out to check the performance of treatment plant and safety of water supply service.

Monitoring plan for Sewerage System

The sampling and water quality analysis of influent and effluent in the sewage treatment plant will be carried out to check the performance of treatment plant. Moreover, sludge characteristics and air quality should be monitored for the consideration of environmental impacts.

The Preliminary Environmental Monitoring Programmes are summarized in **Table 126.5.3**.

Table 126.5.3 Preliminary Environmental Monitoring Programme

Object		Monitoring Point	Parameters	Frequency
Water Supply System	Water quality (Raw water)	NEK old reservoir	Basic parameters for water supply: Escherichia Coli, Colour, Taste, Odour, Turbidity and etc. Hazardous substances: According to the WHO Guidelines	- Daily for basic items - Three or four times a year for hazardous substance
	Water quality (Distributed water)			
	Water quality and others (Tap water)	Selected house connections	Water pressure, pH, Turbidity, Escherichia Coli and etc.	- Once or two times a year
Sewerage System	Water quality (Influent)	TP-1 and TP-3	Simple parameters: Temperature, pH, transparency and etc. Basic parameters: BOD, CODcr, SS, Nitrogen and etc. Hazardous substance: According to the effluent Standards.	- Daily for the simple parameters and weekly for the basic parameters - Three or four times a year for hazardous substances
	Water quality (Treated effluent)			
	Sludge characteristics		Hazardous substance and etc.	- Twice a year
	Air quality		Ammonia, Methyl Mercaptan, Hydrogen Sulphide, and etc.	- Once or two times a year. Each monitoring is done for three consecutive days.

12.6.6 Stakeholder Meeting

Stakeholder were selected by KW&SB in collaboration with JICA Study Team, and they are categorized as follows.

People in the Study area and people who will be affected by the proposed projects, including socially vulnerable people
Ministries and relevant governmental agencies
Local governments such as municipalities, communes, and counsels
International organizations and donors
Non-governmental organizations
Universities and research institutes
Private sectors including bulk users

Main stakeholders will be identified and selected regularly based on the roles and responsibilities of each stakeholder at each stage of the public consultations.

(1) First Stakeholder Meeting

The first stakeholder meeting was organized by KW&SB, CDGK, and held on 7 September 2006 at Regent Plaza Hotel. The aim of the meeting was to inform of the JICA Study, findings on water supply and sewerage system, immediate remedies, to explain the approaches for environmental and social considerations including scope of IEE level study, and to consult with the stakeholders.

1) Participants

The stakeholders were selected by KW&SB in collaboration with JICA Study Team and invitation letters were sent to the invitees from 25 August 2006. At this stage, as the contents of M/P are not fixed yet, it is difficult to specify who will be affected directly or indirectly by the project. The main objective is to inform of the approaches to environmental and social considerations, thus, as the representative of the people, Town Nazims (town head) who are elected directly by the people were invited. The following table shows the categories and number of participants in each category.

Table 126.6.1 Number of Attendants at the First Stakeholder Meeting

City District Government	4	Universities & Research Institutes	4
Town Nazims	7	NGOs	3
Government of Sindh	4	International Organisations &Donors	3
Bulk Consumers	14	Cantonment Board & DHA	1
KW&SB	37	Media	7
JICA Study Team	10	**TOTAL**	**94**

2) Main Topics Discussed and its Correspondence

The main topics discussed in the meeting are summarized below:

- Many Master Plans (M/Ps) were prepared in the late 1980s but never implemented. Various agencies have their own M/Ps so the Study Team should incorporate all the M/Ps into future JICA M/P. Real stakeholders such as towns, citizens should be invited. To this comment, KW&SB answered that the Study Team would go through other M/Ps. About the stakeholders, the representative of Town i.e. Town Nazims are invited to the meeting.
- There is the opinion that the treatment plants are not properly working and the nallahs turned into the sewers. To this comment, treatment plants are working but not at full capacity due to the encroachment on the drainage. CDGK will take the action to remove all the encroaching premises to utilize the nallah / drainage for their original use.
- There is the suggestion to use another water source such as rain harvesting or groundwater, not only Indus River and Hub Dam. The amount of water necessary for Karachi City is huge and the groundwater is not sufficient for water supply according to the study already carried out. Another source is required and desalination is one option that will be considered.

(2) Second Stakeholder Meeting

The second stakeholder meeting was due to be held in August 2007. The aim of the meeting was to inform of the water supply and sewerage Master Plan in 2025 for Karachi City, to inform of the results of environmental and social considerations, and to obtain the opinions/comments from the participants. However, the meeting was postponed and the third meeting has not been scheduled yet as described in the **Section 12.6.1**.

12.6.7 Conclusions

The expected positive impacts of the priority project include:

Realization of the improvement in living condition which has possibility to access safe water during all day;

Possibility to collect all of generated sewage and to treat appropriately, and expectation of the health, sanitary and environmental improvement as the result;

Enhanced employment opportunities particularly in the construction stage. Furthermore, promotion of the regional economy by improvement of the living environment of the overall project area is expected.

Based on the findings of the EIA Study, the following items should be considered as mitigation measures for project implementation. However, the following adverse impacts are not fatal. If mitigation measures are taken properly, the adverse impacts will be satisfactorily controlled to a great extent.

Land acquisition for expansion of reservoir (NEK old)

The site (land owner is the Sindh Province) which adjoins the east side of the existing reservoir is not used for other project and there is sufficient area as the construction site for the expansion of reservoir (NEK Old Reservoir). If this site is determined as a proposed site, it is expected that adverse impacts of land acquisition are very small.

Construction of water distribution network and sewer collection network

The main adverse impacts in the construction stage of water distribution network and sewer collection network are effects on the economic activity, traffic situation, public health condition, air pollution, noise and vibration.

Especially, when appropriate measures are not performed, it is expected that serious traffic disturbance will occur. However, these are short-term impacts, and these can be reduced by appropriate construction site management including an announcement and traffic control.

Impact on the tanker water service by implementation of the Distribution Network Improvement

The Distribution Network Improvement in the priority project area will be completed by 2014. Consequently, it is predicted that the tanker water service will become unnecessary in the project area and its business will end. However, the water supply facilities in the Karachi city will be constructed step by step till 2025, the demand for tanker water supply will not decrease immediately. In fact, it is even predicted that the rapid increase in population of Karachi City will raise the necessity for tanker water service.

Water pollution and offensive odor from sewage treatment plants (TP-1 and TP-3)

According to the sewerage system planning, if the treatment plants are properly operated and maintained, the effluent will meet the effluent water quality standards and no significant adverse impacts may be expected. Similarly, it is expected that when proper operation and maintenance is performed, odour emission can be controlled.

Impact due to disruption of operation of the water supply facilities and the sewage treatment plants (power cut and electrical accident)

A power failure can be compensated for by the installation of power generator. The social infrastructure improvement concerning electricity will progress in the future, and it is expected that power failure will less frequently occur. Furthermore, the adverse Impacts can be controlled to the minimum by preparation of the spare electrical & mechanical equipment, operation manual for emergency, and training to the operation staff for the emergency situation.

12.7 EVALUATION OF PRIORITY PROJECT AND RECOMMENDATIONS

12.7.1 Economic and Financial Evaluation

(1) Overview of Economic and Financial Evaluation

The priority project was evaluated from economic and financial points of view. The economic evaluation of the priority project was conducted in the same manner as described for the master plan project in **Section 11.2**. In the financial evaluation, the priority project was examined in order to identify what financial conditions would make it feasible from the financial viewpoint through evaluation of financial indices. Finally, the financial conditions which would ensure the financial sustainability of the Zone West retail entity were studied through financial simulation analyses.

(2) Preconditions and Criteria of Evaluation

The evaluation method and procedure was already discussed in **Sections 11.2.2** and **11.2.3** in the master plan study. The priority project has the following features.

1°	Base Year:	Beginning of 2008.
2°	Construction Period:	The construction works of the priority project (DNI works) are implemented between 2012 and 2014. However, the construction works for water source development are started in advance in 2008. Therefore, these works which correspond to the demand capacity of the priority project are included as a part of the project.
3°	Disbursement Schedule:	Uniform distribution of project costs during the construction period above
4°	Economic Life:	30 years after the completion of the project
5°	Evaluation Period:	30 years after the completion of the construction work (2008–2044)

In the economic evaluation, the social discount rate is set at 12%, as was the case in the master plan study. Other criteria such as SCF, exchange rate, and benefit distribution of public health improvement were also considered for the economic evaluation in this study.

In the financial evaluation, the financial efficiency of the projects was evaluated by comparing the FIRR of the projects with a likely interest rate of foreign loans. According to the latest information available from agencies concerned and major foreign donors, the likely interest rate falls somewhere between 7% and 9% per annum (8% is adopted in this evaluation as medium rate) including the charges required to avert the risks associated with foreign exchange rates.

(3) Economic Evaluation of Priority Project

At first, the economic evaluation of the priority projects was conducted for water supply and sewerage separately. Then, both projects were combined and evaluated as one scheme as was the case for the master plan.

1) Water Supply System

Tangible economic benefits of the water supply priority project were quantified based on the same data and information as used for the evaluation of the master plan. The structure of benefits is the same as discussed in **Section 11.2.4**. It is expected that the benefits will emerge immediately after the completion of the distribution network improvement (DNI) in the project area, i.e. from the latter half of the year 2012. The total economic benefit was estimated at Rs.8.1 billion in the target year 2015. The annual benefits of the respective components are summarized in **Table 127.1.1** (See **Table A127.1.2** of **Appendix 127.1** for details.).

Table 127.1.1 Economic Benefits of Water Supply Project: 2012-2015

(Unit: Rs. Million/Year)

Item	2012	2013	2014	2015
Domestic Saving Benefit	809	4,753	6,221	6,827
Medical Benefit	111	272	889	913
Non-domestic Saving Benefit	36	223	284	304
Reduction of O&M Expenses	11	45	81	93
Negative Benefit	4,293	8,578	4,648	0
Total	-3,326	-3,285	2,827	8,136

In the economic evaluation, the total economic cost was estimated as the sum of three cost components: (a) DNI in the priority project area: Rs.9.65 billion; (b) costs associated with the use of existing water supply facilities in the project area which were assumed as being sunk costs: Rs.3.01 billion; and (c) costs associated with the bulk water supply to the project area, including the costs of reservoirs and transmission pipelines: Rs.3.70 billion. Details of the estimated costs (a) and (c) are provided in **Table A127.1.3** of **Appendix 127.1**. Item (b) was estimated on the basis of the book values provided in the financial statements of KW&SB for 2004/05. In addition, operation and maintenance costs of relevant facilities and replacement costs of electrical and mechanical equipment were also included as part of the economic cost. These costs are shown in **Tables A127.1.4** and **A127.1.5** of **Appendix A127.1**.

The economic evaluation of the water supply project revealed 23.5% in EIRR, Rs.17.9 billion in NPV and 2.40 in B/C. The stream of benefits and costs and evaluation indices are presented in **Table A127.1.6** of **Appendix A127.1**. The project was found to be quite viable from an economic point of view, since its EIRR is much higher than the social discount rate i.e.12%. The sensitivity analysis indicated that EIRR was still more than 12% even in the case where the benefits decreased by 20% and the costs increased by 20% (See **Table A127.1.7** of **Appendix A127.1** for details.). The sensitivity test of the economic evaluation suggested no risk in terms of economic viability of the priority project. One reason for this is that the project area has already been fully urbanised and as such the intended benefits of the project are expected to emerge immediately after the completion of DNI in the project area. Another reason is that most of the residents in the project area belong to a group of relatively high income and spend a large amount of indirect costs associated with the use of piped water from the system of KW&SB.

2) Sewerage System

Tangible economic benefits of the sewerage priority project were quantified based on the same data and information as used for the economic evaluation of the master plan. It is expected that the benefits would emerge just after the rehabilitation of the treatment plants in the second half of the year 2014. The matured benefit was estimated at Rs.1,246 million in 2015. The annual benefits of the respective components are summarized in **Table 127.1.2** (See **Table A127.1.9** of **Appendix 127.1** for details.).

Table 127.1.2 Economic Benefits of Sewerage Project: 2014-2015

(Unit: Rs. Million/Year)

Item	2014	2015
Domestic Benefit owing to Improved Environment	337	674
Medical Benefit	161	323
Non-domestic Benefit owing to Improved Environment	86	172
Reduction of O&M Expenses	24	48
Negative Benefit*1	136	0
Total	479	1,246

Note: *1 In 2012 and 2013, the useless existing sewer pipes are replaced in the priority project. Thus, these pipes are evaluated as negative benefit in the years.

Sewers have already been installed in most of the project area. It is therefore proposed that only 20% of the existing sewers would be rehabilitated under the priority project. It is also proposed that major mechanical and electrical equipment at the existing sewage treatment plants would be rehabilitated under the project. The residual values of existing sewers and sewage treatment plants were included as sunk cost based on the book values provided in the KW&SB's financial statements for 2004/05. The cost of the proposed rehabilitation works was estimated at Rs.2,672 million in economic terms (See **Table A127.1.10** of **Appendix A127.1** for details.). In addition, O&M and replacement costs were also included in the project cost (See **Tables A127.1.11** and **A127.1.12** of **Appendix A127.1** for details.).

The economic evaluation of the sewerage project indicated 20.3% in EIRR, Rs.2.1 billion in NPV and 1.82 in B/C. The stream of benefits and costs and evaluation indices are tabulated in **Table A127.1.13** of **Appendix A127.1**. The project was considered to be quite viable from an economic point of view, since its EIRR is significantly higher than the social discount rate i.e.12%. The sensitivity test of the economic evaluation suggested no risk in terms of economic viability of the priority project.

3) Integrated System

The water supply and sewerage projects were combined as one project and subjected to economic evaluation. The results indicated 23.0% in EIRR, minus Rs.18.1 billion in NPV and 2.29 in B/C. The stream of benefits and costs and evaluation indices are tabulated in **Table A127.1.15** of **Appendix A127.1**. Thus, the integrated project was also found to be quite viable from an economic point of view.

(4) Financial Evaluation of Priority Project

The following indices were used for the financial evaluation of the priority projects: financial internal rate of return (FIRR); net present value (NPV) and B/C (benefit-cost ratio). The financial benefits would be derived from water sales to consumers, that is, the revenue of water sales. The financial viability of the priority project was judged by comparing the FIRRs of the project with a likely interest rate of foreign loans applicable to finance the project i.e. 8% per annum. In order to make the project viable from a financial point of view, the FIRR of the priority project needs to be more than 8%.

1) Water Supply System

The present tariff of water supply for metered bulk consumers is Rs.44/1000 gallons (Rs.9.7/m^3) for domestic use and Rs.73/1000 gallons (Rs.16.1/m^3) for non-domestic uses. It was found that the FIRR of the project would be negative if the present levels of tariffs were applied, but it would increase to 8.3% if tariffs were increased to Rs.128/1000 gallons (Rs.28/m^3) for domestic use and Rs.212/1000 gallons (Rs.47/m^3) for non-domestic use (See **Tables A127.1.17** and **A127.1.18** of **Appendix A127.1** for details.). The sensitivity analysis of the financial evaluation indicated that if the tariffs were reduced by 20%, then the corresponding interest rate that would be needed to maintain the financial viability of the priority project should be less

than 4% (See **Table A127.1.18** of **Appendix A127.1** for details.).

2) Sewerage System

The current sewerage charge is 25% of clean water charge. The FIRR of the priority sewerage project was also found to be negative if the current level of sewerage charge was applied, but it would increase to 8.2% if the charge was increased to 50% of clean water charge. The stream of revenue and cost of the project, and evaluation indices are tabulated in **Table A127.1.19** of **Appendix A127.1**. The sensitivity analysis of the priority project indicated that if the sewerage charge was reduced by 20% of the original setting, the corresponding interest rate that would be needed to maintain the financial viability of the priority project should be around 5% (See **Table A127.1.20** of **Appendix A127.1** for details.).

3) Integrated System

The FIRR of the integrated project (water supply and sewerage) was estimated to be 8.3% if clean water charge was increased to Rs.128/1000 gallons (Rs.28/m^3) for domestic use and Rs.212/1000 gallons (Rs.47/m^3) for non-domestic use, and so was the sewerage charge to 50% of the clean water charge. The stream of revenue and cost of the project, and evaluation indices are tabulated in **Table A127.1.21** of **Appendix A127.1**.

4) Financial Impacts and Recommendations

An average water and sewerage service charge paid by the residents of the priority project area is estimated at Rs.290/month per household (5,300 gallons/month times Rs.44/1000 gallons plus 25% of sewerage surcharge). This accounts for 1.9% of the average household income (Rs.15,600/month) in the priority project area. However, the charge would increase to Rs.1,014/month per household if the increased tariffs as discussed above are applied; it would account for 6.5% of the household income, exceeding the level of affordability-to-pay suggested by World Bank (5%). This clearly indicates that increasing tariffs alone would not be able to make the priority project financially viable.

(5) Financial Management of the Zone West Retail Entity

The financial sustainability of the Zone West retail entity was examined, by adopting the following assumptions, through a financial simulation analysis based on the schemes proposed in the master plan and priority projects.

1) Prices of water and sewerage services:
   - Domestic water: Rs.88/1000 gallons (2 times of the present price)
   - Non-domestic water: Rs.146/1000 gallons (2 times of the present price)
   - Sewerage Service: 40% of water charge
   - Price escalation: 10% per 3 years
2) Procurement of financial sources for the capital investment:
   - Equity: Rs.14 billion (25% of the total investment)
   - Transferred assets: (a) Rs.12 billion of the existing facilities in Zone West as of 2008
     (b) Rs.18 billion of the facilities to be constructed between 2008 and 2011
   - Foreign loans: Rs.45 billion (80% of the capital investment)
     Repayment period: 30 years Grace period: 10 years
     Interest rate: 8% Other charges: 1%
3) The rate of bulk treated water from KW&SB: Rs.23/1000 gallons
4) Stock dividend for share holders:
   10% (when net profit after tax exceeds 10% of the total equity)
5) Income tax: 35% of the profit of the year

The results of this simulation are shown as 'Base Case' in **Figure 127.1.1**. In this case, the retail entity would only be able to make profits in 2020 for the first time after 8 years of its operation and its accumulated deficits would not be able to be eliminated until 2031. The details of this simulation analysis are presented in **Table A127.1.23** of **Appendix 127.1**.

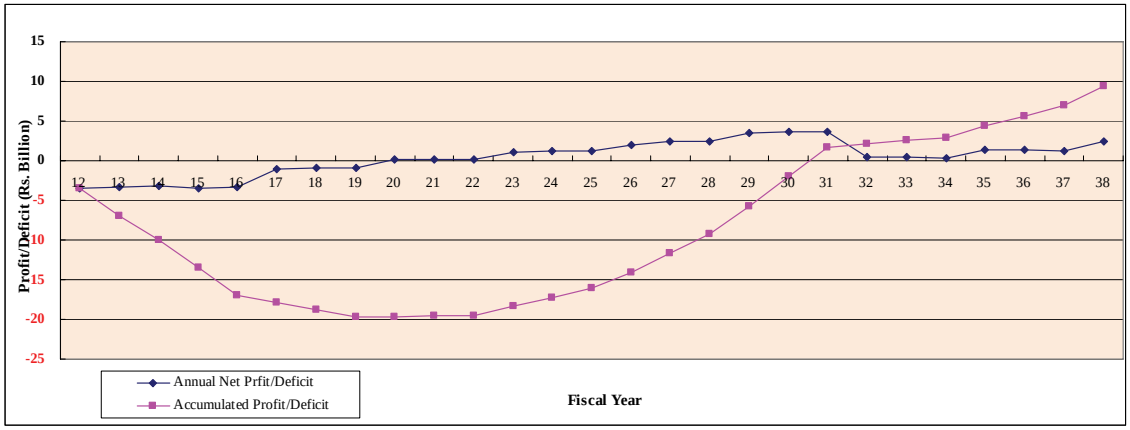

Figure 127.1.1 Results of Financial Simulation Analysis: Base Case

Then, the following changes were made to the assumptions adopted in 'Base Case' and another simulation analysis was conducted.

1) The rate of bulk treated water from KW&SB is Rs.15/1000 gallons for the initial 5 years of operation and thereafter Rs.25/1000 gallons;
2) Interest rate of foreign loans is 4% per annum.

The results of this simulation analysis are shown as 'Case 1' in **Figure 127.1.2**. It was indicated in this case that the retail entity would be able to start making profits in 2016 and its accumulated deficits would be able to be eliminated in 2023. The details of the simulation analysis for this Case 1 are presented in **Table A127.1.24** of **Appendix 127.1**.

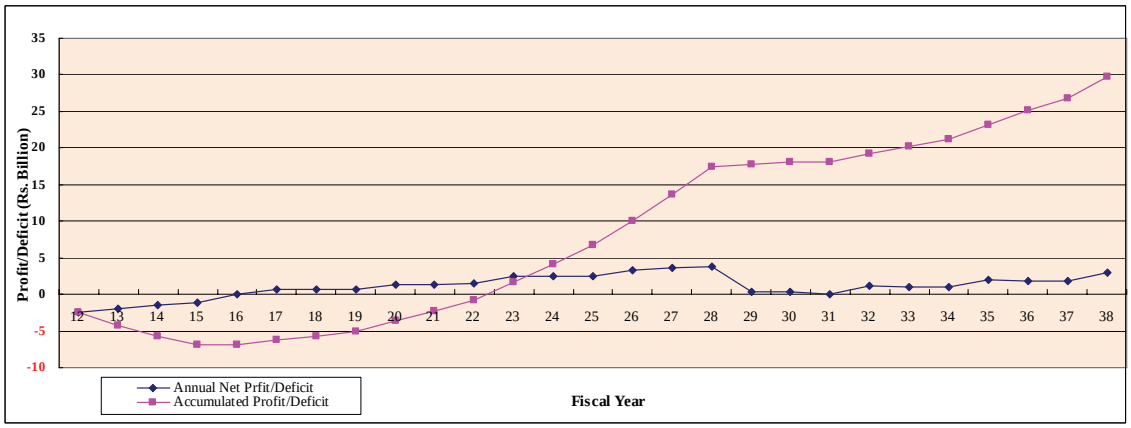

Figure 127.1.2 Results of Financial Simulation Analysis: Case 1

Finally, another simulation analysis was conducted as 'Case 2' shown in **Figure 127.1.3**. It was assumed in this case that the water supply and sewerage charges would be escalated at a rate of 15% per 3 years. Other assumptions are the same as that used for 'Case 1'. The results of this 'Case 2' analysis indicated that the retail entity would be able to eliminate its accumulated deficits in 2020 (See **Table A127.1.25** of **Appendix 127.1** for details.). It is considered that this 'Case 2' would ensure the financial sustainability of the Zone West retail entity. In this case, the average monthly household expenditure for clean water and sewerage

charges would be Rs.653 [(5,300 x 0.088) x 1.4], which is about 4.2% of the current average monthly household income of the residents in the priority project area, i.e. Rs.15,600.

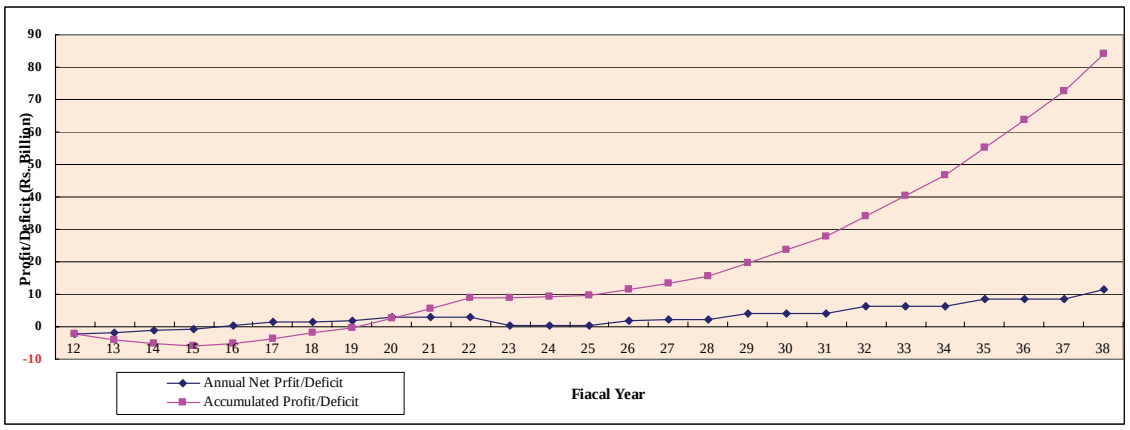

Figure 127.1.3 Results of Financial Simulation Analysis: Case 2

12.7.2 Evaluation of Environmental and Social Impacts

Components of the priority project are classified into two categories; one is water supply system with expansion of reservoir and distribution network improvement (DNI), and the other is sewerage system with improvement of sewage collection network and replacement of electrical equipment in TP-1 and TP-3 sewage treatment plants. Implementation of these components will bring about the following benefits and positive impacts.

Water supply system

- DNI enables access to safe water and sufficient amount of water on 7-24 basis.
- The existing ratio of leakage is estimated to be 30 to 35% of water supplied, and DNI is expected to improve the rate of water leakage effectively.
- By installing water meter to every service, a meter-charge system will be possible. Consequently, user will pay the water consumption corresponding charge, and it is expected to lead the improvement in users' water-saving awareness.
- By improving water supply service and reducing individual compulsory associated fees concerning water use such as installation of private tank and suction pump and operation costs, enhancement in the charge collection rate is expected.
- Financial improvement in the management of water and sewerage services is expected by improvement in the charge collection rate.

Sewerage system

- Improved sewage collection will collect all the sewage in the priority project area and convey it to STPs.
- By replacement of equipment in the TP-1 and TP-3 sewage treatment plants, proper sewage treatment is possible, and the water quality of the treated effluent will be possible to meet the effluent water quality standards.
- Consequently, reduction of the discharged pollution load to the public water bodies and water quality improvement in the public water bodies are expected.

According to the findings of the EIA Study, there are some adverse impacts that require mitigation measures in the priority project implementation. Main adverse impacts and mitigation measures are described below.

- Adverse impacts on the land acquisition by the expansion of reservoir (NEK old

reservoir)

The site which adjoins the east side of the existing reservoir is not used for other purposes and it has a sufficient area as the construction site for the expansion of reservoir. If this site is possible to use as a construction site, it is expected that adverse impacts of land acquisition are minimal.

- Adverse impacts on the construction for improvement of water distribution network and sewage collection network

The main adverse impacts in the construction stage of water distribution network and sewer collection network are the ones on the economic activity, traffic situation, public health condition, air pollution, noise and vibration. Especially, when appropriate measures are not taken serious traffic disturbance will possibly occur. However, these are short-term impacts, and these can be reduced by appropriate construction site management including announcements, traffic control and so on.

- Adverse impacts on the water environment by the increase in the amount of sewage

The increase in the amount of sewage by the DNI was considered in the sewerage system planning. When the treatment plants are properly operated and maintained, the effluent will meet the effluent standards, and water quality improvement in the public water bodies is expected.

- Adverse impacts from sewage treatment plants (TP-1 and TP-3)

Emission of odor is expected from sewage and sludge treatment processes in these sewage treatment plants. Basically, it is expected that if these plants are operated and maintained properly, it is possible to control odor emission to the minimum.

- Adverse impacts on the tanker water supply business

The DNI in the priority project area will be completed by 2014, and the tanker water service will end. However, the water supply facilities in the Karachi city will be constructed step by step till 2025, the demand for tanker water supply will not decrease immediately. Therefore, it is expected that adverse impacts on the tanker water service are not significant.

As a conclusion, though the above adverse impacts may be expected, all the adverse impacts could be controlled to the minimum by taking appropriate measures. In addition, not only the above-mentioned benefits and positive impacts by implementation of the priority project, but improvement of the local economy and sanitary conditions as multiplied effects are also expected.

12.7.3 Evaluation of Technical Feasibility

(1) Water Supply Project

1) Evaluation

In order to maximize the benefits of implementing the water supply priority project, the sustainability of the project was discussed from an engineering point of view by taking into account the technical requirements during and after the implementation of the project and KW&SB's technical capabilities. The project includes only the installation/replacement of pipelines and the expansion of a reservoir as its major construction components. Since KW&SB has enough experiences in constructing pipelines and reservoirs, required knowledge and skills to implement the project are already available within KW&SB. However, some training programs will be required for the operation and maintenance of the new distribution network since 24-hour supply of pressured water and flow control based on measurements will be new in Karachi. In conclusion, no major technical constraints are envisaged during and after the implementation of the water supply priority project, as long as the new corporatised entity, which will be established in Zone West, inherits the experiences, knowledge and skills of KW&SB efficiently.

Regarding the management during the implementation of DNI for the three target towns (i.e. North Nazimabad, Gulberg and Liaquatabad) of the priority project, KW&SB has some similar experiences including international tenders through the past loan projects financed by ADB and JBIC. Therefore, no major difficulties are envisaged in the management of its project implementation. However, since the scale and schedule of the DNI implemented in the priority project is demanding, a Project Implementation Unit (PIU) should be established within the project executing agency (KW&SB or Zone West Water Company).

2) Recommendations

a. Confirmation of Optimum Facility Designs in the Stage of Detailed Design

The preliminary design of distribution network was undertaken during the feasibility study of this JICA Study to identify potential pipe alignments and to propose a possible distribution network system for the three towns. The results of the preliminary design was also used to estimate the project costs for conducting economic and financial analyses and to provide basic information on the project for KW&SB and international donors. The prepared preliminary design of distribution network was based on the location, height, length, etc. of related facilities and geographical futures measured with the GIS established by JICA Study Team. The accuracy of the GIS-based measurements fulfilled the purposes of the preliminary design.

However, the preliminary design of distribution network is not suitable for the reference during the implementation of pipe construction works, as matter of off course, in terms of accuracy and details. Therefore, the detail design of distribution network including more accurate hydraulic analysis should be prepared, before implementing the project, based on detailed topographic and line surveys and geotechnical investigations.

The standard drawings prepared as part of the preliminary design of the proposed water supply facilities, such as reservoir, district mater chamber, service connection, should also be revised through more comprehensive considerations in the stage of detailed design.

b. Implementation of K-IV Projects without Delay

KW&SB are implementing the first phase of K-IV project at present. The project includes the construction of 260 mgd bulk water supply system from Kinjhar Lake to Karachi and the construction of 130 mgd filtration plant at the central part of Gadap Town. For the preparation of the feasibility study, those facilities to be constructed in K-IV project were taken into account. KW&SB should execute the first phase of K-IV project without any delay or suspension.

c. Coordination during DNI

It is important to cooperate with concerned authorities when installing pipes and related facilities by cutting, excavating, refilling and restoring paved roads.

d. Equitable Water Supply

It is necessary to take records of water consumption of each customer and to control the flow entering into each water supply block. Moreover, it is important to identify the customers consuming a lot of water because they may be causing leakage. Leakage survey and repair or warning and sanctions to the consumers causing major leakage are required to improve the effective allocation of the limited water sources of Karachi. And, it is also important to identify the customers consuming very limited amount of water, because it may be because of meter malfunction, illegal connection, or other undesirable reasons.

e. Update of GIS Database

KW&SB or the new corporatised entity of Zone West should update and add pipeline information, on a day-to-day basis before, during and after DNI, to the GIS database of water supply network system which was established during the JICA Study and handed over to the

newly established GIS Department of KW&SB. The GIS database is very helpful for planning, designing, maintaining and operating the network system effectively.

(2) Sewerage Projects

Priority project of sewerage targets three towns of North Nazimabad, Gulberg and Liaquatabad. These three towns are also the target of water supply project in which DNI is implemented. The implementation of DNI will bring about continuous water supply which will inevitably increase sewage generation. Increased sewage has to be collected and treated as required.

Priority projects of sewerage will collect the increased amount of sewage generated in these three towns through new installation of branch sewers in currently non sewered areas and rehabilitation of existing sewers. One of the primary roles of sewage works to promptly collect generated sewage can be played by installation and/or rehabilitation of sewers while making full use of existing facilities.

Another primary role of sewage works is to treat collected sewage at the required level. Increased sewage will be collected and conveyed either to TP-1 or to TP3 where the collected sewage will be treated with the effluent BOD of less than 80 mg/l as stipulated in NEQS. Priority project also includes the rehabilitation of these two treatment plants to restore their original function.

The new installation and rehabilitation of sewerage facilities in these three towns and two sewage treatment plants do not require any sophisticated technologies. Operation and maintenance of implemented/rehabilitated facilities can be done by currently available techniques.

From above mentioned discussions, it is judged that the priority project proposed here is technically feasible.

12.7.4 Overall Evaluation and Recommendations

(1) Overall Evaluation

It is anticipated that the Priority Project would, through implementation of distribution network improvement (DNI), make a substantial improvement to water supply and sewerage services in the three towns located in the western part of Karachi, namely North Nazimabad, Gulberg and Liaquatabad. The total population in these three towns is approximately 2.5 million at present. Almost the entire area covered by these three towns have already been urbanised with the current average population density of the area being as high as 580 persons per hectare. Under the circumstances, the Priority Project is considered to be a highly cost-effective investment, in which intended benefits of the project could emerge immediately upon completion of DNI.

The primary objective of DNI is to provide a 24-hour continuous supply on a regular basis at an adequate pressure. It is expected that once DNI has been completed, it would substantially reduce the indirect costs associated with the use of piped water in Karachi. They would include the costs for providing ground-level water reservoirs, suction/booster pumps, roof-top storage tanks and water filters, as well as electricity charges for pumping and fuel costs for boiling water prior to drinking. Many households who are compelled to use expensive tanker supplies would also be able to reduce their expenditure on water considerably.

Currently, low and negative pressures in the distribution system exposes the system to contamination from polluted ground water and there is a sever danger to public health. In addition, many households are obliged to use poor quality subsoil water from shallow wells. The expense of not having an adequate supply of potable water is compounded by the inevitable

medical bills resulting from the treatment of water-borne diseases (typhoid, cholera, and hepatitis are common) and the loss of income due to sick leave. It is expected that once DNI has been completed, the distribution system would be kept always full of water and under pressure, and as a result, the chances of contamination would be drastically reduced, and so would be the risks of infection from water-borne diseases, spending on medical bills, and loss of time due to sickness.

It is expected that the Priority Project would considerably reduce the potential health risks associated with the repair, replacement, and demolition of existing asbestos cement pipes in the distribution system. For many years, asbestos cement pipes have been used for water mains in Karachi. As a result, they now constitute about 65% of existing water mains in the distribution system. Most of them have already been deteriorated and undersized, and despite the low system pressure the level of leakage in the distribution system is unacceptably high. It is anticipated that leakage and the incidence of pipe bursts would significantly increase when the system pressure is raised by the completion of DNI. This would require all or part of the existing asbestos cement pipe network to be removed or disposed. However, asbestos, in an air borne condition, is a hazardous material. Asbestos cement pipe is non-friable in its intact state but is likely to become friable upon removal, demolition and/or disposal. Once it becomes friable, it will require special safety measures and procedures for handling, containerizing, transporting and disposal, which would also be very costly. It is therefore planned that DNI will develop an entirely new distribution network while leaving the existing distribution network intact. Upon completion of DNI, the new distribution network will replace the existing one completely. The completion of DNI will therefore make the use of the existing distribution network totally unnecessary, and therefore it is expected that no repair, demolition, or replacement work of existing asbestos cement pipes would become necessary in future. It is suggested that existing asbestos cement pipes should continue to remain underground and maintain their non-friable state.

It is anticipated that the Priority Project would greatly enhance the efficient and effective use of water resources. DNI would bring about a substantial improvement to water service quality by significantly reducing leakage and other water losses and introducing metered supplies with a volumetric tariff to all consumers. Introduction of a volumetric charging system would provide a strong incentive for the efficient use of water when it is accompanied by block tariff pricing with increased charges for consumption beyond essential use. This is necessary to prevent the households in areas where DNI has been completed from wasting/misusing water. The tariff structure should differentiate essential use from non-essential use. Low tariffs should be applied to the level of essential use while significantly high tariffs should be applied to the level of consumption that is considered non-essential. This would provide a strong incentive for the efficient use of water and also enable the cross-subsidization of water tariffs from the rich to the poor.

(2) Recommendations

It is recommended that DNI should use good quality pipe materials which comply with internationally accepted standards and competent contractors who would be able to execute pipe laying works in an orderly and disciplined manner. Despite the higher level of initial costs required, this would ensure the quality of constructed pipelines and the smooth execution of pipe laying works. The enforcement of stringent quality control would be required throughout the construction stage, in particular with respect to the pressure and leakage tests of pipelines. It is suggested that the Zone West retail entity should establish a special Project Implementation Unit dedicated to the implementation of DNI and to employ a foreign consultant/s who have had similar experience in other large cities in the past to manage the unit.

It is recommended that the cost for providing service connections should be included as part of

the total project cost and recovered in the long run through water tariffs. This is necessary to ensure that proper materials and workmanship are used for the construction of service connections and to minimize the chances of leakage in service connections in the future. This also applies to water meters. Meters should be the property of the Zone West retail entity who rent them out to customers. This is necessary to maintain the quality of water meters and to minimize the types of water meters used in the distribution system for ease of maintenance. It is recommended that a regulatory board to be established as part of the proposed institutional reform should be responsible for setting out and enforcing 'Water Supply and Sewerage Services Regulations' which clearly define the statutory rights and obligations of both the Zone West retail entity and its customers in delivering and receiving the services. The regulations should clearly define that although meters are the property of the Zone West retail entity, the responsibility for maintenance of meters invariably remains with customers.

It is recommended that bulk meters should be installed at all existing high-rise condominiums and apartment buildings. This is because of the difficulty of installing individual household meters in those buildings. However, in the absence of individual water meters, it is necessary to develop a special charging mechanism which will effectively prevent the tenants of the buildings from wasting/misusing water. Meanwhile, it is strongly suggested that individual water meters should be installed from the outset at all new high-rise condominiums and apartment buildings in the future.

With respect to the actual implementation of DNI, considerable attention should be drawn to the fact that approximately 65% of existing water distribution mains in Karachi are asbestos cement pipes. It is recommended that contractors should be made fully aware of this prior to the submission of tenders and they should be instructed not to cut, damage or demolish any pipes which are not picked up by metal detectors. Other utility service operators should also be informed about the danger and the Zone West retail entity should try to provide them with as much information on the existing distribution system as possible. In addition, both contractors and utility service operators should be informed about the procedures that should be followed by them when they accidentally or unknowingly disturbed existing asbestos cement pipes and thereby causing them to become friable.

There are not so many Katchi Abadis in North Nazimabad, Gulberg and Liaquatabad Towns. Nonetheless, where services must be provided free of charge the Zone West retail entity should be compensated by the relevant local body responsible for social welfare services. Although it is necessary to ensure that residents of Katchi Abadis will receive water for their essential use, it should not be realized at the expense of the Zone West retail entity.

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. We have provided in this report an outline of suggested reforms in principle at this stage, which would be necessary to create such a new institutional framework. It is expected that detailed studies related to the suggested reforms will be carried out under the assistance of ADB and WSP. It is also expected that the reform process would be put into effect through the two Reform Committees (one at provincial level and the other at CDGK level) 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 of the ADB assisted Karachi Mega City Sustainable Development Program.

Understanding and cooperation of the public are indispensable for the smooth and effective execution of DNI. It is therefore recommended that the Zone West retail entity should endeavour to inform the public in advance about the objectives, targets and components of DNI through mass media such as newspapers, TV and radio. Since DNI is expected to take many years to complete across all areas of Karachi, it could only be implemented on an area-by-area basis. This creates the situation where some neighbourhoods enjoy an improved level of service whereas other neighbourhoods continue to suffer from the current poor level of services. This, although being unfavourable from the viewpoint of social justice and equity, is an unavoidable unless and until DNI has been completed across all areas of Karachi. It would therefore be absolutely necessary for the Zone West retail entity to inform the public about this and ask for their understanding. It would also be important for the retail entity to maintain close coordination with NGOs, CBOs, CCBs, UCs, TMAs, traffic police and other utility service operators.

It is 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. We consider that the introduction and enforcement of the dual pricing structure is a prerequisite for the successful implementation of DNI.

It is suggested that the KW&SB's assets relating to the water supply and sewerage system in Zone West would be transferred to CDGK initially and then from CDGK to the Zone West retail entity. CDGK would have an initial shareholding of less than 30% of the voting shares but would, in addition, hold convertible preference shares reflecting the value of the assets transferred from CDGK to the Zone West retail entity. Provisions would be made for converting these shares to voting share after the retail entity's first 5 years of operation. This would allow CDGK the option to ensure that the Zone West retail entity remains under public control after its first 5 years of operation.

All staff transferred from KW&SB to the Zone West retail entity would be on probation for a period of 12 months and would be paid in accordance with their existing contracts of employment. At the end of this period the retail entity will offer new terms and conditions of employment to the staff that it wishes to retain as employees of the retail entity. The staff who do not wish to accept this offer or are not offered continued employment would become the employees of KW&SB and would be eligible for immediate voluntary redundancy.

Because of the extremely poor conditions of the existing distribution network, huge investments would be required to make a substantial improvement to the service quality. Hence, it is likely that the Zone West retail entity's expenses would increase more rapidly than its revenues during the first 5 years of its existence. This implies that special arrangements would have to be made to finance the losses that the Zone West retail entity is likely to make during its first 5 years of operation.