CHAPTER 12

FEASIBILITY STUDY

12 FEASIBILITY STUDY

12.1 SCOPE AND FRAMEWORK OF PRIORITY PROJECTS

12.1.1 Water Supply Projects

(1) Components of Priority Project

Distribution Network Improvement (DNI) for the three towns in Zone West (i.e. North Nazimabad, Gulberg and Liaquatabad) was selected as the priority project of water supply in this JICA Study from technical, economical, financial and institutional points of view as described in the previous chapter. The scale of the water supply priority project was set based on the overall schedule of DNI for the whole Karachi City prepared in the phase of Master Plan, water demand, supply capacity and bulk water availability related to K-IV project. The selected priority project includes not only DNI for the three towns but also components for stably and safely conveying filtered water from NEK Old Filtration Plant to these three towns as shown in **Figure 121.1.1** and described below:

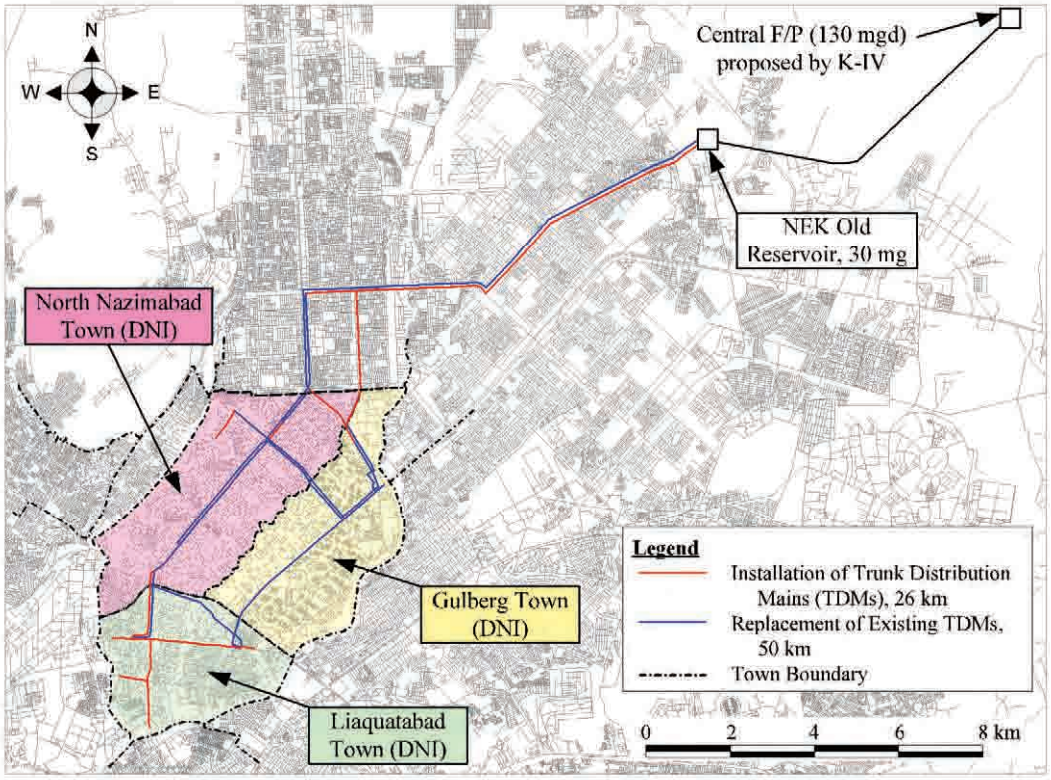


Figure 121.1.1 Components of the Water Supply Priority Project

- Replacement of all the existing distribution network mains in the three towns (about 1,000 km in total length)
- Rehabilitation/replacement of all the existing service pipes branched from the distribution network mains in the three towns (about 230,000 connections in total)

- Installation of individual flow meters at all the existing service connections in the three towns (about 230,000 connections in total)
- Replacement of about 50 km of essential existing trunk distribution mains for supplying water to the three towns (blue lines in **Figure 121.1.1**)
- Installation of about 26 km of new trunk distribution mains (red lines in **Figure 121.1.1**)
- Installation of 17 district flow meters
- Expansion of the existing NEK Old Reservoir (30 mg)

In addition to the above components, it is a precondition for the implementation of the priority project to complete the first phase of K-IV project by the year 2011 successfully. KW&SB should also rehabilitate or replace the existing trunk distribution mains other than those included in the priority project. Moreover, KW&SB should execute leakage control before, during and after the DNI in the priority project.

(2) Conditions for Feasibility Study

1) Water Supply System in 2016 for Zone West

The balance between water demand and supply capacity in Zone West is shown in **Table 121.1.1**.

Table 121.1.1 Water Balance of Each Zone

Target Year	2006	2011	2016	2021	2025
A. Supply Capacity (mgd)	75	75	75	205	335
B. Water Demand* (mgd)	191	222	264	310	346
C. Balance (B-A) (mgd)	-116	-147	-189	-105	-11

*: including water supply of 5 mgd to Barochistan Province

In 2016, which is the target year of this feasibility study, Zone West has only one filtration plant which is Hub F/P (75 mgd). Although the water demand of Zone West will be 264 mgd in 2016, the existing Hub F/P of 75 mgd will still be the only filtration plant at that time within Zone West. Therefore, it was planned to partially cover the remaining demand of 189 mgd by supplying water from Zone Central as shown in **Figure 121.1.2**.

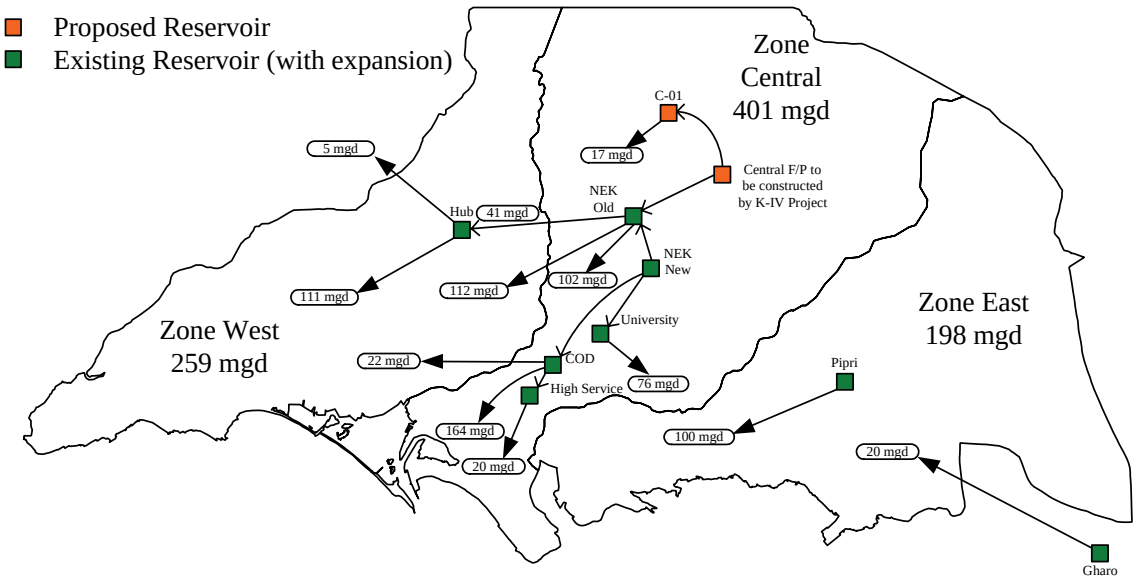


Figure 121.1.2 Schematic Diagram of the Distribution System in 2016

K-IV project includes the construction of a new filtration plant (Central F/P) at the central area of Gadap Town as shown in **Figure 121.1.2**. After the completion of constructing Central F/P

in 2011 filtered water should be supplied or transferred to certain areas or reservoirs without delay. JICA Study proposed in the water supply master plan to covey treated water from Central F/P to the reservoir at NEK Old F/P by gravity and to supply water to areas around the F/P through new transmission system. Therefore, KW&SB should provide the filtered water transmission mains from new Central F/P to the reservoir at NEK Old F/P in order to start supplying the water filtered in Central F/P immediately after the completion of the first phase of K-IV project. KW&SB also has another plan of constructing a new F/P of 100 mgd at the same location of NEK Old F/P as part of K-III System by ADB loan. The schematic diagram of the future development around the existing NEK Old F/P is shown in **Figure 121.1.3**.

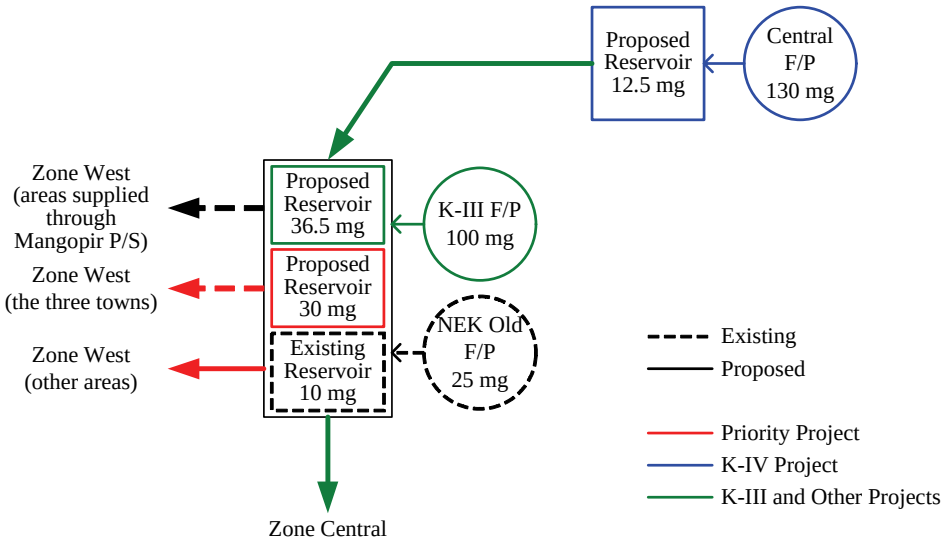


Figure 121.1.3 Schematic Diagram of Future Development around Existing NEK Old F/P

2) Target Area of the Priority Project

The priority project consists of above-mentioned components for supplying water to the three towns of North Nazimabad, Gulberg and Liaquatabad. The current and future populations of the three towns are shown in **Table 121.1.2**.

Table 121.1.2 Population Growth of North Nazimabad, Gulberg and Liaquatabad

Name of Town	Population				
	2006	2011	2016	2021	2025
North Nazimabad	765,820	830,191	907,352	997,474	1,069,572
Gulberg	699,910	758,741	829,261	911,627	977,520
Liaquatabad	988,284	1,002,318	1,019,141	1,038,790	1,054,509
Total	2,454,014	2,591,250	2,755,754	2,947,891	3,101,601

The existing water supply system supplies water mainly from NEK Old F/P to North Nazimabad and Gulberg and from COD F/P to Liaquatabad, respectively. It is recommended to integrate the existing water supply facilities of the three towns into one water supply system connected from NEK Old by 2016.

3) Water Demand of the Three Towns

As discussed in **Chapter 6 Water Demand Forecast**, the future water demand for the three towns is estimated as shown in **Table 121.1.3**.

Table 121.1.3 Water Demand of North Nazimabad, Gulberg and Liaquatabad

Name of Town	Water Demand (mgd)				
	2006	2011	2016	2021	2025
North Nazimabad	24.65	26.34	28.71	32.13	35.03
Gulberg	21.61	23.47	25.83	28.88	31.48
Liaquatabad	30.06	29.43	29.42	30.53	31.51
Total	76.32	79.24	83.96	91.54	98.02

The water demand of Liaquatabad Town was estimated to decrease from 30.06 in 2006 to 29.42 mgd in 2016. This is because the reduction of leakage in Liaquatabad is expected to exceed the water demand increase due to the population increase trend in the same town. Liaquatabad is already densely-populated so that its population increase will be limited.

4) Water Distribution System within the Three Towns

Figure 121.1.4 shows trunk distribution mains required in 2016 for the three towns. In addition to the trunk distribution mains to be installed or replaced in the priority project shown in **Figure 121.1.1**, the water distribution system in 2016 for the three towns will also utilise other existing trunk distribution mains shown as black lines in **Figure 121.1.4**. KW&SB should rehabilitate or replace the other existing trunk distribution mains to secure the full capacity of the distribution system for accommodating the future water demand increase in the three towns.

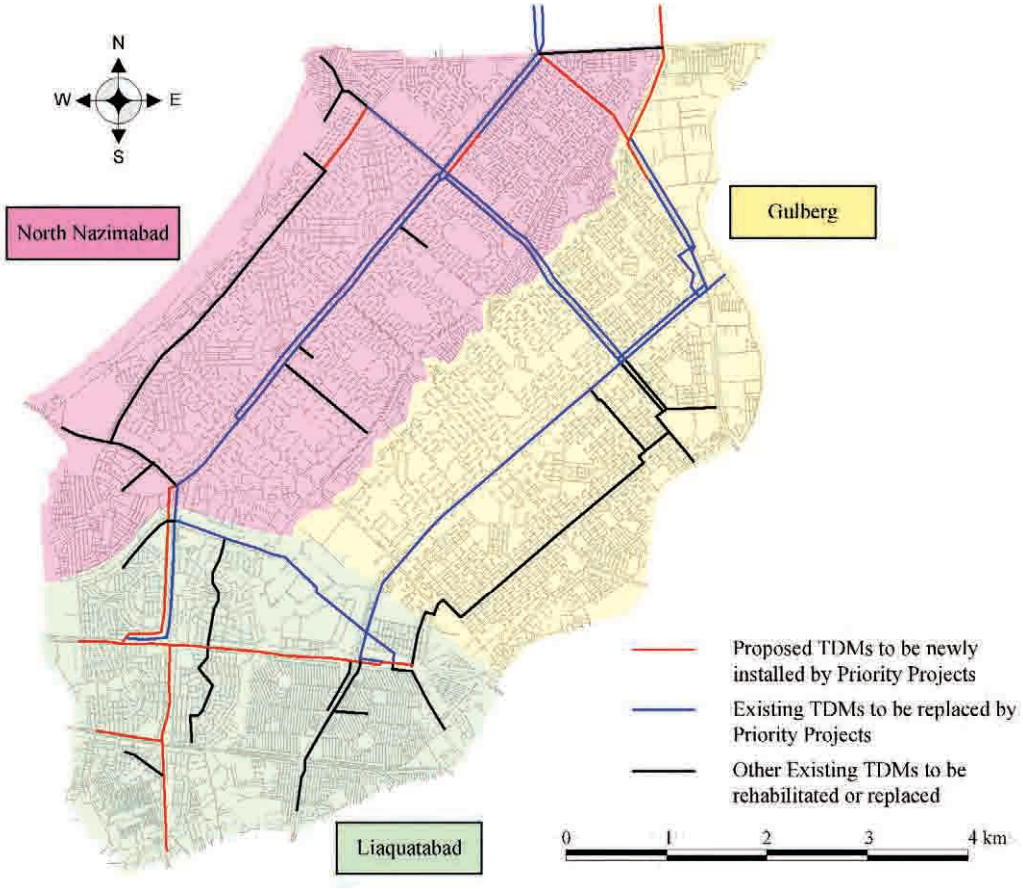


Figure 121.1.4 Distribution System for the Three Towns

The proposed water distribution system of trunk distribution mains was analysed under the following conditions:

a. Formula for friction loss calculation : Hazen-Williams Formula
b. Hazen-Williams Coefficients (C Value) : 110 for trunk distribution mains
c. Hourly peak factor : 1.5

The distribution network system consists of not only trunk distribution mains but also distribution network mains as shown in **Figure 121.1.5**. Details of the proposed trunk distribution mains forming the distribution blocks of the distribution network are explained in **Appendix A123.1**. Distribution network mains usually reach roads and streets around the households of customers.

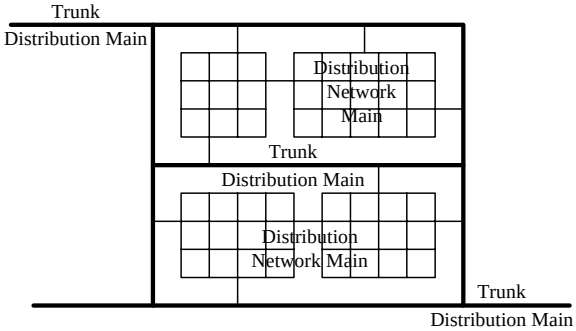


Figure 121.1.5 Trunk Distribution Mains and Distribution Network Mains

5) Distribution Reservoir

Distribution reservoirs should have enough capacity to cope with water demand fluctuation in a day. In general, peaks in water demand appear in the morning, at noon and in the evening. However, hourly demand fluctuation is difficult to accurately quantify because the metering system does not exist in the current system. Based on engineering experiences, the capacity of distribution reservoir is proposed to be the eight-hour worth of daily demand. Because the total water demand of the three towns will be 84 mgd in 2016, securing a storage capacity of 30 mg will be sufficient for the three towns.

In addition, to monitor and control the water supply volume to each water supply area including the one covering the three towns, flow meters and flow control valves should be installed at each outlet pipe of the reservoirs at NEK-Old F/P.

6) Distribution Network Mains and Service Connections

Considering the deteriorate conditions of present water supply service and the low quality materials of existing distribution network mains, it is necessary to improve the entire distribution network system. The existing distribution network mains are mainly Asbestos Cement (AC) pipes (about 65%). Therefore, most of the existing distribution network mains need to be replaced in Distribution Network Improvement (DNI) town by town. At the same time water meters will be installed to all the existing service connections (see **Table 121.1.4**). Service pipes branched from distribution network mains to customers will also be rehabilitated or replaced.

Table 121.1.4 Number of Existing Service Connections

Name of Town	Number of Existing Service Connections as of 2006		
	Domestic	Non-Dom.	Total
North Nazimabad	49,700	15,300	65,000
Gulberg	55,000	12,800	67,800
Liaquatabad	47,900	20,500	68,400
Total	152,600	48,600	201,200

Source: KW&SB

Separately from the trunk distribution mains, distribution network mains were preliminarily designed by using Hazen-Williams Formula based on the water demand shown in **Table 121.1.3** and the following conditions;

- Hazen-Williams Coefficients (C Value) : 140 for distribution network mains
- Hourly Peak Factor : 1.5

Details of the proposed distribution network mains are shown in **Appendix A123.2**.

12.1.2 Sewerage Projects

(1) General

Sewerage projects selected as priority projects include the collection and treatment of sewage generated in three target towns of North Nazimabad, Gulberg and Liaquatabad where DNI will be implemented as priority projects for water supply. The implementation of DNI will inevitably increase sewage generation, which in turn requires the rehabilitation and extension of sewerage facilities there. People residing in these three towns will receive "complete" water supply and sewerage services at the same time and are expected to be satisfied with improved services and consequently to pay the user charge though it would be much more higher than the current one.

Figure 121.2.1 shows the location of three towns and the major sewerage facilities to be rehabilitated and/or implemented as the priority projects.

(2) Basic conditions

Table 121.2.1 outlines the general features of three towns of North Nazimabad, Gulberg and Liaquatabad that are the target towns of Feasibility Study.

Table 121.2.1 Outline of Target Towns (2016)

	Area (ha)	Population (person)	Sewage Generation (mgd / m^3/d)
North Nazimabad Town	1,670	907,400	14.6 66,200
Gulberg Town	1,380	829,300	13.1 59,600
Liaquatabad Town	1,090	1,019,100	14.9 67,900
Total	4,140	2,755,800	42.6 193,700

(3) Principles of Sewage Collection and Its Treatment System Improvement

It is needed to collect all the generated sewage in the target year of 2016 and to convey the collected sewage to either TP-1 or TP-3 where the sewage will be treated with the effluent BOD of less than 80 mg/l.

Existing branch sewers will be partly rehabilitated and additional branch sewers will be installed in the areas that are not sewered for the time being. Sub main sewers and trunk sewers will be implemented where necessary.

When TP-1 was rehabilitated in 1995, two out of four final settling tanks were converted to primary settling tanks, which resulted in three times larger overflow rate of final settling tanks than that of primary settling tanks. This imbalance has to be rectified by diverting flow directions among treatment facilities. Besides, all the mechanical and relevant electrical equipment including pipes connecting treatment facilities and sludge conveyance are decayed and has to be replaced.

TP-3 is equipped with less mechanical and electrical equipment except for plant inlet, primary pumps and secondary pumps. The detailed site survey found that primary pumps are fully functional while secondary pumps need replacement mainly because they are of submersible type and hence difficult to maintain. These pumps are to be replaced with vertical axial type pumps.

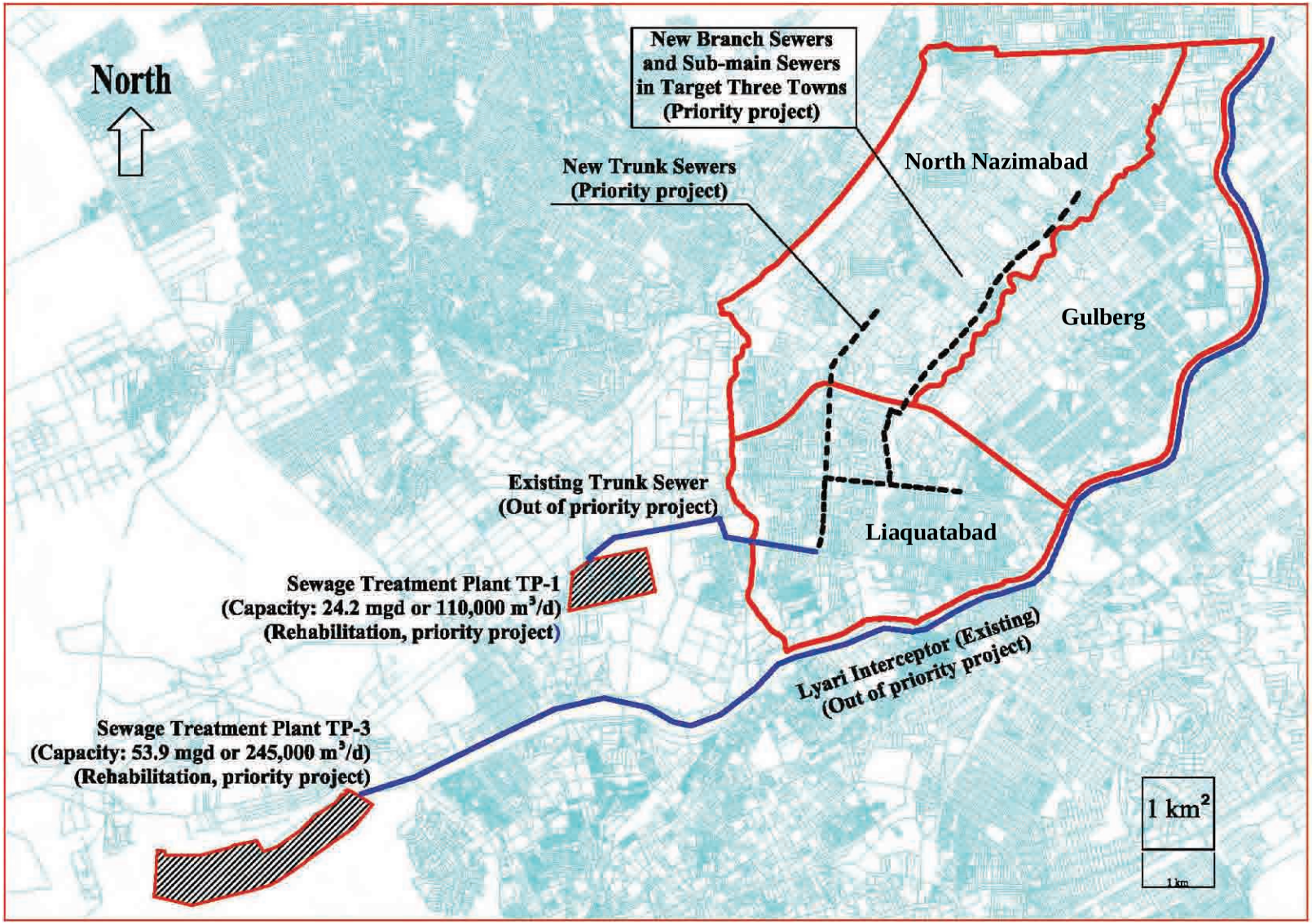


Figure 121.2.1 Components of the Sewerage Priority Project

(4) Scope of Sewerage Projects

Scope of Sewerage Projects is shown in **Table 121.2.2**.

Table 121.2.2 Outline of Sewerage Projects

	Name	Dimension/Specification	Quantity	Remarks
Sewers	Branch sewers Sub-main sewers Trunk sewers	10” 12” to 36” Larger than 42”	269 km 43 km 11 km	To rehabilitate or newly install To newly install To newly install
TP-1	Inlet pumps Primary settling tanks Trickling filter Final settling tanks Connecting pipes	0.52 m^3/s/unit 42 m diameter 41.4 m diameter 42 m diameter -	7 units 4 units 8 units 4 units 1 (LS)	Capacity: 110,000 m^3/d Process: high rate trickling filter Only mechanical and associated electrical equipment 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.
TP-3	Secondary pumps	Vertical centrifugal type 0.83 m^3/s/unit	8 units	Capacity: 245,000 m^3/d Process: stabilization pond

12.2 INSTITUTIONAL DEVELOPMENT

12.2.1 Establishment of a ‘Corporatised’ Retail Entity in Zone West

With respect to the institutional reform, the JICA Study suggests that the Karachi city should be divided into three independent retail service zones by the Lyari and Malir Rivers (see **Figure 91.6.1**), and that in the long run the responsibilities for providing retail services (water supply and sewerage services) should gradually be transferred from KW&SB to ‘corporatised’ retail entities on a zone-by-zone basis as shown in **Figure 91.6.2**. The first stage of this reform process will take place in Zone West in early 2011. The Zone West retail entity will make improvements to the retail services (water supply and sewerage) within the Zone West through implementation of the Distribution Network Improvements (DNI) in the zone. Zone West embraces all of the three ‘priority towns’ selected in **Section 11.3** for implementation of DNI on a priority basis. As such, it is envisaged that DNI in these ‘priority towns’ will be implemented by the new Zone West retail entity.

The Zone West retail entity would be established as a ‘Public Limited Company (PLC)’ under the provisions of the Companies Ordinance 1984. The PLC will purchase treated water from KW&SB in bulk and distribute it to retail customers (both residential and non-residential) within Zone West. They will also be accountable for collection, transportation and treatment of sewage generated in Zone West. The PLC would take responsibility for all financial and technical aspects of the operation and management of water supply and sewerage services within Zone West including the collection of tariffs, employment of staff, dealing with customer complaints, etc. The objective of the PLC would be to undertake the operation of water supply and sewerage services in Zone West in accordance with high commercial and professional standards and without external interference in the day-to-day management of the services. There would be no political representation on the Board of the PLC and the articles of association and shareholders’ agreement would specify that members of the Board should be selected on the basis of their commercial, professional, managerial and/or technical

qualifications and experience.

12.2.2 Establishment of an Independent Regulatory Board

JICA Study proposes that an independent Regulatory Board (RB) should be formed for economic and technical regulation of water supply and sewerage services in Zone West (see **Figure 91.6.3**). The RB should have the obligation to ensure that the new retail entity in Zone West is able to recover the reasonable financial and economic costs of providing water supply and sewerage services in Zone West. The RB would monitor the performance of the Zone West retail entity against the prescribed service standards and will also act as 'Ombudsman' in dealing with customer complaints and related issues of customer service. It would also be responsible for setting out and enforcing 'Water Supply and Sewerage Services Regulations' which define clearly the statutory rights and obligations of both the Zone West retail entity and its customers in delivering and receiving the services.

12.2.3 Way Forward

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

In order to put the institutional reforms suggested by the JICA Study into effect, separate studies will need to be conducted:

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

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

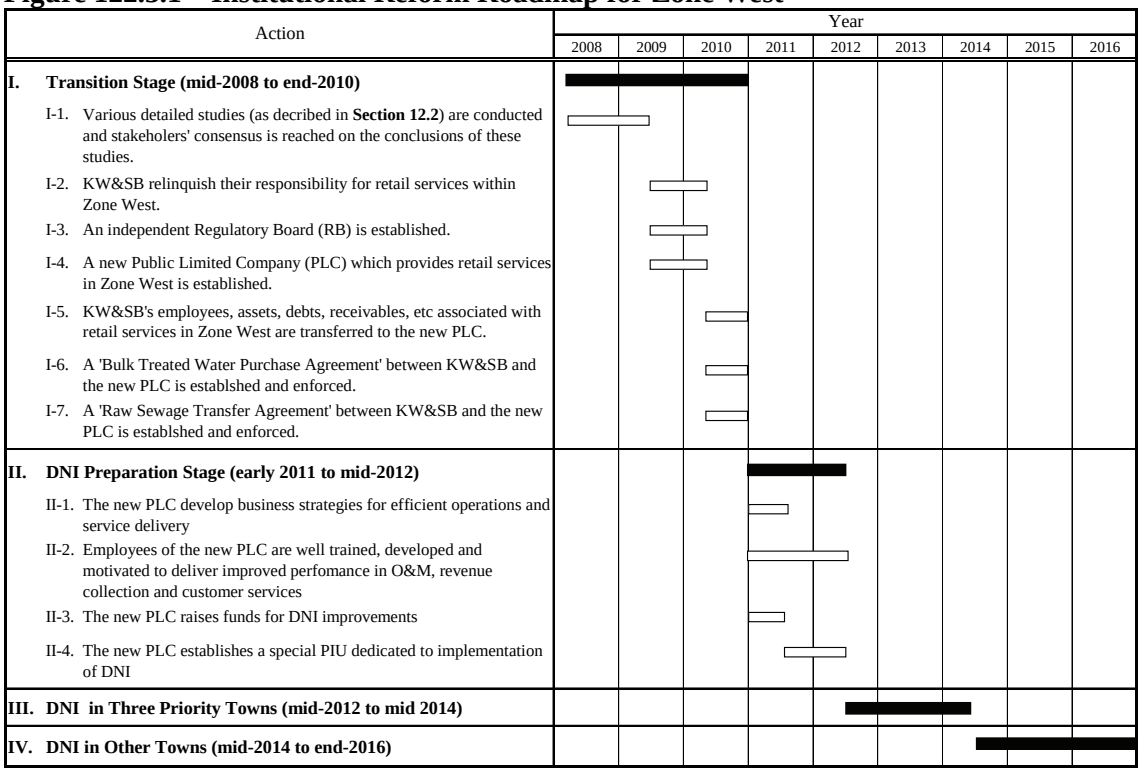
It is envisaged that the preparatory stage for DNI in Zone West will start from early 2011 and it will be followed by the actual implementation of DNI from mid-2012. It is likely that this timing will coincide with the availability of additional water (130 mgd) from the K-IV Project.

In order to achieve these goals, the following actions as a minimum will need to be put into effect between now and mid-2012.

- KW&SB relinquish their responsibility for retail services within Zone West
- A new Public Limited Company (PLC) which provides retail services in Zone West is established
- An independent Regulatory Board is established
- KW&SB's employees, assets, debts, receivables associated with Zone West are transferred to the new PLC
- A 'Bulk Treated Water Purchase Agreement' between KW&SB and the new PLC is established and enforced
- A 'Raw Sewage Transfer Agreement' between KW&SB and the new PLC is established and enforced
- The new PLC develops business strategies for efficient operations and service delivery
- Employees of the new PLC are well trained, developed and motivated to deliver improved performance in O&M, revenue collection and customer services
- The new PLC raises funds for implementation of DNI
- The new PLC establishes a specialist unit (PIU) dedicated to implementation of DNI

Timeframes in which each of these actions will need to be put into effect are given in **Figure 122.3.1**.

Figure 122.3.1 Institutional Reform Roadmap for Zone West



12.3 PRELIMINARY DESIGN OF WATER SUPPLY PROJECT

12.3.1 Distribution Facilities

(1) Distribution System

It is proposed that filtered water supplied to the three towns (North Nazimabad, Gulberg and Liaquatabad) will be conveyed from the proposed service reservoir at NEK Old F/P by existing

and new trunk distribution mains.

The diameter of the trunk distribution mains distributing water to the priority project area should have an enough capacity covering the total estimated water demand of the priority project area in 2016 as shown in **Table 121.1.3**. The proposed trunk distribution mains consist of not only new pipelines but also the existing pipelines such as NEK 3rd Phase Trunk Main, and water will be supplied to the three towns thorough the central part of New Karachi Town.

Water supply system in 2016 is proposed in a way that the existing system should be utilized effectively as much as possible. The priority project is part of Stage I of the proposed three stages of the Water Supply Master Plan. The main purpose of Stage I is to divide the water supply system by zones, and to install new pipes of minimum requirement for the change into the zone-wise water supply. The proposed water supply system for the priority project area will supply water from NEK Old F/P, while the existing water supply system supplies water from the three F/Ps of NEK Old, COD and Hub.

Although water is supplied to Liaquatabad Town from COD F/P at present by Federal Trunk Main (FTM), it is proposed that water should be supplied to Liaquatabad Town from NEK Old F/P reservoir, and that FTM should be used to supply water to only Keamari Town. Therefore, new trunk distribution mains should be installed, instead of FTM, to supply water to Liaquatabad Town.

A hydraulic analysis was conducted to preliminarily design the water supply system for the three towns. The results of the analysis are attached to **Appendix A123.1**. In the analysis, capacity of the existing mains, economical pipe diameter for new mains, and residual water pressure were examined. The proposed layout of the distribution system for the project area is shown in **Figure 123.1.1**. Among the existing trunk distribution mains included in the distribution system for the project area shown in **Figure 123.1.1**, the mains of special importance for supplying water to the area are selected to replace with new pipes by the priority project as shown in **Figure 123.1.1**. Other existing mains will be rehabilitated or replaced by other projects.

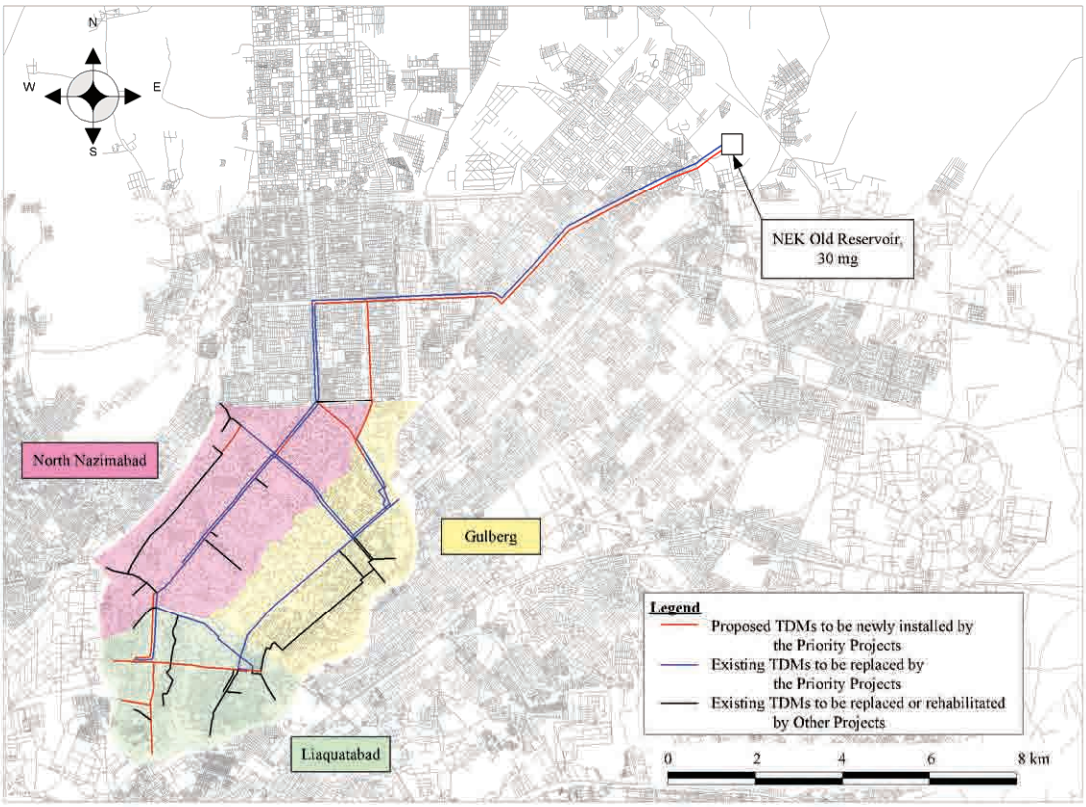


Figure 123.1.1 Distribution System for the Priority Area

(2) Distribution Reservoir

The construction of a distribution reservoir of 30 mg (136,000 m^3) at NEK Old F/P is proposed for coping with the fluctuation of hourly water demand and for securing water supply in case of power outage at the F/P. Its capacity of 30 mgd is equivalent to the 8-hour worth water demand of the three towns. The top water level and the bottom water level of this reservoir should be +82.33m and +77.42m, respectively, which are equal to those of the existing service reservoir at NEK Old F/P. The standard drawing for service reservoirs with large capacity is shown in **Figure 123.1.2**.

The proposed service reservoirs should be divided into more than two parts for facilitating its maintenance and coping with any accidents, and should have chlorination facilities, control valves, flow measurement equipment, water level measurement equipment, etc.

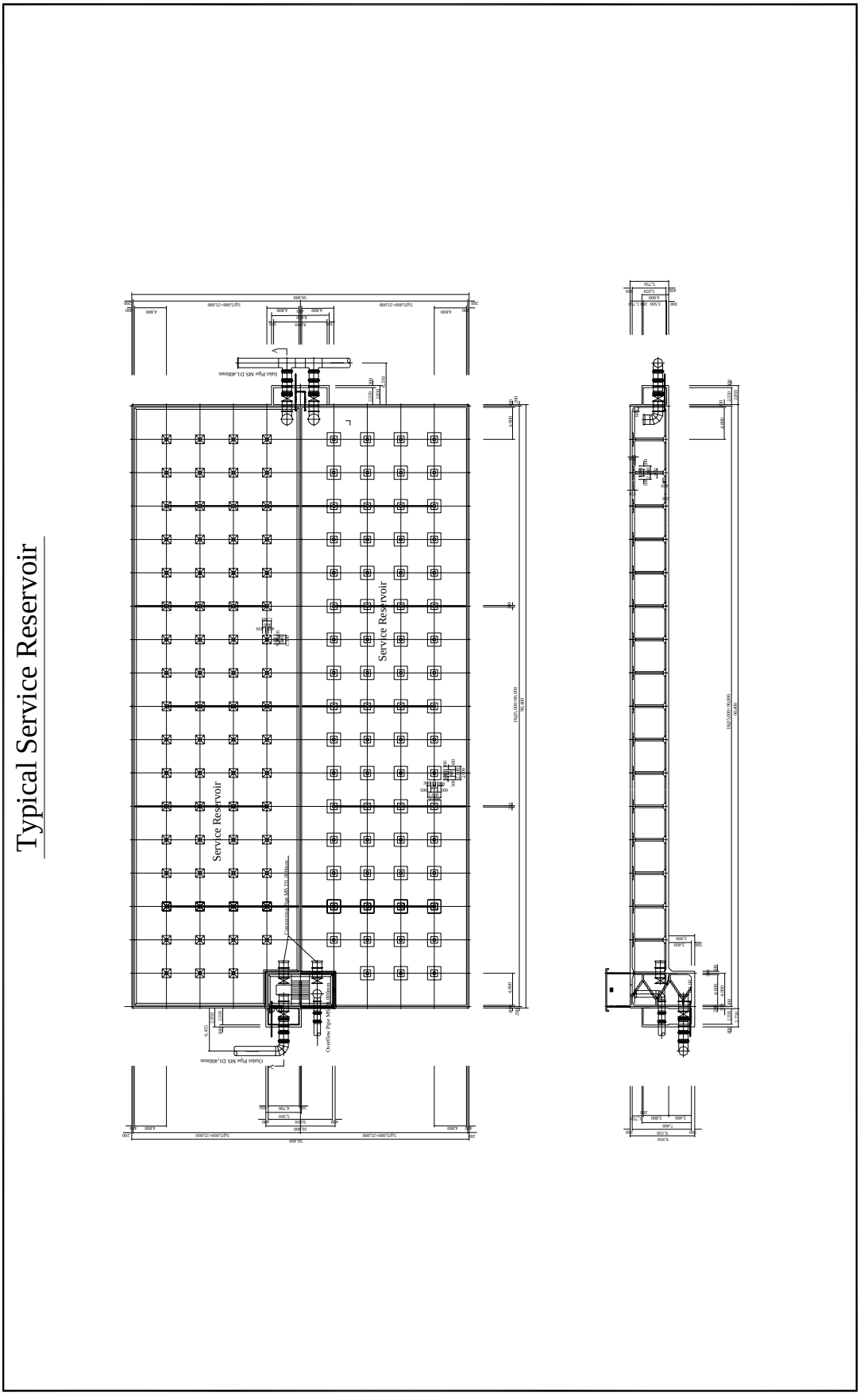


Figure 123.1.2 Standard Drawing of Service Reservoir

(3) Trunk Distribution Mains

1) Material Selection

The proportion of Pre-stressed Reinforced Cement Concrete (PRCC) pipes used in the existing water trunk mains is about 80 %. In general Mild Steel (MS) pipes and Ductile Iron (DI) pipes are widely used for pressured and treated water pipeline of large diameters (300 mm and more) in other countries. PRCC pipes have disadvantages of workability, durability, difficulty of modification at field required to adjust to differing site conditions, and difficulty of repairs for leakages and damages.

Given the important role of the trunk distribution mains, the strength and durability of pipes are among the first factors to be considered. To achieve these requirements, DI pipes or MS pipes should be selected for the trunk distribution mains. The study recommends MS pipes for the trunk distribution mains to be installed in the priority project because KW&SB has experience with MS pipes and MS pipes are available in Karachi.

On the other hand, in general Polyvinyl Chloride (PVC), Polyethylene (PE), MS and DI pipes are used for distribution network mains of small diameter. At present KW&SB are using PE pipes for distribution network mains. Therefore, it is proposed to use PE pipes for the distribution network mains less than 300 mm in diameter.

2) Installation of New Trunk Distribution Mains

To transmit and distribute filtered water from the proposed service reservoir at NEK Old F/P to the three towns, the minimum required new trunk distribution mains, which were identified in the hydraulic analysis described in **Appendix A123.1**, should be installed during the priority project as already explained. The trunk distribution mains to be installed by the priority project are listed in **Table 123.1.1**.

Table 123.1.1 Trunk Distribution Mains for the Priority Project

Diameter (in)	Length (m)	
	New Mains to be installed	Existing Mains to be replaced
100	9,620	0
88	2,320	0
72	1,210	0
64	30	4,180
56	3,830	4,660
48	1,820	19,160
36	3,120	0
32	10	1,030
28	90	0
24	1,360	10,550
18	2,140	4,210
16	440	2,460
14	0	3,240
Total	25,990	49,490

3) Rehabilitation of Existing Trunk Distribution Mains

The conditions of most of the existing trunk distribution mains are old and deteriorated. Some of the existing trunk distribution mains, which are important for supplying water to the three towns, should be replaced with MS pipes by the priority project. The trunk distribution mains to be replaced by the priority project are listed in **Table 123.1.1**. The replaced trunk distribution mains should be re-connected to the replaced distribution network mains which are explained in **Section 12.3.2**.

(4) District Meter

In order to improve the efficiency of distribution system and to supply water equitably to service areas, it is necessary to understand how much water flows into each service area. For this purpose, flow meters (district meters with flow control valves) for trunk distribution mains should be installed to the outlet pipes of the NEK Old F/P Reservoir, at Lyari River crossing point as the boundary between Zone-Central and Zone-West, and at boundaries between towns for monitoring and controlling the water flow, which is shown in **Figure 123.1.3**. The number of district meters proposed for the priority project is listed in **Table 123.1.2**. The standard drawing of meter chamber is shown in **Figure 123.1.4**.

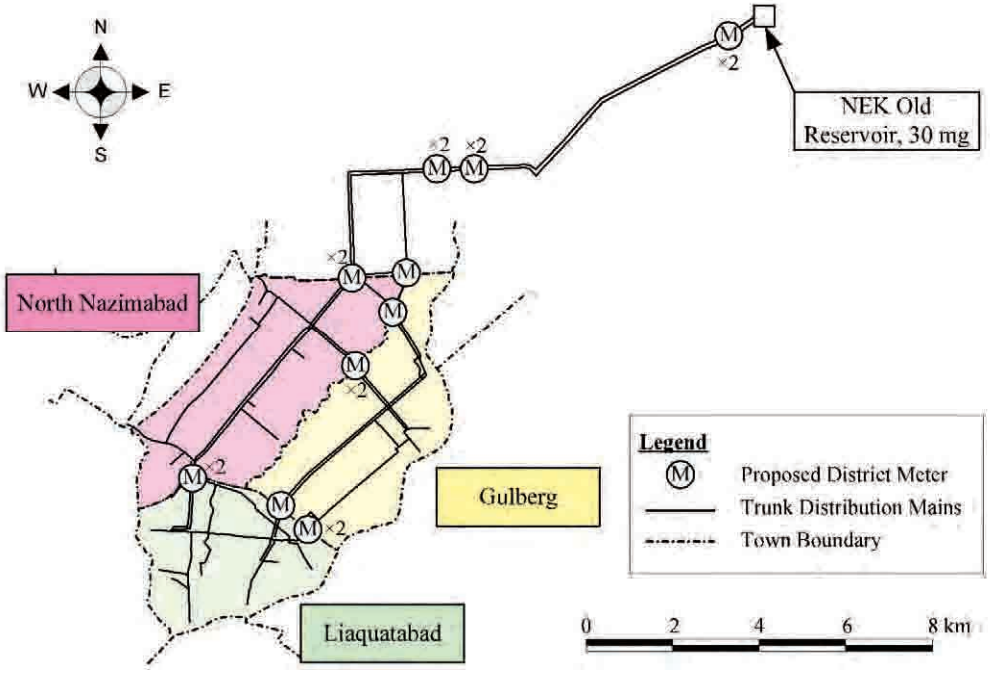


Figure 123.1.3 Locations of Proposed District Meters

Table 123.1.2 Number of District Meters

Diameter (in)	Number
100	3
72	2
64	1
56	1
54	2
48	4
24	2
18	2
Total	17

Also, it is desirable to install sub-district meters (see **Figure 123.1.5**) for flow monitoring and control at each branch of trunk distribution mains connecting to distribution network mains. Only small chambers will be required if mobile type flow meters is used for the flow monitoring and control.

(5) Other Facilities

In addition, air valves, blow-off valves and sluice valves should be installed to the system. The details of these facilities should be designed in the stage of detailed design. The standard drawings of these facilities as well as those of pipe installation works are shown in **Figures 123.1.6** to **123.1.9**.

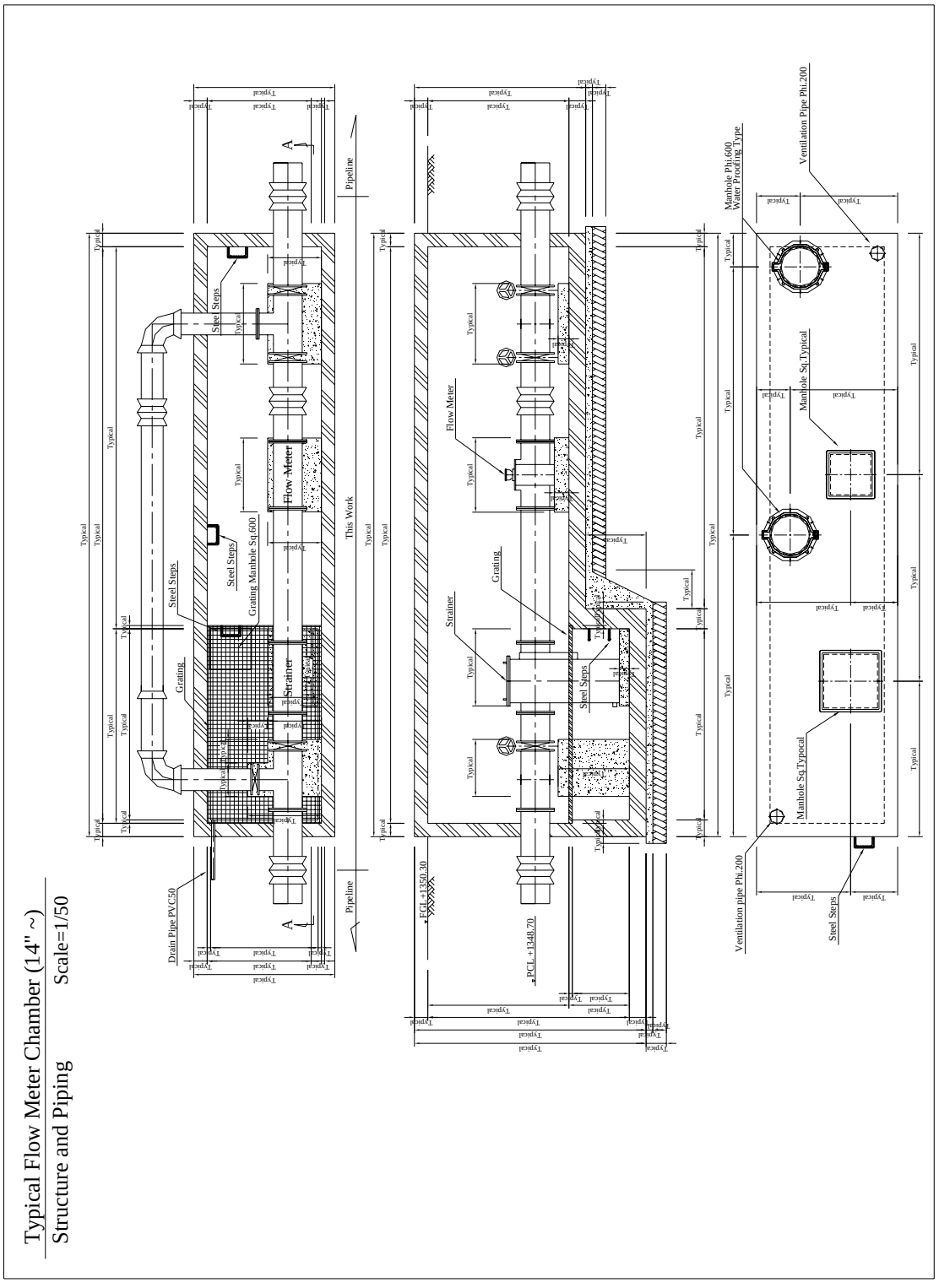


Figure 123.1.4 Standard Drawing of Flow Meter Chamber of Large Diameter

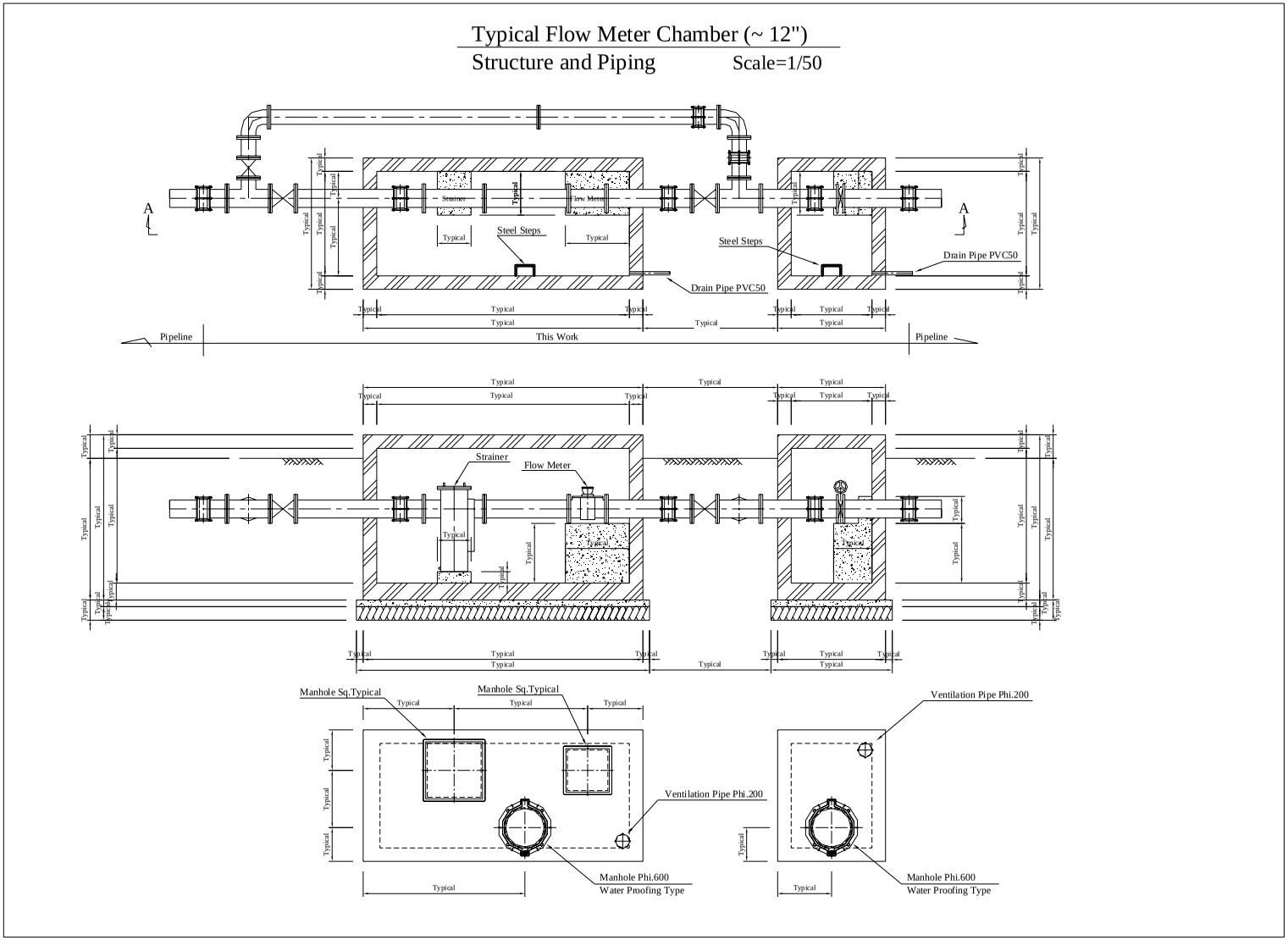


Figure 123.1.5 Standard Drawing of Flow Meter Chamber of Small Diameter

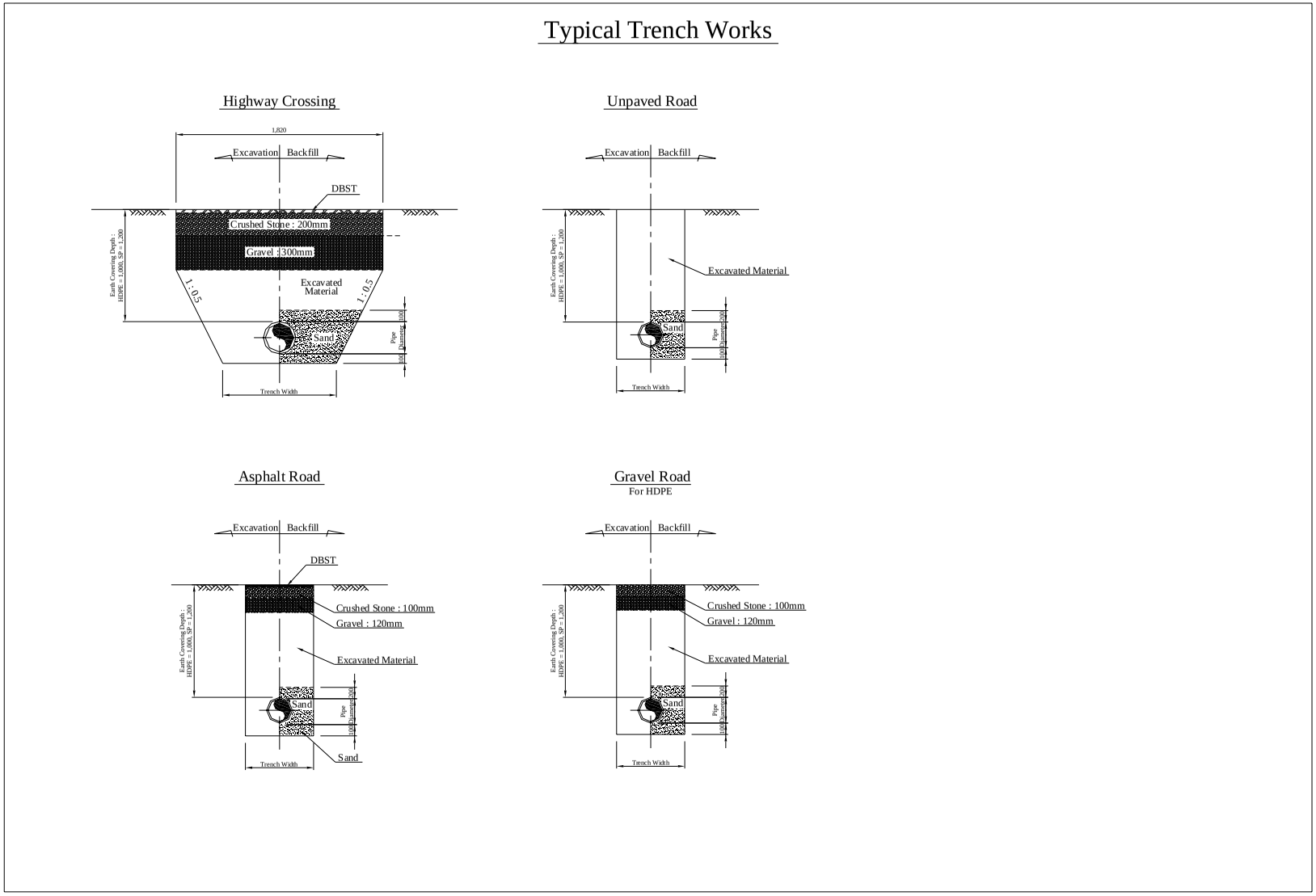


Figure 123.1.6 Standard Drawing of Trench Works

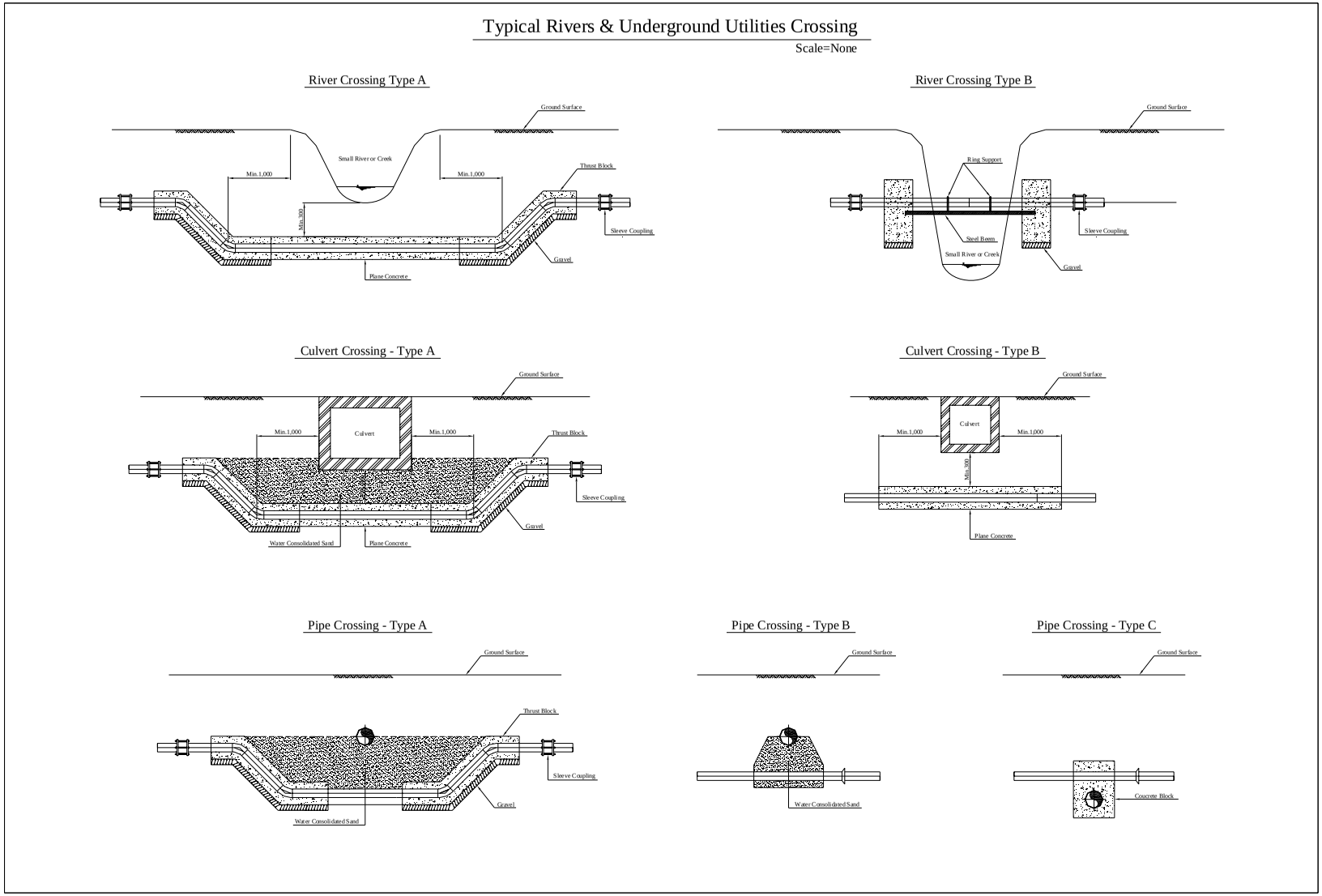
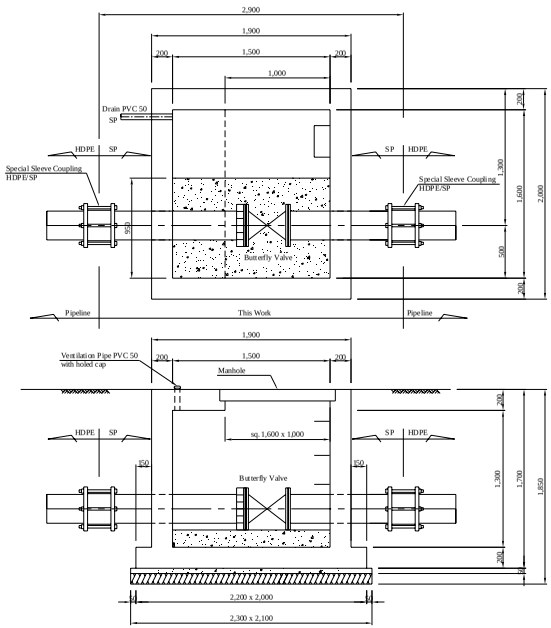


Figure 123.1.7 Standard Drawing of River and Underground Utility Crossing

Typical Valve Boxes

Scale=NONE

Butterfly Valve Chamber
~ 12"



Butterfly Valve Chamber
14" ~

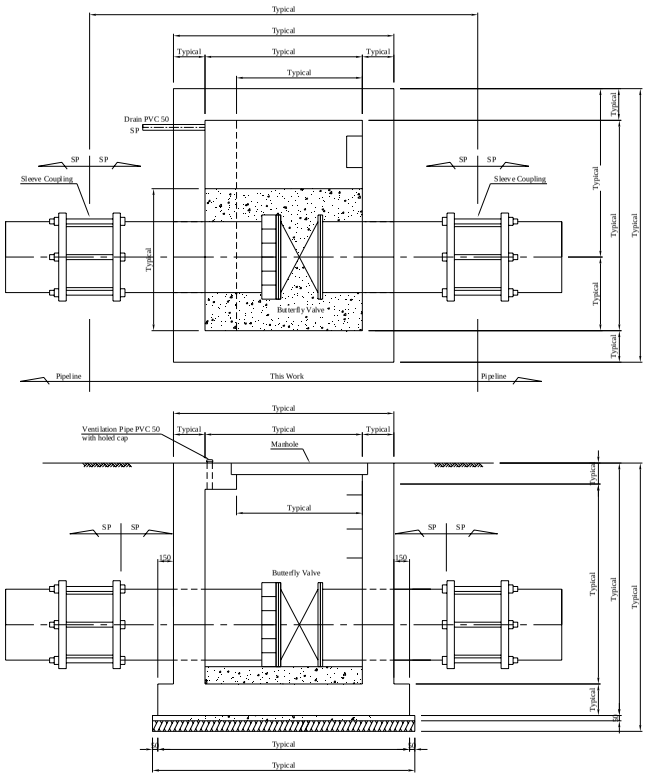


Figure 123.1.8 Standard Drawing of Valve Chamber of Large Diameter

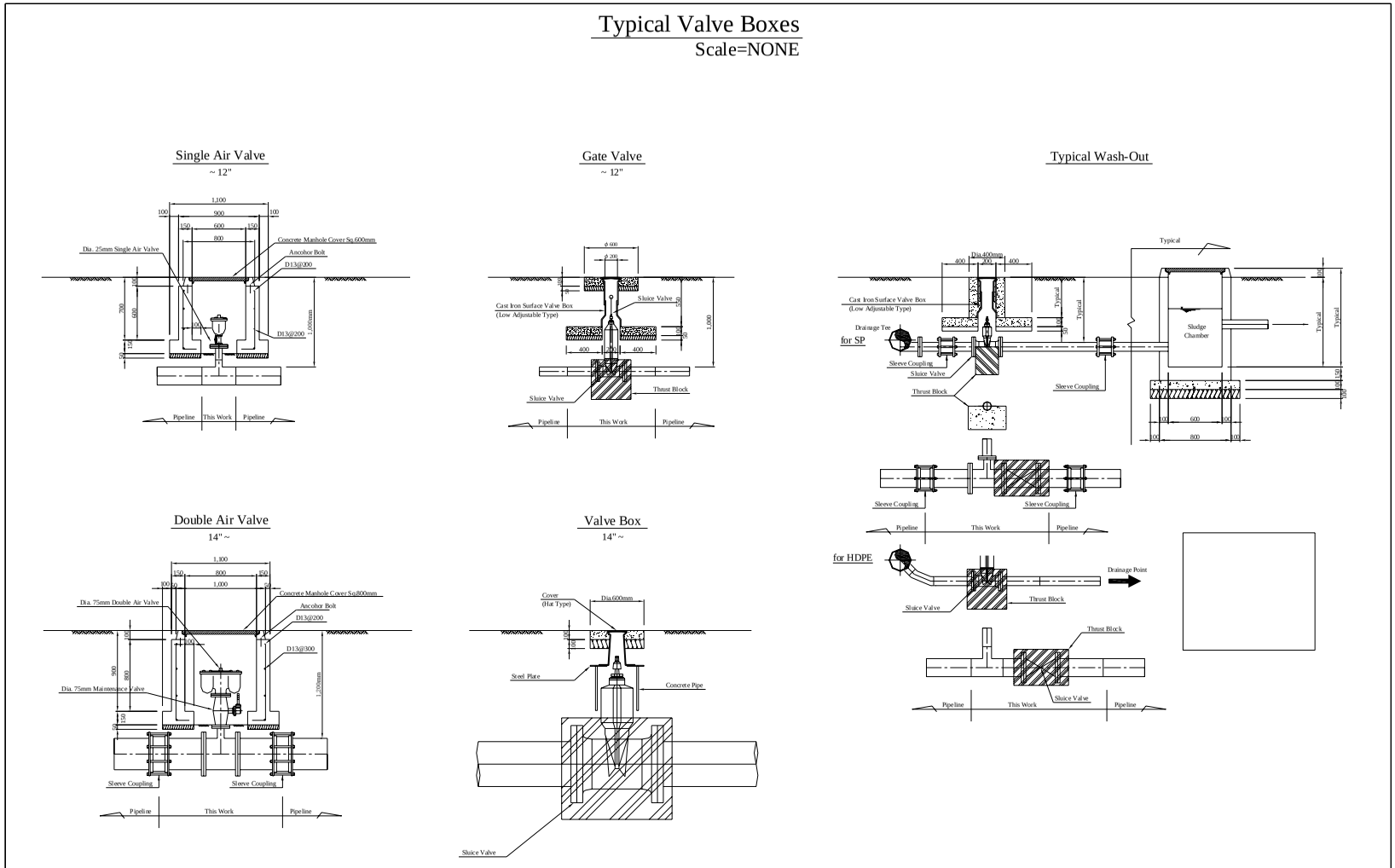


Figure 123.1.9 Standard Drawing of Valve Box

12.3.2 Distribution Network Improvement (DNI)

(1) General

The most important thing for the improvement of distribution network system is the reduction of leakage mainly from the pipeline joints which are the weakest parts of pipelines. Therefore, pipes should be connected properly at joints. It is observed that majority of the existing distribution network mains are of AC pipes, poorly constructed and inappropriately connected. It is recommended that all the existing distribution network mains should be replaced to new PE pipes, except for those which have been recently replaced by TKP projects.

Distribution network improvement (DNI) is divided into two categories of improvement. One is replacement of existing distribution network mains and another is rehabilitation and replacement of existing service connections composed of saddle branches, service pipes and meters. Distribution network mains distribute water to whole service area. Service connections will be connected to distribution network mains with saddle branches and water flows through service pipes and water meters to individual premises.

The boundary between service provider and customers is at water meter, and customers are responsible for maintaining the service pipe such as fixing leakages after the water meter. The standard drawing of service connection is shown in **Figure 123.2.1**.

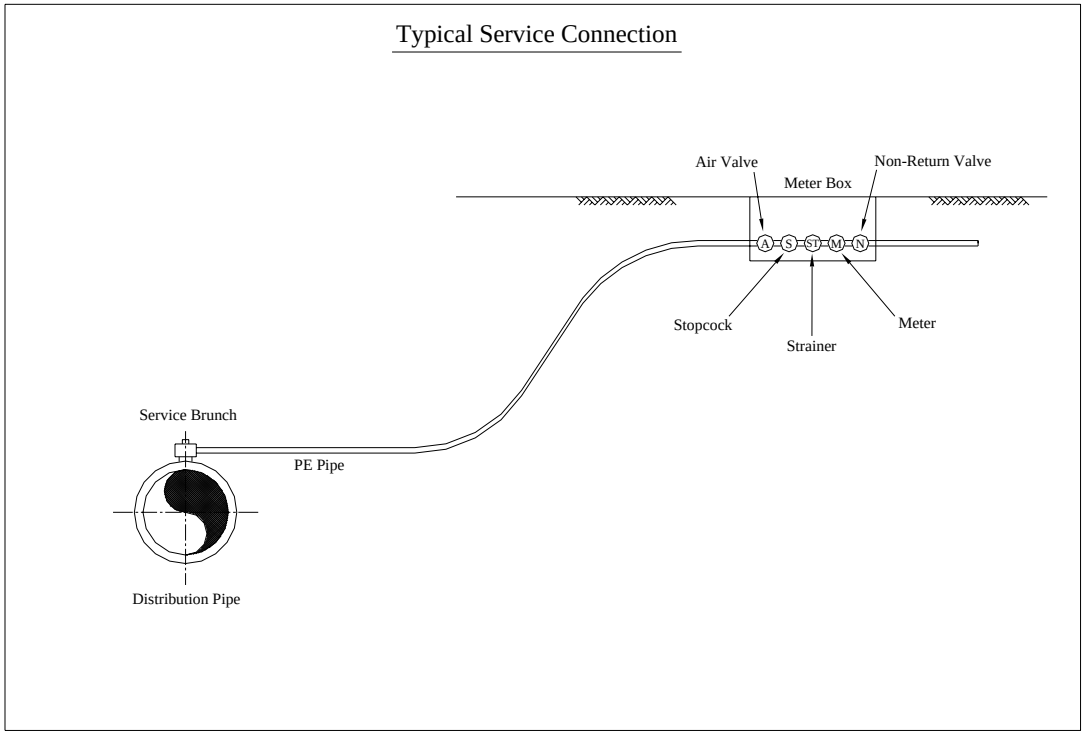


Figure 123.2.1 Standard Drawing of Service Connection

The proposed distribution network system is hydraulically isolated by the boundaries of the towns and their UCs. The system is further segmented into distribution blocks which are separated in consideration of road network configuration and routes of existing and planned trunk distribution mains. These distribution blocks should be connected with trunk distribution mains at several points. and flow measurement and control facilities should be installed at these connecting points in order to control how much water flows into each block.

Based on the things described above, hydraulic analysis for distribution network mains has been conducted and its details are attached to **Appendix A123.2**. For example, UC 5 (Sakhi Hassan) is divided into five distribution blocks and the existing network system will be renewed by DNI as shown in **Figure 123.2.2** (one of the five distribution blocks).

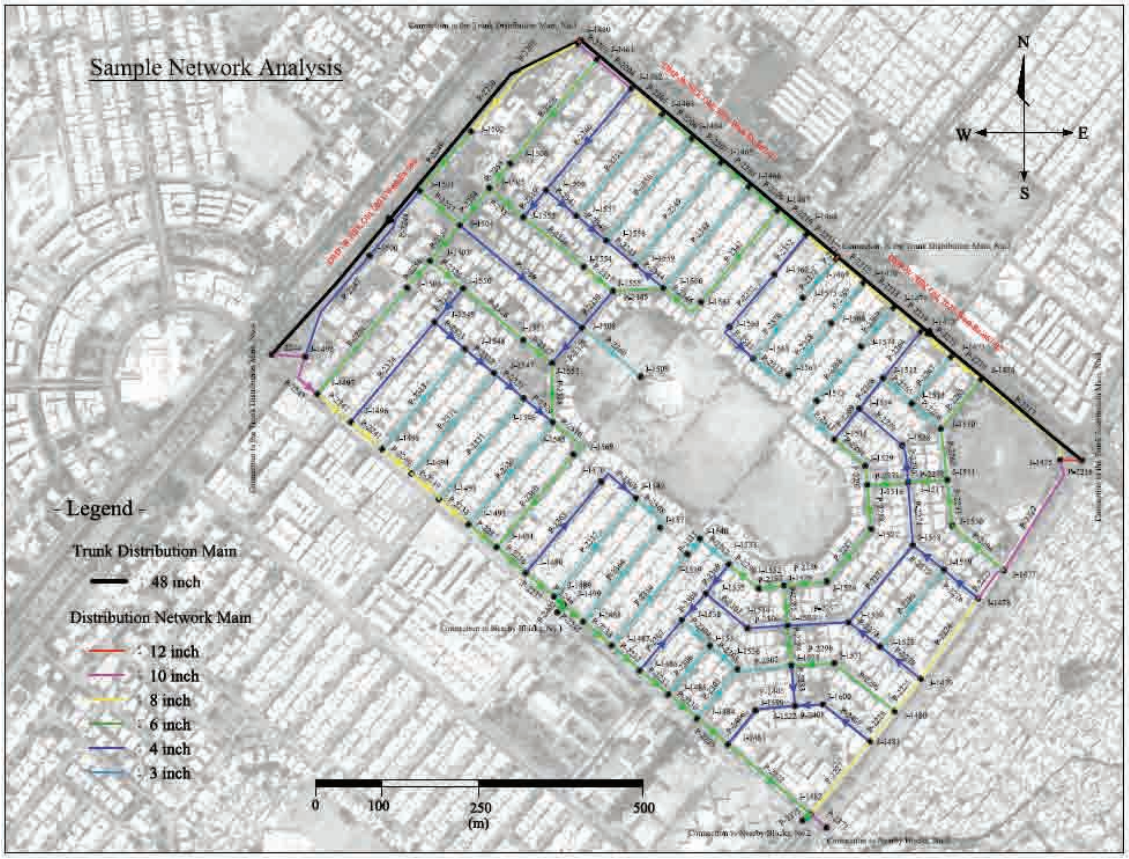


Figure 123.2.2 Distribution Network Mains to be renewed by DNI

(2) Improvement of Existing Distribution Network Mains

As already mentioned the existing distribution network mains should be replaced with new PE pipes of 12 inch or less in diameter by DNI. The total length of the proposed distribution network mains were estimated based on the hydraulic analysis of sample design areas set within the priority area as shown in **Figure 123.2.2**. The length of distribution network mains to be replaced in each town by DNI is summarised in **Table 123.2.1** and the length of replacement in each UC is detailed in **Appendix A123.2**. The total length of replacement in the three towns was estimated at 1,062 km. TKP projects have already replaced and installed new distribution network mains of PE pipes, 66 km in total, so that during the DNI of the priority project, the old distribution network mains of about 996 km will be needed to replace for the three towns of North Nazimabad, Gulberg and Liaquatabad.

Table 123.2.1 Length of Distribution Network Mains to be replaced by DNI

Name of Town	Population in 2016	Area (ha)	DNM Length (m)		
			Estimated	Installed by TKP*	Priority Projects
North Nazimabad	907,352	1,716	353,300	16,700	336,600
Gulberg	829,262	1,428	391,000	16,100	374,900
Liaquatabad	1,019,142	1,126	317,800	33,200	284,600
Total	2,755,756	4,270	1,062,100	66,000	996,100

(3) Improvement of Existing Service Connections

The existing service connections should be rehabilitated or replaced because thier conditions are deteriorated. Since the existing connections have no water meters, water maters should be newly installed to all the connections during DNI. The number of service connections to be rehabilitated or replaced by the DNI will be 228,300 in total for the three towns as shown in **Table 123.2.2**.

Table 123.2.2 Number of Service Connections to be rehabilitated by DNI

Name of Town	Existing Service Connection as of 2006			Expected Service Connection as of 2014		
	Domestic	Non-Dom.	Total	Domestic	Non-Dom.	Total
North Nazimabad	49,700	15,300	65,000	59,200	18,200	77,400
Gulberg	55,000	12,800	67,800	64,700	16,000	80,700
Liaquatabad	47,900	20,500	68,400	49,400	20,800	70,200
Total	152,600	48,600	201,200	173,300	55,000	228,300

12.3.3 Implementation Schedule

As engineering services, detail design works will begin in early 2012 followed by construction supervision which will be finalized in mid 2014. Construction works of reservoir, trunk distribution main, flow meters of trunk distribution main, distribution network main, and service connections will commence simultaneously in mid 2012 and will be finalized in mid 2014. **Figure 123.3.1** shows the implementation schedule of these construction works for water supply priority projects.

No.	Components	Unit	Quantity	Year				
				2012	2013	2014	2015	2016
1	**Engineering Service**							
	Reservoir	-	-					
	Trunk Distribution Main and Flow Meter	-	-					
	Distribution Network Main	-	-					
	House Connection	-	-					
2	**Reservoir**							
	Reservoir	mg	30					
3	**Trunk Disatribution Main**							
	3.1 New Installation							
	DN 100 inch	m	9,620					
	DN 88 inch	m	2,320					
	DN 72 inch	m	1,210					
	DN 64 inch	m	30					
	DN 56 inch	m	3,830					
	DN 48 inch	m	1,820					
	DN 36 inch	m	3,120					
	DN 32 inch	m	10					
	DN 28 inch	m	90					
	DN 24 inch	m	1,360					
	DN 18 inch	m	2,140					
	DN 16 inch	m	440					
	Total		25,990					
	3.2 Rehabilitation/Replacement							
	DN 64 inch	m	4,180					
	DN 56 inch	m	4,660					
	DN 48 inch	m	19,160					
	DN 32 inch	m	1,030					
	DN 24 inch	m	10,550					
	DN 18 inch	m	4,210					
	DN 16 inch	m	2,460					
	DN 14 inch	m	3,240					
	Total		49,490					
4	**Flow Meter**							
	DN 100 inch	nos.	3					
	DN 72 inch	nos.	2					
	DN 64 inch	nos.	1					
	DN 56 inch	nos.	1					
	DN 54 inch	nos.	2					
	DN 48 inch	nos.	4					
	DN 24 inch	nos.	2					
	DN 18 inch	nos.	2					
	Total		17					
5	**Distribution Network Main**							
	North Nazimabad Town	m	336,600					
	Gulberg Town	m	374,900					
	Liaquatabad Town	m	284,600					
	Total		996,100					
6	**House Connection**							
	6.1 Water Meter Only							
	North Nazimabad Town	nos.	8,800					
	Gulberg Town	nos.	9,200					
	Liaquatabad Town	nos.	2,100					
	Total		20,100					
	6.2 Water Meter and Service Pipe							
	North Nazimabad Town	nos.	68,600					
	Gulberg Town	nos.	71,500					
	Liaquatabad Town	nos.	68,100					
	Total		208,200					

Figure 123.3.1 Implementation Schedule of Water Supply System

12.3.4 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.

Reservoir

The reservoir to construct has the volume of 30 million gallons or about 136,000 m^3. The soil bearing capacity of its base has to be verified by plate bearing test. Since the reservoir functions to store potable water and no water leakage should occur, concrete quality will be controlled during its placement and curing avoiding any cracks.

Trunk distribution main

Trunk distribution main constructed as priority projects have diameters ranging between DN 14 inches and DN 100 inches with the total length of 75 kilometres. Pipe material is steel and the accuracy of joint welding is very important. Hence, the accuracy has to be checked by radiographic inspection or by ultrasonic inspection. The possibility of electric corrosion occurrence has to be checked where there are high voltage facilities near pipe installation site and anticorrosion measures need to be taken if necessary.

Distribution network main

Total length of distribution network main to replace is 999 km and there may be lots of construction sites in urbanized areas. Plans for construction need to be prepared taking traffic jams and water supply disruption in replacement of old pipes with new ones into account. Safety measures for pedestrians have to be taken to avoid any traffic accidents.

Many asbestos cement pipes are used for existing distribution network main. Asbestos dust can be carcinogenic and asbestos cement pipes should not be removed and be left as they are underground for safety reasons.

Service connection

The number of service connections will be 228,300, part of which will install service pipes and water meters. Water leakage will be larger if service pipes between divaricated service connections and water meters are constructed with less accuracy. It is important to employ the contractors with sufficient expertise in service connection works.

Water meters are installed in a private plot at the spot nearest to public and private boundary. The spot is selected taking into account easy meter reading, no sewage or storm water intrusion and less possibility of putting obstacles. Water meters have to be placed on the level and the arrow at their surface showing the flow direction has to be the same as the actual flow direction.

As-built drawings

As-built drawings are to be prepared for concrete structures and water supply 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 water supply facilities require various kinds of equipment and materials such as concrete, reinforcing steel bars, pipes, valves, flow meters and water meters. Concrete, reinforcing steel bars, pipes, and flow meters are locally procured and valves and water meters are imported.

Table 123.4.1 Procurement of Equipment and Material for Water Supply System

Item	Description	Procurement
Reservoir	Reinforced Concrete	Domestic
Trunk Distribution Main		
Pipe	Steel Pipe	Domestic
Valve	Sluice Valve and Butterfly Valve	Overseas
Flow Meter	Electromagnetic Type	Domestic
Distribution Network Main		
Pipe	Polyethylene Pipe	Domestic
Valve	Sluice Valve	Overseas
Service Pipe	Polyethylene Pipe	Domestic
Water meter	Rotary Vane Wheel Type	Overseas

12.3.5 Plans for Operation and Maintenance of Priority Projects

(1) Maintenance of Distribution Network

After completion of DNI, the distribution network will be maintained by leakage/NRW reduction survey teams. With the use of a portable flow meter, they will measure the minimum night flow (MNF) in small District Metering Areas (DMAs) with a view to reducing leakage assuming that MNF represents the magnitude of leakage occurring within the DMA.

Each survey team will consist of one engineer, one technical assistant and three workers, and will be equipped with one portable ultrasonic flow meter, one leak detector, two listening rods, one metal pipe locator, one metal detector, and three pressure recorders.

On average, one survey team would be able to cover about 8 km length of distribution mains per week or 32 km per month. It is estimated that after completion of DNI the total length of distribution network mains in one town will be approximately 370 km. Thus, if covered by two teams, it will take about six months (370 / 64 = 5.8) to complete the survey in one town. This will ensure that each and every distribution main in the town will be subject to the survey once in every six months, which is more or less in line with international practices. Ultimately, two survey teams will need to be established for each town or six teams for the three 'Priority Towns'. The number of survey teams can be increased gradually corresponding to the progress of DNI.

The network maintenance work will be conducted in collaboration with the repair/correction section of the operations department. Leaks and other anomalies such as illegal/unauthorized connections and meter tampering detected during the survey will be reported to the repair/correction section for immediate repair and correction.

In the past, leakage/NRW reduction surveys were not conducted by KW&SB. As such, extensive training will need to be provided to staff who take on leakage/NRW reduction surveys. They will require the training on how to isolate a DMA from the rest of the distribution network, how to measure the minimum night flow in the DMA, and how to use ultrasonic flow meters, leakage detectors, pressure recorders and other survey equipment. To this end, it is recommended that the retail entity should request the Japan International Cooperation Agency (JICA) for its technical assistance through implementing a 'Technical Cooperation Project (TCP)'. TCP would be able to offer a comprehensive package of technical assistance to

support the self-help efforts of the retail entity, which would include (a) the dispatch of leakage/NRW reduction experts from Japan to provide technical supports, (b) training of relevant local staff in Japan or in other countries, and (c) the supply of necessary equipment on a grant basis.

(2) Meter Reading/Billing

After implementation of DNI, the distribution network and customer base will be managed by the Zone West retail entity. It is predicted that the number of service connections in Zone West at the start of DNI (2011) will be approximately 600,000 and in the three 'Priority Towns' there will be approximately 217,000 connections.

DNI will be operated on the basis of 100% metering of bulk and retail customers and therefore will require the installation of revenue meters to every service connection. Due to the scale of meter installations required this will be implemented progressively throughout the three 'Priority Towns' on a priority basis in order to maximise revenues.

Efficient meter reading and billing activities will be crucial to the commercial success of the retail entity and as such they will need to invest in a Customer Information System (CIS). To ensure 100% billing, initially a complete customer survey will need to be conducted to ensure that all customers are registered on the CIS database and therefore are subject to regular billing. Regular customer surveys will also be required to eliminate illegal connections and to ensure that all new connection applications are installed and registered correctly on the database.

As household metering will be a new concept for Karachi (currently KW&SB do not meter households), extensive training will be provided to transferred staff from KW&SB to the retail entity, in the use of modern billing and meter reading techniques including the hardware, software and technologies employed. Meters will be read on a monthly basis to maximise revenues and cash flows.

Based on the number of service connections in the three 'Priority Towns', it is expected that approximately 100 qualified and trained meter readers will be required ultimately. This is based on the assumption that each meter reader will be capable of reading approximately 100 meters per day on each of the 22 working days per month which is line with international standards with use of modern meters and electronic 'hand held devices'. The number of meter readers can be increased gradually corresponding to the actual progress of DNI. The 'hand held device' will be linked locally at the town office for downloading meter reading routes to the device from the billing system and for uploading meter readings back to the billing system to update customer accounts. The hardware and software for modern hand held devices as well as proprietary billing/data management systems such as CIS are readily available on the market. Necessary training can be provided by the manufactures of these hardware and software and therefore it should be included as part of the procurement contract.

The hand held devices will deploy modern technology capable of 'local bill presentment' which means that the meter reader will be able to print the bill after reading the meter and present this to the customer at the time of reading. This will minimise the chance of frauds by meter readers and will also eliminate the need for centralised bill printing and bill delivery, thus reducing operating costs and the time for the customer to pay the bill. The use of modern technology such as this (instead of the traditional manual methods) will be prerequisite to processing as many as 10,000 (100 meter readers × 100 meters per meter reader per day) meter readings and consumer bills per day.

(3) Meter Repair/Testing

It is expected that good quality domestic meters will be purchased and installed that will comply with international standards to ensure a long service life. Meters will be the property of the retail entity who rent them out to customers. The retail entity will recover the cost of the meter through tariffs in the long run. The retail entity will therefore invest in good quality meters complying with ISO 4064-1:2005 standards. Whilst the unit price will be higher than cheaper meters available locally, good quality meters would be expected to last trouble-free between 5-10 years in service and therefore the overall life-cycle cost will be lower. Meters of this quality would be procured on the basis of being supplied and maintained by a certified manufacturer/supplier for the life of the meter (possibly with a minimum of 5-year warranty). Each meter would be calibrated, tested and sealed at the manufacturers and come complete with a test/calibration certificate. Meters would be intrinsically sealed and tamper proof to ensure longevity and will prevent illegal tampering by customers. Any tampering will be evident by broken seals etc. to be inspected on a monthly basis by the meter reader.

On this basis it is expected that household meters would be replaced periodically (every 5-10 years and will be determined by field experience over time) and as such it is envisaged that it will not be cost effective for the retail entity to operate a meter repair workshop. Instead, it is suggested that a service contract will be let to a specialist contractor certified by the meter manufacturer for repair of household meters.

The retail entity will invest in and deploy portable meter test equipment (that will be certified and regularly calibrated for accuracy) to test household meters (0.5 to 2 in) where customers complain of irregularities. The retail entity will also need to invest in a meter test bench to conduct the regular calibration of the test equipment. The test meter is taken to site and installed in series with the existing meter to test the revenue meter's recording accuracy. Meters will be replaced at the cost of the retail entity and bills adjusted in cases where meters are determined to be faulty. At the end of their useful life meters will be returned to the manufacturer/supplier for recycling (reuse of the meter housing). The value of returned meters will be taken into account when negotiating the new meter purchase price. It is estimated that approximately 200 sets of such portable meter test equipment (60 sets for 0.5 in, 50 sets for 0.75 in, 30 sets each for 1.0, 1.5 and 2.0 in) will be required for each town ultimately, but this number can be increased gradually corresponding to the actual progress of DNI.

Bulk meters (3 to 24 in) are limited in number at present, but are expected to increase substantially in future since they will be installed at all multi-storey condominiums and apartment buildings in the three 'Priority Towns' during the implementation of DNI. As such it is recommended that the retail entity will invest in bulk meter (3 to 24 in) calibration equipment and facilities (similar to that provided at COD filtration plant) in order to check and confirm bulk meter recording accuracy at the request of bulk customers. Bulk meters will also be the property of the retail entity who rent them out to customers. The retail entity will recover the cost of the bulk meters through tariffs in the long run. It is suggested that a service contract will be let for repair of malfunctioning bulk meters. This is a specialist job and therefore the service contract will be let to the meter manufacturer or a specialist contractor certified by the meter manufacturer. It is also suggested that the retail entity should maintain a stockpile of approximately 50 standby bulk meters which consist of 10 meters each for 3 and 4 in, 8 meters each for 6, 8 and 12 in, 4 meters for 15 in, and 2 meters for 24 in. These bulk meters will be used to replace customer meters while they are being calibrated or repaired.