Water and Sanitation Agency (WASA)
Lahore Development Authority, Lahore

THE PREPARATORY STUDY
ON
LAHORE WATER SUPPLY, SEWERAGE AND DRAINAGE IMPROVEMENT PROJECT
IN
ISLAMIC REPUBLIC OF PAKISTAN

FINAL REPORT
(VOLUME 2: APPENDICES)

JULY 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

NJS CONSULTANTS CO., LTD.
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APPENDIX

Chapter 3-related

Chapter 4-related

Chapter 5-related

Chapter 6-related

Chapter 13-related

Chapter 14-related

Chapter 15-related

Chapter 16-related

Appendix 3.1

National Environmental Quality Standards for Municipal and Liquid Industrial Effluents

S.No	Parameter	Existing Standards	Revised Standards		
			Into Inland Waters	Into Sewage Treatment	Into Sea
1.	Temperature or Temperature Increase *	40℃	≦3℃	≦3℃	≦3℃
2.	pH value (H^+)	6-10	6-9	6-9	6-9
3.	Biochemical Oxygen Demand $(BOD)_5$ at 20℃ (1)	80	80	250	80**
4.	Chemical Oxygen Demand (COD) (1)	150	150	400	400
5.	Total Suspended Solids (TSS)	150	200	400	200
6.	Total Dissolved Solids (TDS)	3,500	3,500	3,500	3,500
7.	Oil and Grease	10	10	10	10
8.	Phenolic compounds (as phenol)	0.1	0.1	0.3	0.3
9.	Chloride (as Cl^-)	1,000	1,000	1,000	SC***
10.	Fluoride (asF^-)	20	10	10	10
11.	Cyanide (as CN^-) total	2.0	1.0	1.0	1.0
12.	An-ionic detergents (as MBAS) (2)	20	20	20	20
13.	Sulphate (SO_4^{2-})	600	600	1,000	SC***
14.	Sulphide (S^{2-})	1.0	1.0	1.0	1.0
15.	Ammonia (NH_3)	40	40	40	40
16.	Pesticides (3)	0.15	0.15	0.15	0.15
17.	Cadmium (4)	0.1	0.1	0.1	0.1
18.	Chromium (trivalent and hexavalent) (4)	1.0	1.0	1.0	1.0
19.	Cooper (4)	1.0	1.0	1.0	1.0
20.	Lead (4)	0.5	0.5	0.5	0.5
21.	Mercury (4)	0.01	0.01	0.01	0.01
22.	Selenium (4)	0.5	0.5	0.5	0.5
23.	Nickel (4)	1.0	1.0	1.0	1.0
24.	Silver (4)	1.0	1.0	1.0	1.0
25.	Total toxic metals	2.0	2.0	2.0	2.0
26.	Zinc	5.0	5.0	5.0	5.0
27.	Arsenic (4)	1.0	1.0	1.0	1.0
28.	Barium (4)	1.5	1.5	1.5	1.5
29.	Iron	2.0	8.0	8.0	8.0
30.	Manganese	1.5	1.5	1.5	1.5
31.	Boron (4)	6.0	6.0	6.0	6.0
32.	Chlorine	1.0	1.0	1.0	1.0

Source: Statutory Notification (S.R.O), S.R.O 549 (I)/2000

Note:

1. Assuming minimum dilution 1:10 in discharge, lower ratio would attract progressively stringent standards to be determined by the Federal Environmental Protection Agency. By 1:10 dilution
2. Methylene Blue Active Substances; assuming surfactant as biodegradable
3. Pesticides include herbicides, fungicides and insecticides.
4. Subject to total toxic metals discharge should not exceed level given at S.No.25.
5. Applicable only when and where sewage treatment is operational and BOD_5=80mg/l is achieved by the sewage treatment system.
6. Provided discharge is not at shore and not within 10 miles of mangrove or other important estuaries.

* The effluent should not result in temperature increase of more than 3 ^{0}C at the edge of the zone where initial mixing and dilution take place in the receiving body. In case zone is not defined, use 100 meters from the discharge.

** The value for industry is 200 mg/l

*** Discharge concentration at or below sea concentration (SC).

Appendix 3.2 Irrigation Water Quality Guidelines for Pakistan (Proposed by WWF)

Parameter	Unit	Proposed Value				
		Class AA	Class A	Class B	Class C	Class D
Physical parameters						
Total Dissolved Solids (TDS)	mg/l	800	800	1,000	1,000	1,000
Electrical Conductivity at 25 0C	dS/m	1.25	1.25	1.50	1.50	1.5
SAR (Sodium absorption ratio)		-	-	-	-	5
RSC (Residual sodium carbonate)		-	-	-	-	1.25
Taste		Unobjectionable		-	-	-
Odor		Unobjectionable		-	-	-
Color (True)	Hazen Units	20	20	-	-	-
Turbidity	NTU	5	-	-	-	-
Temperature		The maximum water temperature change shall not exceed 3^{o}C relative to an upstream control point				-
Chemical parameters						
pH	Units	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.4
BOD	mg/l	2	3	8	8	8
Dissolved Oxygen (DO)	mg/l	>6	>4	4	>5	>4
Chloride	mg/l	250	250	-	-	100
Ammonia	mg/l	-	-	1.0	1.0	-
Nitrates	mg/l	10	10	-	-	-
Nitrite	mg/l	1.0	1.0	-	-	-
Anionic Detergents as MBAS	mg/l	0.2	1.0	0.5	0.5	-
Phenolic Compounds as Phenol	mg/l	0.001	0.002	0.01	0.01	-
Oil and Grease	mg/l	0.01	0.1	2.0	2.0	-
Sulphates	mg/l	400	400	400	-	-
Chromium	mg/l	0.05	0.05	0.05	0.05	0.01
Aluminum		-	-	-	-	5.0
Arsenic	mg/l	0.05	0.05	0.05	0.05	0.1
Boron	mg/l	1.0	0.5	1.0	1.0	-
Barium	mg/l	1.0	1.0	1.0	-	-
Beryllium	mg/l	-	-	-	-	0.1
Cadmium	mg/l	0.005	0.005	0.01	0.002	0.01
Cobalt	mg/l	-	-	-	-	0.05
Copper	mg/l	1.5	1.5	1.5	0.007	0.2
Cyanide	mg/l	0.05	0.05	0.05	0.005	1.0
Fluoride	mg/l	1.5	1.5	1.5	1.5	1.0
Iron	mg/l	0.3	-	-	0.3	5.0
Lead	mg/l	0.05	0.05	0.01	0.01	0.1
Lithium	mg/l	-	-	-	-	2.5
Manganese	mg/l	0.1	-	-	0.1	0.2
Mercury	mg/l	0.001	0.001	0.001	0.000012	0.01
Molybdenum	mg/l	-	-	-	-	0.01
Nickel	mg/l	0.1	0.1	-	0.05	0.2
Selenium	mg/l	0.01	0.01	0.05	0.005	0.02
Vanadium	mg/l	-	-	-	-	0.1
Zinc	mg/l	5	5	15	0.086	2
Total Hardness	mg/l as $CaCo_3$	300	300	-	-	-
Toxic substances and organic pollutants	mg/l	(1)	(1)	(2)	(3)	(4)
Biological parameters						
Coliform bacteria (fecal)	No./100 ml	20	1,000	200	1,000	1,000
Coliform bacteria (total)	No./100 ml	50	5,000	1,000	5,000	-

Note 1: Classification

Class AA: Criteria for Public Water Supply I which requires only approved disinfection to be suitable for drinking water supplies.
Class A: Criteria for Public Water Supply II which requires complete treatment (coagulation, sedimentation filtration and disinfection etc.)
Class B: Criteria for Recreational Water which is used for primary contact recreation such as bathing, swimming, skin diving etc.
Class C: Criteria for Propagation of Fish and Aquatic Life (for propagation of balance growth of fish and other aquatic resources, as well as industrial process water use after treatment and non-contact recreation such as boating etc.)
Class D: Criteria for Irrigation Water which is used for agricultural irrigation and livestock watering, and industrial cooling waters.

Note 2:
(1) The waters shall not contain other toxic substances and organic pollutants in quantities that may be detrimental to public health or impair the usefulness of the water as a source of domestic water supply.
(2) The waters shall not contain other toxic substances and organic pollutants in quantities that may be detrimental to public health or impair the usefulness of the recreational water.
(3) The waters shall not contain toxic substances and organic pollutants in quantities that may be detrimental to fisheries and other aquatic life or to public health or impair the usefulness of the water the intended purpose.
(4) The waters shall not contain toxic substances and organic compounds in quantities that can accumulate in the soils to such a level as to result is the uptake by the crop and thus may be detrimental to public health or impair the quality of water for use in agriculture and livestock watering.

Appendix 3.3 National Standards for Drinking Water Quality (Proposed)

Properties/Parameter	Standard Values for Pakistan	WHO Standards	Remarks
Bacterial			
All water intended for drinking (E.Coli or Thermotolerant coliform bacteria)	Must not be detectable in any 100 ml sample	Must not be detectable in any 100 ml sample	(1)
Treated water entering the distribution system (E.Coli or Thermotolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml sample	Must not be detectable in any 100 ml sample	(1)
Treated water in the distribution system (E.Coli or Thermotolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml sample (a)	(a)	(1)
Physical			
Colour	≦15 TCU	≦15 TCU	
Taste	Non objectionable/Acceptable	Non objectionable/Acceptable	
Odour	Non objectionable/Acceptable	Non objectionable/Acceptable	
Turbidity	<5 NTU	<5 NTU	
Total hardness as CaCO3	<500 mg/l	-	
TDS	<1000	<1000	
pH	6.5-8.5	6.5-8.5	
Chemical			
Essential Inorganic	**mg/liter**	**mg/liter**	
Aluminum (Al)	≦0.2	0.2	
Antimony (Sb)	≦0.005	0.02	
Arsenic (As)	≦0.05	0.01	(2)
Barium (Ba)	0.7	0.7	
Boron (B)	0.3	0.3	
Cadmium (Cd)	0.01	0.003	(2)
Chloride (Cl)	≦250	250	
Chromium (Cr)	≦0.05	0.05	
Copper (Cu)	2	2	
Toxic Inorganic	**mg/liter**	**mg/liter**	
Cyanide (CN)	≦0.05	0.07	(2)
Fluoride (F)*	≦1.5	1.5	
Lead (Pb)	≦0.05	0.01	(2)
Manganese (Mn)	≦0.5	0.5	
Mercury (Hg)	≦0.001	0.001	
Nickel (Ni)	≦0.02	0.02	
Nitrate (NO3)*	≦50	50	
Nitrite (NO2)*	≦3	3	
Selenium (Se)	0.01	0.01	
Residual chloride	0.2-0.5 at consumer end 0.5-1.5 at source	-	
Zinc (Zn)	5	3	(2)
* indicates priority health related inorganic constraints which need regular monitoring			
Organic			
Pesticides, mg/l	(3)		
Phenolic compounds (as phenols), mg/l	≦0.002		
Polynuclear aromatic hydrocarbons (as PAH) g/l	0.01 (By GC/MS method)		
Radioactive			
Alpha Emitters bq/l or pCi	0.1	0.1	
Beta emitters	1	1	

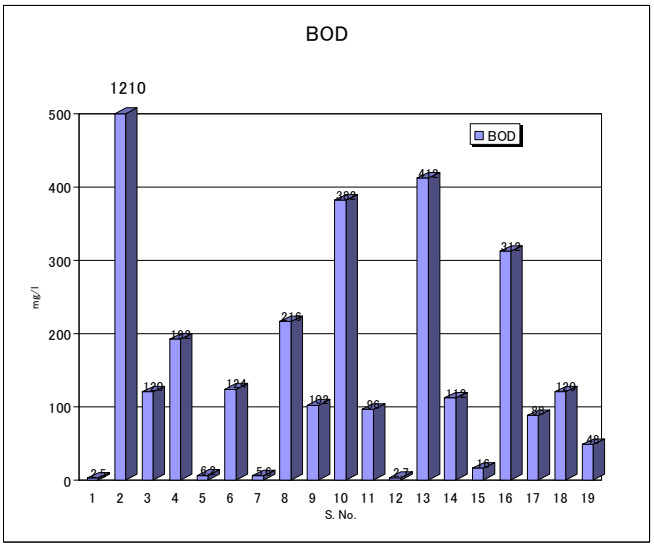
(1) Most Asian countries also follow WHO Standards
(2) Standard for Pakistan similar to most Asian developing countries
(3) PSQCA No. 4639-2004, Page No. 4 Table No.3 Serial No. 20-58 may be consulted.
(a) In case of large supplies, where sufficient samples are examined, must not be present in 95 % of the samples taken throughout any 12-month period.

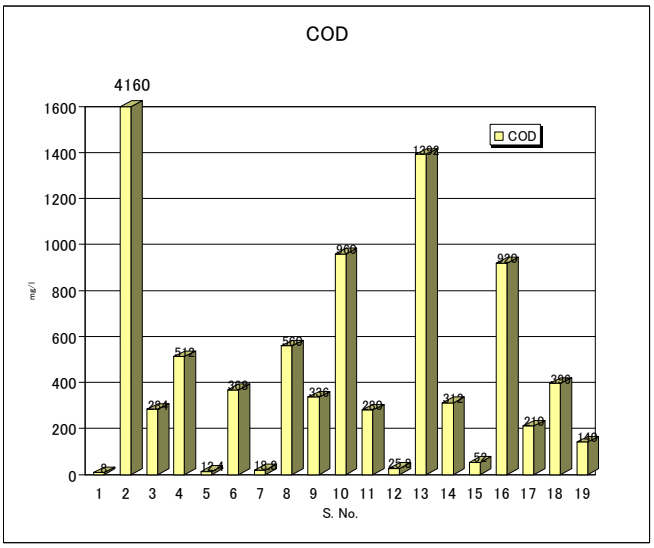
Appendix 3.4 Monitoring Results of River and Drains (EPA)

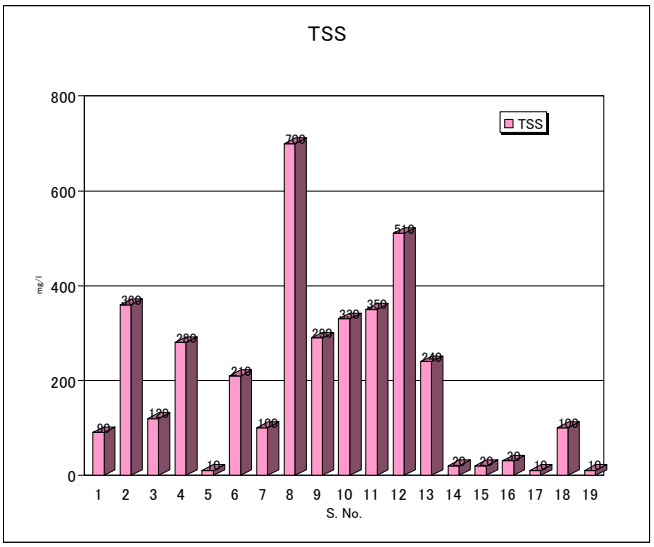
S. No.	Description	Date of collection	Temp.	DO	pH	Discharge	BOD	COD	TDS	TSS	Cl	Sulfate	Sulfide	F	CN	Mn	Cu	Cd	Cr	Zn	Fe	Ni	BOD Load	CN	Mn	Fe
				mg/l		cusec	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	t/day	mg/l	mg/l	mg/l
1	Ravi Syphon Before Mixing with Mehmood Buti, Sukh Naher,Shadbagh Drains Lahore.	04/11/08	22.6	6.3	8.5	-	2.5	8	160	90	5	41	0	0.588	0	0.071	0.057	0.008	0.33	0.047	0.938	0.207				
2	Mehmood Buti Drain Before Mixing With River Ravi.Near Over Head Bridge Ring Road Mehmood Buti Lahore	06/01/09	26.6	0.81	7.65	20.87	1210	4160	760	360	100	158	8	0.569		0.101	0.06	0.031	0.01	0.047	1.35	0.012				
3	Sukh Naher Drain Before Mixing Into River Ravi, Bund Road Lahore.	12/11/08	25.4	0.43	7.3	313.6	120	284	620	120	35	127	8	0.466	50	1.573	0.085	0.006	0.073	0.05	1.727	0.226	23.5	9.7	0.31	
4	Shad Bagh Drain Before Mixing Into River Ravi.	04/11/08	23.4	0.79	7.2	139	192	512	520	280	85	91	12	0.65	0.819	0.261	0.253	0.012	0	1.077	9.387	0.051	93.9			4.5
5	River Ravi, Before Mixing With Shahdara Town Pumping Station.And After Mixing With Mehmood Buti, Sukh Naher,Shadbagh Drains Near Shahdara Town Lahore.	06/01/09	17.3	10.33	7.75	-	6.2	12.4	200	10	25	38	0	0.664		0.198	0.046	0.021	0.066	0.07	0.681	0				
6	Shahdara Town Pumping Station Before Mixing Into River Ravi,NearBund Road ShahdaraTown Lahore.	06/01/09	22.1	1.6	7.53	21.27	124	368	540	210	40	78	8	0.633		0.101	0.05	0.023	0.008	0.053	2.39	0				
7	River Ravi After Mixing With Shahdara Town Pumping Station, And U/S Of Forest Colony Pumping Station, Near Railway Bridge Shahdara Lahore.	06/01/09	17.4	9.4	8.04	-	5.6	18.8	200	100	30	28	4	0.532		0.08	0.052	0.021	0	0.051	1.7	0.02				
8	Forest Colony Pumping Station,Ravi Road Before Mixing Into River Ravi,Near Old Bridge Bund road Lahore.	06/01/09	24.8	1.23	7.34	15.37	216	560	420	700	75	94	16	0.811		0.106	0.04	0.037	0.015	0.085	2.12	0.058				
9	River Ravi New Bridge Lahore D/S Of Forest Colony Pumping Station & U/S Of Furakhabad Drain, & Budha Ravi Drain, Lahore.	04/11/08	23.7	0.71	7.3	-	102	336	400	290	55	115	0	0.61	0.274	0.232	0.092	0.009	0	0.291	5.509	0				
10	Furakhabad Drain Before Mixing In To River Ravi.	04/11/08	22.9	0.5	7.3	219	382	960	1000	330	225	164	0	0.424	2.8	0.421	0.189	0.009	0.176	1.809	7.721	0.275	37.4	0.27		
11	Budha Ravi Drain, Before Mixing Into River Ravi,Near Munshi Hospital Bund Road Lahore.	04/11/08	23.1	0.91	7.62	41.9	96	280	690	350	125	112	16	0.895		0.086	0.035	0.036	0	0.21	1.247	0.02				
12	River Ravi Suggyan Bridge Lahore Afterv Mixing with Furkhabad, & Budha Ravi Drains.& Before Mixing With Main Out fall Drain.	04/11/08	22.2	4.5	8.1	-	2.7	25.8	180	510	10	57	0	0.461	0	0.074	0.053	0.005	0	0.044	0.943	0.012				
13	Main Out Fall Drain Before Mixing Into River Ravi. Near Suggyan Bridge Lahore	04/11/08	23.2	1.01	7.2	193	412	1392	560	240	80	115	20	0.578	0.842	0.163	0.223	0.006	0.058	0.286	1.794	0.128	102.8			
14	Gulshan-E-Ravi Drain Before Mixing Into River Ravi Near Fazal Colony Bund Road Lahore.	06/01/09	22.5	0.83	7.58	246.47	112	312	660	20	50	84	4	1.06		0.215	0.049	0.003	0.032	0.94	1.39	0.029				
15	River Ravi After Mixing With Main Out Fall & Gulshan-E-Ravi Drains,& Before Mixing With Babu Sabu Drain	18/12/08	16.1	1.17	7.8	-	16	52	330	20	45	54	0	0	0	0.062	0.049	0.001	0.024	0.039	0.846	0.018				
16	Babu Sabu Drain Before Mixing With River, Ravi Babu Sabu Lahore	18/12/08	17.6	0.86	7.5	270.7	312	920	660	30	90	140	0	0.005	0	0.416	0.263	0	0.015	1.31	6.23	0.021	54.9			
17	River Ravi After Mixing With Babu Sabu Drain and Before Mixing With Hudiara drain, Chung Lahore	18/12/08	18.0	7.5	8.77	-	88	210	470	10	90	110	0	0.01	0	0.322	0.19	0	0.002	0.082	1.672	0.028				
18	Hudiara Drain Before Mixing With River Ravi Mohlan Wal Lahore	18/12/08	17.8	0.91	7.9	535.7	120	396	1020	100	200	260	8	0.162	11.6	0.516	0.32	0.016	0.058	0.14	0.089	0.163	150.3	14.5		
19	River Ravi After Mixing With Hudiara Drain, Maraka Lahore	18/12/08	17.8	1.16	8.12	-	48	140	500	10	95	78	0	0.18	0	0.239	0.21	0.004	0.003	0.091	1.435	0.031				

Note: Monitoring points of S No. 1, 5, 7, 9, 12, 15 17 and 19 are located in the main stream of Ravi River and the remaings are in drainage channels

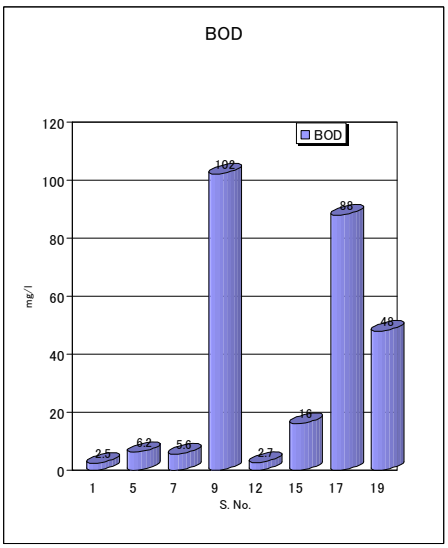
Ravi River & Drainage Cannels

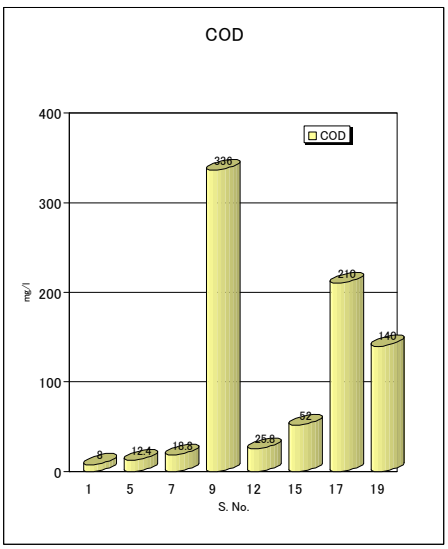






Longitudinal Variation of Ravi River





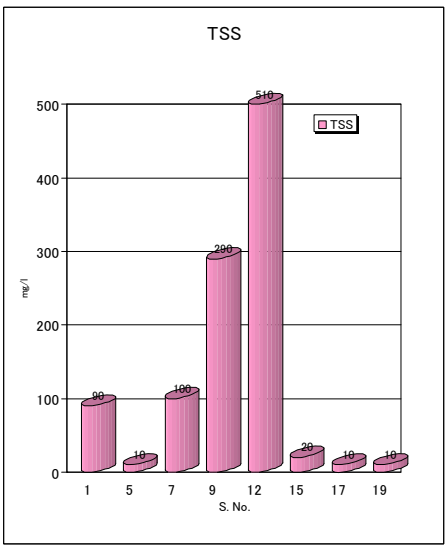


Figure Monitoring Results of River and Drains (EPA)

Appendix 3.5 Monitoring Results of Canal (EPA)

No	Location	pH	BOD_5	COD	TDS	TSS	Cl^-	$SO4^{2-}$	Sampling Date
	N.E.Q.S	6-9	80	150	3,500	200	1,000	600	
A	Near Shalimar P/S BRB canal RD-231	7.4	9	25.5	120	40	30	16.4	28/11/08
B	Near Lahore Medical & Dental College- 239	7.5	7.8	25.2	140	20	25	20	28/11/08
C	Harbans Pura Bridge	7.8	4.2	14.4	160	40	20	24	28/11/08
D	Lal Pull Munghal Pure RD-254	7.8	10.2	29	180	40	20	24	28/11/08
E	Near Main Exist Gate of Metro Cash & Carry, Thoker Niaz Baig Lahore	7.6	12	41.2	120	40	20	16.4	29/11/08
F	Near EME, Housing Society Bridge, 18 km Multan Road Lahore	7.2	12.8	42	160	20	25	20	29/11/08
G	Near Dynamic Sports and Wer Bridge, Chung, 20 km Multan Road Lahore	7.4	13	43.2	140	20	20	20	29/11/08
H	Near Bahria Town Bridge, defence Road Mohlan Wall, 24 km Multan Road Lahore	7.4	8.4	36	160	20	35	24	29/11/08

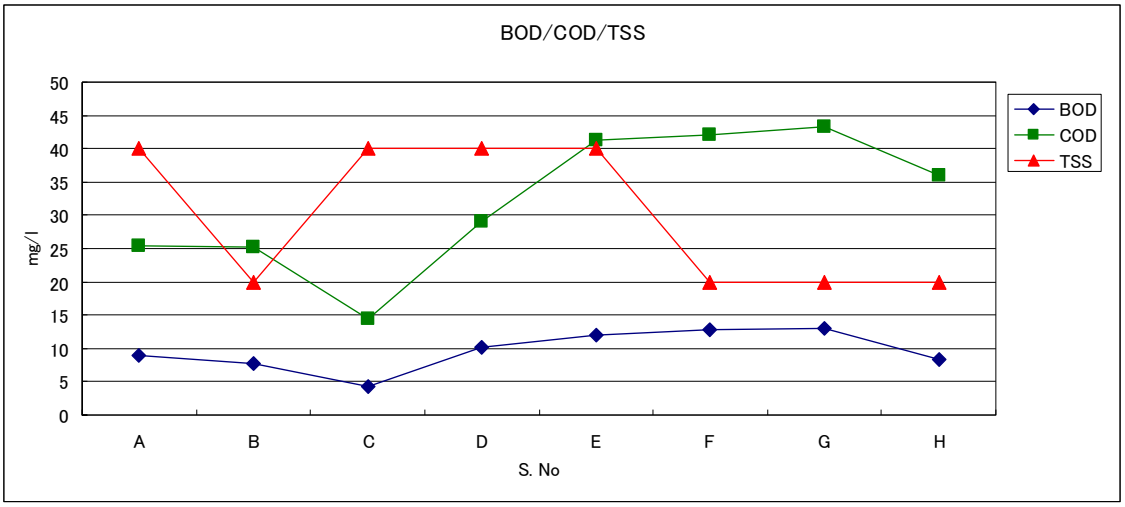


Figure Monitoring Results of Canal (EPA)

Appendix 3.6 Monitoring of Tube-wells and Tap Water by WASA

(1) Number of Tube-well and Tap Water Monitored (WASA)

Year	Month	Total number (1)	Of which T/W	Number of unfit (2)	Percentage of unfit (2)/(1)*100
2008	Jan	231	(32)	44	19
	Feb	325	(51)	53	16
	Mar	285	(35)	57	20
	Apr	409	(37)	86	21
	May	1,091	(116)	50	5
	Jun	1,091	(72)	70	6
	Jul	926	(37)	63	7
	Aug	549	(21)	73	13
	Sep	236	(10)	46	19
	Oct	333	(11)	47	14
	Nov	399	(62)	49	12
	Dec	131	(11)	27	21
Sub Total		6,006	(495)	665	11
2009	Jan	211	(12)	67	32
	Feb	294	(35)	90	31
	Mar	324	(42)	97	30
Sub Total		829	(89)	254	31
Total		6,835	(584)	919	13

(2) Monitoring Parameters for Tube-well and Tap Water (WASA)

No.	Parameters	Tube Well	Tap water	No.	Parameters	Tube Well	Tap water
1	Temperature	X	-	11	Ca	X	-
2	pH	X	X	12	Mg	X	-
3	Odor	X	X	13	Alkalinity	X	-
4	Color	X	X	14	Chlorides	X	-
5	Taste	X	-	15	Nitrites	X	X
6	Turbidity	X	X	16	Nitrates	X	-
7	Clay/Sand/Rust	X	-	17	Ammonia Nitrogen	X	-
8	Conductivity	X	X	18	Fluoride	X	-
9	TDS	X	x	19	E. Coli (Fecal Coliform)	X	X
10	Total Hardness	X	-				

(3) List of Unfit Tube-wells (WASA)

Sym-bol	Name of Tube-well	Reason of Unfit	TW No. of WASA
A	T/Well UVAS.	Bacteria	-
B	T/W Bagh Wale Masjid, Moche Gate	Nitrites	-
C	T/W Akbari Mandi	Nitrites	36
D	T/W Shah Mohammad Ghose, Delhi Gate	Nitrites	301
E	T/W Muhammad Nagar	Bacteria	187
F	T/W Ghari Shahu	Bacteria	190
G	T/W Larex Colony	Bacteria	191
H	T/Well Mozang Adda Main Bazar	Bacteria	297
I	T/W near Govt Boys School, Governor House	Turbidity	-
J	T/W Old Sahuwari	Sus. Matter	112
K	T/W Gulshan Park	Sus. Matter	115
L	T/W Mughal Pura	Sus. Matter	113
M	T/W Fayaz Park	Sus. Matter	117
N	T/W R-Block, Liqata-abad	Bacteria	220
O	T/W Children Park	Bacteria	189

Appendix 3.7 Monitoring Results of Tube Well (PCRWR) (1/2)

[2002]

S. No	S. Code		E.C	As ppb	TDS mg/l	Coliform MPN	E.Coli MPN	WASA TW No.
1	LAH-01	Goharabad T/W Shalimar Town (New bore)	500	10	350	0	0	144
2	LAH-02	Sultanpura T/W Near Chah Meeran Shah	592	10	414	0	0	86
3	LAH-03	Ali Park T/W-1 Fort Road (New bore)	320	20	198	0	0	-
4	LAH-04	Old Shahdara town Centre T/W	338	0	210	0	0	15
5	LAH-05	Goal Bagh T/W Wahdat Colony	694	30	486	0	0	243
6	LAH-06	Guromanget T/W Gulberg-III	904	10	633	0	0	167
7	LAH-07	T/W Cantonment Boad Asghari Flats	827	0	579	0	0	-
8	LAH-08	T/W Tufail Road Saddar Bazar	737	0	516	0	0	-
9	LAH-09	TW-12, Ravi Block, Allama Iqbal Town	623	0	436	0	0	235
10	LAH-10	T/W Federal Lodge, Chamba House (New bore)	520	0	364	0	0	370
11	LAH-11	PCSIR Housing Society, Canal Bank Rd	633	20	443	0	3	-
12	LAH-12	LDA Flats Opp. Faisal Town, Ghosia Masjid	571	20	400	0	0	203
13	LAH-13	T/W Riwaz Garden	1,074	10	698	0	0	341
14	LAH-14	Farooq Colony, Walton Road, Police Line	1,028	0	720	0	0	90
15	LAH-15	Punjab Govt. Co. Opetative Housing Society	797	25	558	0	0	-
16	LAH-16	Govt. Housing Scheme Township A-1	973	10	681	11	11	416

[2003]

S. No	S. Code		E.C	As ppb	TDS mg/l	Coliform MPN	E.Coli MPN	WASA TW No.
1	LAH-01	Goharabad T/W Shalimar Town (New bore)	500	21.16	392	2	0	144
2	LAH-02	Sultanpura T/W Near Chah Meeran Shah	599	28.00	419	0	0	86
3	LAH-03	Ali Park T/W-1 Fort Road (New bore)	345	51.00	214	2	0	-
4	LAH-04	Old Shahdara town Centre T/W	387	16.53	237	0	0	15
5	LAH-05	Goal Bagh T/W Wahdat Colony	715	34.53	501	2	0	243
6	LAH-06	Guromanget T/W Gulberg-III	960	18.00	672	0	0	167
7	LAH-07	T/W Cantonment Boad Asghari Flats	873	19.60	611	0	0	-
8	LAH-08	T/W Tufail Road Saddar Bazar	788	28.86	552	0	0	-
9	LAH-09	TW-12, Ravi Block, Allama Iqbal Town	625	26.96	438	0	0	235
10	LAH-10	T/W Federal Lodge, Chamba House (New bore)	760	24.00	532	0	0	370
11	LAH-11	PCSIR Housing Society, Canal Bank Rd	686	28.80	480	16	0	-
12	LAH-12	LDA Flats Opp. Faisal Town, Ghosia Masjid	641	23.08	449	2	0	203
13	LAH-13	T/W Riwaz Garden	1,061	26.31	743	0	0	341
14	LAH-14	Farooq Colony, Walton Road, Police Line	1,115	19.79	781	0	0	90
15	LAH-15	Punjab Govt. Co. Opetative Housing Society	835	29.25	586	0	0	-
16	LAH-16	Govt. Housing Scheme Township A-1	1,095	31.56	767	16	0	416

[2004]

S. No	S. Code		E.C	As ppb	TDS mg/l	Coliform MPN	E.Coli MPN	WASA TW No.
1	LAH-01	Goharabad T/W Shalimar Town (New bore)	630	37	441	2	0	144
2	LAH-02	Sultanpura T/W Near Chah Meeran Shah	620	31	434	0	0	86
3	LAH-03	Ali Park T/W-1 Fort Road (New bore)	376	55	226	2	0	-
4	LAH-04	Old Shahdara town Centre T/W	380	52	228	0	0	15
5	LAH-05	Goal Bagh T/W Wahdat Colony	760	43	532	2	0	243
6	LAH-06	Guromanget T/W Gulberg-III	988	28	692	0	0	167
7	LAH-07	T/W Cantonment Boad Asghari Flats	900	29	630	0	0	-
8	LAH-08	T/W Tufail Road Saddar Bazar	910	31	637	0	0	-
9	LAH-09	TW-12, Ravi Block, Allama Iqbal Town	630	36	441	0	0	235
10	LAH-10	T/W Federal Lodge, Chamba House (New bore)	790	29	553	0	0	370
11	LAH-11	PCSIR Housing Society, Canal Bank Rd	700	34	490	16	0	-
12	LAH-12	LDA Flats Opp. Faisal Town, Ghosia Masjid	694	30	486	2	0	203
13	LAH-13	T/W Riwaz Garden	1,050	32	735	0	0	341
14	LAH-14	Farooq Colony, Walton Road, Police Line	1,090	31	763	0	0	90
15	LAH-15	Punjab Govt. Co. Opetative Housing Society	890	30	623	0	0	-
16	LAH-16	Govt. Housing Scheme Township A-1	1,020	29	714	16	0	416

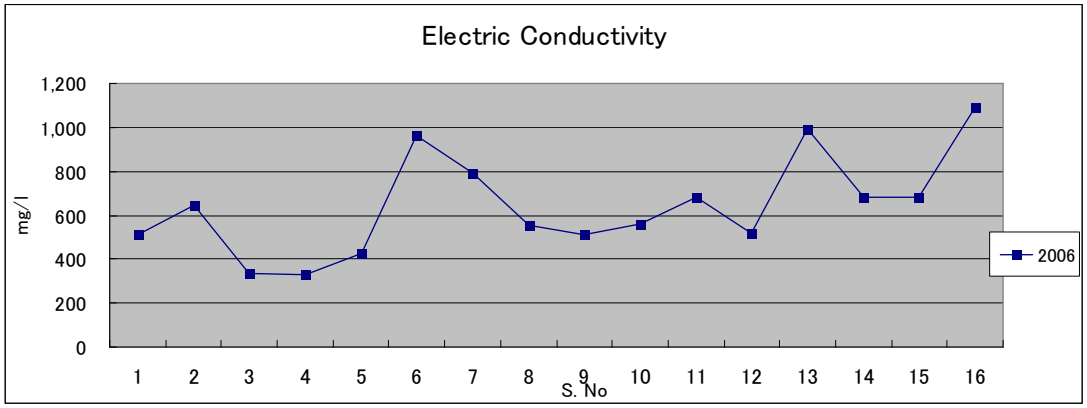
Appendix 3.7 Monitoring Results of Tube Well (PCRWR) (2/2)

[2005]

S. No	S. Code		E.C	As ppb	TDS mg/l	Coliform MPN	E.Coli MPN	WASA TW No.
1	LAH-01	Goharabad T/W Shalimar Town (New bore)	518	31.69	362	38	2.2	144
2	LAH-02	Sultanpura T/W Near Chah Meeran Shah	667	49.52	474	8.8	8.8	86
3	LAH-03	Ali Park T/W-1 Fort Road (New bore)	362	21.75	217	0	0	-
4	LAH-04	Old Shahdara town Centre T/W	314	23.90	188	0	0	15
5	LAH-05	Goal Bagh T/W Wahdat Colony	732	26.92	512	8.8	0	243
6	LAH-06	Guromanget T/W Gulberg-III	930	20.07	651	0	0	167
7	LAH-07	T/W Cantonment Boad Asghari Flats	829	22.03	580	0	0	-
8	LAH-08	T/W Tufail Road Saddar Bazar	520	30.56	364	240	240	-
9	LAH-09	TW-12, Ravi Block, Allama Iqbal Town	543	35.78	380	4.4	0	235
10	LAH-10	T/W Federal Lodge, Chamba House (New bore)	509	23.36	356	8.8	5	370
11	LAH-11	PCSIR Housing Society, Canal Bank Rd	680	28.86	476	>240	2.2	-
12	LAH-12	LDA Flats Opp. Faisal Town, Ghosia Masjid	532	23.57	372	8.8	7.6	203
13	LAH-13	T/W Riwaz Garden	1,064	24.23	745	0	0	341
14	LAH-14	Farooq Colony, Walton Road, Police Line	642	21.75	449	0	0	90
15	LAH-15	Punjab Govt. Co. Opetative Housing Society	900	26.05	630	>240	240	-
16	LAH-16	Govt. Housing Scheme Township A-1	1,067	24.68	747	8.8	5	416

[2006]

S. No	S. Code		E.C	As ppb	TDS mg/l	Coliform MPN	E.Coli MPN	WASA TW No.
1	LAH-01	Goharabad T/W Shalimar Town (New bore)	510	45.20	351	0	0	144
2	LAH-02	Sultanpura T/W Near Chah Meeran Shah	645	33.30	445	15	0	86
3	LAH-03	Ali Park T/W-1 Fort Road (New bore)	335	71.60	214	0	0	-
4	LAH-04	Old Shahdara town Centre T/W	329	24.60	198	0	0	15
5	LAH-05	Goal Bagh T/W Wahdat Colony	429	28.00	296	0	0	243
6	LAH-06	Guromanget T/W Gulberg-III	965	26.40	675	0	0	167
7	LAH-07	T/W Cantonment Boad Asghari Flats	792	29.80	540	240	240	-
8	LAH-08	T/W Tufail Road Saddar Bazar	552	35.80	381	0	0	-
9	LAH-09	TW-12, Ravi Block, Allama Iqbal Town	510	39.00	352	0	0	235
10	LAH-10	T/W Federal Lodge, Chamba House (New bore)	563	29.60	388	240	38	370
11	LAH-11	PCSIR Housing Society, Canal Bank Rd	685	44.80	479	38	38	-
12	LAH-12	LDA Flats Opp. Faisal Town, Ghosia Masjid	519	31.40	358	38	38	203
13	LAH-13	T/W Riwaz Garden	990	40.40	692	0	0	341
14	LAH-14	Farooq Colony, Walton Road, Police Line	680	32.60	470	7.6	5	90
15	LAH-15	Punjab Govt. Co. Opetative Housing Society	683	30.60	478	>15	8.8	-
16	LAH-16	Govt. Housing Scheme Township A-1	1,090	32.90	762	240	240	416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mg/l
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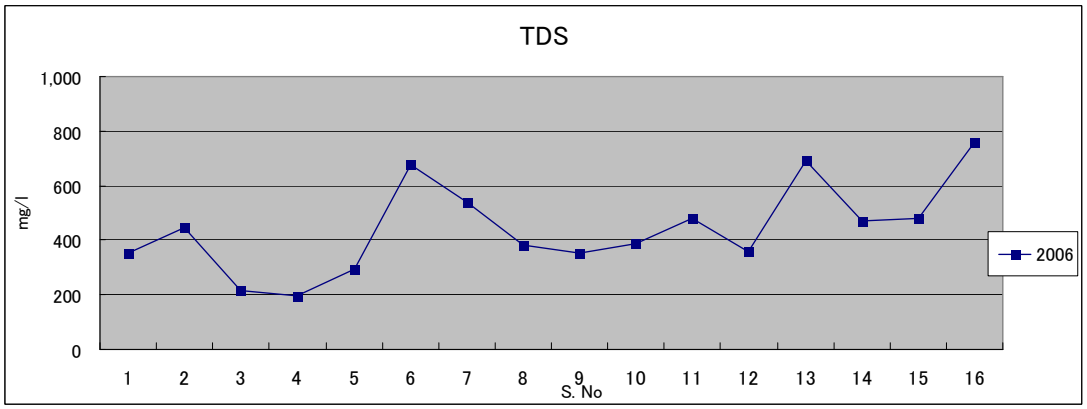
2006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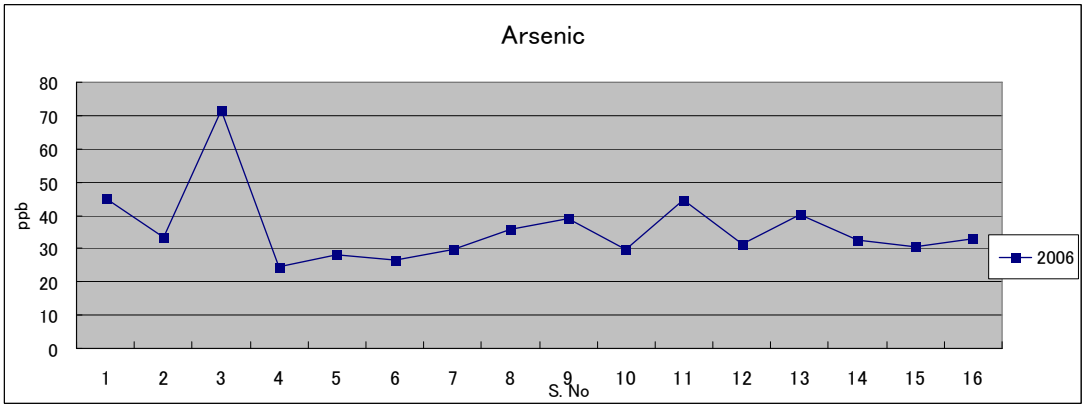
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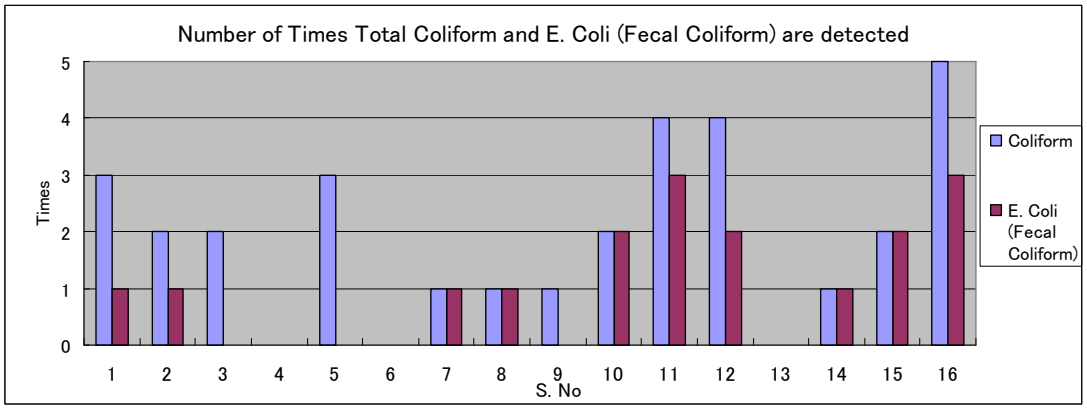
2006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4
3
2
1
0
Times
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S. No
Coliform
E. Coli (Fecal Coliform)

Appendix 3.8 Monitoring Results of Tap Water (EPA)

Sr. No	Name of Town	Samples Monitored	Number of Samples (Fit/Unfit)		Unfit
			Fit	Unfit	%
1	Gulberg	43	18	25	58
2	Shalimar	14	5	9	64
3	Ravi	46	19	27	59
4	Samanabad	41	22	19	46
5	Allama Iqbal	57	22	35	61
6	Data Gunj Bukhsh	86	35	51	59
7	Nishtar	28	13	15	54
8	Wahga	10	0	10	100
9	Aziz Bhatti	20	7	13	65
	Total	345	141	204	59

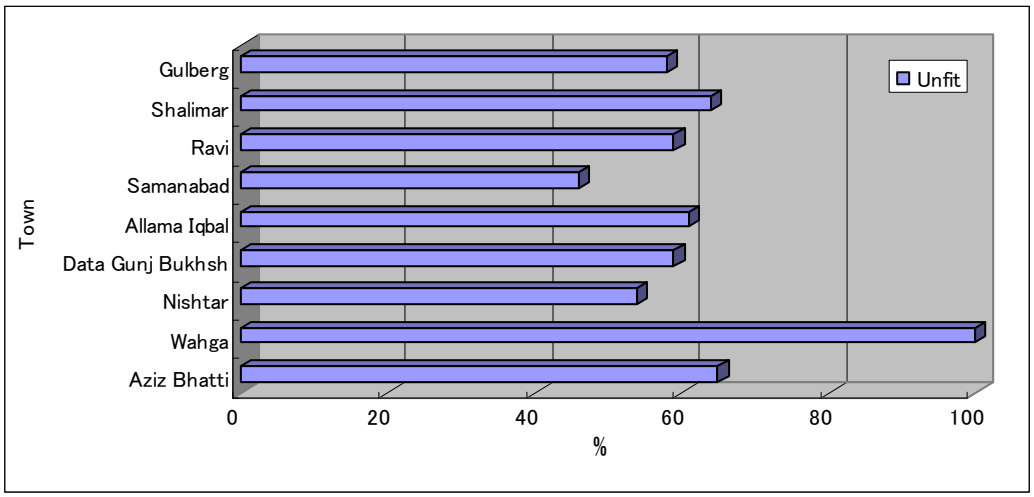


Figure Percentage of Unfit Tap Water Monitored by EPA

Appendix 3.9 List of Factories Monitored by EPA (2008)

Sr. #	Name/addresses of industry
FURNACES/STEEL MILLS:	
1	Ghani Re-rolling mills Shadipura, Lahore.
2	Imtiaz Re-rolling mills Shadipura, Lahore.
3	Waqas Re-rolling mills Shadipura, Lahore.
4	Sheikh Haneef Re-rolling mills Shadipura, Lahore.
5	Sufi steel mill Kala khatai road, shadrah, Lahore .
6	City steel mill ,badami bagh Lahore.
7	Iqbal Furnace mill,khokhar road madina chowk badami bagh Lahore.
8	Naeem Steel mill, bagh banpura G.T. Road Lahore.
9	Karamat Steel mill madina chowk badami bagh Lahore.
10	Javed Steel mill ,vheni road shaddi pura Lahore.
11	New Asia foundry,bund road Lahore.
12	Barkat Steel mill, vheni road shaddi pura Lahore.
13	Shalimar steel/re-rolling mill, shaddipura Lahore.
COTTON WASTE FACTORIES AND TEXTILE MILLS:	
14	Zahoor Dying casting, Furshi bazaar Lahore.
15	Nishat Textile Mills, Lahore
16	Comfort Knitwear (pvt) Ltd, 22-Km Feroze pur road
17	Rustam Weaving (pvt) Ltd, 22-Km Ferozepur road
18	Rustam Towel, (pvt) Ltd, 22-Km Ferozepur road
19	ARC Knitwear (pvt) Ltd, 22-Km Ferozepur road
OIL, PAPER AND CHEMICAL INDUSTRIES:	
20	Hi –Mount pharmaceutical Industries ,17 KM Ferozpur road Lahore
21	Qasim glass factory, Lahore.
22	Packages pvt Ltd, Ferozepur road

Appendix 3.10 Location and Objective of Monitoring Points by the Study Team

(1) River

No.	Monitoring Points	Objectives	Parameters
R1	River Ravi, crossing point of BRB canal siphon	To monitor the contamination level of the water	Category 1
R2	River Ravi, after mixing with Mehmood Buti, Sukh Naher, Shadbagh drains		Category 2
R3	River Ravi, after mixing with Main Outfall drain, and before mixing with Gulshan-E-Ravi drain		Ditto
R4	River Ravi, after mixing with Main Outfall & Gulshan-E-Ravi drains, and before mixing with Babu Sabu drain		Ditto
R5	River Ravi, after mixing with Babu Sabu drain and before mixing with Hudiara drain		Ditto
R6	River Ravi, after mixing with Hudiara drain		Ditto

(2) Drains

No.	Monitoring Points	Objectives	Parameters
D1	Sukh Naher drain, before mixing into River Ravi, Bund Road	To monitor the wastewater discharged from the catchment area of proposed Mehmood STP	Category 2
D2	Shad Bagh drain, before mixing into River Ravi, Bund Road	To monitor the wastewater discharged from the catchment area of proposed Khokhar STP	Ditto
D3	Farakha Shahdara Disposal Station, before mixing into River Ravi	To monitor the wastewater discharged from Shardara area.	Ditto
D4	Chota Ravi drain, before mixing into River Ravi	To monitor the wastewater discharged from the catchment area of proposed South-West STP	Ditto
D5	Main Outfall drain, before mixing into River Ravi	Ditto	Ditto
D6	Gulshan-E-Ravi drain, before mixing into River Ravi	Ditto	Ditto
D7	Babu Sabu drain, before mixing into River Ravi	Ditto	Ditto
D8	Hudiara Drain, crossing point of BRB canal	To monitor the contamination level of wastewater from India	Ditto
D9	Nishtar Colony Disposal Station, before mixing into Hudiara drain	To monitor the wastewater discharged from the catchment area of proposed South-East STP	Ditto
D10	Sattu Katla drain, before mixing into Hudiara drain	To monitor the wastewater discharged from the catchment area of proposed South STP	Ditto
D11	Hudiara drain,before mixing into River Ravi	To monitor the contamination level of the down stream end of Hudiara drain	Ditto
D12	Rohi Nullah, crossing point of Khairy Distributory	To monitor the wastewater discharged from the cantonment area	Ditto
D13	Rohi Nullah, before mixing into Hudiara drain	To monitor the wastewater discharged from the newly developed area in southern Lahore	Ditto

(3) Canals

No.	Monitoring Points	Objectives	Parameters
C1	BRB canal, Ravi syphon	To monitor the contamination level of the water	Category 1
C2	Lahore Branch Canal, D/S of diversion point of BRB Canal		Ditto
C3	Lahore Branch Canal, Mughal Pura Bridge		Ditto
C4	Lahore Branch Canal, Thoker Niaz Beg		Category 2
C5	Lahore Branch Canal, Mohlanwal		Ditto

(4) Tube-wells

No.	Monitoring Points	Objectives	Parameters
W1	Ali Park T/W-1 Fort Road (New bore) (TW No.-)	To monitor water quality of the tube-well operated in the densely populated area, northern part of Lahore	Category 1
W2	Goharabad T/W Shalimar Town (New bore) (TW No.144)		Ditto
W3	T/Well Mozang Adda Main Bazar (TW No.297)		Ditto
W4	T/W Tufail Road Saddar Bazar (TW No.-)		Ditto
W5	TW-12, Ravi Block, Allama Iqbal Town (TW No.235)		Ditto
W6	T/W Cantonment Board Askari Flats (TW No.-)	To monitor water quality of the tube-well operated in Cantonment area	Ditto
W7	T/W R-Block, Liqata-abad (TW No. 220)	To monitor water quality of the tube-well operated in newly developed area, southern part of Lahore	Ditto
W8	Punjab Govt. Co. Opetative Housing Society (TW No.-)		Ditto
W9	Shallow well in LDA Avenue Area	To monitor water quality of the shallow tube-well	Ditto
W10	Shallow well in Chongi Amar Sadhu Area		Ditto

(5) Tap Water

No.	Monitoring Points	Objectives	Parameters
W1-TP	Tap water provided by Ali Park T/W-1 Fort Road (New bore) (TW No.-)	To monitor water quality of the tap water which is provided by each tube-well monitored in the monitoring survey.	Category 1
W2-TP	Tap water provided by Goharabad T/W Shalimar Town (New bore) (TW No.144)		Ditto
W3-TP	Tap water provided by T/Well Mozang Adda Main Bazar (TW No.297)		Ditto
W4-TP	Tap water provided by T/W Tufail Road Saddar Bazar (TW No.-)		Ditto
W5-TP	Tap water provided by TW-12, Ravi Block, Allama Iqbal Town (TW No.235)		Ditto
W6-TP	Tap water provided by T/W Cantonment Boad Askari Flats (TW No.-)		Ditto
W7-TP	Tap water provided by T/W R-Block, Liqata-abad (TW No. 220)		Ditto
W8-TP	Tap water provided by Punjab Govt. Co. Opetative Housing Society (TW No.-)		Ditto
W9-TP	Tap water provided by Shallow well in LDA Avenue Area		Ditto
W10-TP	Tap water provided by Shallow well in Chongi Amar Sadhu Area		Ditto

Appendix 3.11 Monitoring Results of River obtained by the Study Team

Sr. No.	Parameters / Sampling Point	Air Temperature ° C	Water Temperature ° C	pH -	DO mg/l	Total Hardness mg/l	BOD mg/l	COD mg/l	TSS mg/l	NO_2 mg/l	NO_3 mg/l	NH_4 mg/l	Fe mg/l	Mn mg/l
	Permissible Limits		>=3°C	6.0-9.0	NGVS	NGVS	80	150	200	NGVS	NGVS	40	8	1.5
R1	River Ravi, crossing point of BRB canal syphon	36.0	30.0	7.79	0.65	80	16	40	105	0.050	0.721	0.30	1.11	BDL
R2	River Ravi, after mixing with Mehmood Buti, Sukh Naher,Shadbagh drains	37.0	28.0	6.87	0.55	120	59	147	313	-	-	-	-	-
R3	River Ravi, after mixing with Main Outfall drain, and before mixing with Gulshan-E-Ravi drain	35.0	26.0	7.41	0.55	120	62	155	365	-	-	-	-	-
R4	River Ravi, after mixing with Main Outfall & Gulshan-E-Ravi drains, and before mixing with Babu Sabu drain	36.0	25.0	7.57	1.00	110	51	127	193	-	-	-	-	-
R5	River Ravi, after mixing with Babu Sabu drain and before mixing with Hudiara drain	38.0	26.0	6.93	0.40	110	52	130	391	-	-	-	-	-
R6	River Ravi, after mixing with Hudiara drain	42.0	28.0	7.09	0.20	115	82	205	251	-	-	-	-	-
Maximum		42.0	30.0	7.79	1.00	120	82	205	391	0.050	0.721	0.30	1.11	-
Minimum		35.0	25.0	6.87	0.20	80	16	40	105	0.050	0.721	0.30	1.11	-

Sr. No.	Parameters / Sampling Point	Mg mg/l	As µg/l	F mg/l	Ca mg/l	Cl mg/l	SO_4 mg/l	Fecal Coliform MPN/100ml	Total Coliform MPN/100ml	T-N mg/l	T-P mg/l	Hg µg/l	Cr^{6+} mg/l	Monitoring Date
	Permissible Limits	NGVS	1,000	10	NGVS	NGVS	600	Nil	Nil	NGVS	NGVS	10	1	
R1	River Ravi, crossing point of BRB canal syphon	2.30	10.38	0.31	28	9.8	15	>=240	>=240	-	-	-	-	16/5/2009
R2	River Ravi, after mixing with Mehmood Buti, Sukh Naher,Shadbagh drains	-	25.00	-	-	-	30	>=240	>=240	5.6	2.9	0.4857	0.044	20/5/2009
R3	River Ravi, after mixing with Main Outfall drain, and before mixing with Gulshan-E-Ravi drain	-	13.52	-	-	-	46	>=240	>=240	6.4	0.7	0.6774	0.003	22/5/2009
R4	River Ravi, after mixing with Main Outfall & Gulshan-E-Ravi drains, and before mixing with Babu Sabu drain	-	13.32	-	-	-	44	>=240	>=240	5.4	0.8	0.0256	0.004	22/5/2009
R5	River Ravi, after mixing with Babu Sabu drain and before mixing with Hudiara drain	-	12.60	-	-	-	36	>=240	>=240	4.6	0.3	0.2584	0.012	21/5/2009
R6	River Ravi, after mixing with Hudiara drain	-	25.40	-	-	-	52	>=240	>=240	21.0	1.6	0.2971	0.121	21/5/2009
Maximum		2.30	25.40	0.31	28	10	52	>=240	>=240	21.0	2.94	0.6774	0.121	
Minimum		2.30	10.38	0.31	28	10	15	>=240	>=240	4.6	0.33	0.0256	0.003	

Appendix 3.12 Monitoring Results of Drainage Channels obtained by the Study Team

Sr. No.	Parameters / Sampling Point	Air Temperature ° C	Water Temperature ° C	pH -	DO mg/l	Total Hardness mg/l	BOD mg/l	COD mg/l	TSS mg/l	T-N mg/l	T-P mg/l	SO_4 mg/l	As µg/l	Hg µg/l	Cr^{6+} mg/l	Fecal Coliform MPN/100ml	Total Coliform MPN/100ml	Monitoring Date
	Permissible Limits		40	6.0-10.0	NGVS	NGVS	80	150	200	NGVS	NGVS	600	1,000	10	1	Nil	Nil	
D1	Sukh Naher drain, before mixing into River Ravi, Bund Road	32	30	6.96	0.20	225	182	373	326	56.8	10.6	35	59.00	0.3654	0.052	>=240	>=240	20-05-09
D2	Shad Bagh drain, before mixing into River Ravi, Bund Road	30	29	6.92	0.15	250	189	259	467	45.6	12.0	7	61.20	0.1124	0.143	>=240	>=240	20-05-09
D3	Farakha Shahdara Disposal Station, before mixing into River Ravi	33	30	6.79	0.20	230	185	270	888	62.0	9.7	25	74.60	BDL	0.088	>=240	>=240	20-05-09
D4	Chota Ravi drain, before mixing into River Ravi	39	26	6.85	0.25	220	147	259	237	8.8	15.8	23	22.50	BDL	0.060	>=240	>=240	20-05-09
D5	Main Outfall drain, before mixing into River Ravi	39	28	6.88	0.15	205	152	243	244	49.6	16.5	35	58.46	BDL	0.056	>=240	>=240	20-05-09
D6	Gulshan-E-Ravi drain, before mixing into River Ravi	36	30	6.92	0.12	200	166	259	230	52.6	16.3	38	53.40	BDL	0.077	>=240	>=240	19-05-09
D7	Babu Sabu drain, before mixing into River Ravi	47	29	6.90	0.12	225	190	275	376	45.6	16.5	17	45.58	BDL	0.225	>=240	>=240	20-05-09
D8	Hudiara Drain, crossing point of BRB canal	33	31	6.91	0.12	400	190	340	4,410	45.6	11.7	28	22.30	BDL	0.096	>=240	>=240	21-05-09
D9	Nishtar Colony Disposal Station, before mixing into Hudiara drain	32	30	6.80	0.12	210	188	373	424	61.6	24.3	25	29.40	BDL	0.067	>=240	>=240	18-05-09
D10	Sattu Katla drain,before mixing into Hudiara drain	44	29	7.12	0.12	215	193	346	138	44.0	13.8	33	29.60	0.7212	0.118	>=240	>=240	18-05-09
D11	Hudiara drain,before mixing into River Ravi	39	34	7.67	0.12	245	174	389	220	33.6	12.2	48	31.84	0.8956	0.139	>=240	>=240	21-05-09
D12	Rohi Nullah, crossing point of Khairy Distributory	35	32	6.55	0.12	225	173	389	360	28.8	11.6	138	35.46	0.4290	0.288	>=240	>=240	18-05-09
D13	Rohi Nullah, before mixing into Hudiara drain	35	31	6.62	0.12	275	205	427	681	20.0	8.1	155	23.84	0.1260	0.515	>=240	>=240	18-05-09
	Maximum	47	34	7.67	0.25	400	205	427	4,410	62.0	24.3	155	74.60	0.8956	0.515	>=240	>=240	
	Minimum	30	26	6.55	0.12	200	147	243	138	8.8	8.1	7	22.30	BDL	0.052	>=240	>=240	

Appendix 3.13 Monitoring Results of Canal obtained by the Study Team

Sr. No.	Parameters / Sampling Point	Air Temperature ° C	Water Temperature ° C	pH -	DO mg/l	Total Hardness mg/l	BOD mg/l	COD mg/l	TSS mg/l	NO_2 mg/l	NO_3 mg/l	NH_4 mg/l	Fe mg/l	Mn mg/l
	Permissible Limits		>=3°C	6.0-9.0	NGVS	NGVS	80	150	200	NGVS	NGVS	40	8	2
C1	BRB canal, Ravi syphon	32.0	24.2	7.66	1.50	80	3.2	7	81	0.003	0.771	0.08	1.86	BDL
C2	Lahore Branch Canal, D/S of diversion point of BRB Canal	41.0	23.0	7.93	1.75	80	5.7	15	78	0.005	0.745	0.14	3.86	0.0251
C3	Lahore Branch Canal, Mughal Pura Bridge	33.0	22.0	7.83	1.80	70	7.2	17	46	0.010	0.966	0.12	3.36	0.0400
C4	Lahore Branch Canal, Thoker Niaz Beg	39.0	20.2	7.32	1.70	90	8.1	21	199	-	-	-	-	-
C5	Lahore Branch Canal, Mohlanwal	33.0	24.5	7.36	1.50	90	9.2	24	177	-	-	-	-	-
Maximum		41.0	24.5	7.93	1.80	90	9.2	24	199	0.010	0.966	0.14	3.86	0.0400
Minimum		32.0	20.2	7.32	1.50	70	3.2	7	46	0.003	0.745	0.08	1.86	BDL

Sr. No.	Parameters / Sampling Point	Mg mg/l	As µg/l	F mg/l	Ca mg/l	Cl mg/l	SO_4 mg/l	Fecal Coliform MPN/100ml	Total Coliform MPN/100ml	T-N mg/l	T-P mg/l	Hg µg/l	Cr^{6+} mg/l	Monitoring Date
	Permissible Limits	NGVS	1,000	10	NGVS	NGVS	600	Nil	Nil	NGVS	NGVS	10	1	
C1	BRB canal, Ravi syphon	2.40	3.42	BDL	28	9.8	13	>=240	>=240	-	-	-	-	16/5/2009
C2	Lahore Branch Canal, D/S of diversion point of BRB Canal	1.21	10.20	BDL	30	13.0	13	>=240	>=240	-	-	-	-	16/5/2009
C3	Lahore Branch Canal, Mughal Pura Bridge	2.43	6.40	0.24	36	8.4	12	>=240	>=240	-	-	-	-	16/5/2009
C4	Lahore Branch Canal, Thoker Niaz Beg	-	13.02	-	-	-	22	>=240	>=240	2.0	0.54	0.2044	BDL	11/5/2009
C5	Lahore Branch Canal, Mohlanwal	-	11.48	-	-	-	23	>=240	>=240	2.4	0.96	0.2090	BDL	12/5/2009
Maximum		2.43	13.02	0.24	36	13	23	>=240	>=240	2.4	0.96	0.2090	BDL	
Minimum		1.21	3.42	BDL	28	8	12	>=240	>=240	2.0	0.54	0.2044	BDL	

Appendix 3.14 Monitoring Results of Tube Wells and Tap Water obtained by the Study Team

Sr. No.	Parameters / Sampling Point	Air Temerature °C	Water Temerature °C	pH	DO mg/l	Total Hardness mg/l	BOD mg/l	COD mg/l	TSS mg/l	NO_2 mg/l	NO_3 mg/l	NH_4 mg/l	Fe mg/l	Mn mg/l	Mg mg/l	As µg/l	F mg/l	Ca mg/l	Cl mg/l	SO_4 mg/l	Fecal Coliform MPN/100ml	Total Coliform MPN/100ml	Monitoring Date
	Permissible Limits	NGVS	NGVS	6.5-8.5	NGVS	500	NGVS	NGVS	NGVS	0.5	10	NGVS	0.30	0.5	150	10	1.5	NGVS	250	250	Nil	Nil	
W1	Ali Park T/W-1 Fort Road (New bore) (TW No.-)	38.0	31.0	7.05	0.65	160	BDL	BDL	10	0.108	0.384	BDL	0.10	BDL	9.72	81.38	0.03	48	17	20	<2	<2	16/5/2009
W2	Goharabad T/W Shalimar Town (New bore) (TW No.144)	37.0	31.5	7.69	0.50	110	BDL	4	14	BDL	BDL	BDL	0.15	BDL	7.29	23.40	0.19	32	23	41	<2	<2	16/5/2009
W3	T/Well Mozang Adda Main Bazar (TW No.297)	37.0	31.0	7.56	0.60	170	BDL	BDL	3	BDL	0.023	BDL	0.17	0.0733	17.01	48.20	BDL	40	67	75	<2	<2	12/5/2009
W4	T/W Tufail Road Saddar Bazar (TW No.-)	38.0	31.2	7.50	0.59	110	BDL	2	6	0.073	BDL	BDL	0.16	BDL	9.72	31.00	1.40	28	19	39	<2	<2	16/5/2009
W5	TW-12, Ravi Block, Allama Iqbal Town (TW No.235)	32.0	28.0	7.53	0.60	140	BDL	3	15	0.052	BDL	BDL	0.35	0.0034	9.72	44.40	0.89	40	24	53	<2	<2	12/5/2009
W6	T/W Cantonment Boad Asghari Flats (TW No.-)	40.0	31.0	7.23	0.45	200	1	5	36	0.046	BDL	BDL	0.37	BDL	1.87	37.00	0.55	44	24	54	38	240	12/5/2009
W7	T/W R-Block, Liqata-abad (TW No. 220)	39.0	32.0	7.58	0.56	70	BDL	BDL	14	BDL	BDL	BDL	0.02	BDL	6.07	38.68	0.66	18	28	61	<2	<2	11/5/2009
W8	Punjab Govt. Co. Opetative Housing Society (TW No.-)	37.0	25.3	7.05	0.47	150	BDL	2	9	0.049	BDL	BDL	0.10	BDL	18.22	40.40	0.62	30	19	128	15	38	11/5/2009
W9	Shallow well in LDA Avenue Area	36.0	30.2	7.35	0.55	120	BDL	BDL	7	0.041	BDL	BDL	0.18	BDL	12.15	58.34	1.24	28	26	68	<2	<2	11/5/2009
W10	Shallow well in Chongi Amar Sadhu Area	38.0	32.2	7.53	0.45	80	BDL	1	4	0.002	BDL	BDL	0.10	BDL	8.50	44.80	0.31	18	26	50	5	20	11/5/2009
	Maximum	40.0	32.2	7.69	0.65	200	1	5	36	0.108	0.384	BDL	0.37	0.0733	18.22	81.38	1.40	48	67	128	38	240	
	Minimum	32.0	25.3	7.05	0.45	70	BDL	BDL	3	0.002	BDL	BDL	0.02	BDL	1.87	23.40	BDL	18	17	20	<2	<2	

Sr. No.	Parameters / Sampling Point	Air Temerature °C	Water Temerature °C	pH	DO %age	Total Hardness mg/l	BOD mg/l	COD mg/l	TSS mg/l	NO_2 mg/l	NO_3 mg/l	NH_4 mg/l	Fe mg/l	Mn mg/l	Mg mg/l	As µg/l	F mg/l	Ca mg/l	Cl mg/l	SO_4 mg/l	Fecal Coliform MPN/100ml	Total Coliform MPN/100ml	Monitoring Date
	Permissible Limits	NGVS	NGVS	6.5-8.5	NGVS	500	NGVS	NGVS	NGVS	0.5	10	NGVS	0.30	0.5	150	10	1.5	NGVS	250	250	Nil	Nil	
W1-TP	Tap water provided by Ali Park T/W-1 Fort Road (New bore) (TW No.-)	38.0	31.0	7.56	0.45	90	BDL	BDL	11	0.089	0.021	BDL	0.06	BDL	2.43	52.00	0.06	32	14	23	<2	<2	12/5/2009
W2-TP	Tap water provided by Goharabad T/W Shalimar Town (New bore) (TW No.144)	37.0	31.0	7.63	0.35	110	2.3	6	3	0.005	BDL	BDL	0.11	BDL	7.29	63.24	0.18	32	23	33	20	38	16/5/2009
W3-TP	Tap water provided by T/Well Mozang Adda Main Bazar (TW No.297)	37.0	31.5	7.57	0.45	160	1.5	4	4	BDL	0.264	BDL	BDL	BDL	15.79	33.34	BDL	38	62	80	15	21	12/5/2009
W4-TP	Tap water provided by T/W Tufail Road Saddar Bazar (TW No.-)	38.0	30.5	7.60	0.35	120	BDL	3	7	0.058	BDL	BDL	0.11	BDL	10.93	30.44	0.28	30	19	35	2	5	12/5/2009
W5-TP	Tap water provided by TW-12, Ravi Block, Allama Iqbal Town (TW No.235)	32.0	29.0	7.42	0.45	190	BDL	2	22	0.001	BDL	BDL	0.09	BDL	19.44	48.10	0.39	44	46	86	5	7	12/5/2009
W6-TP	Tap water provided by T/W Cantonment Boad Asghari Flats (TW No.-)	40.0	31.0	7.25	0.35	210	4.2	9	8	BDL	0.584	BDL	0.31	BDL	26.73	32.92	0.78	40	22	54	96	>=240	12/5/2009
W7-TP	Tap water provided by T/W R-Block, Liqata-abad (TW No. 220)	39.0	31.0	7.28	0.47	200	BDL	BDL	10	0.018	BDL	BDL	0.09	BDL	25.50	46.28	0.32	38	32	77	<2	<2	11/5/2009
W8-TP	Tap water provided by Punjab Govt. Co. Opetative Housing Society (TW No.-)	37.0	27.0	7.25	0.45	130	2.0	6	12	BDL	BDL	BDL	0.14	BDL	14.58	36.22	1.28	28	14	62	38	96	11/5/2009
W9-TP	Tap water provided by Shallow well in LDA Avenue Area	36.0	29.3	7.23	0.50	390	BDL	BDL	6	BDL	0.042	BDL	0.18	BDL	12.15	58.32	1.24	28	26	68	<2	<2	12/5/2009
W10-TP	Tap water provided by Shallow well in Chongi Amar Sadhu Area	38.0	31.0	7.25	0.42	80	1.3	4	14	0.002	BDL	BDL	0.11	BDL	8.50	38.54	BDL	18	28	52	11	20	11/5/2009
	Maximum	40.0	31.5	7.63	0.50	390	4.2	9	22	0.089	0.584	BDL	0.31	BDL	26.73	63.24	1.28	44	62	86	96	>=240	
	Minimum	32.0	27.0	7.23	0.35	80	BDL	BDL	3	BDL	BDL	BDL	0.06	BDL	2.43	30.44	BDL	18	14	23	<2	<2	

Appendix 3.15 Suggestions from Other References

(1) "Surface Water Quality Monitoring in Punjab - Annual Report 2007", Irrigation & Power Department, the Government of the Punjab

1) Irrigation System of Punjab

The Indus Basin Irrigation System (IBIS) comprises of five main rivers, i.e. the Indus, the Jehlum, the Chenab, the Ravi and the Sutlej River. The network of Punjab Irrigation System consists of the dams, barrages, headworks, Canals and Link Canals that were built with a concept to transfer water from the Western Rivers i.e. Indus, Jehlum and Chenab to the Eastern Rivers, i.e. Ravi and Sutlej after the Indus Water Treaty of 1960, whereas, the feeder canals taken out from different headworks are meant mainly to irrigate the agricultural lands throughout Punjab. The detail of this irrigation system is given in **Figure 3.15(1)**.

The Punjab Irrigation System is accompanied by a network of drainage system. The drains were originally constructed to counter the problem of waterlogging and to collect the surplus water and flood water. But in the present scenario due to increased population and industrialization, the drains mainly carry the industrial and municipal effluents that are ultimately carried to the canals and rivers. The untreated industrial and municipal wastes have created multiple environmental hazards for mankind and have become a threat to the various useful uses including irrigation, drinking and sustenance of aquatic life. The drainage water contains trace metals in addition to biological contaminations. This water adds pollution to the food chain in addition to groundwater contamination when used to irrigate the crops.

Chenab River (see **Figure 3.15(1)**)

a) Marala Headworks → Marala Ravi Links
→ UCC →BRBD → CBDC
→ UDC

b) Khanki Headworks → LCC → Upper Gogera → Lower Gogera
→ Burala
→ Main LCC → Jhang Branch
→ Rakh Branch

c) Qadirabad Headworks
→ Qadirabad Balloki Link

d) Trimmu Headworks → Rangpur Canal
→ Havali Canal
→ Trimmu Sidhnai Link

Ravi River

a) Balloki Heasworks → LBDC
→ B.S. Link → Lower Depalpur Canal

b) Sidhnai Headworks → Sidhnai Mailsi Link Canal
→ Sidhnai Canal

Source: "Surface Water Quality Monitoring in Punjab - Annual Report 2007", Irrigation & Power Department, Government of the Punjab

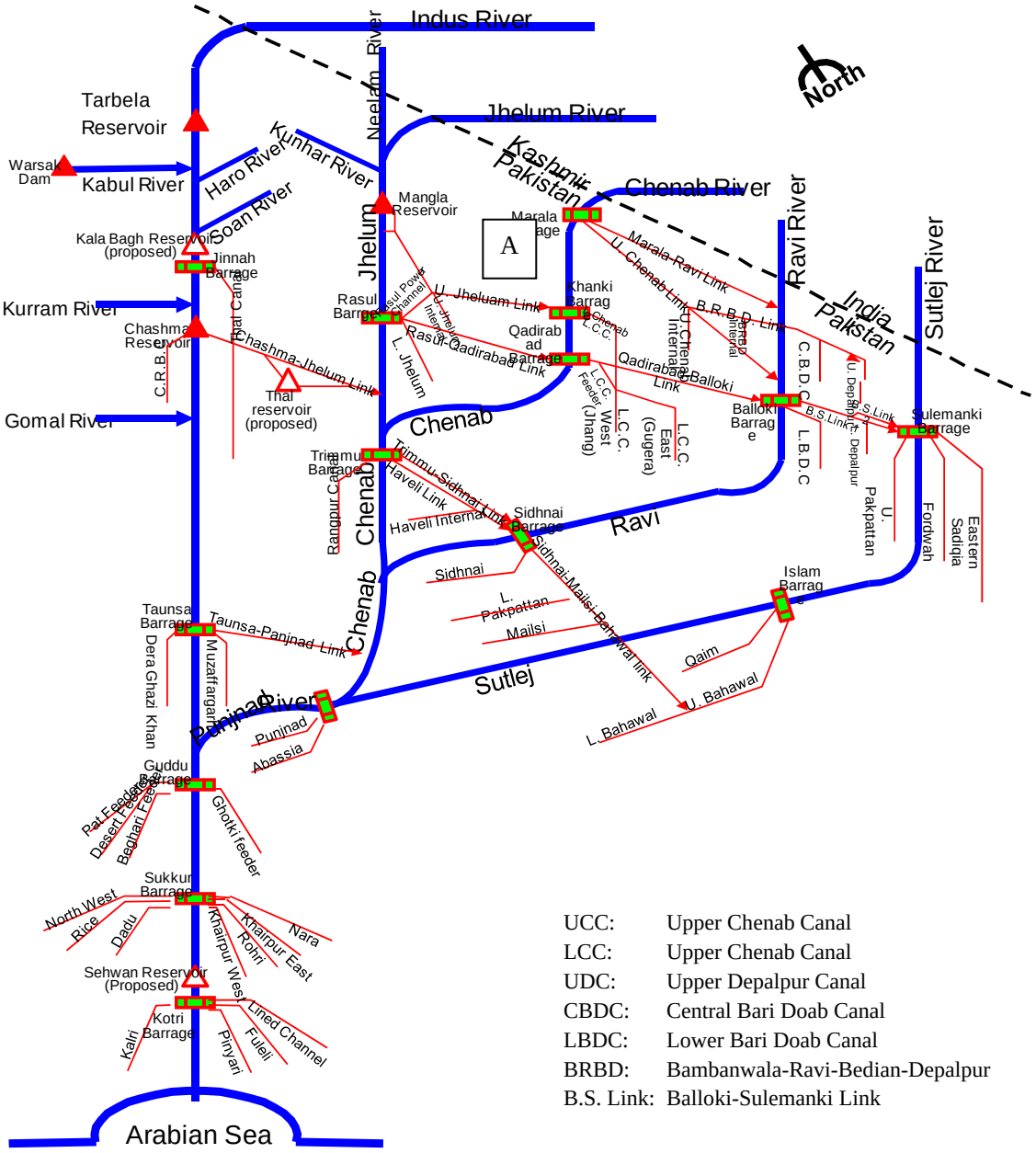


Figure 3.15(1) Reservoirs, Barrages and Main Canals in the Indus Basin Irrigation System

Source: Hasan, quoted in ***Pakistan's Water Economy: Running Dry****, Report, The World Bank, November 8, 2005, pg 4*

2) River Chenab – Marala Canal – River Ravi

The River Chenab takes its origin from Kulu and Kangra Districts of Himachal Pardesh Province of India and enters in Pakistan at Sialkot District near Diawara Village to flow southwestwards through Marala, Khanki, Qadirabad and Trimmu Headworks. A part of flow is diverted southwards via Marala Headworks to irrigate the surrounding area and to pour the River Ravi

The River Ravi emanates from the basin of Bangahal. In Pakistan it enters Shakargarh Tehsil of Narowal at Jassar. India has diverted its flow as per Indus Water Treaty 1960 and has full rights accordingly. The flow of River Ravi in Pakistan is regulated through Balloki and Sidhnai Headworks, where link canals are transporting/diverting the water from western rivers.

In the flow from the River Chenab to the River Ravi via Marala Canal, water was sampled at four points, namely Marala in the River Chenab and Shahdara, Balloki and Sidhnai in the River Ravi by the Irrigation and Power Department, the Government of the Punjab. Six samples per annum were collected at each site for analysis of eight parameters, or pH, EC (Electrical Conductivity), SAR (Sodium Absorption Ratio), RSC (Residual Sodium Carbonate) and trace metals such as Copper (Cu), Nickel (Ni), Lead (Pb) and Zinc (Zn) as presented in **Table 3.15(1)**.

Analytical data reveals that the parameters of pH, EC, SAR and RSC are within the limit of FAO standards at the four sampling sites. Amongst trace metals, only average concentration of Cu is exceeding the FAO limit of 0.2 mg/L at Balloki and Sidhani Headworks. But as shown in **Table 3.15(1)** and **Figure 3.15(2)**, two data out of six at Marala Headworks are above the limit. Although its water quality is considered to represent the natural condition not-polluted artificially, it shows relatively high concentrations in Cu and Zn as presented in **Figure 3**. The Cu concentration indicates the effect of industrial effluents coming from the industries located at Sheikhupura and Lahore Districts. The other determined metals namely Ni, Pb and Zn remains within limit at all the sampling sites during monitoring period. But the concentrations of Ni and Pb at Balloki and Sidhnai also indicate the effect of industrial effluents coming from the industries.

Table 3.15(2) shows the district-wise flow of industrial and municipal effluent in Punjab, which amounts to 5,846 cusecs. The level of pollution varies from district to district and district Lahore is at the top of the list along with Sialkot, Kasur, Sheikhupura and Faisalabad. The effluent from Lahore, Kasur, Sheikhupura and Faisalabad concentrates at the Balloki Headworks, which amount to 5,054 cusecs or about 86% of total effluent in Punjab.

Table 3.15(1) Analytical Data of River Chenab and Ravi (Marala H/W – Shahdara – Balloki H/W – Sidhnai H/W)

Sr.#	Parameters	Unit	Source	Location	Dec-'06	Feb-'07	Apr-'07	Jun-'07	Aug-'07	Oct-'07	Avg.	FAO Limits
1	pH		River Chenab	Marala H/W	7.10	7.91	7.42	7.01	7.49	7.59	7.42	6-9
			River Ravi	Shahdara	8.30	8.27	8.30	7.93	7.44	8.16	8.07	6-9
			River Ravi	Balloki H/W	7.40	7.52	7.90	7.26	7.26	7.51	7.48	6-9
			River Ravi	Sidhnai H/W	7.20	7.32	7.50	8.04	8.13	7.48	7.61	6-9
2	EC	dS/m	River Chenab	Marala H/W	0.33	0.34	0.32	0.22	0.32	0.35	0.31	1.5
			River Ravi	Shahdara	0.37	0.41	0.48	0.30	0.34	0.62	0.42	1.5
			River Ravi	Balloki H/W	0.47	0.52	0.56	0.35	0.32	0.59	0.47	1.5
			River Ravi	Sidhnai H/W	0.79	0.65	0.68	0.44	0.33	0.62	0.59	1.5
3	SAR		River Chenab	Marala H/W	0.53	1.10	0.98	0.42	0.97	0.93	0.82	10.0
			River Ravi	Shahdara	0.68	1.48	1.92	1.41	1.39	2.32	1.53	10.0
			River Ravi	Balloki H/W	1.33	2.65	1.39	1.40	1.42	2.28	1.75	10.0
			River Ravi	Sidhnai H/W	48.00	21.00	18.00	1.96	2.05	2.13	2.67	10.0
4	RSC	me/L	River Chenab	Marala H/W	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.5
			River Ravi	Shahdara	0.00	0.50	0.40	0.00	0.00	0.20	0.18	2.5
			River Ravi	Balloki H/W	0.30	0.70	0.30	0.10	0.10	0.29	0.30	2.5
			River Ravi	Sidhnai H/W	0.00	0.80	0.20	0.40	0.40	0.30	0.35	2.5
5	Cu	mg/L	River Chenab	Marala H/W	0.19	**0.30**	**0.21**	0.10	0.14	0.19	0.19	0.2
			River Ravi	Shahdara	0.11	0.18	**0.28**	0.17	0.17	0.18	0.18	0.2
			River Ravi	Balloki H/W	0.14	**0.23**	**0.36**	**0.36**	**0.23**	0.17	**0.25**	0.2
			River Ravi	Sidhnai H/W	**0.26**	**0.28**	**0.39**	**0.39**	**0.38**	0.13	**0.31**	0.2
6	Ni	µg/L	River Chenab	Marala H/W	0.11	0.00	0.00	0.00	0.00	0.00	0.02	200
			River Ravi	Shahdara	0.00	0.12	0.18	0.12	0.10	0.32	0.14	200
			River Ravi	Balloki H/W	0.00	0.19	0.21	0.56	0.43	0.30	0.28	200
			River Ravi	Sidhnai H/W	0.11	0.20	0.19	0.50	0.58	0.25	0.31	200
7	Pb	µg/L	River Chenab	Marala H/W	0.18	0.17	0.11	0.00	0.00	0.00	0.08	5000
			River Ravi	Shahdara	0.12	0.28	0.30	0.19	0.14	0.24	0.21	5000
			River Ravi	Balloki H/W	0.22	0.34	0.32	0.76	0.81	0.21	0.44	5000
			River Ravi	Sidhnai H/W	0.23	0.38	0.30	0.73	0.80	0.22	0.44	5000
8	Zn	mg/L	River Chenab	Marala H/W	0.41	0.43	0.36	0.28	0.19	0.22	0.32	2.0
			River Ravi	Shahdara	0.21	0.38	0.41	0.61	0.29	0.31	0.37	2.0
			River Ravi	Balloki H/W	0.31	0.42	0.49	0.32	0.32	0.37	0.37	2.0
			River Ravi	Sidhnai H/W	0.36	0.48	0.48	0.35	0.35	0.31	0.39	2.0

Source: "Surface Water Quality Monitoring in Punjab - Annual Report 2007", Irrigation & Power Department, Government of the Punjab

H/W: Headworks
EC: Electrical Conductivity
SAR: Residual Sodium Carbonate
SAR: Sodium Adsorption Ratio

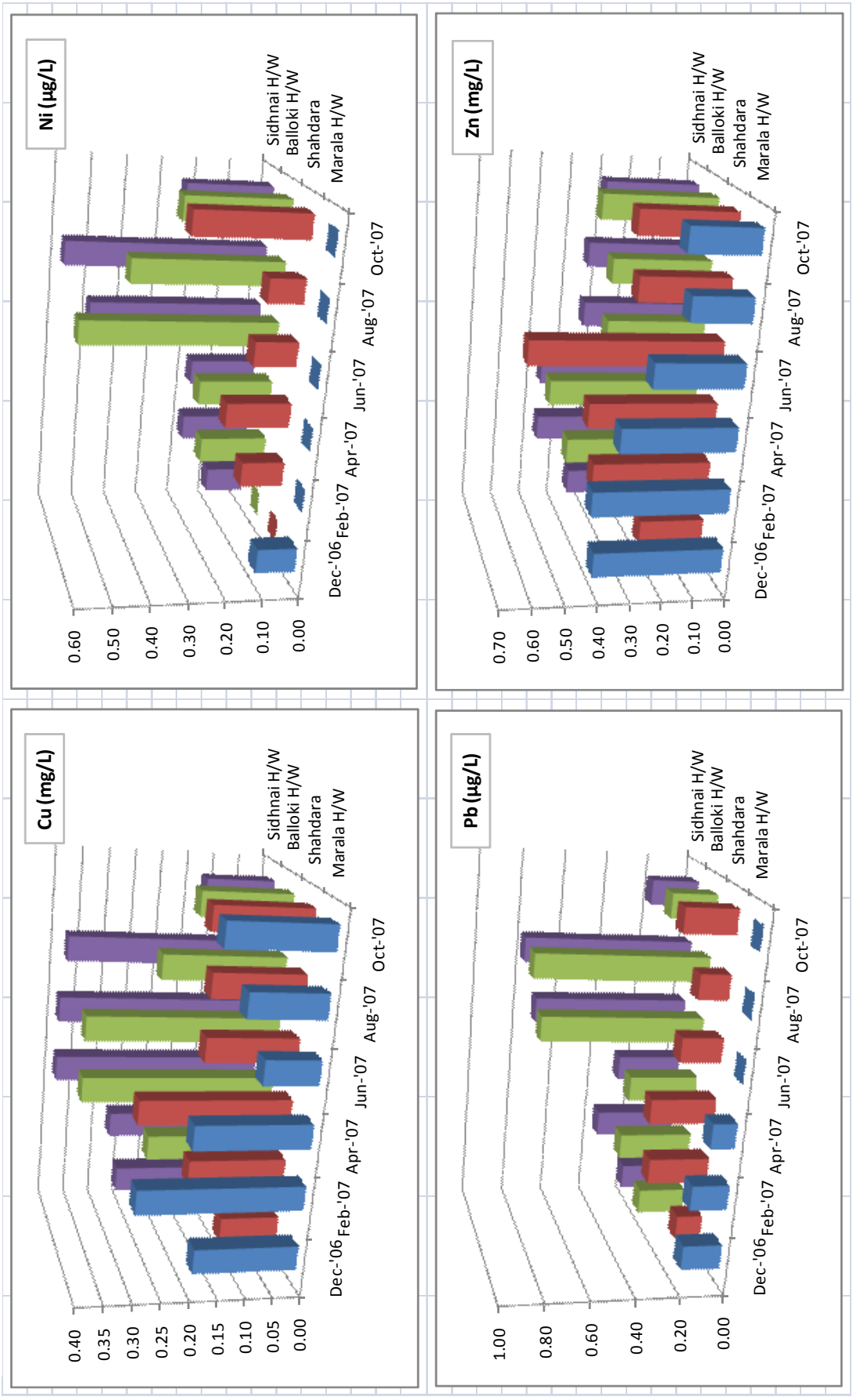


Figure 3.15(2) Trace Metal Analytical Data of River Chenab and Ravi by parameter (Marala H/W – Shahdara – Balloki H/W – Sidhnai

Table 3.15(2) District Wise Detail of Industrial and Municipal Pollution in Punjab

Sr. No.	District	No. of Industries	Effluent from Industries (Cusecs)	Major Disposal Stations	Effluent from Municipalities (Cusecs)	Total Effluent (Cusecs)
1	Faisalabad	279	436	40	842	1278
2	Lahore	191	168	6	3136	3304
3	Hafizabad	2	1.1	2	25.5	27
4	Gujranwala	94	97	16	215	312
5	Sialkot	58	57	4	35	92
6	Kasur	19	16	3	40	56
7	Sheikhpura	202	316	14	100	416
8	M.B.Din	3	7	7	25	32
9	Gujrat	3	2	4	40	42
10	Sargodha	14	24	19	75	99
11	Jhang	19	18.5	1	3	21
12	Khanewal	3	10.6	1	2.4	13
13	Multan	20	17	8	218	235
14	Lodhran	1	0.5	0	0	0.5
15	Bahawalpur	2	2	3	20	22
16	Bahawalnagar	2	1	0	0	1
17	Rahim Yar Khan	4	10	0	0	10
18	D.G.Khan	0	0	2	60	60
19	Muzaffarghar	6	26	8	18	45
20	Sahiwal	10	8.1	0	120	128
21	T.T. Singh	4	6.15	0	0	6.15
22	Khushab	13	6	0	0	6
23	Okara	5	15	0	0	15
	Total	875	1055	129	4790	5846
About 90% of the effluents from industries and munlcipalities is untreated which is directly polluting the water resources of the province.						

Source: "Surface Water Quality Monitoring Plan (Revised) – September 2007", Irrigation & Power Department, the Government of the Punjab

The Secretary of the Environmental Protection Department issued the letter titled "Installation of Waste Water Treatment Plants to Save River Ravi from Pollution" to the Secretaries of HUD&PHED, I&PD and Industrial Department on September 16, 2009, saying that "the river is under a constant threat of indiscriminate disposal of untreated Municipal Sewage from Lahore / Industrial sewage from Faisalabad through Maduana Drain and Industrial Effluent from industrial units of Kala Shah Kaku along G.T. Road, Sheikhupura Road, Township and Gulberg Industrial Estate located in Metropolitan of Lahore and untreated Industrial Waste Water of District Kasur.

The irrigation-commanded area around Lahore in the Punjab Irrigation System is shown in **Table 3.15(3)** and **Figure 3.15(3)**, respectively.

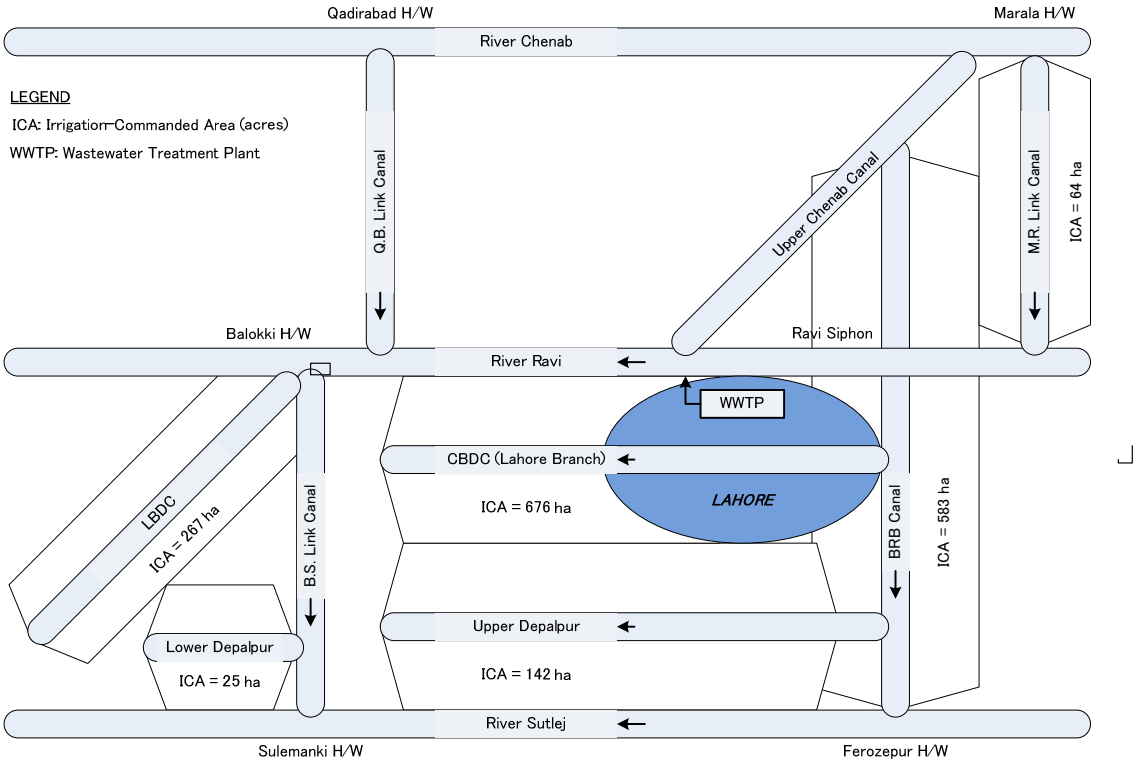


Figure 3.15(3) Irrigation Commanded Area around Lahore

Table 3.15(3) Different Features of Existing River-Canal System of Punjab (Akhter, 2000)

Sr. No.	Canal	Year of Const.	CCA	GA	Length (km)	
			(ha)	(ha)	Main	Total*
1	Upper Jhelum	1915	220	248	142.0	1,176.0
2	Lower Jhelum	1901	614	654	63.0	2,521.0
3/4	Upper Chenab/BRBD	1912/1956	583	633	69.0	2,565.0
5	M.R.Link (int)	1956	64	71	-	306.0
6	Lower Bari Doab	1859	267	287	-	1,295.0
7	Lower Chenab	1892	1,236	1,497	251.0	4,802.0
8	CBDC	1913	676	724	209.0	2,449.0
9	Upper Depalpur	1928	142	155	85.0	774.0
10	Pakpattan	1927	425	476	295.0	1,840.0
11	Muzaffargarh	1958	332	376	119.0	1,695.0
12	Thai	1947	774	898	51.0	3,412.0
13	Rangpur	1939	140	145	222.0	842.0
14	D.G. Khan	1958	367	387	111.0	1,800.0
15	Puninad	1929	548	620	92.0	2,640.0
16	Abassia	1929	62	120	41.0	271.0
17	Bahawal	1927	295	297	29.0	1,088.0
18/19	Qaim/Mailsi	1927/1928	419	444	53.0	1,582.0
20	E. Sadiqia	1926	426	474	79.0	1,454.0
21	Fordwah	1927	173	227	15.0	815.0
22	Lower Depalpur	1928	25	25	10.0	1,254.0
23/24	Sidhnai Canal/ Haveli	1886/1939	412	472	59.0	1,843.0
CCA= Canal Commanded Area, G.A= Gross Area, CS = cusecs, CM = canal mile.						
* Total length includes length of branches, sub branches, distributaries and minors						
Source: "Surface Water Quality Monitoring Plan (Revised)", Irrigation & Power Department, Government of the Punjab, September 2008						

(2) "Environmental Monitoring of River Ravi", Environmental Protection Department, the Government of the Punjab, November, 2008

Table 3.15(4) and **Figure 3.15(4)** show the water pollution status of the River Ravi system and the relationship of monitoring points, respectively in November 2008 carried out by the Environmental Protection Department, the Government of the Punjab. For the section of the River Ravi from the entry point into Pakistan originating from India to Ravi Siphon after Marala Ravi Link Canal joins, the river keeps a good quality such as 2.8 to 4.3 mg/L in BOD_5, 4.8 to 11.5 mg/L in COD, and 20 to 40 mg/L in SS. However it deteriorates rapidly receiving domestic and industrial wastewater from the urban area of Lahore City through drainage pumping stations and drains starting from the Medmood Buti Drain. The drains that are likely affected by other than domestic wastewater are Medmood Buti Drain, Farikhabad Drain, Main Outfall Drain, Babu Sabu Drain and Deg Nullah, of which both of BOD_5 and COD exceed 300 mg/L. In addition, COD exceeds 300 mg/L in Shad Bagh Drain, Shahdra P/S, Forest Corony P/S, Gulshan-e-Ravi Drain, Hudiara Drain and Upper Chenab Canal. Some drains also exceed the limits largely defined by the National Environmental Quality Standard (NEQS). For example, the cyanide concentrations are 50 mg/L in Sukhmehr Drain, 2.8 mg/L in Farikhabad Drain and 11.6 mg/L in Hudiara Drain above NEQS of 1.0 mg/L.

The water quality of the River Ravi is worst at the River Ravi New Bridge downstream of the confluence with Medmood Buti Drain and Shad Bagh Drain and upstream of the confluence with Farikhabad Drain where BOD_5, COD and SS are 102 mg/L、COD 336 mg/L and SS 290 mg/L, respectively, followed by the point S21 downstream of the confluence with Babu Sabu Drain and upstream of the confluence with Hudiara Drain with BOD_5 of 88 mg/L, COD of 210 mg/L and SS of 10 mg/L, respectively. However, they drop sharply at the immediately-downstream of monitoring points for both, sampling has done in the condition that river water has not well mixed with wastewater downstream of the confluence with drains.

The maximum of the monthly average flow of the River Ravi is 22,083 cusecs (54,026,000 m^3/day) in August, while the minim 374 cusecs (915,000 m^3/day) in March. November that sampling was done is categorized into significantly low discharge season as 549 cusecs (1,343,000 m^3/day), namely high percentage of wastewater in the total river flow.

Table 3.15(4) Monitoring of the River Ravi

Parameters	Unit	NEQS	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15
			River Ravi Entry Pt. into Pakistan	River Ravi	River Ravi	MRLC	River Ravi at Ravi Siphon	Mehmood Buti Drain	Sukhnehr Drain	Shad Bagh Drain	River Ravi U/S of Shardra Town P.S.	Shardra Town P.S.	River Ravi D/S of Shardra Town P.S.	Forest Colony P.S.	River Ravi New Bridge D/S	Furikhabad Drain	Bhuda Ravi Drain
Temperature	ºC	=<3ºC	22.87	22.94	22.50	22.49	22.6	26.6	25.4	23.4	17.3	22.1	17.4	24.8	23.7	22.9	23.1
Value of pH		6-9	8.34	8.44	8.5	8.3	8.5	7.6	7.3	7.2	7.75	7.5	8.04	7.34	7.3	7.3	7.6
Dissolved Oxygen	mg/L	-	6.68	6.17	6.35	6.01	6.30	0.81	0.43	0.79	10.33	1.60	9.40	1.23	0.71	0.50	0.91
Biochemical Oxygen Demand (BOD_5)	mg/L	80	2.8	3.2	4.3	3.6	2.1	1210	120	192	6.2	124.0	5.6	216	102	382	96
Chemical Oxygen Demand (COD)	mg/L	150	6.4	4.8	11.5	8.16	8.0	4160	284	512	12.4	368.0	18.8	560	336	960	280
Total Dissolved Solids (TDS)	mg/L	3500	200	220	220	160	160	760	620	520	200	540	200	420	400	1000	690
Total Suspended Solids (TSS)	mg/L	200	60	60	40	20	90	360	120	280	10	210	100	700	290	330	350
Chloride	mg/L as Cl^{-1}	1000	35	20	15	30	5	100	35	85	25	40	30	75	55	225	125
Sulphate	mg/L as SO_4^{-2}	600	20	41	41	32	41	158	127	91	38	78	28	94	115	164	112
Sulfide	mg/L	1.0	0.0	0.0	0.0	0.0	0.0	8.0	8.0	12	0.0	8.0	4.0	16.0	0.0	0.0	16.0
Fluoride	mg/L as F^-	10	0.380	0.449	0.486	0.557	0.588	0.570	0.466	0.650	0.660	0.633	0.532	0.811	0.610	0.424	0.895
Cyanide	mg/L as CN^-	1.0	0.350	0.007	0.373	0.407	0.000	0.000	50	0.819	0.000	0.000	0.000	0.000	0.274	2.800	0.000
Manganese (Mn)	mg/L	1.5	0.093	0.066	0.053	0.015	0.071	0.101	1.573	0.261	0.198	0.101	0.080	0.106	0.232	0.421	0.086
Copper (Cu)	mg/L	1.0	0.046	0.050	0.023	0.025	0.057	0.060	0.085	0.253	0.046	0.050	0.052	0.040	0.092	0.189	0.035
Cadmium (Cd)	mg/L	0.1	0.007	0.004	0.000	0.000	0.008	0.031	0.006	0.012	0.021	0.023	0.021	0.037	0.009	0.009	0.036
Chromium (Cr)	mg/L	1.0	0.000	0.022	0.022	0.003	0.330	0.010	0.073	0.000	0.066	0.008	0.000	0.015	0.000	0.176	0.000
Zinc (Zn)	mg/L	5.0	0.021	0.010	0.003	0.000	0.047	0.047	0.050	1.077	0.700	0.053	0.051	0.085	0.291	1.809	0.210
Iron (Fe)	mg/L	8.0	0.862	1.174	0.828	0.086	0.938	1.350	1.727	9.387	0.681	2.390	1.700	2.120	5.509	7.712	1.247
Nickel (Ni)	mg/L	1.0	0.000	0.000	0.004	0.000	0.207	0.012	0.226	0.051	0.000	0.000	0.020	0.058	0.000	0.275	0.020

Parameters	Unit	NEQS	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25	S26	S27	S28	S29	S30
			River Ravi D/S of Furikhabad Drain	Main Outfall Drain	Giulshan-e-Ravi Drain	River Ravi after Main Outfall Drain	Babu Sabu Drain	River Ravi after Babu Sabu Drain	Hudiara Drain	River Ravi after Hudiara Drain	Upper Chenab Canal	River Ravi D/S of Upper Chenab Drain	River Ravi U/S of QBLC	QBLC	River Ravi D/S of QBLC	River Ravi U/S of Deg Nullah	Deg Nullah
Temperature	ºC	=<3ºC	22.2	23.2	22.5	16.1	17.6	18.0	17.8	17.8	19.9	21.95	20.87	21.79	21.9	22.59	21.9
Value of pH		6-9	8.1	7.2	7.58	7.8	7.5	8.77	7.90	8.12	7.2	7.54	7.50	7.76	7.70	8.27	7.62
Dissolved Oxygen	mg/L	-	4.50	1.01	0.83	1.17		7.50	0.91	1.16	1.20	4.20	2.45	5.89	4.20	6.23	0.54
Biochemical Oxygen Demand (BOD_5)	mg/L	80	2.7	412	112	16	312	88	120	48	168	24	12.6	2.4	1.4	3.2	360
Chemical Oxygen Demand (COD)	mg/L	150	25.8	1392	312	52	920	210	396	140	747	85	38.4	7.2	19.8	9.6	1280
Total Dissolved Solids (TDS)	mg/L	3500	180	560	660	330	660	470	1020	500	600	400	280	140	200	170	2920
Total Suspended Solids (TSS)	mg/L	200	510	240	20	20	30	10	100	10	40	10	80	60	10	110	60
Chloride	mg/L as Cl^{-1}	1000	10	80	50	45	90	90	200	95	135	40	45	10	10	10	845
Sulphate	mg/L as SO_4^{-2}	600	57	115	84	54	140	110	260	78	193	98	54	32	106	40	390
Sulfide	mg/L	1.0	0.0	20	4.0	0.0	0	0.0	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40
Fluoride	mg/L as F^-	10	0.461	0.578	1.060	0.000	0.005	0.010	0.162	0.180	0.212	0.176	0.553	0.365	0.113	0.378	0.395
Cyanide	mg/L as CN^-	1.0	0.000	0.842	0.000	0.000	0.000	0.000	11.600	0.000	2.500	0.900	1.000	0.862	0.754	0.720	0.076
Manganese (Mn)	mg/L	1.5	0.074	0.163	0.215	0.062	0.416	0.322	0.516	0.239	0.667	0.231	0.132	0.034	0.370	0.044	0.451
Copper (Cu)	mg/L	1.0	0.053	0.223	0.049	0.049	0.263	0.190	0.320	0.210	0.070	0.044	0.070	0.049	0.047	0.054	0.068
Cadmium (Cd)	mg/L	0.1	0.005	0.006	0.003	0.001	0.000	0.000	0.016	0.004	0.000	0.000	0.004	0.000	0.000	0.000	0.000
Chromium (Cr)	mg/L	1.0	0.000	0.058	0.032	0.024	0.015	0.002	0.058	0.003	0.037	0.095	0.040	0.016	1.839	0.018	0.064
Zinc (Zn)	mg/L	5.0	0.044	0.286	0.940	0.039	1.310	0.082	0.140	0.091	0.044	0.021	0.014	0.001	0.014	0.000	0.009
Iron (Fe)	mg/L	8.0	0.943	1.794	1.390	0.846	6.230	1.672	0.089	1.435	0.422	0.345	0.489	0.370	0.059	0.557	4.047
Nickel (Ni)	mg/L	1.0	0.012	0.128	0.029	0.018	0.021	0.028	0.163	0.031	0.218	0.221	0.006	0.005	0.202	0.000	0.015

Source: "Monitoring of River Ravi", EPA Laboratories, Environmental Protection Department, November 2008

MRLC: Marala Ravi Link Canal QBLC: Qadirabad Balloki Link Canal U/S: Upstream D/S: Downstream

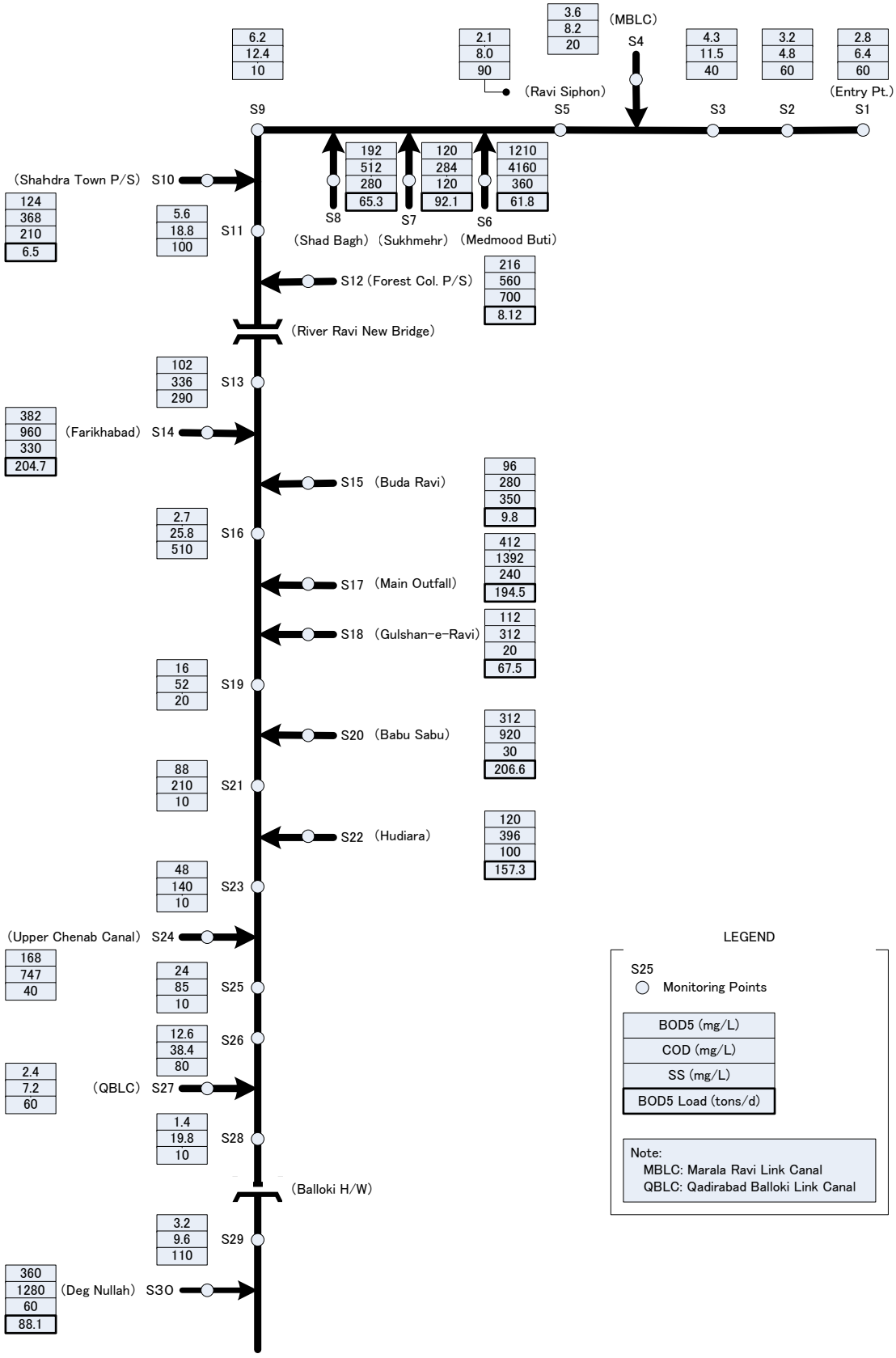


Figure 3.15(4) Water Quality (BOD_5, COD and SS) and BOD_5 Load along River Ravi

(3) "Environmental Profile of Lahore (2007-08)", Environmental Department, City District Government Lahore

The following is the abstraction from the above reference on the present condition of the River Ravi:

- The wide variety of fish that once swam in the Ravi has vanished, as have the tiny minnows and crabs children used to catch in the shallow waters along the banks. Even the reeds that used to line the river have gone. The river is virtually dead even when the normally dry bed carries water, such as after the rains.

- At present, the major downstream use of the River Ravi is for irrigation beyond the Balloki Headworks. However, the population and economic activities in the immediate areas along the river from Lahore to Balloki Headworks (64 km) are affected in different degrees by pollution in the river. It is estimated that waste water (domestic and industrial) from Lahore will increase significantly as a proportion of total flow in the river. In a one in twenty year minimum monthly flow, wastewater from Lahore accounted for about 47 percent of total flow in 1987, rising to about 68 percent in 2007.

- The area irrigated with raw sewage from the city's outfalls is estimated at 800 to 1,000 hectares. The main crops grown on this land are vegetables which are marketed in Lahore. The most serious threat posed by wastewater irrigation was to public health. In order to reduce this risk, suitable sewage treatment facilities would be required to reduce bacteriological contamination when recycling the effluent for irrigation purposes.

- Historically, the River Ravi has not been used as a major source of potable water. Most communities in the area, including Lahore, are dependent on ground water as the major source of drinking water. In the rural areas of districts which border the river from Lahore to Balloki Headworks, only 0.3 percent of households are dependent on open surface watercourses (river, springs and streams) for their drinking water. This represents about 1,700 households and 10,600 people. There are no known plants to use the River Ravi as a major water supply source.

- During the dry season, this discharge may exceed the river's own base flow. As Ravi is also one of the sources of recharge to the ground water aquifer of Lahore, the disposal of untreated effluents including toxic metals etc. into the river may have negative impacts on the ground water quality of Lahore.

Appendix 4.1

Abstraction from the Lahore Development Authority Act Concerned with the WASA

6 Powers and Functions of the Authority

(iii) develop, operate and maintain water-supply sewerage and drainage systems within the service area of the Water and Sanitation Agency to be established under Section 10(2) of this Act;

10 Delegation

(2) The Authority shall establish, by special order, an Agency, hereinafter called the Water and Sanitation Agency.

(3) Save as provided in Sections 13, 14, 19, 22, 23, 24 and 28 of this Act and the matters specified in the Schedule, the Agency established under sub-section (2) shall perform all functions and exercise all powers of the Authority with regard to water supply, sewerage and drainage with power to collect rates, fees and charges for water supply, sewerage and drainage.

(4) The Managing Director of the Water and Sanitation Agency and other Agencies shall:

(a) be appointed by Government on such terms and conditions as may be determined by Government:

(b) hold office for a period of three years and will be responsible for its administration in accordance with such powers as shall be prescribed; and

(c) remain in office for three months thereafter or until a successor in that office is appointed, whichever is earlier.

(5) Nothing in this section shall preclude the Government from extending the term of office of the Managing Director for such period as the Government may determine.

(6) Notwithstanding anything contained in this Act, the Managing Director may, at any time before the expiry of his term and upon three months notice, resign his office or upon similar notice be removed by Government without assigning any person:

Provided that Government may, upon payment of three months salary and allowances, in lieu of the notice, remove him immediately without assigning any reason.

27 Lahore Development Authority Fund

(1) There shall be formed a fund to be known as the "LAHORE DEVELOPMENT AUTHORITY FUND" which shall vest in the Authority and shall be utilized by the Authority in connection with its functions under this Act including the payment of salaries and other remunerations to the members, officers, servants, experts and consultants of the Authority.

(2) To the credit of the LAHORE DEVELOPMENT AUTHORITY FUND, shall be credited -

(a) grants and loans made by the Government;

(b) all moneys received from Federal Government or any international agency by way of grants, loans, advances or otherwise;

(c) all fees, rates and charges received by the Authority under the Act;

(d) all moneys received by the Authority from the disposal of lands, buildings and other properties movable and immovable;

(e) proceeds from the self-financing schemes of urban development and environmental sanitation; and

(f) all other sums receivable by the Authority

(3) The aforesaid sums in respect of services related to water supply, sewerage and drainage shall be credited separately to the Head "Water Supply and Sanitation" and all other sums to the Head "Urban Development". The sums credited to the Head "Water Supply and Sanitation" shall be exclusively utilized for the purposes of water supply, sewerage and drainage.

(4) In case of deficit revenue of the Authority, the Government shall provide from its own revenues or from any other sources, such sum as may be necessary for the efficient performance of the functions of the Authority under this Act.

(5) The Authority may keep in current account of any scheduled bank such sums as may be prescribed and any amount in excess of the said amount shall be invested in Government securities, Government sponsored saving schemes or in such manner as may be determined by the Authority.

Explanation-For the purpose of this sub-section, Government includes Federal Government.

28 Rates and Fees

(1) With the previous consent of the Government adequate funds may be raised by the Authority from time to time, to meet the cost of its schemes by imposing rates, fees and other charges.

(2) The rates, fees and other charges for water supply, sewerage and drainage schemes shall be such as to provide sufficient revenues-

(i) to cover the operating expenses including taxes, if any, an interest to provide adequate maintenance and depreciation;

(ii) to meet repayments on long term indebtedness to the extent that such repayments exceed the provision of depreciation;

(iii) to finance the normal year to year extension of any of such schemes and to provide a reasonable portion of the cost of future major expansion of such schemes.

29 Fees on Tube-wells

(1) The Authority shall have the exclusive right to use ground water resources within the area.

(2) No person shall, without the permission of the Authority, install a tube-well at such places within the Area as may be notified from time to time in the official Gazette by the Authority.

47 Succession

On the establishment of the Authority under this act-

(i) all functions and powers with respect to the formulation, sanction and execution of schemes, and all functions with regard to water supply, sewerage and drainage within the area, heretofore performed by the Lahore Improvement Trust, shall be exercised and performed by the Authority.

(ii) all properties, assets and liabilities pertaining to the Lahore Improvement Trust shall vest in and be the liabilities, as the case may be, of the Authority.

Appendix 4.2 Sewage Rate in Non WASA Jurisdiction

Table Sewage Rate in Non WASA Jurisdiction

	WASA Area	Non-WASA Area						
		Lahore Cantonment Board	Walton Cantonment Board	Defense Housing Authority	Model Town Society	Pakistan Railways	Private Developers	TMAs
Sewerage Charge		ARV<500 Rs.48/month Rs.500≤ARV<Rs.1,000 Rs.72/month Rs.1,000≤ARV<Rs.2,000 Rs.96/month Rs.2,000≤ARV<Rs.3,000 Rs.120/month Rs.3,000≤ARV<Rs.4,000 Rs.144/month Rs.4,000≤ARV<Rs.20,000 Rs.180/month Rs.20,000≤ARV Rs.200/month			Member of MTC Rs.40/month Non-member Rs.80/month Commercial Rs.75/month	No charge		No charge

Appendix 5.1 Groundwater Recharge System Using Treated Wastewater

There are three types of groundwater recharge systems or (a) surface spreading basin, (b) vadose zone injection well and (c) direct injection well of which technical characteristics are shown **Table 1**. It should be noted that the type applicable to confined aquifer is limited to direct injection well only.

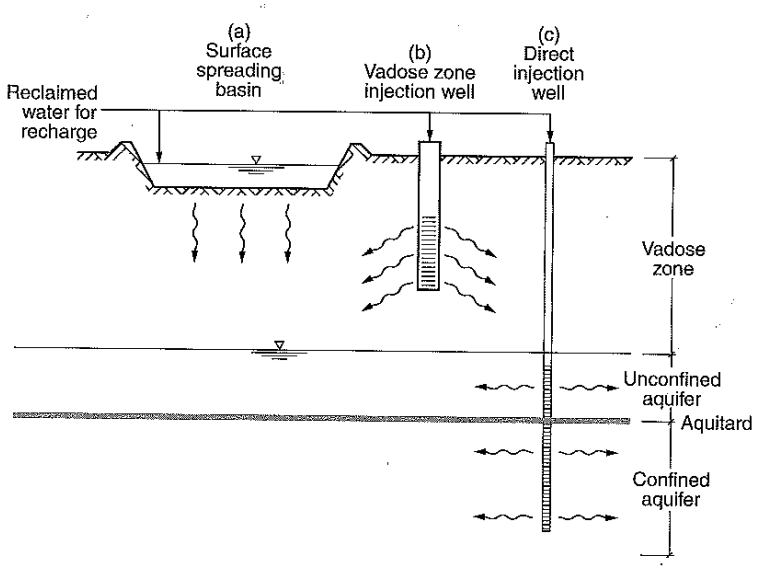


Figure 1 Groundwater Recharge System

Source: Metcalf & Eddy / AECOM, "Water Reuse – Issues, Technologies, and Applications", The McGraw-Hill Companies, 2007

Source:

Figure 2 Groundwater Recharge System

Table 1 Characteristics of Principle Aquifer Recharge Methodologies

Characteristic	Recharge basins	Vadose zone injection wells	Direct injection wells
Location where treatment occurs	Vadose zone and saturated zone	Vadose zone and saturated zone	Saturated zone
Aquifer type	Unconfined	Unconfined	Unconfined or confined
Pretreatment requirements	Secondary treatment[a]	Secondary treatment plus filtration[a]	Advanced treatment
Capacity	1,000-20,000 m3/ha·d	1,000—3000 m3/well·d	2,000-6,000 m3/well·d
Maintenance requirements	Drying and scraping	Drying and disinfection	Disinfection and flow reversal
Estimated life cycle	>100 yr	5-20 yr	25-50 yr
Estimated major capital costs [b], US$	Land and distribution system	$100,000-150,000 per well	$100,000-1,500,000 per well

*Source: Same as **Figure***

Table 2 Advantages and disadvantages of various groundwater recharge methods

Advantages	Disadvantages
Surface spreading	
• Relatively easy to construct and operate • Primary or secondary levels of pretreatment may be satisfactory	• Large land area required • Limited availability of suitable sites; Soil characteristics are very important in site selection • Wetting and drying cycles required to maintain infiltration rates as well as vector control • Periodic bed maintenance required • Some evaporation losses from open water • Algae growth may affect clogging
Vadose zone injection	
• Relatively small site required • Negligible evaporation losses • Less expensive technology than direct injection wells • Greater potential for water quality improvement as compared to direct injection wells	• Relatively new technology • Only short-term life cycle data available • Soil characterization required • Special design and construction of well is necessary • Extensive pretreatment of wastewater is to prevent clogging with solids and development of microbial growth • No effective method available to redevelop clogged well
Direct injection	
• Relatively small site required • May be used for both injection and extraction of reclaimed water • High rate of reclaimed water injection	• Relatively expensive to construct • Energy intensive; high pressure pumping for reclaimed water injection • Design and construction requires greater than vadose

• Flow in well can be reversed for maintenance and redevelopment of well • Can be designed to recharge multiple aquifers	zone injection wells • Extensive pretreatment of wastewater is to prevent clogging with solids and development microbial growth; may require a higher treatment than vadose zone injection wells • Limited additional improvement in water be expected

*Source: Same as **Figure** 1*

More than 400 tube-wells of WASA abstract groundwater from the confined aquifer beneath confined unit while private tube-wells in housing estates are found to withdraw it from the unconfined aquifer above confined unit Therefore, a groundwater recharge system into the confined aquifer is the object in this case and is limited to the direct injection well.

Possible direct injection well is composed of the following facilities:

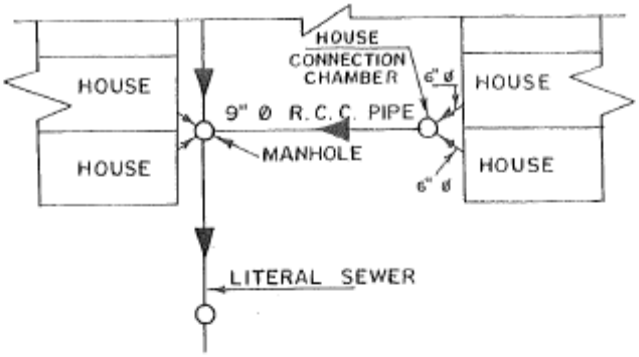
Advanced wastewater treatment facilities → Distribution network → Injection wells

The EPA's "guidelines for Water Reuse says that the direct injection system require water quality comparable to drinking water, if potable aquifers are affected, and treatment processes beyond secondary treatment that are used prior injection includes disinfection, filtration, air stripping, ion exchange, granular activated carbon and reverse osmosis or other membrane separation processes.

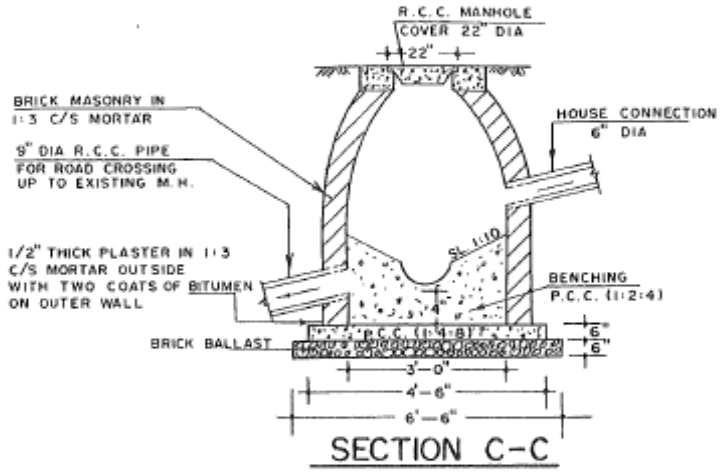
For direct injection, locating the extraction wells as great a distance as possible from the recharge site increases the flow path length and residence time in the underground as well as the mixing of the recharged water with the natural groundwater. Although the well can be dual used for extraction and injection, In case of the use for recharge purpose only, the almost same number of injection wells as the extraction wells will be necessary due the limitation of a capacity per well which require the installation of a water distribution network from the additional treatment facilities for treated wastewater to the direct injection wells.

Hence, It is unavoidable that groundwater recharge of treated wastewater into the confined aquifer will be significantly costly and considered financially not feasible.

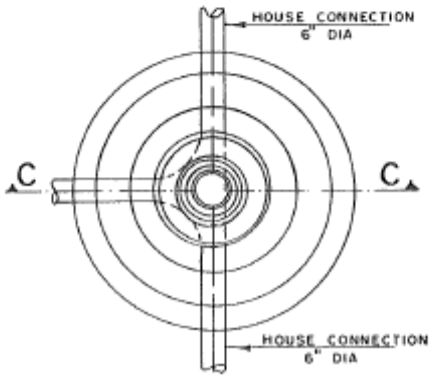
Appendix 5.2 Typical drawing of house connection



TYPICAL HOUSE CONNECTION DETAIL



SECTION C-C



TYPICAL HOUSE CONNECTION CHAMBER

Source: WASA

Appendix 5.3 Inundation Data of Critical Locations (Year 2007)

S. No.	Location	Corresponding Disposal Station (DS), Lift Station (LS) and Main Drain	Date: 15 Jun. 2007 Time: 7:15AM - 12:15PM Rain Record Jail Road: 31 mm Air Port: 18 mm		Date: 17 Jun. 2007 Time: 6:20AM - 14:45PM Rain Record Jail Road: 72 mm Air Port: 41 mm		Date: 29 Jun. 2007 Time: 5:40AM - 13:15PM Rain Record Jail Road: 32 mm Air Port: 8.4 mm		Date: 22 Jul. 2007 Time: 17:25PM - 19:55PM Rain Record Jail Road: 20 mm Air Port: 23 mm		Date: 23 Aug. 2007 Time: 13:40PM - 15:30PM Rain Record Jail Road: 28 mm Air Port: 11 mm		Date: 6 Sep. 2007 Time: 10:10AM - 11:20AM Rain Record Jail Road: 32 mm Air Port: 28 mm	
			Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)
1	Laxami Chowk	Main Outfall No.1 and No.3 DS	1.0		8.5	0.30	11.3	0.84	2.5	0.20	4.3	0.43	7.3	0.61
2	GPO	Main Outfall No.1 DS	1.0		4.0	0.30	8.0	0.30					2.8	0.30
3	Kashmir Road	Main Outfall No.1 DS	5.3	0.23	11.0	0.23	16.0	0.46	2.0	0.08	5.4	0.43	6.3	0.30
4	Thorton Road	Main Outfall No.1 DS	4.0	0.05	9.0		10.8	0.81	2.3	0.05	1.5	0.10	4.0	0.76
5	Cooper Road	Main Outfall No.1 DS	3.0	0.15	7.5		11.5	0.30	2.5	0.05				0.20
6	Bashir Sons	Main Outfall No.1 DS	1.0		8.0	0.46	9.0	0.46	2.0	0.05			3.5	0.23
7	Rehman Gallian	Mochi Gate LS→Batti Gate DS			12.0									0.20
8	Do Moria Pul	Shad Bagh/Khokhar Road DS	3.5	0.10	5.5	0.15	9.5	0.23	3.0	0.08	5.0	0.08	5.0	0.61
9	Lytton Road	Lytton Road LS→Central Drain												
10	Plaza Cinema	Main Out Fall No. 1	5.0	0.30	11.5	0.46	11.0	0.53	3.0	0.30			3.8	0.25
11	Nabha Road	Gulshan-E-Ravi DS, Lytton Road LS	3.0	0.23	8.0	0.38	9.5	0.53	3.0	0.38	1.0	0.10	3.8	0.15
12	Church Road	Planetarium LS												
13	Mozang Chungi (Chowk Qurtaba)	Gulshan-E-Ravi DS												
14	Shadman/Shah Jamal	Gulshan-E-Ravi DS												
15	Waris Road	Gulshan-E-Ravi DS												
16	Galaxy Plaza	Gulshan-E-Ravi DS												
17	Park Lane Road	Center Point LS→Gulshan e Ravi DS			12.0		16.0	0.20		0.10				
18	Chauburji	Gulshan-E-Ravi DS	2.5		4.0		8.0	0.15					2.8	
19	Lake Road	Chauburji LS→Central Drain	2.5	0.15	8.0		8.5	0.08					3.8	0.10
20	PU Ground, HCC	Planetarium LS→Central Drain												
21	Rewaz Garden	Gulshan-E-Ravi DS												
22	Sanda Road	Gulshan-E-Ravi DS												
23	Fazlia Colony	Shadman LS→Cantonment Drain												
24	SSP Office Dev Samaj Road	Main Outfall No.1 DS												
25	Malik Park	Main Outfall No.2 DS												
26	Nasir Park (Tonga Adda)	Main Outfall No.3 DS												
27	Secondary Board	Gulshan-E-Ravi DS												
28	Firdous Market	Makka Colony LS→Sattu Katla Drain					13.6	0.20	2.0	0.13	2.0	0.13		
29	Kalma Chowk	Nursery LS, Usman Block LS→Sattu Katla Drain												
30	Central Point	Center Point LS→Gulshan-E-Ravi DS												
31	Gari Shahu	Main Outfall No.1 DS												
32	Muhammad Nagar	Muhammad Nagar LS→Railway Drain												
33	Bibi Pak Daman	Muhammad Nagar LS→Railway Drain												
34	Empress Road	Main Outfall No.1 DS	2.0		6.5	0.1016	12.0	0.53		0.05			7.8	0.46
35	Railway Station	Main Outfall No.1 DS												
36	Akbar Chowk	Johar Town LS→Sattu Katla Drain												
37	Hussain Chowk	Gurumangat LS→Cantt. Drain												
38	Barkat Market	Usman Block LS→Sattu Katla Drain												
39	L-Block Gulberg	LMP Block DS→Sattu Katla Drain												
40	Tipu Block Garden Town	LMP Block DS→Sattu Katla Drain												
41	Model Town Link Road	LMP Block DS→Sattu Katla Drain												
42	Mini Market Gulberg	Gulshan-E-Ravi DS												
43	Aik Moria Pul	Shad Bagh / Khokhar Road DS	3.5	0.05	6.0	0.20	8.0	0.23	2.3	0.08	5.0	0.08	5.0	0.61
44	Rahim Road	Shad Bagh / Khokhar Road DS	3.5	0.08	5.5	0.15	8.8	0.23	3.0	0.08	5.0	0.08	5.0	0.61
45	Aziz Road	Shad Bagh / Khokhar Road DS	3.0	0.08	4.0	0.30	6.0	0.20			5.0		4.0	0.15
46	Umer Din Road	Shad Bagh / Khokhar Road DS	3.0	0.05	7.0	0.30	12.0	0.41	3.3	0.18			6.8	0.69
47	Chowk Na-Khuda	Shad Bagh / Khokhar Road DS	3.0	0.05	5.0	0.38	8.8	0.41	3.3	0.08	5.0	0.25	5.0	0.76
48	Shairanwala Gate	Main Outfall No.2 DS	1.0		3.0		7.0	0.15	2.3	0.20				
49	O/S Bhati Gate	Bhati Gate LS	1.0	0.10	6.5	0.38	8.5	0.91	2.3	0.15			4.0	0.61
50	Main Road, Shahdara	Farrukhabad DS	4.0	0.15	14.0									
51	Lajpat Road Shahdara	Farrukhabad DS												
52	Timber Market	Forest Colony LS												
53	Haq Nawaz Road	Mehmood Booti DS	2.0	0.15	15.5	0.30	8.0	0.30			2.0	0.08		0.10
54	Toheed Park	Toheed Park LS→Shalimar Escape Channel	1.0		6.0	0.15	8.0	0.23			4.0	0.15	4.0	0.25
55	Milap Street	What Man Road LS→Upper Chotta Ravi PS	1.0		3.5	0.18	7.0	0.30			2.0	0.20	1.8	0.10
56	Angoori Cinema (Shalimar Link Road)	What Man Road LS→Upper Chotta Ravi PS												
57	Police Station (Mughalpura)	Shalimar Link Road LS→Shalimar Escape Channel												
58	Shah Kamal Road	Shah Kamal Road LS→Shalimar Escape Channel	1.0		6.0	0.15	7.0	0.23			4.0	0.15	4.0	0.25
59	Yammi 36, Begum Pura	Wheat Man Road LS→Upper Chotta Ravi PS	1.0		5.5	0.30	7.0	0.30			4.3	0.20	3.5	0.61
60	Bagheechi Saithan	Wheat Man Road LS→Upper Chotta Ravi PS	1.0		3.0	0.15	3.5				3.3	0.15	3.0	0.30
61	UET G.T. Road	Wheat Man Road LS→Upper Chotta Ravi PS	1.0		5.5	0.23			2.0	0.08	4.3	0.20	5.0	0.30
62	Scheme More	Multan Road DS	1.0		3.0		8.3	0.13						
63	Rachna Block Road	Multan Road DS												
64	Al-Hamad Colony	Multan Road DS												
65	H-Block Sabzazar	Multan Road DS												
66	Poonch Road	Gulshan-E-Ravi DS												
67	Millat Chowk	Gulshan-E-Ravi DS												
68	Multan Road Bhalla Stop	Gulshan-E-Ravi DS												
69	Sultan Ahmed Road Rehmanpura	Gulshan-E-Ravi DS												
70	Zaildar Road Ichhra	Gulshan-E-Ravi DS												
71	Chowk Yateem Khana	Multan Road DS												
72	Infantory Road	Infantory Road LS→Cantt. Drain												
73	Allama Iqbal Road Mustafabad	Infantory Road LS→Cantt. Drain												
74	B-Block Tajpura	Tajpura LS→Shalimar Escape Channel												

Appendix 5.3 Inundation Data of Critical Locations (Year 2008)

S. No.	Location	Corresponding Disposal Station (DS), Lift Station (LS) and Main Drain	Date: 5 Apr. 2008 Time: 8:00AM - 14:50PM Rain Record Jail Road: 27 mm Air Port: 16 mm		Date: 5 Jun. 2008 Time: 16:05AM - 22:30PM Rain Record Jail Road: 16 mm Air Port: 4 mm		Date: 20 Jun. 2008 Time: 9:00AM - 10:00AM Rain Record Jail Road: 9 mm Air Port: 9 mm		Date: 29 Jun. 2008 Time: 7:00AM - 14:30PM Rain Record Jail Road: 16 mm Air Port: 70 mm		Date: 12 Jul. 2008 Time: 7:30AM - 12:15PM Rain Record Jail Road: 86 mm Air Port: 70 mm		Date: 13 Jul. 2008 Time: 7:15AM - 15:15PM Rain Record Jail Road: 6 mm Air Port: 28 mm		Date: 30 Jul. 2008 Time: 13:40PM - 17:00PM Rain Record Jail Road: 21 mm Air Port: 68 mm		Date: 3 Aug. 2008 Time: 11:50AM - 12:50PM Rain Record Jail Road: 23 mm Air Port: 10 mm		Date: 7 Aug. 2008 Time: 0:00AM - 12:40PM Rain Record Jail Road: 62 mm Air Port: 0 mm		Date: 11 Aug. 2008 Time: 14:00PM - 15:00PM Rain Record Jail Road: 38 mm Air Port: 44 mm		Date: 16 Sep. 2008 Time: 13:15PM - 14:45PM Rain Record Jail Road: 7.4 mm Air Port: 9.2 mm	
			Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)
1	Laxami Chowk	Main Outfall No.1 and No.3 DS							7.0	0.41	8.5	1.04	12.0	0.36	7.5	0.71	5.0	0.64			5.3	0.66	3.3	0.18
2	GPO	Main Outfall No.1 DS			2.3	0.05			3.0		5.3	0.08	8.8	0.13	3.8	0.30	2.0	0.18	12.5	0.08	2.3	0.25	1.5	0.03
3	Kashmir Road	Main Outfall No.1 DS		0.13				0.08	7.0	0.08	10.3	0.38	9.3	0.10	3.3	0.46	6.0	0.25	15.5	0.25	4.5	0.61	3.3	0.13
4	Thorton Road	Main Outfall No.1 DS							3.0		6.5	0.25	6.5		3.8	0.08	2.8	0.23	11.5	0.08	1.8	0.30	1.3	
5	Cooper Road	Main Outfall No.1 DS		0.08					4.0	0.15	8.5	0.30	8.5	0.08	6.0	0.46	4.0	0.30	12.5	0.15	4.5	0.43	3.0	0.15
6	Bashir Sons	Main Outfall No.1 DS			1.0	0.05			3.5	0.03	6.0	0.23	6.5		3.8	0.23	3.0	0.18	12.5	0.08	2.8	0.03	1.5	0.03
7	Rehman Gallian	Mochi Gate LS→Batti Gate DS						0.05	8.5	0.23	10.3	0.20	10.5	0.10	7.5	0.61	7.8	0.46			4.0	0.30	3.3	0.20
8	Do Moria Pul	Shad Bagh/Khokhar Road DS		0.08	1.3	0.03		0.10	8.3	0.15	5.5	0.25	7.8	0.10	4.3	0.46	3.5	0.46	12.0		6.8	0.23	4.0	0.13
9	Lytton Road	Lytton Road LS→Central Drain																			2.8			
10	Plaza Cinema	Main Out Fall No. 1		0.15	3.0	0.15		0.13	7.3	0.30	9.0	0.15	6.5		4.5	0.46	3.3	0.30	16.3		4.0	0.61	2.3	0.08
11	Nabha Road	Gulshan-E-Ravi DS, Lytton Road LS		0.08					3.5		4.3		6.5	0.30	4.5	0.46	3.0	0.08	13.5			0.30	1.0	0.05
12	Church Road	Planetarium LS																	13.5		2.5			
13	Mozang Chungi	Gulshan-E-Ravi DS								0.25		0.25					2.3		17.5					
14	Shadman/Shah Jamal	Gulshan-E-Ravi DS															2.3		14.0		2.3			
15	Waris Road	Gulshan-E-Ravi DS															1.8		17.0					
16	Galaxy Plaza	Gulshan-E-Ravi DS																	11.8					
17	Park Lane Road	Center Point LS→Gulshan e Ravi DS							3.5		3.5		3.5		9.3	0.13	3.5	0.15			5.5			
18	Chauburji	Gulshan-E-Ravi DS							7.0		12.3		6.8		6.0		3.3		13.0		5.5			
19	Lake Road	Chauburji LS→Central Drain							7.0		12.5		6.8		7.0		2.8		13.0		0.3			
20	PU Ground, HCC	Planetarium LS→Central Drain															3.3							
21	Rewaz Garden	Gulshan-E-Ravi DS															3.8		17.3					
22	Sanda Road	Gulshan-E-Ravi DS															3.3		17.3		2.8			
23	Fazlia Colony	Shadman LS→Cantonment Drain															4.3							
24	SSP Office Dev Samaj Road	Main Outfall No.1 DS															3.8							
25	Malik Park	Main Outfall No.2 DS															3.3							
26	Nasir Park (Tonga Adda)	Main Outfall No.3 DS									10.0		10.0				3.5							
27	Secondary Board	Gulshan-E-Ravi DS							7.5		7.5		7.5				3.5		17.0					
28	Firdous Market	Makka Colony LS→Sattu Katla Drain			4.0	0.08			7.0		12.0	0.30		0.30	4.8	0.15	4.5	0.25	15.0		0.5		1.0	
29	Kalma Chowk	Nursery LS, Usman Block LS→Sattu Katla Drain															4.5		13.0					
30	Central Point	Center Point LS→Gulshan-E-Ravi DS											19.5	0.30			4.5		13.5					
31	Gari Shahu	Main Outfall No.1 DS											15.5	0.25		0.46	5.8		15.5	0.05		0.46		
32	Muhammad Nagar	Muhammad Nagar LS→Railway Drain																	13.5					
33	Bibi Pak Daman	Muhammad Nagar LS→Railway Drain													6.3		3.3		13.5		4.0	0.30		
34	Empress Road	Main Outfall No.1 DS						0.10	3.0		8.5	0.25	10.5				4.8	0.46	13.5		5.0	0.30	3.3	0.15
35	Railway Station	Main Outfall No.1 DS															3.0				1.8			
36	Akbar Chowk	Johar Town LS→Sattu Katla Drain															2.8							
37	Hussain Chowk	Gurumangat LS→Cantt. Drain											15	0.25			4.5		13.0		0.5			
38	Barkat Market	Usman Block LS→Sattu Katla Drain																	12.5		0.5			
39	L-Block Gulberg	LMP Block DS→Sattu Katla Drain																	12.8					
40	Tipu Block Garden Town	LMP Block DS→Sattu Katla Drain																	11.8		0.5			
41	Model Town Link Road	LMP Block DS→Sattu Katla Drain																	13.3		0.5			
42	Mini Market Gulberg	Gulshan-E-Ravi DS																	13.0		1.0			
43	Aik Moria Pul	Shad Bagh / Khokhar Road DS		0.05				0.10		0.25	5.5	0.25	5.3	0.61	6.5		3.5	0.61			3.8	0.23	4.8	0.10
44	Rahim Road	Shad Bagh / Khokhar Road DS						0.10	7.0	0.46	5.5	0.25	4.3	0.46			2.8	0.46			2.5	0.20	1.3	0.05
45	Aziz Road	Shad Bagh / Khokhar Road DS						0.20	7.0	0.46	12.0	0.46	7.0	0.46			6.3	0.46			1.0	0.20	3.3	0.08
46	Umer Din Road	Shad Bagh / Khokhar Road DS						0.10	11.0	0.46	10.5	0.46	7.0	0.61			5.5	0.46			3.8	0.30	3.3	0.05
47	Chowk Na-Khuda	Shad Bagh / Khokhar Road DS						0.08	11.0	0.46	10.5		7.5	0.46	6.5		2.8	0.46			3.8	0.46	3.3	0.05
48	Shairanwala Gate	Main Outfall No.2 DS		0.08					5.3		5.5	0.15	3.5	0.15	6.8		3.5	0.15			1.0	0.30		
49	O/S Bhati Gate	Bhati Gate LS		0.08					6.8		7.5	0.30	6.0	0.76	6.8	0.08	2.5	0.15			3.0	0.46		
50	Main Road, Shahdara	Farrukhabad DS																						
51	Lajpat Road Shahdara	Farrukhabad DS																						
52	Timber Market	Forest Colony LS																						
53	Haq Nawaz Road	Mehmood Booti DS						0.10	6.5	0.30	5.5	0.15	5.5	0.30	6.5		0.8					0.30		
54	Toheed Park	Toheed Park LS→Shalimar Escape Channel							6.5	0.25	5.5	0.15	5.5	0.30	6.5		0.8				1.3			
55	Milap Street	What Man Road LS→Upper Chotta Ravi PS						0.10	6.5	0.30	5.0	0.05	5.8	0.30	6.5		0.8					0.23		
56	Angoori Cinema (Shalimar Link Road)	What Man Road LS→Upper Chotta Ravi PS															0.8							
57	Police Station (Mughalpura)	Shalimar Link Road LS→Shalimar Escape Channel									5.8	0.15	5.0				1.3							
58	Shah Kamal Road	Shah Kamal Road LS→Shalimar Escape Channel							6.5	0.25	5.5	0.15	5.5	0.30	6.5		0.8				1.3			
59	Yammi 36, Begum Pura	Wheat Man Road LS→Upper Chotta Ravi PS						0.10	6.5	0.30	6.0	0.23	5.8	0.30	6.5		0.8				1.0			
60	Bagheechi Saithan	Wheat Man Road LS→Upper Chotta Ravi PS						0.15	6.5	0.23	4.0	0.08	3.5	0.30	6.5		0.8				1.5	0.23		
61	UET G.T. Road	Wheat Man Road LS→Upper Chotta Ravi PS							6.5	0.23	8.3	0.23	5.8	0.30	6.5		0.8				5.5	0.76		
62	Scheme More	Multan Road DS											5.5				1.8		14.0		1.5			
63	Rachna Block Road	Multan Road DS															2.0		14.0		2.5			
64	Al-Hamad Colony	Multan Road DS															1.8		13.0		2.8			
65	H-Block Sabzazar	Multan Road DS															1.8							
66	Poonch Road	Gulshan-E-Ravi DS															1.8							
67	Millat Chowk	Gulshan-E-Ravi DS															2.3							
68	Multan Road Bhalla Stop	Gulshan-E-Ravi DS															1.3							
69	Sultan Ahmed Road Rehmanpura	Gulshan-E-Ravi DS															3.8							
70	Zaildar Road Ichhra	Gulshan-E-Ravi DS															3.8							
71	Chowk Yateem Khana	Multan Road DS															1.3				2.5			
72	Infantory Road	Infantory Road LS→Cantt. Drain																						
73	Allama Iqbal Road Mustafabad	Infantory Road LS→Cantt. Drain																						
74	B-Block Tajpura	Tajpura LS→Shalimar Escape Channel																						

Appendix 5.3 Inundation Data of Critical Locations (Year 2009)

S. No.	Location	Corresponding Disposal Station (DS), Lift Station (LS) and Main Drain	Date: 22 Jul. 2009 Time: 16:30PM - 17:30PM Rain Record Jail Road: 45 mm Air Port: 11 mm		Date: 24 Jul 2009. Time: 6:30AM - 12:30PM Rain Record Jail Road: 4 mm Air Port: 16 mm		Date: 31 Jul. 2009 Time: 0:10AM - 1:25AM Rain Record Jail Road: 1 mm Air Port: - mm		Date: 1 Aug. 2009 Time: 13:10AM - 15:35PM Rain Record Jail Road: 3 mm Air Port: 13 mm		Date: 11 Aug. 2009 Time: 12:50PM - 14:30PM Rain Record Jail Road: 49.4 mm Air Port: 11.0 mm Farrukhabad: 52.0 mm Chowk Nakhuda: 8.2 mm Pani Wala Talab: 36.0 mm Upper Mall: 11.0 mm		Date: 15 Aug. 2009 Time: 15:50PM - 18:40PM Rain Record Jail Road: 13.4 mm Air Port: 15.0 mm Farrukhabad: Traces Chowk Nakhuda: 1.6 mm Pani Wala Talab: 1.0 mm Upper Mall: 21.0 mm		Date: 21 Aug. 2009 Time: 9:30AM - 12:20PM Rain Record Jail Road: 10.0 mm Air Port: 9.0 mm Farrukhabad: 12.0 mm Chowk Nakhuda: 8.2 mm Pani Wala Talab: 8.0 mm Upper Mall: 7.0 mm		Date: 2 Sep. 2009 Time: 10:55AM - 12:45PM Rain Record Jail Road: 3.3 mm Air Port: 2.0 mm Farrukhabad: 3.2 mm Chowk Nakhuda: 3.6 mm Pani Wala Talab: 6.0 mm Upper Mall: 4.0 mm		Date: 3 Sep. 2009 Time: 10:15AM - 11:15AM (1st.), 12:45PM - 15:30PM (2nd) Rain Record Jail Road: 12.0 mm Air Port: 21.0 mm Farrukhabad: 7.0 mm Chowk Nakhuda: 12.0 mm Pani Wala Talab: 8.0 mm Upper Mall: 25.0 mm	
			Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)	Period (hour)	Depth (m)
1	Laxami Chowk	Main Outfall No.1 and No.3 DS	2.3	0.28					2.3	0.20	4.3	0.66										
2	GPO	Main Outfall No.1 DS	1.3	0.15							1.3	0.18										
3	Kashmir Road	Main Outfall No.1 DS	3.0	0.15	1.5	0.08			1.0	0.13	5.5	0.36										
4	Thorton Road	Main Outfall No.1 DS	3.0	0.23																		
5	Cooper Road	Main Outfall No.1 DS	2.3	0.10	1.5	0.05			0.8	0.05	3.0	0.10										
6	Bashir Sons	Main Outfall No.1 DS	2.3	0.15							1.8	0.03										
7	Rehman Gallian	Mochi Gate LS→Batti Gate DS	2.3	0.20	2.0	0.15			3.5	0.18	5.3	0.30										
8	Do Moria Pul	Shad Bagh/Khokhar Road DS	2.5	0.15	2.0	0.20			1.3	0.23	2.0	0.30										
9	Lytton Road	Lytton Road LS→Central Drain	3.0																			
10	Plaza Cinema	Main Out Fall No. 1	2.5	0.23					0.8	0.05	5.3	0.30							0.3	0.03		
11	Nabha Road	Gulshan-E-Ravi DS, Lytton Road LS	1.3						0.8	0.05												
12	Church Road	Planetarium LS	2.5																			
13	Mozang Chungi	Gulshan-E-Ravi DS	2.8								1.8	0.05										
14	Shadman/Shah Jamal	Gulshan-E-Ravi DS	2.8																			
15	Waris Road	Gulshan-E-Ravi DS	2.8								3.8	0.30										
16	Galaxy Plaza	Gulshan-E-Ravi DS	9.0	0.08							3.5	0.30					1.0	0.10				
17	Park Lane Road	Center Point LS→Gulshan e Ravi DS	2.8								1.5	0.03										
18	Chauburji	Gulshan-E-Ravi DS	1.3								3.3	0.10										
19	Lake Road	Chauburji LS→Central Drain	1.3		1.3	0.05					1.5	0.10										
20	PU Ground, HCC	Planetarium LS→Central Drain	1.3																			
21	Rewaz Garden	Gulshan-E-Ravi DS	4.0	0.05							1.8	0.05										
22	Sanda Road	Gulshan-E-Ravi DS	4.0	0.05							2	0.10										
23	Fazlia Colony	Shadman LS↔Cantonment Drain	9.0	0.10							3.8	0.20					1.5	0.15			0.5	0.08
24	SSP Office Dev Samaj Road	Main Outfall No.1 DS	2.8	0.20																		
25	Malik Park	Main Outfall No.2 DS	3.5	0.05																		
26	Nasir Park (Tonga Adda)	Main Outfall No.3 DS	3.5	0.05																		
27	Secondary Board	Gulshan-E-Ravi DS	2.8								3.3	0.30										
28	Firdous Market	Makka Colony LS→Sattu Katla Drain	5.0	0.05	4.0	0.08							3.8	0.15								
29	Kalma Chowk	Nursery LS, Usman Block LS→Sattu Katla Drain	3.0																			
30	Central Point	Center Point LS→Gulshan-E-Ravi DS	6.5	0.05									3.5	0.15					0.5	0.08		
31	Gari Shahu	Main Outfall No.1 DS	7.0	0.23	8.0	0.23	2.3	0.15	3.5	0.46	5.5	0.15	4.3	0.08							1.8	0.15
32	Muhammad Nagar	Muhammad Nagar LS→Railway Drain	7	0.15	7.0	0.15	1.8	0.15	3.5	0.46	4.3	0.30										
33	Bibi Pak Daman	Muhammad Nagar LS→Railway Drain	4.5	0.05	7.0	0.15			3	0.30	4.3	0.30										
34	Empress Road	Main Outfall No.1 DS	2.5		7.0	0.15	1.0	0.15	3.5	0.23	4.3	0.30										
35	Railway Station	Main Outfall No.1 DS	4.5	0.15	7.5	0.23	2.5		1.5	0.23	3.8	0.30										
36	Akbar Chowk	Johar Town LS→Sattu Katla Drain	3																			
37	Hussain Chowk	Gurumangat LS→Cantt. Drain	4	0.10									2.8	0.08								
38	Barkat Market	Usman Block LS→Sattu Katla Drain	3																			
39	L-Block Gulberg	LMP Block DS→Sattu Katla Drain	9.8	0.10																		
40	Tipu Block Garden Town	LMP Block DS→Sattu Katla Drain	9.3	0.05							1.8	0.03										
41	Model Town Link Road	LMP Block DS→Sattu Katla Drain	4.8	0.05																		
42	Mini Market Gulberg	Gulshan-E-Ravi DS	5	0.05																		
43	Aik Moria Pul	Shad Bagh / Khokhar Road DS	2.0		2.0	0.20	0.5	0.03	0.5	0.23	2.3	0.10										
44	Rahim Road	Shad Bagh / Khokhar Road DS	2.0						0.5													
45	Aziz Road	Shad Bagh / Khokhar Road DS	2.5								0.8	0.05										
46	Umer Din Road	Shad Bagh / Khokhar Road DS	1.3		1.0	0.08					0.8	0.05										
47	Chowk Na-Khuda	Shad Bagh / Khokhar Road DS	1.3																			
48	Shairanwala Gate	Main Outfall No.2 DS	2.3						5.5	0.05	4.3	0.25										
49	O/S Bhati Gate	Bhati Gate LS	2.3						2.0	0.10	2.3	0.15										
50	Main Road, Shahdara	Farrukhabad DS	2.5								2.3	0.10					1.0	0.05				
51	Lajpat Road Shahdara	Farrukhabad DS	4.0	0.08	5.3	0.05			3.5	0.05	6.8	0.30					3.5	0.08				
52	Timber Market	Forest Colony LS	8.0	0.15	5.3	0.08			2.0	0.05	4.3	0.46										
53	Haq Nawaz Road	Mehmood Booti DS	1.3																			
54	Toheed Park	Toheed Park LS→Shalimar Escape Channel	1.3		6.3	0.08																
55	Milap Street	What Man Road LS→Upper Chotta Ravi PS	1.5																			
56	Angoori Cinema (Shalimar Link Road)	What Man Road LS→Upper Chotta Ravi PS	1.5		2.5	0.08																
57	Police Station (Mughalpura)	Shalimar Link Road LS→Shalimar Escape Channel																				
58	Shah Kamal Road	Shah Kamal Road LS→Shalimar Escape Channel	1.3																			
59	Yammi 36, Begum Pura	Wheat Man Road LS→Upper Chotta Ravi PS	1.3																			
60	Bagheechi Saithan	Wheat Man Road LS→Upper Chotta Ravi PS	1.3		1.0	0.15																
61	UET G.T. Road	Wheat Man Road LS→Upper Chotta Ravi PS	1.5																			
62	Scheme More	Multan Road DS	3.0																			
63	Rachna Block Road	Multan Road DS	2.5														1.0	0.10				
64	Al-Hamad Colony	Multan Road DS	3														2.0	0.08				
65	H-Block Sabzazar	Multan Road DS	1.5																			
66	Poonch Road	Gulshan-E-Ravi DS	2.5								4.5	0.20					3.0	0.15				
67	Millat Chowk	Gulshan-E-Ravi DS	5.3	0.18							4.3	0.18					2.0	0.15				
68	Multan Road Bhalla Stop	Gulshan-E-Ravi DS	2.8								2.3	0.10										
69	Sultan Ahmed Road Rehmanpura	Gulshan-E-Ravi DS	12.3	0.10							8.3	0.46					3.0	0.15				
70	Zaildar Road Ichhra	Gulshan-E-Ravi DS	8.5	0.15							7.3	0.30					3.0	0.15				
71	Chowk Yateem Khana	Multan Road DS	2.8								2.3	0.05					1.0	0.08				
72	Infantory Road	Infantory Road LS→Cantt. Drain	1.8																			
73	Allama Iqbal Road Mustafabad	Infantory Road LS→Cantt. Drain	1.8																			
74	B-Block Tajpura	Tajpura LS→Shalimar Escape Channel	1.8																			
75	Shabab Chowk	Tajpura Lift Station→Shalimar Escape Channel	1.8														2.8	0.10				
76	Garden Town Drainage	ADA Nullah																				
77	Ferozepur Road Drain	ADA Nullah																				
78	Shaikh Zaid Drain	AIT Drain																				
79	Hali Road Gulberg	ADA Nullah																				
80	E-Block Gulberg	ADA Nullah																				

Appendix 5.4 Rainwater Storage/Infiltration Facilities

The stormwater runoff control methods are classified into the rainwater storage type and rainwater infiltration type as shown **Figure 1**.

The rainwater storage type has a function to reduce the stormwater runoff through its equalization with no change in the total stormwater runoff, which is stored on site (parks, school ground, parking lots, space between buildings, individual premises, etc.) or off site (regulation reservoir, multi-purpose retarding ponds, rainfall storage pipes, etc.)

The rainwater infiltration type is to reduce the stormwater runoff itself through its infiltration into the ground by means of the rainwater infiltration facilities such as infiltration chambers, permeable pavement and so on. These infiltration facilities should be installed on the area with high permeability and low groundwater level.

To control the stormwater runoff, it is necessary to regulate the land use including the measures to reduce the stormwater runoff before it enters into a sewer system and important to study not only the hardware (facilities) but also the software (legislation) in close cooperation with other administrative agencies concerned with the river, road, park, etc.

The on-site storage facilities and infiltration facilities are planned based of the design infiltration capacity, taking into account topographical and geological conditions. It is important to clarify the role of facility planning and operation and maintenance against the choking control. Consideration should be paid for that it will take a long time until the required number of units will be installed for full development of control effect by on-site storage and design infiltration capacity.

For an introduction of stormwater runoff control measures, the required storage capacity and infiltration amount are calculated for stormwater runoff control facilities using the runoff hydrograph showing time series variation of the stormwater runoff.

The image of rainwater infiltration facilities are presented in **Figure 2 and Figure 3**.

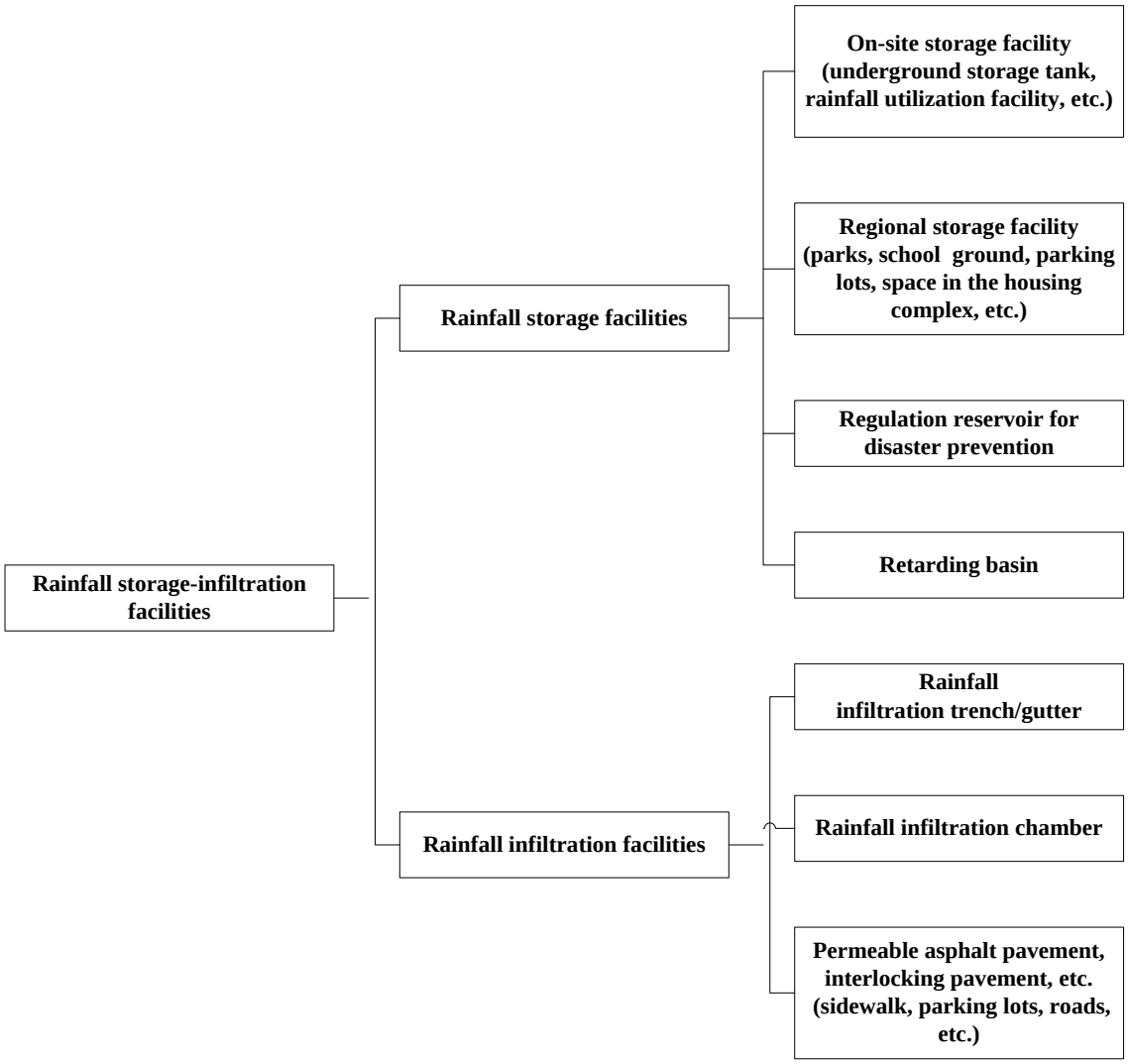


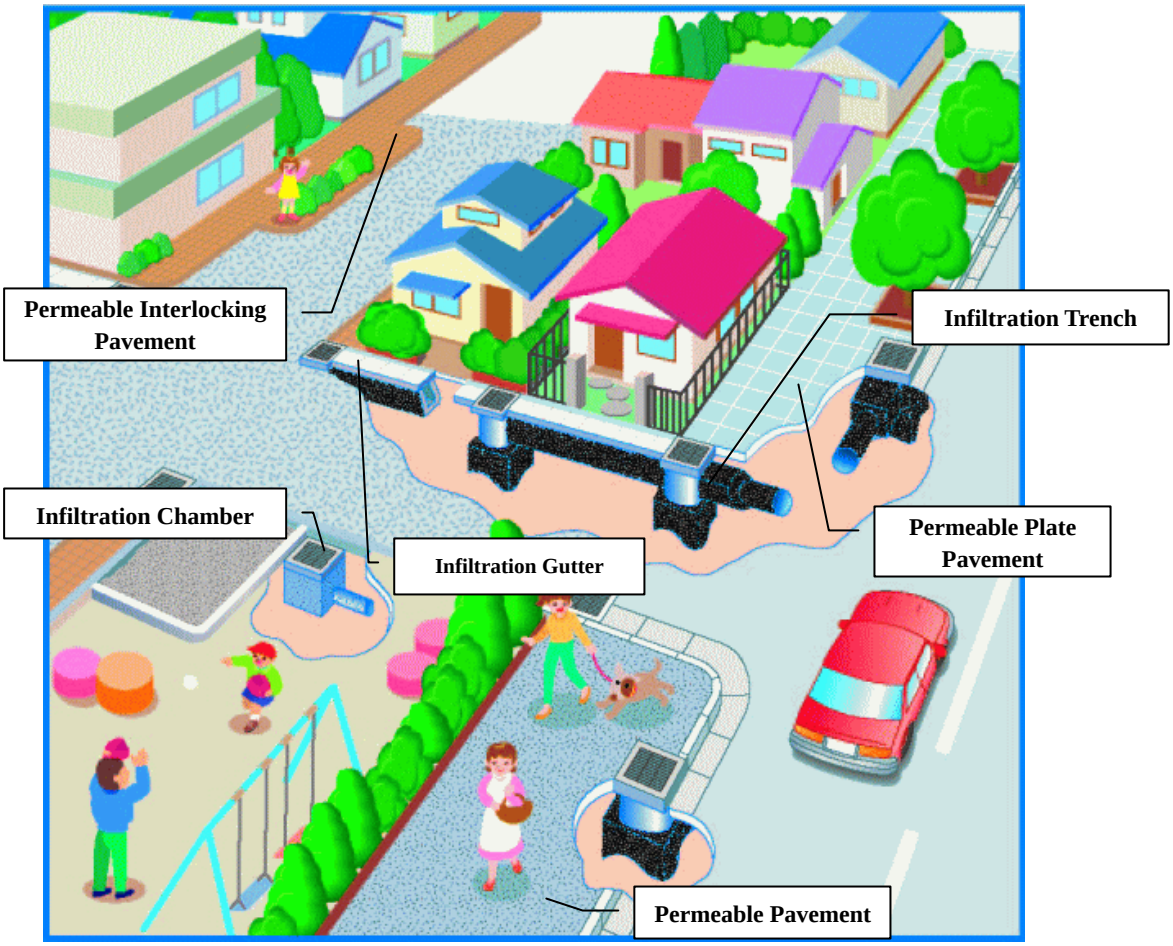
Figure 1 Classification of Rainwater Storage/Infiltration Facilities

The rainfall infiltration facility is the structure with holes at the sides and bottom enclosed with filling material like aggregate so as to make rainwater infiltrate into the ground. The rainwater infiltration capacity depends on the ground condition, but it is possible to infiltrate a certain amount of stormwater into the ground during the wet weather. By making stormwater infiltrate into the ground aggressively, it has an effect to control the stormwater runoff.

To make stormwater infiltrate into the ground, It is desirable that the ground is of sandy soil or gravelly soil. Since clayey soil has less permeability, storage facility is adaptable as shown in **Table 1**.

Table 1 Permeability of Soil

Permeability of soil	Type of Soil	Saturated permeability coefficient (cm/s)	Suitable facility
High	Gravel (0.2 mm) Middle-particle sand (0.2 mm) Fine-particle Sand (0.2 mm)	1.8 1×10^{-2} 1×10^{-3}	Infiltration facility
Low	Clayey soil	Less than approx. 1×10^{-4}	Storage facility



Source: Association for Rainfall Storage and Installation Technology - http://www.arsit.or.jp/

Figure 2 Rainwater Infiltration Facilities

	
Infiltration Chamber	**Infiltration Manhole**

	
Infiltration Pipe	**Infiltration Conduit**

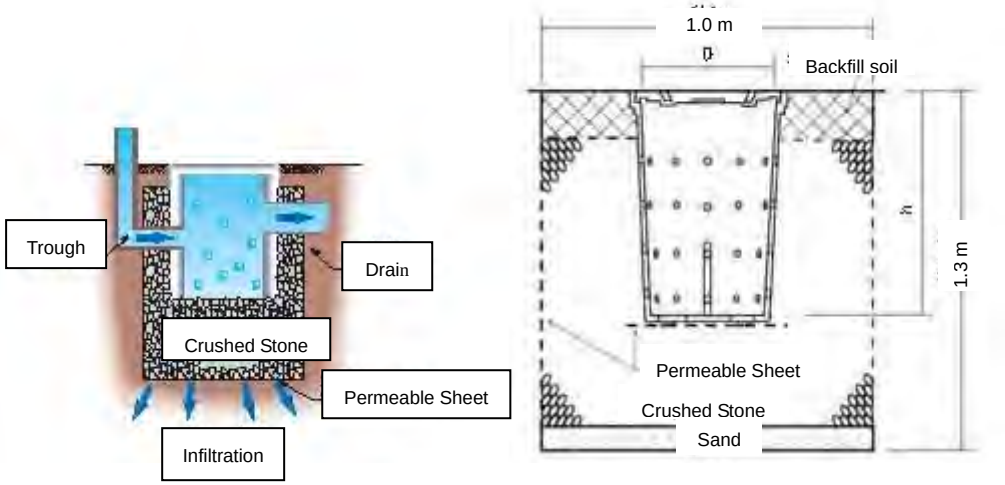
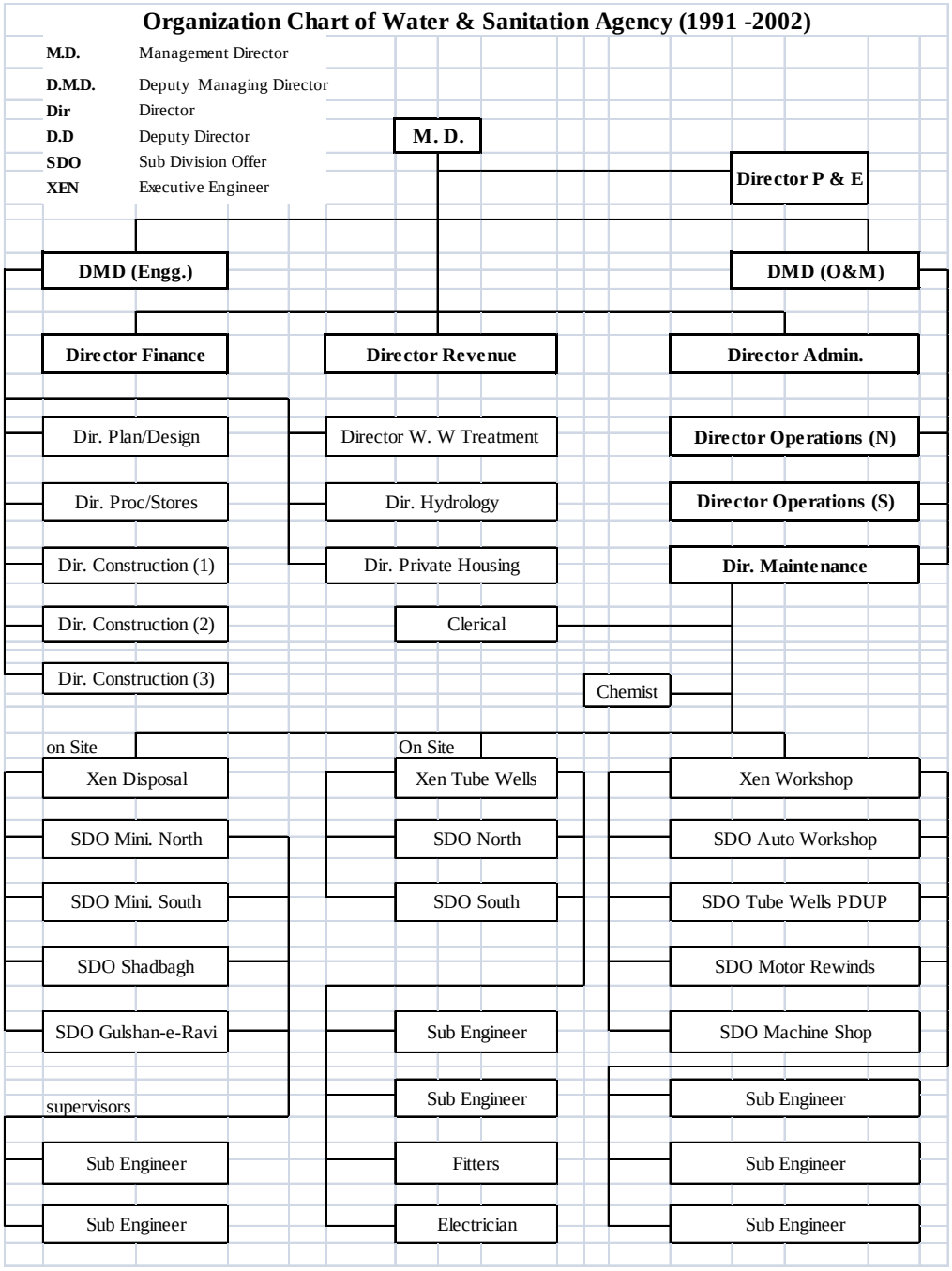


Figure 3 Design Example of Rainfall Infiltration Chamber

In Tokyo, based on the analytical result of the past rainfall records that about 80% of annual rainfall has an rainfall intensity of not more than10 mm/hr, the Metropolitan Government has established the goal to make rainwater with an rainfall intensity of not more than10 mm/hr

infiltrate into the ground and promoted an infiltration of rainwater collected from the roofs through the troughs, on the bare land such as the gardens without planting and grounds, and on the paved place such as parking lots.

Appendix 6.1.1



Appendix 6.1.2 Major Duties (Roles) and Scope of Work

(1) Planning & Evaluation Div. (Dir)

- WASA's spokesperson
- Leakage improvement
- Responsible official in charge of the complaints response contact inside of Head Office
- Public relations/educational campaign

(2) Engineering Dep. (DMD):

1) Planning & Design Dep. (Dir)
   - Planning/design/cost estimate

2) Procure & Storage Dep. (Dir)
   - Order of purchases and store management

3) Construction Dep-1 (Dir.)
   - Construction works/supervision (private construction works: water & wastewater facilities) etc. in WASA area
   - Survey on revenue/non-revenue water and accounted-/unaccounted-for water ratio

4) Construction Dep-2(Dir)
   - Construction works/supervision, application examination (water & wastewater facilities) etc. where the sites are not controlled by WASA (including privately-owned area)
   - Leakage detection by leakage detection cell (water & wastewater system), measurement by bulk flow meter (BFM) to pump out discharge from tube-wells

5) Hydrology Det. (Dir)
   - Erection and construction supervision of tube-wells (civil, machine, electricity)
   - Monitoring (water table of tube-wells, measurement of pumping discharge)

(3) Finance Dep. (DMD)

1) Administration Dep. (Dir)
   - Human resources management
   - Management of employee/ retired employee
   - Management on pension/insurance/health and accident countermeasure
   - Administration on dispute matters
   - Countermeasure on labor union

- Selection on participants (BR17-19 class) for education/trainning

2) Finance Dep. (Dir)
- Property administration
- Water meter reading/billing
- Income management on water tariff and financial management on purchased materials
- Controls on spending (payrolls, utilities, and office expenses etc.)

3) Revenue Dep. (Dir)

Revenue Department conducts all management tasks to Head Office and 6 towns. On the other hand, branch office exists for 6 towns and Director of Department supervises the on-the-spot direction.
- Superintendence on water meter reading by each town
- Inspector and billing affairs
- Credit management from consignment banks/agencies
- Superintendence to inspector and person in charge of billing
- Complaint window in term of water tariff by each town

4) Tanning Dep. (Dir)
- Education for staff and technicians

(4) Operation & Maintenance Dep. (DMD)

1) Ravi Town (Dir)
- Each sub division is in charge of drainage (XEN), O&M-1 (XEN), and O&M-2 (XEN) respectively because the possession of O&M equipment and materials.
- Each sub division acts as complaint response contact and complaint measures in term of O&M
- There exist branch offices under Revenue Department conduct water meter reading, billing, response contact for application of connection, and complaint response/measures
- There exist storage home base for interim storage of parts from Gunj Buksh Town and parts supply

2) Shalimar Town (Dir):
- Each sub division is in charge of drainage (XEN) and O&M (XEN) respectively because the possession of O&M equipment and materials.
- Each sub division is in charge of drainage (XEN), O&M-1 (XEN), O&M-2 (XEN) respectively because the possession of O&M equipment and materials.

- There exist branch offices under Revenue Department conduct water meter reading, billing, response contact for application of connection, and complaint response/measures

3) Gunj Buksh Town (Dir)

- There exists a facility with a central function for WASA.
- Each sub division is in charge of drainage (XEN), O&M-1 (XEN), and O&M-2 (XEN) respectively because the possession of O&M equipment and materials.
- Dewatering Department is in charge of storm water/inundation countermeasure occurred within all of the 6 towns and operation/management on repair yard of water meter because of the possession of special purpose heavy equipment and workshop.
- Each sub division acts as complaint response contact and complaint measures in term of O&M
- There exist branch offices under Revenue Department conduct water meter reading, billing, response contact for application of connection, and complaint response/measures
- Confirmation on water tariff recipient agencies dispatched by financial institutions and water tariff receipts
- Inspection on tap water quality by Water Chemical Laboratory (sewerage is not under control)
- There exists a central storage home base to supply the parts to Procure & Storage Department: Supply of parts and chlorine agent

4) Aziz Bhatti Town (Dir)

- O&M (XEN) is in charge of O&M on drainage and each sub division because the possession of O&M equipment and materials.
- Each sub division acts as complaint response contact and complaint measures in term of O&M
- There exist branch offices under Revenue Department conduct water meter reading, billing, response contact for application of connection, and complaint response/measures

5) Allama Iqbal Town (Dir)

- Each sub division is in charge of drainage (XEN), O&M-1 (XEN), and O&M-2 (XEN) respectively because the possession of O&M equipment and materials.
- Each sub division acts as complaint response contact and complaint measures in term of O&M
- There exist branch offices under Revenue Department conduct water meter reading, billing, response contact for application of connection, and complaint response/measures

6) Nishtar Town (Dir)

- Each sub division is in charge of drainage (XEN), O&M-1 (XEN), and O&M-2 (XEN) respectively because the possession of O&M equipment and materials.
- Each sub division acts as complaint response contact and complaint measures in term of O&M
- There exist branch offices under Revenue Department conduct water meter reading, billing, response contact for application of connection, and complaint response/measures

7) JICA Project Management Unit (Dir. PMU)

- Be in charge of O&M on pilot drainage because the possession of O&M equipment and materials

Appendix 6.2.1

List of Leakage Investigation by Leakage Detection Cell

Sr. No.	Dated	Town	Area	Nature of Complaints
1	25/04/07	Ravi Town	Rehmat Colony	Water shortage / Contamination
2	30/04/07	Ravi Town	Iltifaq Colonly	Water shortage / Contamination
3	05/05/07	Ravi Town	Match Factory	Water shortage / Contamination
4	1 5/05/07	Ravi Town	Latif Chowk	Water shortage / Contamination
5	23/05/07	Allam Iqbal Town	Block G, F2, HI & K2 of Johar Town	Water shortage / Contamination
6	01/1 1/07	Gunj Bukhsh	Qartaba Chowk and in Shahdab Colony	Buried Manhole covers
7	01/11/07	Gunj Bukhsh	Kalyar Road and in Rustam Park	Buried Manhole covers
8	29/11/07	Allam Iqbal Town	Fai/ Road and B-Block New Muslim Town	Buried Manhole covers
9	30/04/08	Ravi Town	A llama Iqbal Colony	Buried Manhole covers
10	05/05/08	Ravi Town	Nasir Colony	Water shortage / Contamination
I I	07/05/08	Ravi Town	Ittefaq Colony	Water shortage / Contamination
12	10/05/08	Ravi Town	Dogar Chowk	Water shortage / Contamination
13	12/05/08	Ravi Town	Muhammad i Chowk	Water shortage / Contamination
14	14/05/08	Ravi Town	Sui Gas Chowk / Road	Water shortage / Contamination
15	16/05/08	Ravi Town	Islam Nagar	Water shortage / Contamination
16	20/05/08	Ravi Town	Bajwa Shaheed Chowk	Water shortage / Contamination
17	04/09/08	Allam Iqbal 'Town	Samnabad	Buried Manhole covers
18	21/10/08	Ravi Town	Gali Sheai.theair, Langay Mandi	Water leakages
19	1 2/02/09	Allam Iqbal Town	Rchmanpura	Water leakages
20	20/02/09	Allam Iqbal Town	Johar Town	Water leakages
21	10/03/09	Allam Iqbal Town	Allama Iqbal Town	Water leakages
22	22/03/09	Allam Iqbal Town	Johar 'Town	Welter leakages
23	1 5/04/09	Ni shier Town	Township	Water shortage / Contamination

Appendix 6.2.2

Table Salient Features of Sodium Hypochlorite and Twin Oxide

Items	Evaluation Indexes	Twin Oxide (ClO_2)	Sodium Hypochlorite
Product condition	-Injection by chlorine solution, -Liquid (direct chemical dosing)	Powder (0.3%)	Liquid (20%)
		Need mixing tanks	No need of mixing tanks (Merit)
Place of origin	-Stable supply -Availability from domestic industries	Import from India or UK,	Available near Lahore, (Domestic)
		(Demerit)	(Merit)
Minimum order	-With no restriction of supply	Minimum of 2,000 kg supply required	Any amount
		(Demerit)	(Merit)
Delivery time	- period of time / storage space, -Prevention from degradation, correspondence in an emergency	15 days	1~2 days
		Indoor stock space required and has to be kept dry (Demerit)	Minimum space / outdoor (Merit)
Experience	-Long experience of use - WASA Lahore	Only overseas experience (little in Japan) (Demerit)	Common practice-worldwide (Merit)
Water quality (from deep tube-well)	-Supply safety for drinking water quality (Trihalomethane by product : THM)	No THM production by chemical reaction with NH_3	THM production by chemical reaction with Cl_2 and NH_3
		(Merit)	-Less chance (estimated max. (NH_3) about 5 ppm, Std. (50 ppm)
Disinfection efficiency	-Long-term residual chlorine period, -Less change of contamination by a microbe	Strong (oxidizing action)	Normal
		(Good Merit)	(Merit)
Selection of material	-Cost of equipment, - Less expensive	Corrosion-resistant	FRP container can be used
		Expensive material container required (Demerit)	(Merit)
Other factors	-Convenient in handling -Special training required	Needs special cautions	Needs special cautions
		(i) ClO_2 solution + organic substance (by accident) = Danger of explosion, (ii) ClO_2 gas from solution + oxygen = Danger of explosion,	NaOHCl + soap by mistake =Cl_2 gas production, others

Appendix 6.2.3

Number of Water Meters Repaired by Town

(Unit:Qty)

YEAR	1.Gunj Buksh Town			2.Ravi Town			3.Allama Iqbal Town		
	Received (New)	Repaired/ Shipback	Remaining (+Previous Balance)	Received (New)	Repaired/ Shipback	Remaining (+Previous Balance)	Received (New)	Repaired/ Shipback	Remaining (+Previous Balance)
Carry-over	-	-	**261**	-	-	**83**	-	-	**366**
Jan-08	8	0	269	0	0	83	0	0	366
Feb-08	2	45	226	0	0	83	0	0	366
Mar-08	7	0	233	0	0	83	0	0	366
Apr-08	4	0	237	85	17	151	0	0	366
May-08	6	0	243	0	0	151	0	0	366
Jun-08	0	172	71	0	86	65	0	60	306
Jul-08	0	0	71	40	0	105	0	0	306
Aug-08	4	0	75	0	0	105	0	0	306
Sep-08	0	3	72	0	0	105	0	0	306
Oct-08	212	70	214	51	76	80	0	0	306
Nov-08	16	0	230	0	0	80	0	57	249
Dec-08	7	1	236	0	0	80	0	0	249
Jan-09	12	100	148	0	0	80	0	0	249
Feb-09	9	12	145	0	19	61	0	2	247
Mar-09	30	30	145	78	0	139	0	0	247
Total Number of Received WMs+ Carry over from 2007)	317	433	578	254	198	337	0	119	366
Beyond repair	0	0	0	-	-	-	-	-	-
Balance (Carry Over to 2009)	-	-	**145**	-	-	**139**	-	-	**247**

YEAR	4/5.Shalimar/ Aziz Bhatti Town			6.Nishtar Town			**Total**			% of Status of Repair works
	Received (New)	Repaired/ Shipback	Remaining (+Previous Balance)	Received (New)	Repaired/ Shipback	Remaining (+Previous Balance)	Received (New)	Repaired/ Shipback	Remaining (+Previous Balance)	
Carry-over	-	-	**185**	-	-	**26**	-	-	**921**	-
Jan-08	0	0	185	0	0	26	8	0	929	-
Feb-08	24	29	180	0	0	26	26	74	881	-
Mar-08	0	0	180	0	0	26	7	0	888	-
Apr-08	39	0	219	3	0	29	131	17	1002	-
May-08	0	0	219	0	0	29	6	0	1008	-
Jun-08	0	104	115	0	0	29	0	422	586	-
Jul-08	0	0	115	3	0	32	43	0	629	-
Aug-08	0	0	115	0	0	32	4	0	633	-
Sep-08	150	0	265	0	0	32	150	3	780	-
Oct-08	0	115	150	0	6	26	263	267	776	-
Nov-08	36	0	186	0	0	26	52	57	771	-
Dec-08	0	84	102	0	0	26	7	85	693	-
Jan-09	54	0	156	0	0	26	66	100	659	-
Feb-09	0	59	97	0	0	26	9	92	576	-
Mar-09	64	64	97	0	0	26	172	94	654	-
Total Number of Received WMs+ Carry over from 2007)	367	455	552	6	6	32	**944**	**1,211**	**1,865**	-
Beyond repair	-	-	-	-	-	0	-	-	**65**	96.5%
Balance (Carry Over to 2009)	-	-	**97**	-	-	26	-	-	**589**	31.6%

Source: Meter repair Workshop in Gunj Buksh Town, April 23,2009.

Appendix 6.2.4

List of Existing Maintenance Equipment and Request

MECHANICAL TOOLS										
S.No.	Name of Tool	Capacity	Horsepower	No. of Unit (Nos.)	Name of Manufacturer	Year of Manufact-uring	Size/ Model #	Condition	Problems	Necessary to replace (Urgent) or Repair
	METER SHOP									
1	Test bed	500 liters	-	1	Kimmon Japan	1974	½" to 1½" Ø	OK	-	-
2	Test bed	500 liters	-	1	Kimmon Japan	1974	½" to 1½" Ø	Out of order	Calibration tube broken	Required to be replaced
3	Test bed	24 gallons	-	1	Germany	1963	½" to 1" Ø	OK	-	-
4	Test bed	15000 liters	-	1	Kimmon Japan	1974	6" to 12" Ø	Out of order	Calibration tube broken	Required to be replaced

Appendix 6.2.5 Change of amount of New Water Meters Supplied

The number of water service meters provided for each city is shown in Table 6.3 in seven years recently. The number of water service meters from which the yearly average is supplied is about 8,479.

Change of Amount of New Water Meters Supplied (Domestic)

S.No	Year	Name of Town																							
		Gunj Buksh Town								Allama Iqbal Town							Ravi Town								
		NAME OF SUB DIVISION								NAME OF SUB DIVISION							NAME OF SUB DIVISION								
		Krishan Nagar	Ravi Road	Mozang	Anarkali	Gulberg	Shimla Hill	DDR GB Town	Subtotal	Iqbal Town	Samanabad	Sabzazar	Ichhra	M.A Johar Town	DDR AI Town	Subtotal	City	Shahdara	Farakhabad	Data Nagar	Misrishah	Shadbagh	DDR Ravi Town	Subtotal
1	2002	200	100	100	0	0	0	0	400	200	200	0	200	0	200	800	0	0	0	0	200	0	0	200
2	2003	400	200	100	0	300	200	1,400	2,600	600	400	0	300	1,000	1,000	3,300	50	300	0	0	500	0	600	1,450
3	2004	200	200	200	0	300	0	600	1,500	500	400	0	229	500	1,900	3,529	0	0	0	100	0	0	200	300
4	2005	200	100	200	0	0	200	600	1,300	0	0	0	0	500	0	500	0	200	0	500	1,000	0	400	2,100
5	2006	400	500	200	200	200	500	2,500	4,500	500	500	500	200	2,000	2,500	6,200	150	200	0	0	500	250	500	1,600
6	2007	300	0	50	0	0	0	600	950	0	150	200	100	350	0	800	50	75	0	0	0	0	500	625
7	2008	25	0	55	0	0	0	0	80	0	50	60	0	25	0	135	10	0	20	0	0	0	25	55
Total		1,725	1,100	905	200	800	900	5,700	**11,330**	1,800	1,700	760	1,029	4,375	5,600	**15,264**	260	775	20	600	2,200	250	2,225	**6,330**
Average /year		246	157	129	29	114	129	814	**1,619**	257	243	109	147	625	800	**2,181**	37	111	3	86	314	36	318	**904**

S.No	Year	Name of Town														
		Nishtar Town						Aziz Bhatti Town			DDR Shlimar & Aziz Bhatti Town	Shalimar Town			Others	G.Total
		NAME OF SUB DIVISION						NAME OF SUB DIVISION				NAME OF SUB DIVISION				
		Industrial Area	Green Town	Garden Town	Town Ship	DDR Nishtar Town	Subtotal	Mustafabad	Tajpura	Subtotal		Mughal Pura	Baghban Pura	Subtotal		
1	2002	200	0	0	0	100	300	0	200	200	0	300	300	600	900	3,400
2	2003	1,500	50	200	400	500	2,650	100	300	400	600	1,500	1,200	2,700	0	13,700
3	2004	1,000	0	526	200	300	2,026	0	300	300	300	0	400	400	0	8,355
4	2005	1,000	200	0	1,000	1,111	3,311	0	300	300	500	1,000	500	1,500	0	9,511
5	2006	200	0	400	0	1,500	2,100	100	500	600	2,000	1,200	1,500	2,700	0	19,700
6	2007	700	100	0	0	100	900	0	375	375	400	0	225	225	0	4,275
7	2008	50	0	0	0	0	50	0	60	60	0	0	10	10	25	415
Total		4,650	350	1,126	1,600	3,611	**11,337**	200	2,035	**2,235**	**3,800**	4,000	4,135	**8,135**	925	**59,356**
Average /year		664	50	161	229	516	**1,620**	29	291	**319**	**543**	571	591	**1,162**	**132**	**8,479**

Source: WASA Perocue & Stock Dep. April 27, 2009

Appendix 6.2.6 Example at Gunj Buksh Town (O&M-1 XEN)

JICA Study Team conducted an acceptance sampling within the populous district to grasp the status on O&M in six (6) towns under the jurisdiction of WASA.

1) Scope of work for O&M-1 XEN

The numbers of staff were predicted as approximately 230 persons in total. Staff are mostly consisted of the person in charge of O&M and pipeline clearing crew concerned and almost without technicians for machine/electronics. **Table (1)** shows the summary of scope work of O&M in Gunj Buksh Town.

Table (1) Summary of Scope of Work of O&M-1 in Gunj Buksh Town

Name of Facilities	Name of Machinery	Capacity & Number of Unit
Water Works	Water Supply Network 3" to 12"	482.75 Km
	Tube wells	Total 202 Cfs * 57units
Sewage / Drain	Trunk Sewer	33.48 Km
	Lateral Sewer	338.33 Km
	Lift Station	Total 57 Cfs * 3 Units
Pumps	Sewerage Pump at Disposal Station	Total 930 Cfs * 33units
Generators at Tube wells	Tube wells	Total 600 Kva* 3 units
Generators at Disposal Stations	Disposal Station	3260 KVA * 5 units

2) Waterworks facilities

Fifty-seven (57) tube-wells remarkably deteriorated, and about 180 staff conduct the operation management by three shift working.

Chlorine feeding facility was mostly shifted by drip system; however, O&M on chlorine equipment was deficient.

Water pressure gauges were mostly not installed and measurement error easily results from the broad measurement range by meter.

With regard to the cleanup on water service pipeline network, fire hydrant was utilized for flushing.

3) Elevated tank

Five (5) elevated tanks (80ft in height) on the scale of 60,000gallons were built; however, their application was stopped taking the insufficient distribution capacity, labor hours on cleanup and inspection into consideration 20 years ago.

Distribution pipe to be connected with the said elevated tank connects the bypass pipe underground and the floor was consolidated by concrete.

4) Standby generator

Three (3) area where the power supply conditions was very poor (insufficient power, blackout measures, and no other available well sources) and thus portable diesel generator set was set up. However, operating rates on such facilities was very low owing to the generation capacity (200 KVA/unit) is twice as large as the motor capacity (80-150 Hp).

5) Request on restriction/rehabilitation of civil structures

The following items were requested due to the limited working area of office, warehouse and complaint reception counter.

- Reconstruction on the five (5) abandoned tube-wells (approximately 225 ft^2 of building area)
- Conversion on the foot open space under the five (5) elevated tanks mention above

In general, unit price on the reconstruction and conversion of the structures made by bricks was approximately 6,000 Rs/ft^2.

Abandoned Elevated Tank (60,000gallons cap.)

Abandoned Tube-well Building

Tube-well with Generators (200KVA)

Pressure Gauges (Full Scale 350ft)

6) Request on improvement/rehabilitation of O&M equipment/materials

Inquiry survey on the present situation for the existing equipment/materials was carried

out to improve the process conditions.

The following renewal on the facilities and increase on the number of vehicles were requested.

- Increase of truck
- Renewal of vehicle
- Increase of vehicle on O&M
- Renewal of drainage pump
- Reinforcement on workplace safety facilities/materials for office use

Table (2) shows the list of existing maintenance equipment and request by Gunj Buksh Town.

7) O&M on wastewater pipe

Fifteen (15) staff and some other employed contract utility workers conduct the affairs.

Standby generator was put in action to operate the wastewater pump during blackout.

Table (2) List of Existing Maintenance Equipment and Request by Gunj Buksh Town

Name of Town (Division): **O&M-I, GUNJ BUKHSH TOWN** Date: 23-04-2009

S#	Name of Machinery	Capacity	Horsepower (Hp)	No. of Unit	Name of Manufacture	Year of Manufacture	Condition	Problems	Necessary to replace (Urgently) or Repair
A) Civil Works									
1.	Old Pump House at Jahangir Park (Krishan)	–	–	1	–	30-40 years	Deteriorated Condition	–	Need to repair for WASA Store
2.	Old Pump House at Shama Park (Mozang)	–	–	1	–	30-40 years	- Do -	–	- Do -
3.	Old Pump House at Rifle Ragne (Krishan)	–	–	1	–	30-40 years	- Do -	–	- Do -
4.	Old Pump House at Dev Samaj Road (Krishan)	–	–	2	–	30-40 years	- Do -	–	- Do -
5.	Old Pump House at National Ravi No. 3(Mozang)	–	–	1	–	30-40 years	- Do -	–	- Do -
6.	Overhead Reservoir Rewaz Garden (Krishan)	60,000 Gal	–	1	–	30-40 years	Abandoned	–	Need to repair for Complaint Office
7.	Overhead Reservoir Rifle Range (Krishan)	60,000 Gal	–	1	–	30-40 years	- Do -	–	- Do -
8.	Overhead Reservoir Sodiwal (Krishan)	60,000 Gal	–	1	–	30-40 years	- Do -	–	- Do -
9.	Overhead Reservoir Islampura (Krishan)	60,000 Gal	–	1	–	30-40 years	- Do -	–	- Do -
10.	Overhead Reservoir Main Out Fall (Krishan)	60,000 Gal	–	1	–	30-40 years	- Do -	–	- Do -
B) Water Works									
1.	Water Supply Network 3" to 12"	482.75 Km	---	---	---	---	Partially Outlived	Water Shortage in different areas	Required to be replaced in different areas
2.	Tubewells (Total)	202 Cfs (Total)	---	57	---	---	- Do -	- Do -	- Do -
C) Sewage / Drain									
1.	Trunk Sewer	33.48 Km	---	---	---	---	Satisfactory	Overflow condition whereas	Required to be replaced partially and rehabilitation required at other locations.
2.	Lateral Sewer	338.33 Km	---	---	---	---	Under size, outlived at	- Do -	- Do -
3.	Lift Station	57 Cfs	---	3	---	---	Partially Satisfactory	- Do -	Required improvement by replacement of machinery
D) Pumps									
1.	Sewerage Pump at Disposal Station	Total 930 Cfs		33			Partially satisfactory	Replacement of Parts like impellers, Shafts	Required urgently for proper functioning of disposal station
E) Generators at Tubewells									
1.	Tubewells	Total 600 Kva		3	Siemens	2009	Satisfactory	---	---
F) Generators (Disposal Station)									
1.	Disposal Station	Total 3260 Kva		5	---	---	Satisfactory	---	---
G) Vehicles									
1.	Sucker Machine	---	---	2	---	---	Un-Satisfactory	Outlived their useful life	Required to be replaced for proper (O&M) & functioning of (O&M) system
2.	Jetting Unit	---	---	2	---	---	Un-Satisfactory	- Do -	- Do -
3.	Mazda Truck	---	---	1	---	---	Un-Satisfactory	- Do -	- Do -
4.	Crane	---	---	1	---	---	Un-Satisfactory	- Do -	- Do -
5.	Water Tanker	---	---	2	---	---	Un-Satisfactory	- Do -	- Do -
6.	Tractor Trolley	---	---	3	---	---	Un-Satisfactory	- Do -	- Do -
7.	Vehicle for SDO & XEN	---	---	3	---	---	Un-Satisfactory	Deteriorated Condition	Required to be replaced into vehicles for better filed performance
H) Communication Tools									
1.	Wireless Set	---	---	3	---	---	---	Two no. Defective	Required for better communications
2.	Mobile Set Telephone	---	---	---	---	---	---	---	Required for every officer for better communications
3.	Computer	---	---	2	---	---	Satisfactory	---	2-Nos. Required for better officers performances
4.	Photo copy	---	---	1	---	---	---	---	3-Nos. Required for better officers performances
5.	Fax Machine	---	---		---	---	---	---	- Do -
I) Other									
1.	Safety equipments for sewer cleaning	---	---	---	---	---	---	---	20-Sets Required for human safety of sewer cleaning staff
2.	Metal Detectors	---	---	---	---	---	---	---	5-Nos. Required for detection of buried manholes
3.	Computers	---	---	---	---	---	---	---	2-Nos. required for better officers performances
4.	Photo Copies	---	---	---	---	---	---	---	- Do -
5.	Fax Machines	---	---	---	---	---	---	---	- Do -

Appendix 6.2.7 Example at Ravi Town (O&M-1)

JICA Study Team conducted acceptance sampling within the populous district to grasp the status on O&M in six (6) towns under the jurisdiction of WASA.

1) Scope of work by O&M-1

The numbers of employee were predicted as approximately 413 persons in total and most of them were engaged in on-the-spot work concerned. Employees are mostly consisted of personnel in charge of O&M and pipeline clearing crews concerned, and technician for machine/electronics was very few in number. **Table (1)** shows the scope of work by O&M-1 Department in Ravi Town. **Table (2)** shows the numbers of employee for O&M-1 Department in Ravi Town.

Table (1) Summary on Scope of Work by O&M-1 Department in Ravi Town

Sr. No.	Name of Machinery	Capacity
Water Works	Service Reservoir, Langay Mandi	Total 1-Mg (4-tanks)
	Overhead Reservoir Ravi Park Qila Lachman Singh	50,000 Gallon
	Overhead ReservoirBadamiBagh Fruit & Vegetable Market	50,00 Gallon
	Overhead Reservoir Timber Market	50,00 Gallon
	Water Supply Networks (3" to 12")	500 Km
	Tube wells	Total 146-Cfs * 47 units
Sewer Line	Laterial Sewer 9" to 18"	382 Km
	Trunk Sewer 21" to 60" Dia	70 km
	Disposal Stations	Total 240 Cfs *3 units
	Lift Stations	Total 125Cfs * 28 units
Pumps	Sewage Pumps at Disposal Stations	Total 240 Cfs *10 units
Generators at Tube-wells	Generators	Total 1600 KVA *8 units
Generators at Disposal Station	At Disposal Stations	Total 1323 KVA *2 units
	Lift Stations	Total 60 Cfs* 7 units

Source: Ravi Town (O&M-1), 23 April, 2009

Table (2) Numbers of Employees work for O&M-1 Department in Ravi Town

NO. OF O&M STAFF BY GRADE XEN (O&M-I) RAVI TOWN, WASA, LDA- LAHORE			
Sr. No.	**Description**	**Scale**	**Quantity**
1	XEN	18	1
2	SDO	17	1
3	SDO	16	1
4	Sub-Engineer	16	1
5	Sub-Engineer	11	4
6	Stanogarpher	12	1
7	Assistant	14	1
8	Foreman Mechanical	11	2
9	Asstant Foreman (Elect)	11	2
10	H.M.D	9	2
11	Vehicle Driver	7	5
12	S.S Fitter	9	2
13	Senior Clerks	7	3
14	Junior Clerks	5	9
15	Assistant to mechanic	4	2
16	Vehicle Cleaner	3	3
17	Pipe Fitter	4	14
18	Assistant pipe Fitter	4	24
19	Mechanical Helper	3	16
20	Junior Pump Operator	3	141
21	Head Pipe fitter	9	2
22	Supervisor	7	1
23	Assistant supervisor	5	7
24	Head Mali	4	2
25	Water Leackage inspector	9	1
26	Baildar	2	1
27	Security Guards	2	3
28	Sewerman	2	158
29	Naib Qasid	3	3
Total			413

2) Waterworks facilities

Fifty-seven (47) tube-wells remarkably deteriorated, and about 150 staff (three-shift working) conduct the operation management by three shift working.

Among the chlorine feeding facility by pump for the said 47 tub wells, approximately 40% were out of order and the remaining 60% were still not installed, that is, most of them did not work. Drip system was adopted instead; however, O&M on chlorine equipment was deficient.

3) Elevated tank

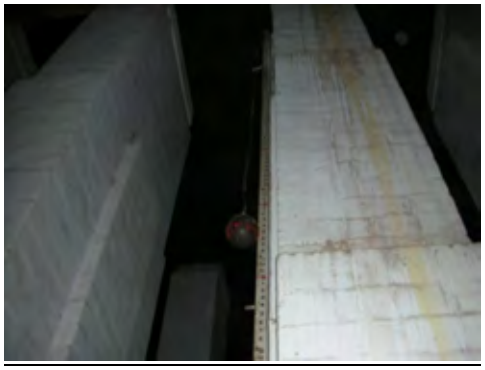
Three (3) elevated tanks (80ft in height) on the scale of 50,000gallons were built; however, their application was stopped taking the insufficient distribution capacity, labor hours on

cleanup and inspection into consideration 20 years ago.

One service reservoir (steel made with 4-line about 10m high built in 1883) with the scale of 1MG was built indoors and was still utilized. Water was pressured by four (4) well pumps to the elevated tank. The distribution by gravity was regularly operated opening the gate manually. Performance and O&M were recorded in accordance with the gate operation time. The cleanup on the sediments/deposits and extraneous matters in the tank was carried out by switching the drain valve.

The items on operation management of service reservoir are shown as follows:

- Date/time and name
- Service hours
- Drainage time
- Water gauge
- Calculation of water volume (water gauge/service hours)
- Special instruction (bad condition of tank, leakage, operation of gate valve, defect of structure etc.)



Water Gauge

Operation Records

4) Installation conditions on Bulk Flow Meters (BFM)

With regard to the operational status on BFM to be used for measuring the pumping-out water volume from the tube-wells, only approximately 38% of BFMs can work due to the inferior precision.

Table (3) shows the status of BFM performance in Ravi Town.

Table (3) Status of BFM Performance in Ravi Town

Flow Meters(Qty)			
Installed	Installed But Not working	Not Installed	Total
18	5	24	47
38.3%	10.6%	51.1%	100.0%

Source: Ravi Town (O&M-1), 23 April, 2009

5) Standby generators

Eight (8) area where the power supply conditions was very poor (insufficient power, blackout measures, and no other available well sources) and thus portable diesel generator set was set up. However, operating rates on such facilities was very low owing to the generation capacity (200KVA/unit) is twice as large as the motor capacity (80-150Hp).

6) Request on reconstruction/rebuild of structures

O&M-1 is responsible for the safekeeping on historical heritage (steel made elevated tank of 1 MG with steam power pump facilities built 1883); however, the location cannot be ameliorated due to the financial difficulties. Therefore, the improvement in term of civil buildings was requested by O&M-1.

Pumps Operated by Steam Power

Reservoir Structure (Indoor Installed)

7) Request on improvement/rehabilitation of O&M equipment/materials

Inquiry survey on the present situation for the existing equipment/materials was carried out to improve the process conditions.

The following renewal on the facilities and increase on the number of vehicles were requested.

- Increase of truck
- Renewal of vehicle
- Increase of vehicle on O&M
- Renewal of drainage pump
- Reinforcement on workplace safety facilities/materials for office use

Table (4) shows the list of existing maintenance equipment and request by Ravi Town.

8) O&M on wastewater pipes

Twenty (20) staff and some other employed contract utility workers conduct the affairs.

Standby generator was put in action to operate the wastewater pump during blackout.

Table (4) List of Existing Maintenance Equipment and Request by Ravi Town (O&M-1)

1.CIVIL WORKS — OFFICE OF THE EXECUTIVE ENGINEER (O&M-I)

Sr. No.	Name of Machinery	Capacity (Total)	Hp	No. of Unit	Year of Manufacturing	Size/ Model No.	Condition	Problems	Necessary to Replace (Urgently) or Repair
1	Old/Abondoned Pump house at Badami Bagh	–	–	2	1883	–	Abondoned	–	Heritage for WASA, required to refurbished for coming generation/Museum purposes
2	Office Building for D (O&M) Ravi Town and for XEN's, SDO's	–	–	3	1883	–	Outlived its Life	–	Required to be re-constructed urgently for human sources safety and environmental protection

2. WATER WORKS/WATER SUPPLY NETWORKS

Sr. No.	Name of Machinery	Capacity (Total)	Hp	No. of Unit	Year of Manufacturing	Size/ Model No.	Condition	Problems	Necessary to Replace (Urgently) or Repair
1	Service Reservoir ,Langay Mandi	1 M gallon	–	4	1883	–	Outlived its Life	–	Required to be Refurbished
2	Overhead Reservior,Ravi Park Qila Lachman Singh	50,000Gallon	–	1	–	–	–	–	–do–
3	Overhead Reservior, BadamiBagh Fruit & Vegetable Market	50,000Gallon	–	1	–	–	–	–	–
4	Overhead Reservior, Timber Market	50,000Gallon	–	1	–	–	–	–	–
5	Water Supply Networks (3" to 12")	500 Km	–	1	–	–	Partially Outlived	Water Shortage in many Areas	Required to be Replaced in different Areas
6	Tubewells	146-Cfs	–	47	–	–	–do–	–do–	–do–

3. SEWER LINES

Sr. No.	Name of Machinery	Capacity (Total)	Hp	No. of Unit	Year of Manufacturing	Size/ Model No.	Condition	Problems	Necessary to Replace (Urgently) or Repair
1	Laterial Sewer 9" to 18"	382-K.M	–	–	–	–	Under sized, outlived at different locations	Overflow condition whereas in Rainy Season	Required to be replaced partially and rehablitation required at oher locations
2	Trunk Sewer 21" to 60" Dia	70-K.M	–			–	Satisfactory	–do–	–do–
3	Disposal Stations	240-Cfs	–	3	–	–	Partially satisfactory	–do–	Improvement required inro replacement of working at Shahdra town & Forest Colony Diposal Station
4	Lift Stations	125-Cfs	–	28	–	–	Partially satisfactory	–do–	Required Improvement by Replacement of Machinary

4. PUMPS

Sr. No.	Name of Machinery	Capacity (Total)	Hp	No. of Unit	Year of Manufacturing	Size/ Model No.	Condition	Problems	Necessary to Replace (Urgently) or Repair
1	Sewage Pumps at Dispaosal Stations	240-Cfs	–	10	–	–	Partially Satisfactory	Replacement of parts like impellers, Shafts, Bearing	Required urgently for proper functioning of disposal station

5. GENERATORS AT TUBEWELLS

Sr. No.	Name of Machinery	Capacity (Total)	Hp	No. of Unit	Year of Manufacturing	Size/ Model No.	Condition	Problems	Necessary to Replace (Urgently) or Repair
1	Generators	1600-KV	–	8	2008-09	–	Satisfactory	–	–

6. GENERATORS (DISPOSAL STATIONS)

Sr. No.	Name of Machinery	Capacity (Total)	Hp	No. of Unit	Year of Manufacturing	Size/ Model No.	Condition	Problems	Necessary to Replace (Urgently) or Repair
3	At Disposal Stations	1323-KVA	–	2	2008-09	–	Satisfactory	–	–
4	Lift Stations	60-Cfs	–	7	–	–	Satisfactory	–do–	Required Improvement by Replacement of Machinery

7. VEHICLES

Sr. No.	Name of Machinery	Capacity (Total)	Hp	No. of Unit	Year of Manufacturing	Size/ Model No.	Condition	Problems	Necessary to Replace (Urgently) or Repair
1	Sucker machines	–	–	3	–	–	Un-satifactory	–do–	Required to be replaced for proper (O&M) & Functioning of (O&M) System
2	Jewtting Units	–	–	2		–	Un-satifactory	–do–	–do–
3	Trucks	–	–	2	–	–	Un-satifactory	–do–	–do–
4	Cranes	–	–	1	–	–	Un-satifactory	–do–	–do–
5	Water Tanker	–	–	2	–	–	Un-satifactory	–do–	–do–
6	Vehicles for XEN's & SD's for field duties	–	–	4	–	–	Un-satifactory	–do–	Required to be replaced

7. COMMUNICATIONS

Sr. No.	Name of Machinery	Capacity (Total)	Hp	No. of Unit	Year of Manufacturing	Size/ Model No.	Condition	Problems	Necessary to Replace (Urgently) or Repair
1	Wireless Sets	–	–	–	–	–	–	–	Required for better communication
2	Mobile TelephoeSets	–	–	–	–	–	–	–	Required for better communication
3	Computers	–	–	–	–	–	–	–	Required for better Performance
4	Photo Copiers	–	–	–	–	–	–	–	–do–
5	Fax Machines	–	–	–	–	–	–	–	–do–

7. OTHERS

Sr. No.	Name of Machinery	Capacity (Total)	Hp	No. of Unit	Year of Manufacturing	Size/ Model No.	Condition	Problems	Necessary to Replace (Urgently) or Repair
1	Saftey equipements for Sewe	–	–	–	–	–	–	–	10-Sets required for human sftey of sewer cleaning staff
2	Metal Detectors	–	–	–	–	–	–	–	5-No. required for detection of buried manholes
3	Computers	–	–	–	–	–	–	–	4-no. required for better officers performance
4	Photo Copiers	–	–	–	–	–	–	–	–do–
5	Fax Machines	–	–	–	–	–	–	–	–do–

Appendix 6.2.8 Example in Gunj Buksh Town (Drainage XEN)

1) Dredging volume

Dredging tasks were divided into Dev-1 and Dev-2. The cleanup on the whole drainage channel including the large rivers and brooks with roughly 90kms within some 3-4 months by three times a year was a goal; however, the achievement ration was as estimated about 61%.

The dredging was carried out to remove the volume with 50,000 ft^3 (1,400m^3) a day by the existing fourteen (14) O&M vehicles and manual labors (working days are nearly 20 days a month on average). The existing dredged volume can be roughly considered as the maximum operational capacity from the viewpoint of insufficient haul dump trucks (8-ton truck: 5 trucks) and the distance access to the throwaway dump-site (one-way 10kms).

2) Content of dredged spoils

The removed dredged silts emit the offensive odor owing to half of their contents are garbage with high water.

3) Disposal method

Total numbers with roughly 965 persons (2008/09) are 64 staff (SDO-1), 52 staff (SDO-2) and 850 contract-based workers.

4) Numbers of worker

Total numbers with roughly 965 persons (2008/09) are 64 staff (SDO-1), 52 staff (SDO-2) and 850 contract-based workers.

Figure (1) illustrates the drainage XEN's organization chart in Gunj Buksh Town.

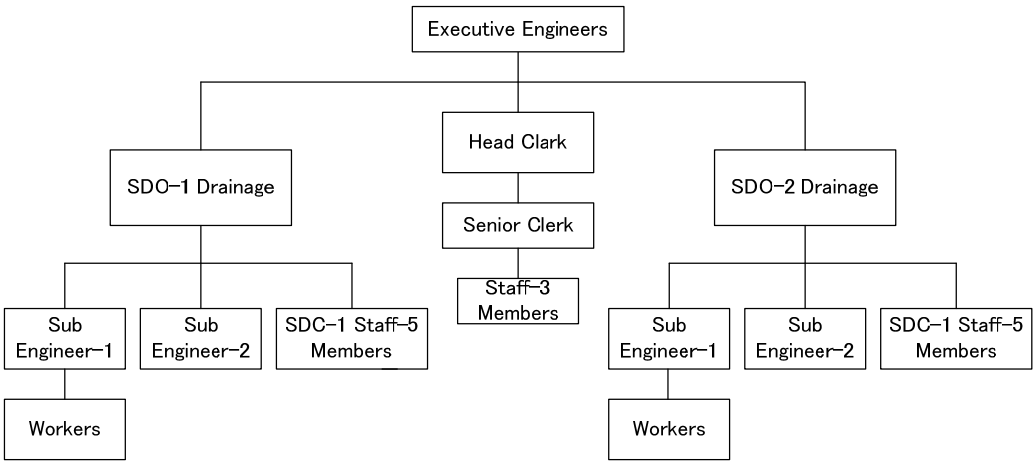


Figure (1) Drainage XEN's Organization Chart in Gunj Buksh Town

5) Operation cost

With regard to the prime cost, the fuel bills on heavy equipment occupies some 83% of the total costs and the cost per dredged spoil volume was about 1.88 Rs/ft^3. The annual maintenance expenses on heavy equipment by outsourcing reached 8.0 MRs due to the low efficiency by deterioration of materials and thus the cost per dredged spoil volume was about 0.25 Rs/ft^3, therefore, the cost were finally estimated as 2.13 Rs/ft^3 in total.

Garbage are existent in the silt dredged; however, no more supports by burden charge from the City District Government Lahore (CDGL) that controls the waste.

Table (1) and **Table (2)** show the operation/repair costs respectively per ft^3 in case of silt removal volumes with 1,000,000 ft^3.

Table (1) Operation Cost of Maintenance Equipment

S.No.	Name of Vehicle	Total Diesel (Month)	Cost (Rs./Month)	Total Mobil Oil (Month)	Cost (Rs./Month)	Oil Filter (Nos/Month)	Cost (Rs./Month)
1	Hitachi Excavator	2,400	137,640	24 (6-Tin)	8,790	1	750
2	Daewoo Excavator	2,400	137,640	24 (6-Tin)	8,790	1	750
3	D/Trucks 5-Nos.	15,000	860,250	16Ltr4-Tin*5	29,300	5	3,750
4	Back Hoe 3-Nos.	3,600	206,460	12Ltr3-Tin*3	13,185	3	750
5	Tractor Trolley	3,600	206,460	12Ltr3-Tin*4	210,960	4	1,000
Total		-	1,548,450	-	271,025	-	7,000
% of cost by items		-	**83%**	-	14%	-	0.4%
Unit Cost per Silt (Rs/ft^3)		-	**1.55**	-	0.27	-	0.01

S.No.	Name of Vehicle	Diesel Filter (Rs./Month)	**Cost (Rs./Month)**	Hydrolic Oil (Rs./Month)	**Cost (Rs./Month)**	Total Expenditure (Rs./Month) 2008-2009
1	Hitachi Excavator	2	780	35	8,225	156,185
2	Daewoo Excavator	2	780	15	4,700	152,660
3	D/T rucks 5-Nos.	10	7,000	50	11,750	912,050
4	Back Hoe 3-Nos.	6	4,200	30	7,050	231,645
5	Tractor Trolley	8	5,600	0	0	424,020
Total		-	18,360	–	31,725	1,876,560
% of cost by items		-	1.0%	-	1.7%	100.0%
Unit Cost per Silt (Rs/ft^3)		-	0.02	-	0.03	**1.88**

Source: WASA Gunj Buksh Town Drainage Division, April 24, 2009

Not: Assumed Amount of Silt yield is 1.0 Milion ft^3 (28,310m^3) per Month

Table (2) Repairing Cost of Maintenance Equipment

S.No.	Type of Vehicle	Expenditure on Engine & Transmission.	Expenditure on Tyre Replacement.	Expenditure on Body.	Total Expenditure(Rs/year) 2008-2009	Remarks (Type of Vehicle)
1	Hitachi Excavator	400,000	~	50,000	450,000	15.1%
2	Daewoo Excavator	40,000	200,000	—	240,000	8.0%
3	Dump Trucks	750,000	360,000	250,000	1,360,000	45.5%
4	Back Hoe 3-Nos.	300,000	120,000	60,000	480,000	16.1%
5	Tractor Trolley	260,000	140,000	60,000	460,000	15.4%
Total (Annually)		1,750,000	820,000	420,000	2,990,000	100.0%
% of cost by Services		58.5%	27.4%	14.0%	100.0%	–
Monthly Cost (Rs)		145,833	68,333	35,000	249,167	–
Unit Cost per Silt (Rs/ft^3)		0.15	0.07	0.04	**0.25**	–

Source: WASA Gunj Buksh Town Drainage Division, April 24, 2009

Not: Assumed Amount of Silt yield is 1.0 Million ft^3 (28,310m^3) per Month

6) Request on improvement/renewal of O&M equipment/materials

Inquiry survey on the present situation for the existing equipment/materials was carried out to improve the process conditions.

The requests from the site in term of the maintenance on vehicles are as below.

- Downsized bulldozers for entry into the river
- Augmentation on number of trucks
- Renewal of vehicles
- Excavators equipped with long boom
- Motorcycles

Table (3) shows the list of existing maintenance equipment and request contents by Gunj Buksh Town.

Table (3) List of Existing Maintenance Equipment and Request in Gunj Buksh Town

S.No.	Name of Machinery	Capacity	Horsepower	No. of Unit	Name of Manufacturer	Year of Manufacturing	Size/ Model #	Condition	Problems	Necessary to replace (Urgently) or Repair
1	Excavator	Medium Boom	120 HP	1	Hitachi (Slow Speed)	1980	UH 08-3	Poor condition but operative	Chain problem, engine weak	Chan and Engine needs replacement
2	Excavator Machine		116 HP	1	Daewo,No. LET-3440 (Tyre Driven)	2006	Dosa TW-401677	Good	Tyres Weak	Tyres need replacement
3	Dumber Truck	8 Ton	165 HP	2	HINO LHN-6831	1985	HINO super	Operative	Tyres Weak	Tyres need replacement
4	Dumber Truck	8 Ton	165 HP	2	NissanLXK-8260	1995	CP-87	Operative	Tyres Weak	Tyres need replacement
5	Dumber Truck	8 Ton	165 HP	3	NissanLXK-9103	1995	CP-87	Operative	Tyres Weak	Tyres need replacement
6	Dumber Truck	8 Ton	165 HP	2	HINOLXK-6832	1985	HINO super	Operative	Tyres Weak	Tyres need replacement
7	Dumber Truck	8 Ton	165 HP	3	Nissan LXK-9106	1995	CP-87	Operative	Tyres Weak	Tyres need replacement
8	Back Hoe Tractor	24″ Bucket Size	65 HP	2	FIATLRT-5515	2005	FIAT-640	Operative	Tyres Weak	Tyres need replacement
9	Back Hoe Tractor	24″ Bucket Size	65 HP	2	FIATLRT-5517	2003	FIAT-640	Operative	Tyres Weak	Tyres need replacement
10	Back Hoe Tractor	24″ Bucket Size	60 HP	1	MassyBHT-4	1997	M.F-265	Body needs denting and painting	Tyres Weak	Engine needs overhauling. Tyres need replacement
11	Tractor Trolly/ Front Head Loader	2 Ton	60 HP	1	MassyLEG-1017	2007	M.F-260	Operative	Pressure Plates/Oil seal leakage/Tyres weak	Needs minor repair/ Tyres need replacement
12	Tractor Trolly (1 CMeter Bucket)	capacity 4 Ton	80 HP	1	Massy LZR-4303	2004	M.F-385	Operative	Tyres Weak	Needs minor repair/ Tyres need replacement
13	Tractor Trolly	3 Ton	75 HP	1	MassyLEG-2882	2007	M.F-375	Operative	Tyres Weak	Needs minor repair/ Tyres need replacement
14	Tractor Trolly	3 Ton	75 HP	1	Jonh Deere LEG-1912	2008	JDT-720	Operative	Speed meter & Wiring Burnt	Needs minor repaire/Speed Meteryres
Total				23						

Source : Gunj Buksh Town (Drainage XEN), 22

Appendix 6.2.9

List of Existing Maintenance Equipment and Request

DEWATERING SHOP

1.Civil Works										
S.No.	Name of Machinery	Capacity	Hp	No. of Unit	Name of Manufacturer	Year of Manufact-uring	Size/ Model #	Condition	Problems	Necessary to replace (Urgent) or Repair
1	Renovate the old building of dewatering shop, machine shop, meter shop, stores and other rooms	-	-	Main out fall building	-	-	-	-	The building structure is very old and worned out	Repair work needed urgently(workshop 8 offices)
2. Pumps										
1	Portable Engine Pumps, Dong Feng single Tank	1-Cusec	12 HP	**159**	China	1996	1996	Running	50% creates frequent problems	50% needs replacement, 75 New out of 159
2	Portable Engine Pumps, Dong Feng Double Tank	1-Cusec	12 HP	208	China	1980	1980	Running	Too old	50% needs replacement
3	Mobile Engine Pumps, Lister	4-Cusec	90 HP	2	England	1980	1980	Running	Too old	Needs replacement
4	Mobile Engine Pumps, Lister	2-Cusec	45 HP	13	England	1980	1980	Running	Too old	Needs replacement
5	Mobile Engine Pumps, Lister Peter 2-Cylinder	1-Cusec	45 HP	4	England	1980	1980	Running	Too old	Needs replacement
6	Mobile Engine Pumps China (2-	2-Cusec	24 HP	4	China	1999	1999	Running		Two more required
7	Mobile Engine Pumps, Deutze 3-	2-Cusec	45 HP	59	Germany	2008	2008	Running	20 more required	30 more required
8	Portable Engine Pumps, Deutze	½-cusec	6 HP	25	China	1996	1996	Running	50% needs	50% needs replacement
9	Portable Engine Pumps, Deutze-	2-Cusec	16 HP	1	England	1975	1975	Running	Too old	Needs replacement
10	Portable Engine Pumps, Deutze	½-cusec	¼ HP	46	Japan	996, 2005	996, 200	Running	50% needs replacement	50% needs replacement and 25 Nos. more required
11	Submersible Pumps (Elect.),	½-cusec	2 HP	18	China	2005	2005	Running	-	-
12	Portable Engine Pumps, Deutze	½-cusec	4 HP	6	China	2005	2005	Running	Needs	Needs replacement
	Total	-	-	**545**	-	-	-	-	-	-
3. Vehicles										
S.No.	Name of Machinery	Capacity	Hp	No. of Unit	Name of Manufacturer	Year of Manufact	Size/ Model #	Condition	Problems	Necessary to replace (Urgent) or Repair
1	Crane	6-Ton	190-HP	2	Japan	-	Latest Model	-	Shifting of dewatering sets	2 Nos. required Urgently before monsoon 2009
2	Truck Shehzore	3500 cc	90-HP	3	Koria	-	Latest Model	-	2 for dewatering sets mobile squade & one for	3 Nos. Urgently required before monsoon 2009
3	Land Rover LHO-6083	-	-	1	England	1988	1988	Poor	Need frequent	Needs replacement
4	Pick up truck 500kg LHO-1765	800 cc	800 cc	1	Pakistan	1988	1988	Poor condition	Need frequent repairs	Needs replacement
5	Tractor Trolley	2500 cc	2500 cc	1	Pakistan	2007	2007	OK	-	-
	Toal	-	-	**8**	-	-	-	-	-	-
4. Generator										
S.No.	Name of Machinery	Capacity	Hp	No. of Unit	Name of Manufacturer	Year of Manufact-uring	Size/ Model #	Condition	Problems	Necessary to replace (Urgent) or Repair
1	Generator	10 KVA	-	1	Japan	-	Latest Model	-	To carry out work during frequent load shedding	1 No. Urgently required before monsoon 2009
5.Machine Shop										
1	Lathe Machine	16 Ft long	7½-HP	1	PECO Pakistan	1980	CL-305	OK	-	-
2	Lathe Machine	8 Ft long	3-HP	1	PECO Pakistan	1974	BE-165	Out of order	Needs repair	Needs repair
3	Shaper Machine	-	5-HP	1	PECO Pakistan	1974	SH-460	Out of order	Needs repair	Needs repair
4	Hacksaw Machine	-	1-HP	1	PECO Pakistan	1974	HS-160	Out of order	Needs repair	Needs repair
5	Drill Machine	-	-	1	PECO Pakistan	1974	-	Out of order	Needs repair	Needs repair
6	Drill Machine	-	-	1	PECO Pakistan	1974	-	Out of order	Needs repair	Needs repair
7	Grinder Machine	-	1-HP	1	PECO Pakistan	1974	-	Out of order	Needs repair	Needs repair
8	Welding Plant	-	-	1	Pakistan	1974	-	Out of order	Needs repair	Needs repair
	Total	-	-	**8**	-	-	-	-	-	-
6. Dewatering Shop										
1	Drill Machine	Single	1-HP	1	Pakistan	1971	-	OK	-	-
2	Grinder Machine	Single	1-HP	1	Pakistan	1971	-	OK	-	-
3	Compressor	100	-	1	Pakistan	1971	-	OK	-	-
	Total	-	-	**3**	-	-	-	-	-	-

Appendix 6.2.10

List of Existing Instruments in Water/Wastewater Laboratory (WASA)

A Analytical Instrumentation

S.NO.	NAME OF INSTRUMENT	Measuring Range	Mesrement Accuracy	No. of Unit	Name of Manufacture	Year of Manufactur e	Size / Model#	CONDITION	Reason of trouble	Necessary to replace (Urgently)
1	Computer with Printer			2	Intell	-	p-3, p-4	Working	1 system is old	Yes
2	Stirrer	not readable	not readable	2	-	-	-	Not Working	not readable	yes
3	Digital Burrette	1-50ml	95%	3	-	1993	-	Working	-	more required
4	Auto Still (Meriden)	5l/h	97%	1	china	-	TT-98-11	Working	-	2 more required(glass Distillation assembly)
5	PH Meter	0-14	99%	1	-	-	jenco 6173	Working	-	4 no. required
6	Conductivity Meter	0-2000µS	98%	1	-	-	Jecnco 3173	Working	-	4 more requred 2No. bench model 2 No portable
7	Water Bath	-	-	1	-	-		Not Working	-	yes 2 more required
8	Tripple Beam Balance	-	-	1	-	-		NotWorking	-	No
9	Four Beam Balance	-	-	1	-	-		Not Working	-	No 4 nos. Anlytical Balances are required
10	Anlytical Balance	-	-	1	Denver	-		Working	-	No 4 nos. Anlytical Balances are required
11	Turbidity Meter	0-1000FTU	95%	1	-	-	HANNA HI93703	Working	-	Four more required 2No. bench model 2 No portable
12	Flame Photometer	wave lenth 410	Not satisfactory	1	Uk	-	Corning 410	Not Working	Not availability of sui gas pipeline	yes 2 more required
13	Spectro Photometer	-	-	1	Spectronic 21	-	-	Not Working	-	-
14	Auto Digital Colorimeter	-	-	1	WPA	-	-	Not Working	-	-
15	Magnetic Stirrer Hot Plate	-	-	1	SMS	-	-	Working	-	-
16	Electro Thermal	-	-	1	-	-	-	Not Working	-	-
17	Desicator	-	-	1	-	-	-	Working	-	-
18	Oven	-	-	1	Binder	-	-	Working	-	-
19	Auto Clave	-	-	1	LEEC	-	-	Not Working	-	-
20	Beam Balance	-	-	1	Stanton	462 AL	-	Not Working	-	-
21	Thermostatic water bath (Electrically heated)	-	-	1	-	-	-	Not Working	-	-
22	Electronic Balance	-	-	1	perkin elemers	-	-	Not Working	-	-
23	Atomic Absorption spectrophotometer	-	-	1	-	-	-	Not Working	-	-
24	Arsenic analytical instrument	-	-	1	-	-	-	Working	Not Working of AAS	-
25	Centrifugal	-	-	1	-	-	-	Not Working	-	yes
26	PH Meter Model PBI	-	-	1	-	-		Not Working	-	yes
27	Spectrophotometer	-	-	1	-	-	Nv 202	Not Working	-	yes
28	PH Meter	-	-	1	Corning	-	-	Not Working	-	yes
29	Millipore filter assembly	-	-	1	-	-	-	Working	-	yes
30	Kjeldahl apparatus	-	-	1	-	-	-	Not Working	-	yes
31	Refrigerators	-	-	2	Dawlance	-	-	Working	no	no
32	Air conditionor	-	-	3	PEL	-	-	Not working properly	-	yes 6 new is required (Split Units)
	Sub Total	-	-	39	-	-	-	-	-	-

B. **Instruments in the Nicro Biological Lab**

S.NO.	NAME OF INSTRUMENT	Measuring Range	Mesrement Accuracy	No. of Unit	Name of Manufacture	Year of Manufactur	Size/Model#	CONDITION	Reason of trouble	Necessary to replace(Urgently)
1	Microscope Assembly	-	-	1	-	-	-	Not Working	-	yes
2	Incubator Millipore	-	-	1	-	-	-	Working	-	yes
3	Hot Plate (STAURT)	-	-	1	-	-	-	Working	-	yes 4 more required
4	Auto Clave (Astell)	-	-	1	-	-	-	Not Working	-	yes
5	Vacuum Pump	-	-	1	-	2003	mediam	Working	-	3 more required
6	Oven	0-230C	90%	1	GALLEN KAMP)	-	GALLEN KAMP)	Working	-	2 more required
7	Micro Wave Oven	-	-	1	GALLEN KAMP)	-	-	Working	-	no
8	Incubator	-	-	1	(UMS)	-	-	Not Working	-	repaire is required or replacement
9	Moniter(TV)	-	-	1	-	-	-	Working	-	
10	Water coolant to carry samples	-	-	1	-	-	-	Working	-	Three nos.
	Subtotal	-	-	**10**	-	-	-	-	-	-

C Glassware

S.NO.	NAME OF INSTRUMENT	Measuring Range	Measurement Accuracy	No. of Unit	Name of Manufacture	Year of Manufacture	Size/Model#	CONDITION	Reason	Necessary to replace(Urgently)
1	Sampling bottles	500ml	-	100	-	-	-	Normal	-	300 more required
2	Flasks	100ml	-	20	-	-	-	Normal	-	Flasks of different measurement is required 12
3	Beakers	-	-	-	-	-	-	Normal	-	Beakers of different measurement is required 12
	Subtotal	-	-	120	-	-	-	-	-	-

D Office automation

S.NO.	Chemist Office	Measuring Range	Measurement Accuracy	No. of Unit	Name of Manufacture	Year of Manufacture	Model#	CONDITION	Reason of trouble	Necessary to replace(Urgently)
1	Printers	-	-	1	-	-	Hp 2015, Hp 300	Working	-	1 heavy duty printer is required for chemist office
2	Office desk & chairs	-	-	-	-	-	-	Working	-	shelves and book rack are required
3	Internet facility	-	-	0	-	-	-	-	-	Required
4	Laptop	-	-	0	-	-	-	-	-	Required
5	Photocopy machine	-	-	0	-	-	-	-	-	Required
	Subtotal	-	-	1	-	-	-	-	-	

E Transportation

S.NO.	NAME OF INSTRUMENT	Measuring Range	Measurement Accuracy	No. of Unit	Name of Manufacture	Year of Manufactur	Size/Model#	CONDITION	Reason of trouble	Necessary to replace(Urgently)
1	Vehicles	-	-	2	-	-	pickup,bolan	Very bad	not suitable for sampling and chemist use	yes and 1 more is required
2	Motorcycles	-	-	not any	-	-	-	-	-	1 is required
3	Bicycles	-	-	not any	-	-	-	-	-	not required
	Subtotal	-	-	-	-	-	-	-	-	-

F Means of Communication

S.NO.	NAME OF INSTRUMENT	Measuring Range	Measurement Accuracy	No. of Unit	Name of Manufacture	Year of Manufacture	Size/Model#	CONDITION	Reason of trouble	Necessary to replace(Urgently)
1	Ptcl line rent	-	-	ptcl	good	-	-	-	-	one handset is required for the use in field (V fone)
2	Fax machine	-	-	-	-	-	KX-FT937		not separate telephone connection	1 is required
	Subtotal	-	-	-	-	-	-	-	-	-

G Others

S.NO.	NAME OF INSTRUMENT	Measuring Range	Measurement Accuracy	No. of Unit	Name of Manufacture	Year of Manufacture	Size/Model#	CONDITION	Reason of trouble	Necessary to replace(Urgently)
1	List of available water and wastewater's analysis items	-	-	-	-	-	-	-	-	-
2	Atomic Absorption spectrophotometer	-	-	0	-	-	-	-	-	required with standards
3	COD Apparatus	-	-	0	-	-	-	-	-	required with standards
4	BOD Apparatus	-	-	0	-	-	-	-	-	required with standards
5	UV Spectrophotometer	-	-	0	-	-	-	-	-	three no. required with standards
	Subtotal	-	-	-	-	-	-	-	-	

Any comment/Request:

Renovation of lab is very necessary for the safety of expensive instruments as a no. of instruments are out of order due to not proper handling and cleanliness. Existing area where WASA alb is located is not enough to run working of Lab smoothly so Area should be extended. WASA lab is further divided into four sections.1 Analytical section 2. Chemical Section 3. Bacteriological Section 4. Waster water analysis section so to run working of Lab and to assist chemist following staff is required in future.

Source: WASA chemical laboratory, 14 April, 2009

Appendix 6.2.11 Other Laboratories

6.1 Pakistan Council of Research in Water Resources (PCRWR)

Regional Water Quality Laboratory in Lahore Office, as the provincial organization, is established in December, 2008, supervised by Ministry of Science & Technology, Government of Pakistan.

(1) Existing Instruments Laboratory

The analysis work is executed with Research Center in Lahore water analyses place and three other research centers.

The water testing laboratory executes the water sampling, water analyses and its evaluation, according to the request from WASA and private company and request form international organization.

The analyses instruments are enough as equipment that inspects the water quality item of the drinking water. The number of staff is about 23 in Regional office.

On the other hand, PCRWR has disclosed the water quality information to the homepage of the Internet in cooperation with Punjab EPA.

The list of the table and the water quality analyzer of the execution organization is as follows:

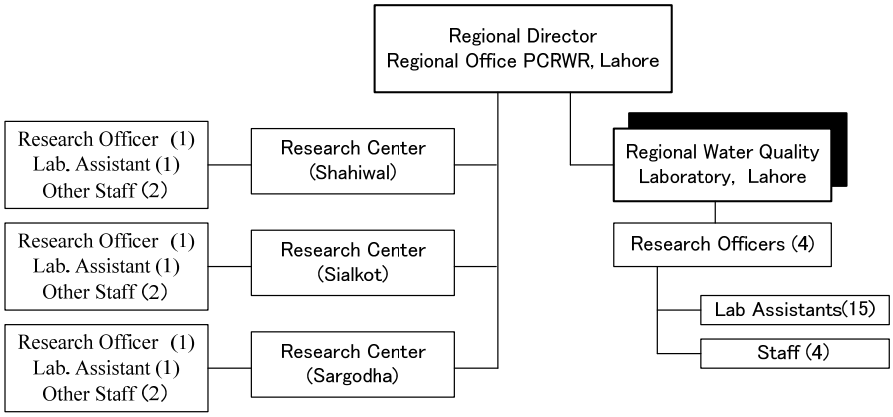


Figure (1) Implementing Organization Chart

pH Analysis

Atomic Absorption Spectrometer

Table (1) List of Existing Instruments Laboratory (PCRWR)

Sr. No.	Equipment Name	Qty.
1	Atomic Absorption Spectrometer	1
2	UV/VIS Spectrophotometer(Double Beam)	1
3	UV/VIS Spectrophotometer(Single Beam)	1
4	COD Reactor	1
5	Incubator	3
6	Hygrometer	2
7	Turbidity Meter	1
8	pH Meter	7
9	EC Meter	2
10	Colorimeters	3
11	Fluoride Meter	1
12	Free and Total Chlorine Meter	1
13	Water Distillation Plant	2
14	Flame Photometer	2
15	Microscope	1
16	Oven	5
17	Magnetic Stirrer	2
18	Balance	2
19	Refrigerator	1
20	Auto Clave	2
21	Ion Meter	1
22	DO Meter	1
23	PC, Printer and other laboratory	34
	Total	77

6.2 EPA（Punjab Province）

EPA of Punjab Province is a statutory body established as an implementing agency of EPD based on regulations of PEPA Act 1997.

EPA executes the setting of the National water standard, the monitoring of domestic water quality and wastewater discharge, the environmental assessment, and the disclosing of above information.

(1) **Existing Instruments Laboratory**

The monitoring work is to execute test of water and wastewater, administrative guidance of the environmental control.

EPA cooperates for WASA Laboratory and PCRWR Laboratory using EPA's Laboratory.

The water analyses work is shown below.

- －Mainly complaint investigations such as the drinking water and sewage (sampling, water analyses, and the evaluations).
- －EPA executes the spot inspection to the wastewater analyses frequency about once a year.
- －The main analysis item is BOD, COD, TSS, DO, water temperature, color, etc.

The analysis staff is about 32 whole numbers, and additionally, the contract employee is employed if necessary.

The list of the table and the water quality analyzer of the execution organization is as follows.

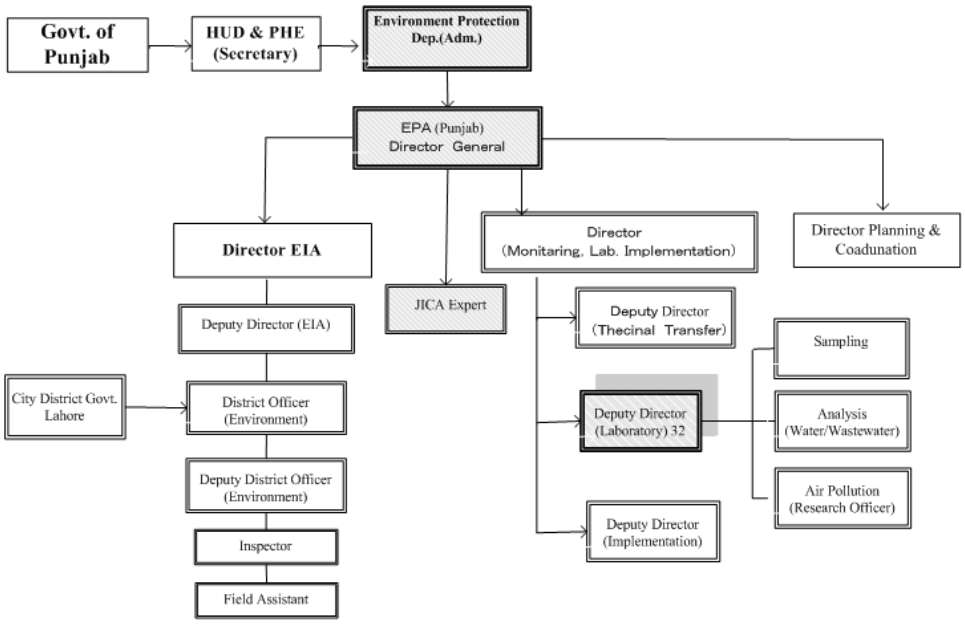


Figure (2) Implementing Organization Chart

Table (2) List of Existing Instruments Laboratory (EPA)

No.	Work / Parameter	Equipment/ Apparatus	No. of Equipment	No.	Work / Parameter	Equipment/ Apparatus	No. of Equipment
1	Sampling Works	Water Sampler	1	17	Hexavalent Chromium	Spectro photometer	1
		Current Meter	1			Hot plate	1
		Quanta for water quality monitoring in field	1	18	Mercury	Atomic absorption Spectro Photometer	1
2	Temperature	Thermometer	8			Hollow cathode lamp	1
3	pH	pH Meter	2			Vaporization generator	1
4	BOD5	Incubator	2	19	Arsenic	Atomic absorption Spectro Photometer	1
		BOD barometer	1			Hollow cathode lamp	1
		Buratte	2			Hydride generator	1
		Dispenser	1	20	Boron	Atomic absorption Spectro Photometer	1
5	COD	Heater	1			Hot plate	1
		Buratte	1			Paqualab Photometer	1
		Dispenser	1			Sulfur Content Analyzer in Fuel	0
		Magnetic stirrer	2			Microwave Digester	1
6	TSS	Filtration unit with pump unit	2			COD Analyzer Apparatus	1
		Dry Oven	2			BOD Analyzing Apparatus (Incubator)	2
		Desiccators	1			Low Temperature Incubator	2
		Analytical Balancer (MDL 1mg/L)	1			Oven	2
7	TDS	Hot plate	1			Furnace	2
		Desiccators	1			Muffle Furnace	1
		Analytical Balancer (MDL 1mg/L)	1			Rotary evaporator	1
8	Oil and Grease	Separator funnels	12			Aspirator w/ cooling unit	1
		Oil contents analyzer	1			Tabletop Type Centrifuge	1
		Desiccators	1			Magnetic stirrer (small)	1
		Analytical Balancer (MDL 1mg/L)	1			Magnetic stirrer (large)	1
9	Phenol Compounds	GC	1			Magnetic stirrer (W/Hot Plate)	1
		GC-column	1			Water Bath (small)	1
		Rotary evaporator	1			Water Bath (large)	1
		Shaker	1	21	Residual Chlorine Other/ General	Distillation Apparatus (for CN, NH4, and F)	1
10	Chloride	Absorption method Spectro Photometer	1			Vacuum Filter Unit	2
		Titration method Dispenser	1			Analysis Balance	1
		Buratte	1			Macro Analysis Balance	1
11	Fluoride	Selective Electrode Spectro photom	1			Clean Bench	1
		Spectro photometer	0			Autoclave (Vertical Type)	1
12	Total Cyanide	Ion Selective Electrode	1			Colony Counter	1
		Spectro photometer	0			Microscope	1
13	MBAS	Spectro photometer	0			Shaker	1
		Automatic shaker	0			Laboratory pH Meter	1
14	Ammonium Nitogen	Gravimeteric method	0			Laboratory Type DO Meter	1
		Titration method	0			Laboratory Conductivity Meter	1
		Paqualab Photometer	1			Laboratory Turbidity Meter	1
		Spectro photometer	0			Standard Thermometer set	1
		Ion chromatograph	0			Pure Water supply Unit	1
15	, Pb, Cu, Zn, Se, Ni,	Atomic absorption Spectro Photometer	1			Refrigerator	1
		Hallow cathode lamp	1			Wastewater Treatment Equipment	1
		Separator funnels	1			Draft chamber with Gas cleaning Device	1
		Hot plate	1	22	Ion chromatograph		1
16	Pesticide	GC	1		Total		116
		GC-column	1				
		Rotary evaporator	1		Source: EPA, April 16,2009		
		Shaker	1				

Appendix 6.3.1

Detail of Employees' Education Level in 2008

1.Educational level for **Administrator / Office workers**	Doctor/Master		College graduate		Academy/High school		junior high school/other		Total	
	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)
Under 5 years	8	15.4%	19	16.8%	14	12.4%	55	13.7%	96	14.1%
Over 5-under 10	0	0.0%	8	7.1%	7	6.2%	5	1.2%	20	2.9%
Over 10^under 15	1	1.9%	7	6.2%	6	5.3%	24	6.0%	38	5.6%
Over 15- under 20	3	5.8%	15	13.3%	7	6.2%	76	18.9%	101	14.9%
Over 20-under 25	4	7.7%	10	8.8%	3	2.7%	148	36.8%	165	24.3%
Over 25- under 30	10	19.2%	19	16.8%	20	17.7%	42	10.4%	91	13.4%
Over 30-under 35	21	40.4%	19	16.8%	47	41.6%	3	0.7%	90	13.2%
Over 35yeras	5	9.6%	16	14.2%	9	8.0%	49	12.2%	79	11.6%
Total	**52**	100.0%	**113**	100.0%	**113**	100.0%	**402**	100.0%	**680**	100.0%

2.Educational level for **Engineers/Technical staff**	Doctor/Master		College graduate		Academy/High school		junior high school/other		Total	
	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)
Under 5 years	1	50.0%	25	34.2%	73	41.5%	83	46.4%	182	42.3%
Over 5-under 10	0	0.0%	2	2.7%	19	10.8%	40	22.3%	61	14.2%
Over 10^under 15	0	0.0%	6	8.2%	7	4.0%	8	4.5%	21	4.9%
Over 15- under 20	0	0.0%	13	17.8%	2	1.1%	6	3.4%	21	4.9%
Over 20-under 25	0	0.0%	19	26.0%	12	6.8%	13	7.3%	44	10.2%
Over 25- under 30	0	0.0%	8	11.0%	29	16.5%	15	8.4%	52	12.1%
Over 30-under 35	0	0.0%	0	0.0%	32	18.2%	10	5.6%	42	9.8%
Over 35yeras	1	50.0%	0	0.0%	2	1.1%	4	2.2%	7	1.6%
Total	**2**	100.0%	**73**	100.0%	**176**	100.0%	**179**	100.0%	**430**	100.0%

3.Educational level for **Assistant staff**	Doctor/Master		College graduate		Academy/High school		junior high school/other		Total	
	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)
Under 5 years	1	5.0%	13	20.0%	60	25.3%	44	21.7%	118	22.5%
Over 5-under 10	7	35.0%	38	58.5%	9	3.8%	2	1.0%	56	10.7%
Over 10^under 15	0	0.0%	3	4.6%	18	7.6%	25	12.3%	46	8.8%
Over 15- under 20	0	0.0%	1	1.5%	0	0.0%	5	2.5%	6	1.1%
Over 20-under 25	1	5.0%	7	10.8%	49	20.7%	77	37.9%	134	25.5%
Over 25- under 30	0	0.0%	1	1.5%	9	3.8%	14	6.9%	24	4.6%
Over 30-under 35	1	5.0%	0	0.0%	28	11.8%	15	7.4%	44	8.4%
Over 35yeras	10	50.0%	2	3.1%	64	27.0%	21	10.3%	97	18.5%
Total	**20**	100.0%	**65**	100.0%	**237**	100.0%	**203**	100.0%	**525**	100.0%

4.Educational level for **Supporting staff & Others(Site Staff)**	**Less/No Education**		Total	
	Number of employee (personnel)	Ratio(%)	Number of employee (personnel)	Ratio(%)
Under 5 years	904	23.9%	1,300	24.0%
Over 5-under 10	595	15.7%	732	13.5%
Over 10^under 15	532	14.1%	637	11.8%
Over 15- under 20	1,090	28.8%	1,218	22.5%
Over 20-under 25	249	6.6%	592	10.9%
Over 25- under 30	392	10.4%	559	10.3%
Over 30-under 35	23	0.6%	199	3.7%
Over 35yeras	0	0	183	3.4%
Total	**3,785**	100.0%	**5,420**	100.0%

Source: Administration Dep. May 13, 2009 As of April 2009

Education Level	# of Employees	%
Doctor/Master	74	1.4%
College graduate	251	4.6%
Academy/High school	526	9.7%
junior high school/other	784	14.5%
Less/No Education	3,785	**69.8%**
Total	**5,420**	100.0%

Appendix 6.3.2 Layout of WASA Training Centre

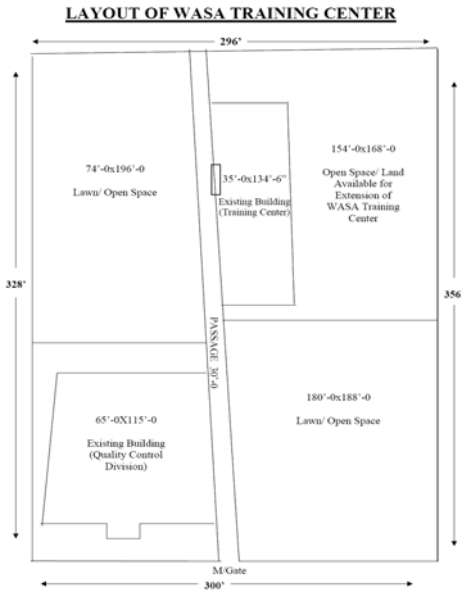


Figure 6.3.8 Renovation Schedule

Appendix 6.4.1 Details of Complaints on Water Quality

The water-quality test result in the dry season and the rainy season is shown.

Table (1) Complaints on Water Quality (Dry Season)

01-01-2009 TO 31-01-2009

S.NO	Date of Complaints Received	NATURE OF COMPLAINT	E-Coliform	Color	Smell	Turbidity (5NTU)	TDS (1000m/l)	No of Total Sampling Bottles
1	2009/1/1	Water Quality is not good	Present	Colorless	Odorless	3.54	180	19
2	2009/1/1	Water Quality is not good	Present	Colorless	Odorless	2	190	12
3	2009/1/1	Water Quality is not good	Present	Colorless	Odorless	5.47	367	8
4	2009/1/1	Water Quality is not good	Present	Colorless	Odorless	2.3	355	20
5	2009/2/1	Water Quality is not good	Present	Color	Odorless	2.28	213	20
6	2009/5/1	Water Quality is not good	Not By WASA's Lab					
7	2009/7/1	Water Quality is not good	Nil	Colorless	Odorless	3.26	293	9
8	2009/10/1	Water Quality is not good	Present	Colorless	Odorless	2.58	238	16
9	2009/12/1	Water Quality is not good	Present	Colorless	Odorless	1.16	386	9
10	13/1/2009	Water Quality is not good	Nil	Colorless	Odorless	3.94	196	2
11	13/1/2009	Water Quality is not good	Not By WASA's Lab					
12	15/1/2009	Water Quality is not good	Not By WASA's Lab					
13	17/1/2009	Water Quality is not good	Present	Colorless	Odorless	3.1	741	20
14	18/1/2009	Water Quality is not good	Present	Colorless	Odorless	3.18	519	27
15	18/1/2009	Water Quality is not good	Present	Colorless	Odorless	2.29	381	12
16	20/1/2009	Water Quality is not good	Nil	Colorless	Odorless	3.86	498	15
17	21/1/2009	Water Quality is not good	Not By WASA's Lab					
18	23/1/2009	Water Quality is not good	Not By WASA's Lab					
19	23/1/2009	Water Quality is not good	Not By WASA's Lab					
20	26/1/2009	Water Quality is not good	Not By WASA's Lab					
21	27/1/2009	Water Quality is not good	Present	Colorless	Odorless	2.59	452	15
22	31/1/2009	Water Quality is not good	Nil	Colorless	Odorless	3.91	476	12
23	31/1/2009	Water Quality is not good	Nil	Colorless	Odorless	3.21	406	12
24	2009/2/1	Water Quality is not good	Nil	Colorless	Odorless	2.92	289	12
25	2009/2/1	Water Quality is not good	Present	Colorless	Odorless	2.24	291	20
26	2009/3/1	Water Quality is not good	Present	Colorless	Odorless	3.21	511	18
27	2009/3/1	Water Quality is not good	Present	Colorless	Odorless	2.82	311	16
28	2009/3/1	Water Quality is not good	Present	Colorless	Odorless	3.15	183	19
29	2009/3/1	Water Quality is not good	Not By WASA's Lab					
30	2009/5/1	Water Quality is not good	Present	Colorless	Odorless	3.47	279	16
31	2009/10/1	Water Quality is not good	Present	Colorless	Odorless	2.58	287	12
32	14/1/2009	Water Quality is not good	Present	Colorless	Odorless	2.99	282	28
33	17/1/2009	Water Quality is not good	Nil	Colorless	Odorless	3.42	417	24
34	19/1/2009	Water Quality is not good	Nil	Colorless	Odorless	3.01	196	20
35	21/1/2009	Water Quality is not good	Not By WASA's Lab					
36	24/1/2009	Water Quality is not good	Not By WASA's Lab					
37	29/1/2009	Water Quality is not good	Present	Colorless	Odorless	3.43	563	17
38	30/1/2009	Water Quality is not good	Not By WASA's Lab					
39	30/1/2009	Water Quality is not good	Not By WASA's Lab					
Total		**No. of WASA Water Test**	**27**	**27**	**27**	**27**	**27**	430
		Positive/Abnormal value	**19**	**0**	**0**	**0**	**0**	-
		Negative/Normal value	**8**	**27**	**27**	**27**	**27**	-
Possibility of Positive			**70%**	**0%**	**0%**	**0%**	**0%**	-

Source : Water Chemical Laboratory, May, 2009

Table (2) Complaints 0n Water Quality (Rainy Season)

01-07-2008 TO 31-07-2008

S.NO	Date of Complaints Received	NATURE OF COMPLAINT	E-Coliform	Color	Smell	Turbidity (5NTU)	TDS (1000m/l)	No of Total Sampling Bottles
1	2008/2/7	Sewerage Water mix in Water Supply	Nil	Colorless	Odorless	0.00	230.00	18
2	2008/2/7	Sewerage Water mix in Water Supply	Present	Colorless	Odorless	1.96	322.00	14
3	2008/3/7	Sewerage Water mix in Water Supply	Nil	Colorless	Odorless	0.00	230.00	18
4	2008/3/7	Sewerage Water mix in Water Supply	Present	Colorless	Odorless	0.44	264.00	17
5	2008/5/7	Sewerage Water mix in Water Supply	Nil	Colorless	Odorless	0.42	300.00	14
6	2008/5/7	Sewerage Water mix in Water Supply	Present	Colorless	Odorless	0.81	355.00	15
7	2008/6/7	Sewerage Water mix in Water Supply	Present	Colorless	Odorless	0.81	355.00	15
8	2008/7/7	Sewerage Water mix in Water Supply	Not By WASA's Lab					
9	2008/7/7	Sewerage Water mix in Water Supply	Present	Colorless	Odorless	1.25	390.00	10
10	2008/7/7	Sewerage Water mix in Water Supply	Present	Colorless	Odorless	0.98	425.00	20
11	2008/7/7	Sewerage Water mix in Water Supply	Not By WASA's Lab					
12	2008/8/7	Sewerage Water mix in Water Supply	Present	Colorless	Odorless	0.98	425.00	20
13	2008/8/7	Sewerage Water mix in Water Supply	Nil	Colorless	Odorless	0.02	233.00	15
14	2008/9/7	Water Quality is not good	Present	Colorless	Odorless	0.97	480.00	13
15	2008/9/7	Water Quality is not good	Present	Colorless	Odorless	0.44	264.00	17
16	2008/11/7	Water Quality is not good	Not By WASA's Lab					
17	2008/11/7	Water Quality is not good	Nil	Colorless	Odourless	0.00	230.00	18
18	2008/12/7	Water Quality is not good	Present	Colorless	Odourless	2.09	460.00	9
19	13/7/2008	Water Quality is not good	Present	Colorless	Odourless	3.18	364.00	6
20	13/7/2008	Water supply mixing with sewer line	Not By WASA's Lab					
21	14/7/2008	Water Quality is not good	Present	Colorless	Odorless	0.81	355.00	15
22	14/7/2008	Water Quality is not good	Not By WASA's Lab					
23	14/7/2008	Water Shortage, Quality is not good	Nil	Colorless	Odorless	2.71	611.00	25
24	14/7/2008	Water Quality is not good	Present	Colorless	Odorless	0.98	425.00	20
25	15/7/2008	Water Quality is not good	Nil	Colorless	Odorless	0.96	238.00	21
26	15/7/2008	Water Quality is not good	Present	Colorless	Odorless	2.09	460.00	9
27	16/7/2008	Water Quality is not good	Present	Colorless	Odorless	1.96	322.00	14
28	16/7/2008	Water Quality is not good	Not By WASA's Lab					
29	18/7/2008	Water Quality is not good	Present	Colorless	Odorless	0.39	310.00	19
30	20/7/2008	Water Quality is not good	Nil	Colorless	Odorless	0.98	440.00	15
31	22-07-2008	Dirty Water	Not By WASA's Lab					
32	22-07-2008	Dirty Water	Present	Colorless	Odorless	0.82	480.00	27
33	22-07-2008	Dirty Water	Present	Colorless	Odorless	0.82	480.00	27
34	22-07-2008	Dirty Water	Present	Colorless	Odorless	0.82	480.00	27
35	22-07-2008	Dirty Water	Present	Colorless	Odorless	0.49	451.00	16
36	23-07-2008	Dirty Water	Not By WASA's Lab					
37	23-07-2008	Dirty Water	Nil	Colorless	Odorless	1.25	250.00	19
38	24-07-2008	Dirty Water	Not By WASA's Lab					
39	25-07-2008	Dirty Water	Not By WASA's Lab					
40	25-07-2008	Dirty Water	Nil	Colorless	Odorless	1.25	250.00	19
41	26-07-2008	Dirty Water	Present	Colorless	Odorless	0.87	929.00	22
42	26-07-2008	Dirty Water	Present	Colorless	Odorless	0.87	929.00	22
43	26-07-2008	Dirty Water	Present	Colorless	Odorless	0.87	929.00	22
44	26-07-2008	Dirty Water	Present	Colorless	Odorless	0.87	929.00	22
45	26-07-2008	Dirty Water	Present	Colorless	Odorless	0.87	929.00	22
46	26-07-2008	Dirty Water	Present	Colorless	Odorless	0.87	929.00	22
47	27-07-2008	Dirty Water	Present	Colorless	Odorless	0.87	929.00	22
48	27-07-2008	Dirty Water	Present	Colorless	Odorless	0.87	929.00	22
49	27-07-2008	Dirty Water	Present	Colorless	Odorless	0.87	929.00	22
50	27-07-2008	Dirty Water	Present	Colorless	Odorless	0.87	929.00	22
51	27-07-2008	Dirty Water	Present	Colorless	Odorless	0.87	929.00	22
52	27-07-2008	Dirty Water	Present	Colorless	Odorless	0.87	929.00	22
53	28-07-2008	Dirty Water	Nil	Colorless	Odorless	1.26	278.00	22
54	28-07-2008	Sewerage Water mix in Water Supply	Nil	Colorless	Odorless	1.48	1169.00	24
55	29-07-2008	Sewerage Water mix in Water Supply	Nil	Colorless	Odorless	1.48	1169.00	24

56	29-07-2008	Dirty Water	Nil	Colorless	Odorless	1.53	525.00	11
57	29-07-2008	Dirty Water	Present	Colorless	Odorless	1.17	393.00	4
58	29-07-2008	Sewerage Water mix in Water Supply	Nil	Colorless	Odorless	1.48	1169.00	24
59	29-07-2008	Sewerage Water mix in Water Supply	Nil	Colorless	Odorless	1.48	1169.00	24
60	29-07-2008	Sewerage Water mix in Water Supply	Nil	Colorless	Odorless	1.20	214.00	14
61	29-07-2008	Dirty Water	Present	Colorless	Odorless	0.65	201.00	18
62	29-07-2008	Sewerage Water mix in Water Supply	Present	Colorless	Odorless	1.96	322.00	14
63	29-07-2008	Dirty Water	Nil	Colorless	Odorless	1.53	525.00	11
64	30-07-2008	Dirty Water	Nil	Colorless	Odorless	0.00	318.00	16
65	30-07-2008	Dirty Water	Nil	Colorless	Odorless	0.00	318.00	16
66	30-07-2008	Dirty Water	Nil	Colorless	Odorless	0.00	318.00	16
67	30-07-2008	Dirty Water	Nil	Colorless	Odorless	0.00	318.00	16
68	30-07-2008	Sewerage Water mix in Water Supply	Present	Colorless	Odorless	1.96	322.00	14
69	31-07-2008	Dirty Water	Nil	Colorless	Odorless	1.53	525.00	11
70	31-07-2008	Dirty Water	Nil	Colorless	Odorless	0.00	422.00	28
71	31-07-2008	Dirty Water	Present	Colorless	Odorless	0.44	264.00	17
Total		**No. of WASA Water Test**	**61**	**61**	**61**	**61**	**61**	1,100
		Positive/Abnormal value	**37**	**0**	**0**	**0**	**0**	-
		Negative/Normal value	**24**	**71**	**71**	**71**	**71**	-
Possibility of Positive			**61%**	**0%**	**0%**	**0%**	**0%**	-

Source : Water Chemical Laboratory, May, 2009

Appendix 6.4.2 Details of Complaints on Billing & Revenue

Detail of Complaints on Billing & Revenue by Town

Sr.No.	Descriptions	Gunj Buksh Town (01-07-2005 to 30-04-2009)				Ravi Town (01-07-2005 to 30-04-2009)				Shalmar Town (01-07-2005 to 30-06-2008)				Allama *qbal* Town (01-07-2005 to 30-04-2009)			
		Complaints Received	Complaints Finalized	Outstanding Balance	% of Complaints	Complaints Received	Complaints Finalized	Outstanding Balance	% of Complaints	Complaints Received	Complaints Finalized	Outstanding Balance	% of Complaints	Complaints Received	Complaints Finalized	Outstanding Balance	% of Complaints
1	Adjustment of Incorrect Debit	95	95	0	0.7%	293	291	2	2.5%	262	257	5	5.3%	20	20	0	0.1%
2	Adjustment of Surcharge	508	503	5	3.7%	125	124	1	1.0%	2	2	0	0.0%	**2,863**	**2,863**	**0**	**20.8%**
3	Change of ARV(Annual Rental Value) & Plot size	137	130	7	1.0%	95	92	3	0.8%	48	46	2	1.0%	24	24	0	0.2%
4	Change of Connection / Category	353	346	7	2.6%	**1,009**	**1,000**	**9**	**8.5%**	119	116	3	2.4%	**882**	**882**	**0**	**6.4%**
5	**Change of Name/Address/Property #**	**1,441**	**1,379**	**62**	**10.6%**	**794**	**760**	**34**	**6.7%**	165	83	82	3.3%	802	802	0	5.8%
6	Consumer Receive more than one bill	1	1	0	0.0%	3	2	1	0.0%	48	48	0	1.0%	202	202	0	1.5%
7	**Conversion (Un-meter to Metered)**	**1,806**	**1,767**	**39**	**13.2%**	**1,953**	**1,909**	**44**	**16.4%**	137	116	21	2.8%	705	705	0	5.1%
8	Correction of Name /Address / property #	285	284	1	2.1%	485	483	2	4.1%	32	32	0	0.6%	470	470	0	3.4%
9	Disconnection on Request	697	663	34	5.1%	608	586	22	5.1%	137	129	8	2.8%	354	354	0	2.6%
10	**Incorrect Ave. Charge**	**2,824**	**2,799**	**25**	**20.7%**	**1,606**	**1,600**	**6**	**13.5%**	**738**	**721**	**17**	**14.9%**	**1,251**	**1,251**	**0**	**9.1%**
11	Incorrect Credit Charged	0	0	0	0.0%	893	819	74	7.5%	1	1	0	0.0%	**3,796**	**3,796**	**0**	**27.6%**
12	**Installation/Charge of Meter (Charge)**	**2,831**	**2,723**	**108**	**20.7%**	61	57	4	0.5%	**2,381**	**1,256**	**1,125**	**48.1%**	370	370	0	2.7%
13	**Installation/Charge of Meter (No Charge)**	10	9	1	0.1%	2	2	0	0.0%	19	19	0	0.4%	9	9	0	0.1%
14	Installation of Test meter	5	5	0	0.0%	**1,212**	**1,207**	**5**	**10.2%**	1	1	0	0.0%	24	24	0	0.2%
15	**No Sewer/Connection at Site**	137	136	1	1.0%	244	231	13	2.0%	**430**	**424**	**6**	**8.7%**	**948**	**948**	**0**	**6.9%**
16	**Payment not Accounted for double-Payment)**	213	201	12	1.6%	58	58	0	0.5%	183	152	31	3.7%	48	48	0	0.3%
17	Payment of Wrong Bill (Wrong Mailing Addrr)	48	48	0	0.4%	**2,460**	**2,355**	**105**	**20.6%**	1	1	0	0.0%	**805**	**789**	**16**	**5.9%**
18	Reconnection on Request	**2,142**	**1,879**	**263**	**15.7%**	11	11	0	0.1%	172	135	37	3.5%	91	91	0	0.7%
19	Revision of Bill on Actual Read	100	99	1	0.7%	3	3	0	0.0%	77	75	2	1.6%	62	61	1	0.5%
20	Wrong Meter Reading	16	16	0	0.1%	2	2	0	0.0%	1	1	0	0.0%	6	6	0	0.0%
21	Wrong Meter Size & Type	2	2	0	0.0%	0	0	0	0.0%	0	0	0	0.0%	0	0	0	0.0%
22	Others	0	0	0	0.0%	0	0	0	0.0%	0	0	0	0.0%	0	0	0	0.0%
	Grand Total (for 4 years)	**13,651**	**13,085**	**566**	**100.0%**	**11,917**	**11,592**	**325**	**100.0%**	**4,954**	**3,615**	**1,339**	**100.0%**	**13,732**	**13,715**	**17**	**100.0%**
	Ave (for 1 year)	3,413	3,271	142	-	2,979	2,898	81	-	1,239	904	335	-	3,433	3,429	4	-
	Ave (for month)	284	273	12	-	248	242	7	-	103	75	28	-	286	286	0	-
	% of finalized Achievement		95.9%				97.3%				73.0%				100%		

Sr.No.	Descriptions	Nishtar Town (01-07-2005 to 30-04-2009)				Aziz Bhatti Town (01-07-2005 to 30-06-2008)				Total			
		Complaints Received	Complaints Finalized	Outstanding Balance	% of Complaints	Complaints Received	Complaints Finalized	Outstanding Balance	% of Complaints	Complaints Received	Complaints Finalized	Outstanding Balance	% of Complaints
1	Adjustment of Incorrect Debit	0	0	0	0.0%	109	107	2	5.1%	779	770	9	1.5%
2	Adjustment of Surcharge	46	8	38	0.9%	0	0	0	0.0%	**3,544**	**3,500**	**44**	**6.9%**
3	Change of ARV(Annual Rental Value) & Plot size	17	15	2	0.3%	4	4	0	0.2%	325	311	14	0.6%
4	Change of Connection / Category	28	19	9	0.5%	40	40	0	1.9%	2,431	2,403	28	4.7%
5	**Change of Name/Address/Property #**	211	9	202	4.1%	41	35	6	1.9%	**3,454**	**3,068**	**386**	**6.7%**
6	Consumer Receive more than one bill	5	0	5	0.1%	11	11	0	0.5%	270	264	6	0.5%
7	**Conversion (Un-meter to Metered)**	**4,147**	**3,937**	**210**	**80.1%**	49	48	1	2.3%	8,797	8,482	315	**17.1%**
8	Correction of Name /Address / property #	10	9	1	0.2%	14	13	1	0.7%	1,296	1,291	5	2.5%
9	Disconnection on Request	198	136	62	3.8%	34	34	0	1.6%	2,028	1,902	126	3.9%
10	**Incorrect Ave. Charge**	74	46	28	1.4%	**447**	**421**	**26**	**21.0%**	**6,940**	**6,838**	**102**	**13.5%**
11	Incorrect Credit Charged	0	0	0	0.0%	1	1	0	0.0%	**4,691**	**4,617**	**74**	**9.1%**
12	Installation/Charge of Meter (Charge)	44	1	43	0.8%	1,081	1,056	25	**50.7%**	**6,768**	**5,463**	**1,305**	**13.1%**
13	**Installation/Charge of Meter (No Charge)**	13	4	9	0.3%	13	13	0	0.6%	66	56	10	0.1%
14	Installation of Test meter	7	6	1	0.1%	0	0	0	0.0%	1,249	1,243	6	2.4%
15	**No Sewer/Connection at Site**	4	3	1	0.1%	**112**	**112**	**0**	**5.3%**	1,875	1,854	21	3.6%
16	**Payment not Accounted for double-Payment)**	107	48	59	2.1%	77	73	4	3.6%	686	580	106	1.3%
17	Payment of Wrong Bill (Wrong Mailing Addrr)	3	3	0	0.1%	0	0	0	0.0%	**3,317**	**3,196**	**121**	**6.4%**
18	Reconnection on Request	180	11	169	3.5%	71	63	8	3.3%	**2,667**	**2,190**	**477**	**5.2%**
19	Revision of Bill on Actual Read	46	32	14	0.9%	27	27	0	1.3%	315	297	18	0.6%
20	Wrong Meter Reading	21	12	9	0.4%	1	1	0	0.0%	47	38	9	0.1%
21	Wrong Meter Size & Type	17	14	0	0.3%	0	0	0	0.0%	19	16	0	0.0%
22	Others	0	0	0	0.0%	0	0	0	0.0%	0	0	0	0.0%
	Grand Total (for 4 years)	**5,178**	**4,313**	**862**	**100.0%**	**2,132**	**2,059**	**73**	**100.0%**	51,564	48,379	3,182	**100.0%**
	Ave (for 1 year)	1,295	1,078	216	-	533	515	18	-	12,891	12,095	796	-
	Ave (for month)	108	90	18	-	44	43	2	-	1,074	1,008	66	-
	% of finalized Achievement	-	83.3%	-	-	-	96.6%	-	-	-	93.8%	-	-

Source : WASA Revenue Det. May 9, 2009

Appendix 6.7.1 Balance Sheet

Table (1) Balance Sheet Amended by WASA-JICA Study Team

Balance Sheet Statements (Estimated), Rs in Million				2007-2008	% of Item of Busyness
Assets	(a)Fixed Assets	Tangible Fixed Asset	Land	254	-
			Building	150	-
			Tube wells	1,273	-
			Sewerage Pumping Stations	1,147	-
			Drains	1,537	-
			Pipe line Water	1,217	-
			Pipe line Sewer	2,234	-
			Mobile & other Equipments	274	-
			Office Furniture Fixture	27	-
			Vehicles	111	-
			Subtotal	**8,224**	-
			Accumulated depreciation	(2,941)	-
			Total Net Tangible assets	**5,283**	**49.0**
			Construction in progress	688	6.4
		Intangible fixed asset		-	-
		Capital investment Long		647	6.0
	(b)Current Assets	Cash deposit (Banks)		1,571	-
		Accounts receivable (cons.& other)		1,796	-
		Store held for capital expenditure		29	-
		Securities deposited from others		14	-
		Inventory goods		30	-
		Advance payment/temporary advance		45	-
		Subtotal		**3,485**	**32.3**
	(C) Deferred Account	Development cost		688	6.4
	G. Total Assets			**10,791**	**100**
Liability/ Capital	(a) Liabilities	Fixed Liabilities	Reserves	-	-
			Revenue bond	-	-
			Other account loan	5,589	-
			Others	-	-
		Current Asset	Debt service	-	-
			Expenses unpaid	-	-
			Advance receipt	-	-
			Money in custody	-	-
			Customer's stock and bonds	-	-
			Other current debt	-	-
		Total Fixed liabilities		**5,589**	**51.8**
	(b)Capital	Capital Contribution	Owned capital	4,862	-
			Borrowed capital/Loan	-	-
			Grant	1,371	-
			Employees benefits	993	-
			Consumers & Plumbers deposits	23	-
			D.W.I.P.net	307	-
			Creditors accrued & other liabilities	5,065	-
			Defferred Credit	391	-
		Surplus	Capital surplus	-	-
			Retained revenue or retained loss	(7,810)	-
		Total Capital		**5,202**	**48.2**
	Total of Liabilities and Capital			**10,791**	**100**

Source: Revenue Det. April 16, 2009

Table (2) Balance Sheet Used by the Provincial Government of Punjab Financial Audit (2004)

WATER AND SANITATION AGENCY
LAHORE DEVELOPMENT AUTHORITY

BALANCE SHEET AS AT 30 JUNE 2004

	NOTE	2004 Rupees	2003 Rupees
FUND AND LIABILITIES			
Capital contribution	5	1,319,555,109	1,301,849,712
Accumulated loss		(5,004,208,842)	(4,241,000,097)
		(3,684,653,733)	(2,939,150,385)
GRANTS	6	319,409,812	341,399,432
DEFERRED CREDIT	7	380,328,443	286,669,287
LONG TERM LIABILITIES			
Long term loans - unsecured	8	3,569,664,189	3,348,856,189
Employee benefits	9	992,886,537	966,572,234
Consumer and plumber deposits	10	20,595,476	20,153,375
		4,583,146,202	4,335,581,798
CURRENT LIABILITIES			
Current portion of long term loans	8	1,714,534,000	1,588,342,000
Deposits work-in-progress	11	15,239,108	-
Creditors, accrued and other liabilities	12	3,774,847,087	2,695,746,385
		5,504,620,195	4,284,088,385
CONTINGENCIES AND COMMITMENTS	13	-	-
		7,102,848,919	6,308,588,517

	NOTE	2004 Rupees	2003 Rupees
ASSETS			
NON CURRENT ASSETS			
Operating fixed assets	14	4,629,146,199	4,306,212,929
Capital works-in-progress	15	213,315,988	243,953,283
Stores held for capital expenditure	16	17,121,211	18,127,235
Advances for acquisition of land	17	29,485,160	30,826,566
		4,889,068,558	4,599,119,993
Long term investments	18	477,072,372	366,126,269
Long term loans to employees	19	10,751,430	8,078,243
Long term security deposits	20	14,786,611	13,967,676
Deferred expenditures	21	3,686,507	3,880,632
		506,296,920	391,052,820
CURRENT ASSETS			
Stores and spares	22	15,394,538	28,744,071
Consumer receivables - considered good	23	1,078,025,879	883,760,192
Deposit work-in-progress	11	-	4,354,460
Current portion of long term investments	18	1,852,200	35,240,000
Loans and advances to employees	24	6,949,356	6,090,527
Prepayments and other receivables	25	146,256,137	55,430,671
Cash and bank balances	26	459,005,329	314,795,783
		1,707,483,440	1,328,415,704
		7,102,848,919	6,308,588,517

The annexed notes form an integral part of these financial statements.

MANAGING DIRECTOR

DEPUTY MANAGING DIRECTOR (F.A AND R)

DIRECTOR FINANCE

Appendix 6.7.2 Profit and Loss

Table (1) Change in Profit & Loss Status in couple years

(Rs.in Million)

Profit & Loss Account as on June 30, 2009				
Description (Development Budget)			2007-2008 Revised	2008-2009 Budget
	-Opening Balance	(1)	2,778.268	329.573
Precepts:	Annual Development Programme	(2)	72.800	980.883
	Non-ADP/Supplements	(3)	183.678	-
	Replacement of Outlived Water Supply Line	(4)	-	500.000
	Community Uplift Programme	(5)	23.471	-
	City District Governments Funds	(6)	35.943	-
	Development Receipts -Own Sources	(7)	17.000	15.000
	WASA Development Receipts	(8)=(2)~(7)	332.892	1,495.883
	LDA(Udwing) deposit Works Funds	(9)	2.758	-
	Other Deposit Works Funds	(10)	86.929	-
	TOTAL RECEIPTS DURING THE YEAR	(11)	422.579	1495.883
	Funds Surrendered	(12)	(500.000)	-
	TOTAL RECEIPTS	(13)=(1)+(11)+(12)	**2,700.847**	**1,825.456**
Expenditure:	Annual Development Programme	(14)	422.446	980.883
	CM's Accelerated Programme	(15)	57.138	10.000
	Non-ADP/CM's Directives	(16)	476.380	50.314
	Tameer-E-Punjab Programme	(17)	93.100	-
	Community Uplift Programme	(18)	43.753	13.969
	Replacement of Outlived Water Supply Line	(19)	822.487	500.000
	City District Governments Package	(20)	33.373	13.924
	W & Sew Works For Monsoon	(21)	16.984	-
	WSD Schemes in Run Down Areas	(22)	1.953	-
	DEV: Works-Own Sources	(23)	34.671	60.000
	WASA Development Expenditure	(24)=(14)~(23)	2,002.285	1,629.090
	LDA(Udwing) deposit Works Funds	(25)	34.041	2.758
	Other Deposit Works Funds	(26)	334.947	193.609
	TOTAL OPERATING EXPENDITURE:	(27)=((24)~(26)	**2,371.273**	**1,825.457**
Closing Balance		(28)=(13)~(27)	329.574	(0.001)
Total (Non-Development & Development)				
Receipts:		(29)=(10)+(13)	**4,983.497**	**3,676.306**
Expenditure:		(30)=(15)~(2')	**5,078.373**	**5,021.657**
Surplus/Shortfall		(31)=(29)-(30)	-94.876	-1345.351

Source: Finance Administration /Revenue Det DMD May 15, 2009

Table (2) Profit & Loss Accounting Used by the Provincial Government of Punjab Financial Audit (2004)

WATER AND SANITATION AGENCY
LAHORE DEVELOPMENT AUTHORITY

PROFIT AND LOSS ACCOUNT FOR THE YEAR ENDED 30 JUNE 2004

	NOTE	2004 Rupees	2003 Rupees
REVENUE			
Water			
Sales	27	727,373,737	692,250,053
Connection fee		2,724,600	1,816,400
		730,098,337	694,066,453
Sewerage and drainage			
Sales		457,890,138	444,780,191
Sewerage service augmentation fee		478,012	349,710
Connection fee		6,702,120	5,690,100
Share in property tax		285,456,270	321,193,286
		750,526,540	772,013,287
Amortization of deferred credit and grant	28	20,816,274	16,361,944
Aquifer charges	29	34,214,692	20,691,289
Other fees and charges		1,851,011	1,816,196
Sale of water meters		14,842,780	8,124,032
		1,552,349,634	1,513,073,201
EXPENSES			
Operating expenses	30	1,659,841,021	1,380,259,229
Depreciation	14	198,750,709	183,428,477
Allowances for uncollectible	23.1	25,738,871	82,452,110
Effect of actuarial valuation of employee benefits		-	814,405,738
		1,884,330,601	2,460,545,554
		(331,980,967)	(947,472,353)
Other income	31	98,179,360	80,324,655
		(233,801,607)	(867,147,698)
Financial and other charges	32	529,407,138	434,001,179
Loss for the year		(763,208,745)	(1,301,148,877)
Loss brought forward		(4,241,000,097)	(2,939,851,220)
Accumulated loss		(5,004,208,842)	(4,241,000,097)

The annexed notes form an integral part of these financial statements

MANAGING DIRECTOR | DEPUTY MANAGING DIRECTOR (F.A & R) | DIRECTOR FINANCE

Appendix 6.7.3

Change in Power Cost for O&M

STATEMENT SHOWING ELECTRICITY UNIT CONSUMED						
DURING JAN-08 TO DEC-08						
SR.#	MONTHS	UNIT CONSUMED (KWhr/Month)	Monthly consumption Ratio	KWhr/day	NET ASSESSMENT(Rs/ Month)	Unit Price(Rs/KWhr)
1	JANUARY	11,180,035	6.1%	15,528	71,383,900	6.38
2	FEBRUARY	15,079,959	8.2%	20,944	96,475,880	6.40
3	MARCH	13,467,758	7.4%	18,705	93,358,549	6.93
4	APRIL	12,080,691	6.6%	16,779	84,094,778	6.96
5	MAY	15,046,889	**8.2%**	**20,898**	104,029,200	6.91
6	JUNE	17,935,435	**9.8%**	**24,910**	127,974,202	7.14
7	JULY	18,770,883	**10.3%**	**26,071**	129,702,473	6.91
8	AUGUST	14,531,536	**7.9%**	**20,183**	99,859,036	6.87
9	SEPTEMBER	21,550,993	**11.8%**	**29,932**	186,023,411	8.63
10	OCTOBER	11,155,887	6.1%	15,494	77,350,388	6.93
11	NOVEMBER	19,834,670	10.8%	27,548	160,183,614	8.08
12	DECEMBER	12,282,459	6.7%	17,059	103,082,464	8.39
	TOTAL	182,917,195	100.0%	254,052	1,333,517,895	7.29
	Source : WASA, Revenue Dep. May 19, 2009					

Appendix 6.7.4

Trend on Detailed O&M Costs by Fiscal Year

(Unit: Million Rs)

Sr. No.	Description	2007-2008	2008-2009	Actual Up to 3/09	Rate of Increase
	Expenditure: PAYROLL AND PAYROLL BURDEN				
A	**PAYROLL**				
1	SALARIES AND WAGES	676.0	805.0	578	1.19
2	OVERTIME	25.0	30.0	22	1.20
3	LEAVE SALARY / PENSION CONTRIBUTION	0.5	1.0	0	2.00
4	HONORARIUM	0.0	0.0	0	
	SUB TOTAL:	**701.5**	**836.0**	**600**	1.19
B	**PAYROLL BURDEN**				
5	PENSION FUND	56.0	56.0	56	1.00
6	GRATUITY / COMMUTATION	30.0	30.0	30	1.00
7	WORKMEN COMPEN./FINANCIAL ASSISTANCE	4.0	4.0	4	1.00
8	GROUP INSURANCE	3.0	3.0	3	1.00
9	LIVERIES	0.8	0.8	1	1.00
10	STIPENDS	0.1	0.1	0	1.00
11	TRAINING	0.1	0.1	0	1.00
12	TRAINING SCHOOL	0.2	0.2	0	1.00
13	STAFF WELFARE / HAJ / SPORTS	1.1	1.1	1	1.00
14	MEDICAL EXPENSES	70.0	70.0	70	1.00
	SUB TOTAL:	**165.3**	**165.3**	**165**	1.00
TOTAL PAYROLL & BURDEN:		**866.8**	**1,001.3**	**765**	1.16

Source: WASA's Revenue Dep. May 15, 2009,Modificated

Sr. No.	Description	2007-2008	2008-2009	Actual Up to 3/09	Rate of Increase
	Expenditure: Repair Nd Maintenance				
A	**REPAIR AND MAINTENENCE:**				
15	R & M - DISPOSAL STATIONS' BLDGS.	5.0	6.0	6	1.20
16	R & M - T/WELL CHAMBERS / RESERVIORS	6.0	7.0	5	1.17
17	R & M - TUBEWELLS	70.0	75.0	56	1.07
18	REPLACEMENT OF T/WELL MACHINERY	25.0	30.0	6	1.20
19	DRILLING & BORING OF TUBEWELLS (20)	32.0	35.0	8	1.09
20	R & M - PUMPING STATIONS	38.0	40.0	31	1.05
21	DEWATERING	10.0	12.0	9	1.20
22	REPL. / REHABILITATION OF D/S MACHINERY	18.0	20.0	2	1.11
23	POTABLE AUTOMETIC SELF PRIME DEW.SETS	0.0	0.0	0	
24	R & M - MOBILE EQUIP./MISC. MACHINERY	30.0	35.0	20	1.17
25	R & M - METERS	2.5	5.0	1	2.00
26	R & M - WATER SUPPLY LINES	15.0	20.0	15	1.33
27	R & M - SEWER LINES	50.0	45.0	43	0.90
28	R & M - DRAINS	40.0	45.0	38	1.13
29	SEASONAL STAFF	20.0	30.0	23	1.50
30	ARBORICULTURE	0.5	0.5	0	1.00
31	DESILTING OF DRAINS	9.0	10.0	8	1.11
32	R & M - OTHERS	1.0	1.0	0	1.00
	SUB TOTAL:	372.0	416.5	270	1.12
B	**MATERIAL & STORES:**				
33	MATERIAL FOR R & M	50.0	50.0	49	1.00
34	POL FOR MACHINERY	135.0	150.0	191	1.11
35	CHLORINATION	20.0	47.0	36	2.35
	SUB TOTAL:	205.0	247.0	277	1.20
TOTAL PAYROLL & BURDEN:		**577.0**	**663.5**	**547**	1.15

Source: WASA's Revenue Dep. May 15, 2009,Modificated

Sr. No.	Description	2007-2008	2008-2009	Actual Up to 3/09	Rate of Increase
	Expenditure: Light, Power and Energy				
A	LIGHTING, POWER AND ENERGY:				
36	LIGHT	5.0	6.0	4	1.20
37	POWER	1,150.0	1,380.0	543	1.20
38	GAS	0.2	0.2	0	1.00
39	REPL. / REPAIR OF TRANSFORMERS	20.0	25.0	6	1.25
	TOTAL POWER & ENERGY	**1,175.2**	**1,411.2**	**553**	1.20
	OTHER EXPENSES:				
40	R & M OF OFFICE BUILDINGS	2.0	2.0	1	1.00
41	ADDITIONS & ALTERAIONS OF BUILDINGS	14.0	15.0	5	1.07
42	R & M OF RESIDENTIAL BUILDINGS	2.5	2.5	2	1.00
43	R & M - F.F. & OFFICE EQUIPMENT	1.5	2.0	1	1.33
44	PURCHASE OF F.F. & OFFICE EQUIPMENT	2.0	2.0	2	1.00
45	IMP./ MATERIAL FOR TESTING LABORTORIES	0.8	1.0	1	1.25
	Subtotal	22.8	24.5	11	1.07
	TRAVELLING & VEHICLE RUNNING EXPENSES:				
46	TA / DA	0.5	0.5	0	1.00
47	POL FOR VEHICLES	14.0	15.0	17	1.07
48	R & M OF VEHICLES	4.4	4.5	3	1.02
49	REPLACEMENT / PURCHASE OF VEHICLES	1.0	1.0	0	1.00
50	INSURANCE	0.5	0.5	0	1.00
51	LICENCE FEE & OTHER TAXES	1.0	1.0	1	1.00
	Subtotal	21.4	22.5	22	1.05
	COMPUTER, PRINTING & OTHERS CHARGES:				
52	POSTAGE	0.2	0.2	0	1.00
53	TELEPHONE	7.0	7.2	4	1.03
54	PRINTING & STATIONERY	2.0	3.0	2	1.50
55	PUBLICITY & ADVERTISEMENT	16.0	**20.0**	**5**	1.25
56	SUBSCRIPTION	0.1	0.1	0	1.00
57	ENTERTAINMENT	0.0	0.0	0	-
58	COMPUTER CHARGES	9.0	15.0	12	1.67
59	MISCELLANEOUS / Recovery Charges	5.0	1.0	1	0.20
	Subtotal	39.3	46.5	23	1.18
	RENT & TAXES:				
60	RENT & TAXES	0.2	0.1	0	0.50
61	CLAIM FOR DAMAGES	0.0	0.0	0	-
	SUB TOTAL:	0.2	0.1	0	0.50
	LEGAL & PROFESSIONAL CHARGES:				
62	LEGAL CHARGES	1.2	1.5	1	1.25
63	COMMERCIAL AUDIT FEE	0.2	0.4	0	2.00
64	COMMERCIAL / FINANCIAL CHARGES	6.0	7.0	4	1.17
	SUB TOTAL:	7.4	8.9	5	1.20
	MISCELLANEOUS:				
65	ADVANCES TO STAFF	3.0	3.5	0	1.17
	SUB TOTAL:	3.0	3.5	0	1.17
66	TOTAL OTHER EXPENSES(36-65)	94	106	60	1.13
	TOTAL Expenditure (1-66)	**2,713**	**3,182**	**1,925**	1.17
	Source: WASA's Revenue Dep. May 15, 2009,Modificated				

Appendix 6.7.5 Water Tariff (February 1998)

EXTRAORDINARY ISSUE REGISTERED NO. L-7532

THE PUNJAB GAZETTE

PUBLISHED BY AUTHORITY

LAHORE THURSDAY, FEBRUARY 19, 1998

LAHORE DEVELOPMENT AUTHORITY, LAHORE

THE 11th February' 1998.

No. MD/78 Lahore Developmnet Authority in exercise of powers conferred under section 28 of the Lahore Development Authority Act, 1975 (Act No. XXX of 1975) with previous consent of the Governmnet prescribes the following rates and fees in respect of its water supply and sewerage operations w.e.f. 1st January, 1998.

1. WATER RATES

a) Unmetered Connections (Domestic) (Rate per Month)

ARV Slabs			(Rs.)
1. Upto Rs.		400	41.50
2. 401	–	500	64.00
3. 501	–	720	109.00
4. 721	–	1000	190.00
5. 1001	–	1500	268.00
6. 1501	–	2388	282.00
7. 2389	–	4370	300.00
8. 4371	–	4499	314.00
9. 4500	&	Above	(84% of ARV)

NOTE:

1. All New connections shall be sanctioned as metered.
2. Annual Rental Values for all existing unmetered connections will remain frozen except bills issued on Area Rental Value.

b.) Metered connections (Domestic)

Consumption Slabs per Month	(Rs. Per 1000 Gallons)
i) Upto 5000 Gallons	9.20
ii) 5001 to 20000 Gallons	14.90
iii) 20001 Gallons and above	19.50

c.) Metered connections (Commercial/ Industrial/ Non-Residential)

Consumption Slabs per Month	(Rs. Per 1000 Gallons)
i) Upto 5000 Gallons	19.53
ii) 5001 to 20000 Gallons	34.89
iii) 20001 Gallons and above	50.48

2. SEWERAGE / DRAINAGE

a) Unmetered Water Connections (Domestic) (Rate per Month)

ARV Slabs			(Rs.)
1. Upto Rs.		400	29.05
2. 401	–	500	44.80
3. 501	–	720	76.30
4. 721	–	1000	133.00
5. 1001	–	1500	187.60
6. 1501	–	2388	197.40
7. 2389	–	4370	210.00
8. 4371	–	4499	219.80
9. 4500	&	Above	(70% of water)

b) Metered Water Connections (Domestic)

Consumption Slabs per Month	(Rs. Per 1000 Gallons)
i) Upto 5000 Gallons	6.44
ii) 5001 to 20000 Gallons	10.43
iii) 20001 Gallons and above	13.65

c) Metered Connections (Industrial etc.) (Rs. Per 1000 Gallons)

Industrial, including Service Station, Carpet Washing Addas, Commercial, Govt. and Semi-Govt. Organizations, Corporate Bodies etc.	21.30

d) Commercial / non-residential (Rs. Per 1000 Gallons)

i) Upto 5000 Gallons	13.67
ii) 5001 to 20000 Gallons	24.42
iii) 20001 Gallons and above	35.34

3. TARIFF FOR QUAID-E-AZAM TOWN (TOWN SHIP).

a) Unmetered Connections (Domestic) (Rate Per month)

	(Rs.)
i) 5-Marlas	36.85
ii) 7-Marlas	55.55
iii) 10-Marlas	93.50
iv) 1-Kanal	159.50
v) Above 1-Kanal	222.20

b) Unmetered Connections (for construction) (Rate Per month)

	(Rs.)
i) 5-Marlas	212.30
ii) 7-Marlas	346.50
iii) 10-Marlas	480.70
iv) 1-Kanal	869.00
v) Above 1-Kanal	1257.30

c) Unmetered Connections (Commercial) (Rate Per month)

	(Rs.)
i) 5-Marlas	212.30
ii) 7-Marlas	346.50
iii) 10-Marlas	480.70
iv) 1-Kanal	869.00
v) Above 1-Kanal	1257.30

* Based on monthly average consumptin of 10, 15, 20, 30 and 40 throusand gallons for 5, 7, 10, 20 and above 20 marlas respectively until meter is installed. Metered consumption will be charged at WASA tariff effective from 1.7.1997

3.2 SEWERAGE RATES.

a) Unmetered Connections (Domestic) (Rate Per month)

	(Rs.)
i) 5-Marlas	22.00
ii) 7-Marlas	33.00
iii) 10-Marlas	56.10
iv) 1-Kanal	95.70
v) Above 1-Kanal	133.10

b) Unmetered Connections (Commercial) (Rate Per month)

	(Rs.)
i) 5-Marlas	125.40
ii) 7-Marlas	205.70
iii) 10-Marlas	286.00
iv) 1-Kanal	519.20
v) Above 1-Kanal	752.40

4. Governmnet Notification No. M.D/108 dated 28.03.97 has been withdrawn w.e.f. 01.01.98 except for the

4.1 Meter Connections (Commerical/ Industrial/ Non-Residential)

Subject to minimum of:

- 1/2″ size of meter	=	5000 Gallons p/month
- 3/4″ size of meter	=	20000 Gallons p/month
- 1″ size of meter	=	33334 Gallons p/month

Above 1″ minimum consumption to increase in proportion to 1″ size of meter (both for b & c)

4.2 RELIGIOUS AND CHARITABLE INSTITUTIONS: Half of domestic rate.

4.3 SEWERAGE / DRAINAGE

For Private Tubewells

	(Rate per months) (Rs.)
- 1 Cusec	5500.00
- 1/2 Cusec	2750.00

Rates to increase or decrease in proportion to the rate of one cusec.

4.4 DRAINAGE Half of domestic rate.

For industries, commercial, Non-Residential Govt. & Semi Govt. organizations, Corporate Bodies not directly connected with WASA Water / Sewerage system but disposal sewage through drainage system. 1188.00

4.5 ACQUIFER CHARGES

Industrial, commercial, Government and Sami Governmnet Organizations and Corporate Bodies extracting water through tubewells:

Size of Tubewell

	(Rate per months) (Rs.)
- 1 Cusec	5500.00
- 1/2 Cusec	2500.00

Rates to increase or decrease in proportion to the rate of one cusec.

4.6 METER RENT

Size of Meter

	(Rate per months) (Rs.)
- 1/2″	12.00
- 3/4″	14.00

Meter rent to increase in proportion to 1/2″ rent for higher size.

Owner's meter to be charged half of the rent.

4.7 SULLAGE RATE (Rate per acre half year) 75.00 (Auction subject to minimum)

4.8 SECURITY OF NEW CONNECTION (Rs.) 50.00

4.9 MISCELLANEOUS FEES

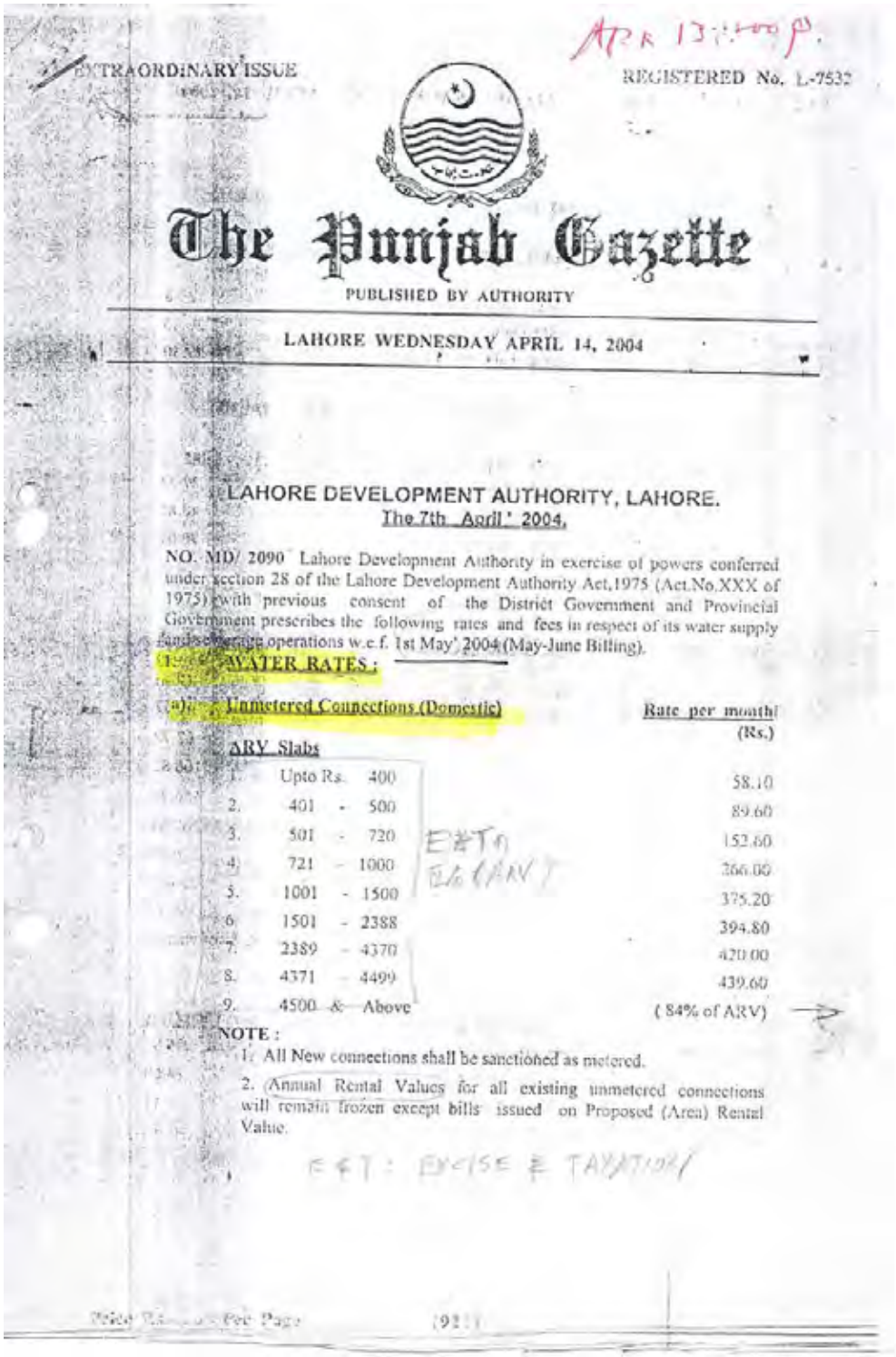
a) New Connection Fees (Water)

	(Rs.)
i) 1/4″	300.00
ii) 3/8″	600.00
iii) 1/2″	1200.00
iv) 3/4″	1500.00
v) 1″	3600.00
vi) Above 1″ (fee for higher sizes to be in proportion to 1″ sizes).	
- Disconnection fee on consumer's request	100.00
- Reconnection fee on consumer's request	150.00
- Reconnection fee (Defaulter's connection)	200.00
- Ferrule shifting fee	100.00
- Ferrule cleaning fee	75.00
- Meter testing fee	50.00

b) New Connection Fees (Sewer)		
- Domestic connection		750.00
- Industrial and Commercial		
Clinic/ Laboratory, Nonby shops, pritning Press, Dispensaries, Hamams without bath, Petrol Pumps without service stations, manufacturers and Bakeries, Scooter/ Riksha repair shops (without service facilities)		4500.00
- Tea stalls, Restaurants including Chargha Houses (without air conditioning), Plastic Industries, Shoes Industries, Power Loom Industries, Pharmaceautical Industries, Match Factory, Nickle and Polish factory, Gujjars with less than 20 animals, Hamam with one or two baths, Milk shops, Private Schools, offices, Motor Show Rooms, Cement Jali factory, Lohar Khanas, Dhobi Ghates (upto two ghats)		7500.00
- Plazas, Commercial Markets etc.		9000.00
- Hotel (B-Class), Restuarants, Ice Cream manufacturers, Shopping Centres, Foundry steel mills, Hamams with three or more baths, Gujjars with more than twenty animals, Chemical and Rubber factories.		12000.00
- Carpet washing and dying addas, Petrol Pumps or workshops with service station, Hotel (A-Class), Ice factories, Ghee Mills, Dairy farms, Dhobi Ghats (more than three ghats), Private Hospital, Beverage factories.		15000.00
4.10 TARIFF FOR QUAID-E-AZAM TOWN (TOWN SHIP)		
SEWERAGE / DRAINAGE		
For own Tubewells.		
Size of Tubewell	(Rate per months)	
	(Rs.)	
- 1 Cusec	5500.00	
- 1/2 Cusec	2750.00	
Rates to increase or decrease in proportion to the rate of one cusec.		
4.11 ACQUIFER CHARGES		
Industrial, Commercial, Government and Semi Government Organizations and Corporate Bodies extracting water through tubewells:	(Rate per months)	
	(Rs.)	
- 1 Cusec	5500.00	
- 1/2 Cusec	2750.00	
Rates to increase or decrease in proportion to the rate of one cusec.		
4.12 MISCELLANEOUS FEES		
a) New Connection Fees (Water)		
	(Rs.)	
i) 1/4"	250.00	
ii) 3/8"	560.00	
iii) 1/2"	1050.00	
iv) 3/4"	1500.00	
v) 1"	3600.00	
vi) Above 1" (fee for higher sizes to be in proportion to 1" sizes).		
- Disconnection fee on consumer's request	100.00	
- Reconnection fee on consumer's request	150.00	
- Reconnection fee (Defaulter's connection)	200.00	
- Ferrule shifting fee	90.00	
- Ferrule cleaning fee	60.00	
4.13 New Connection Fees (Sewer)		
	(Rs.)	
- Domestic connection	750.00	
5. SURCHARGE FOR LATE PAYMENT:	10% surcharge if payment is not made by the due date specified in the bill.	

(Sd. ILLEGIBLE)
DIRECTOR GENERAL
ON BEHALF OF
LAHORE DEVELOPMENT AUTHORITY

Appendix 6.7.6 Water Tariff (April 2004)



EXTRAORDINARY ISSUE

REGISTERED No. L-7532

The Punjab Gazette

PUBLISHED BY AUTHORITY

LAHORE WEDNESDAY APRIL 14, 2004

LAHORE DEVELOPMENT AUTHORITY, LAHORE.

The 7th April, 2004.

NO. MD/ 2090 Lahore Development Authority in exercise of powers conferred under section 28 of the Lahore Development Authority Act,1975 (Act.No.XXX of 1975) with previous consent of the District Government and Provincial Government prescribes the following rates and fees in respect of its water supply and sewerage operations w.e.f. 1st May' 2004 (May-June Billing).

WATER RATES :

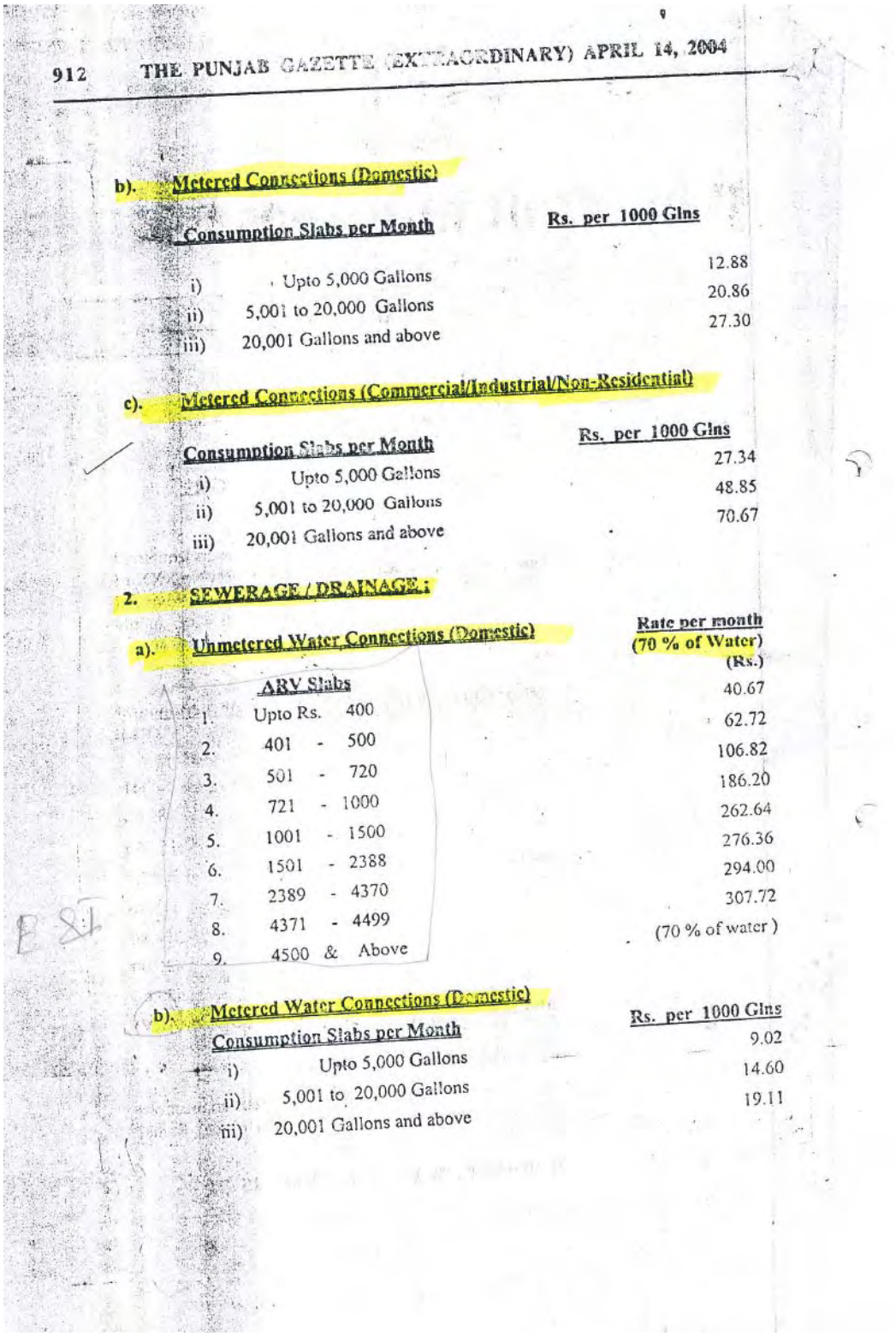
a) Unmetered Connections (Domestic)

ARV Slabs			Rate per month (Rs.)
1.	Upto Rs.	400	58.10
2.	401	- 500	89.60
3.	501	- 720	152.60
4.	721	- 1000	266.00
5.	1001	- 1500	375.20
6.	1501	- 2388	394.80
7.	2389	- 4370	420.00
8.	4371	- 4499	439.60
9.	4500 &	Above	(84% of ARV)

NOTE :

1. All New connections shall be sanctioned as metered.
2. (Annual Rental Values for all existing unmetered connections will remain frozen except bills issued on Proposed (Area) Rental Value.

E&T : EXCISE & TAXATION



912 THE PUNJAB GAZETTE (EXTRAORDINARY) APRIL 14, 2004

b). Metered Connections (Domestic)

Consumption Slabs per Month		Rs. per 1000 Gls
i)	Upto 5,000 Gallons	12.88
ii)	5,001 to 20,000 Gallons	20.86
iii)	20,001 Gallons and above	27.30

c). Metered Connections (Commercial/Industrial/Non-Residential)

Consumption Slabs per Month		Rs. per 1000 Gls
i)	Upto 5,000 Gallons	27.34
ii)	5,001 to 20,000 Gallons	48.85
iii)	20,001 Gallons and above	70.67

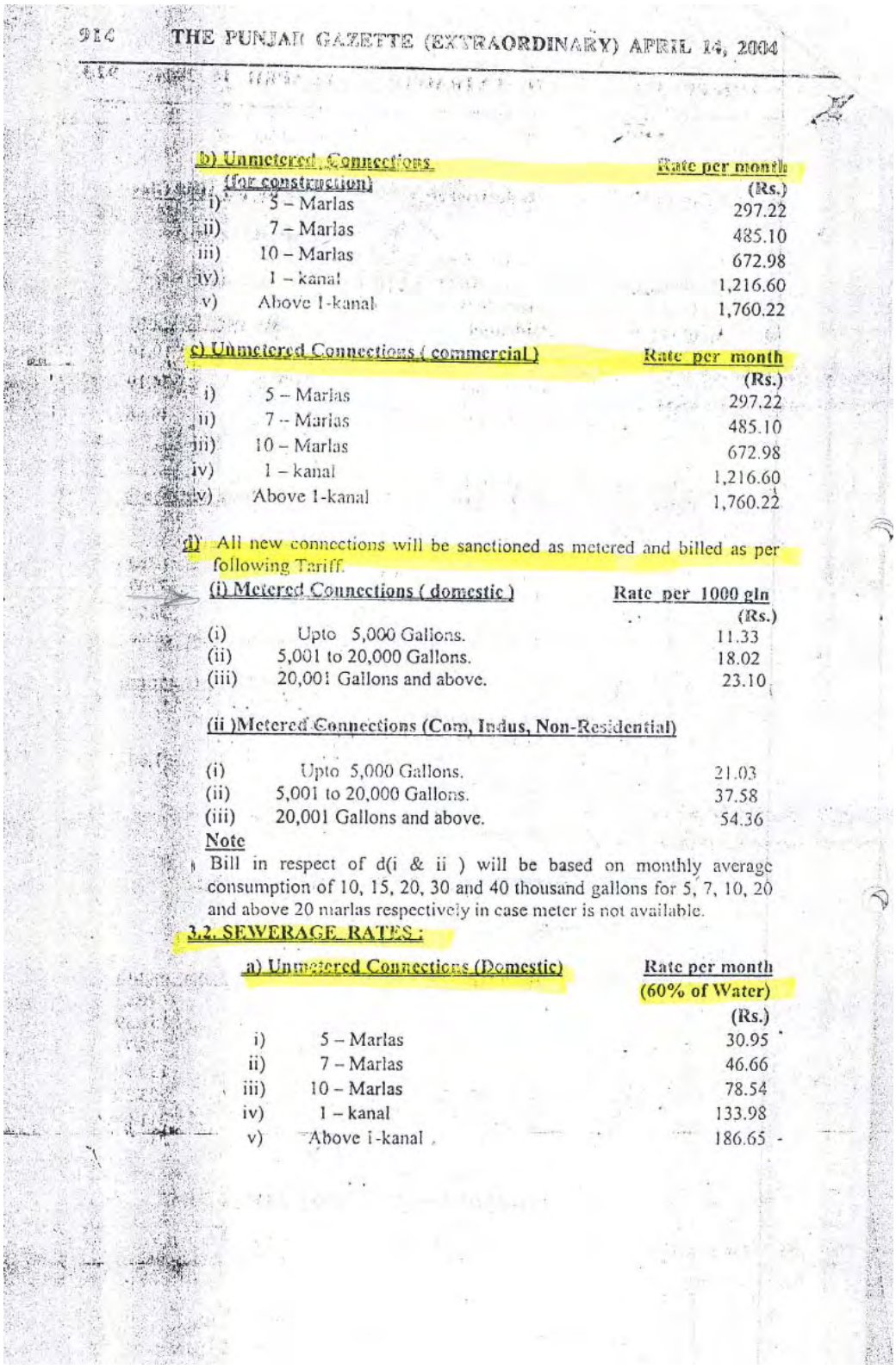
2. SEWERAGE / DRAINAGE :

a). Unmetered Water Connections (Domestic)

	ARV Slabs	Rate per month (70 % of Water) (Rs.)
1.	Upto Rs. 400	40.67
2.	401 - 500	62.72
3.	501 - 720	106.82
4.	721 - 1000	186.20
5.	1001 - 1500	262.64
6.	1501 - 2388	276.36
7.	2389 - 4370	294.00
8.	4371 - 4499	307.72
9.	4500 & Above	(70 % of water)

b). Metered Water Connections (Domestic)

Consumption Slabs per Month		Rs. per 1000 Gls
i)	Upto 5,000 Gallons	9.02
ii)	5,001 to 20,000 Gallons	14.60
iii)	20,001 Gallons and above	19.11



916 THE PUNJAB GAZETTE (EXTRAORDINARY) APRIL 14, 2004

b) Unmetered Connections (for construction)	Rate per month (Rs.)
i) 5 – Marlas	297.22
ii) 7 – Marlas	485.10
iii) 10 – Marlas	672.98
iv) 1 – kanal	1,216.60
v) Above 1-kanal	1,760.22

c) Unmetered Connections (commercial)	Rate per month (Rs.)
i) 5 – Marlas	297.22
ii) 7 – Marlas	485.10
iii) 10 – Marlas	672.98
iv) 1 – kanal	1,216.60
v) Above 1-kanal	1,760.22

d) All new connections will be sanctioned as metered and billed as per following Tariff.

(i) Metered Connections (domestic)	Rate per 1000 gln (Rs.)
(i) Upto 5,000 Gallons.	11.33
(ii) 5,001 to 20,000 Gallons.	18.02
(iii) 20,001 Gallons and above.	23.10

(ii)Metered Connections (Com, Indus, Non-Residential)

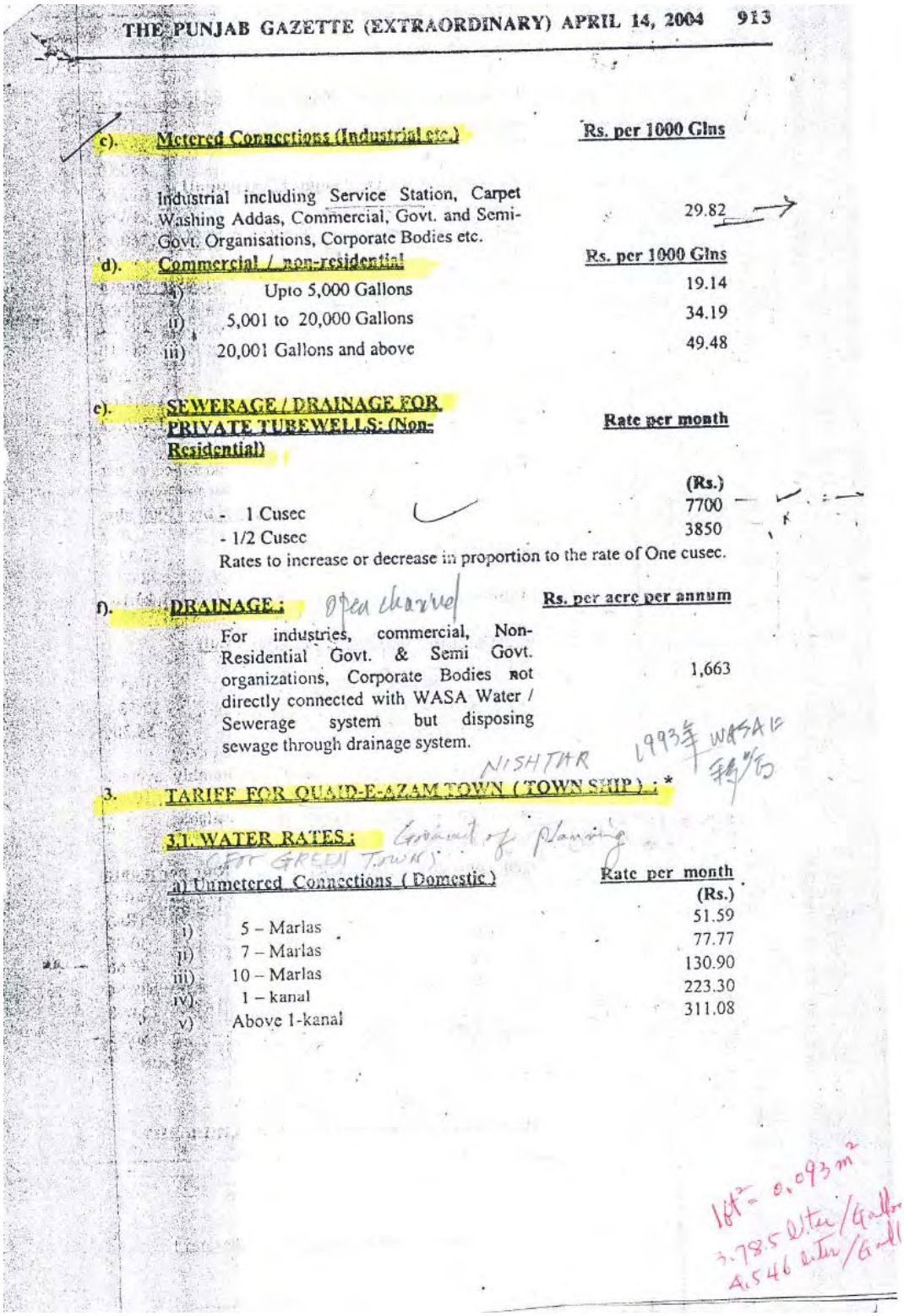
(i) Upto 5,000 Gallons.	21.03
(ii) 5,001 to 20,000 Gallons.	37.58
(iii) 20,001 Gallons and above.	54.36

Note

Bill in respect of d(i & ii) will be based on monthly average consumption of 10, 15, 20, 30 and 40 thousand gallons for 5, 7, 10, 20 and above 20 marlas respectively in case meter is not available.

3.2. SEWERAGE RATES :

a) Unmetered Connections (Domestic)	Rate per month (60% of Water) (Rs.)
i) 5 – Marlas	30.95
ii) 7 – Marlas	46.66
iii) 10 – Marlas	78.54
iv) 1 – kanal	133.98
v) Above 1-kanal	186.65



THE PUNJAB GAZETTE (EXTRAORDINARY) APRIL 14, 2004 913

		Rs. per 1000 Gls
c).	**Metered Connections (Industrial etc.)**	
	Industrial including Service Station, Carpet Washing Addas, Commercial, Govt. and Semi-Govt. Organisations, Corporate Bodies etc.	29.82
d).	**Commercial / non-residential**	**Rs. per 1000 Gls**
	i) Upto 5,000 Gallons	19.14
	ii) 5,001 to 20,000 Gallons	34.19
	iii) 20,001 Gallons and above	49.48

		Rate per month
e).	**SEWERAGE / DRAINAGE FOR PRIVATE TUBEWELLS: (Non-Residential)**	
		(Rs.)
	- 1 Cusec	7700
	- 1/2 Cusec	3850

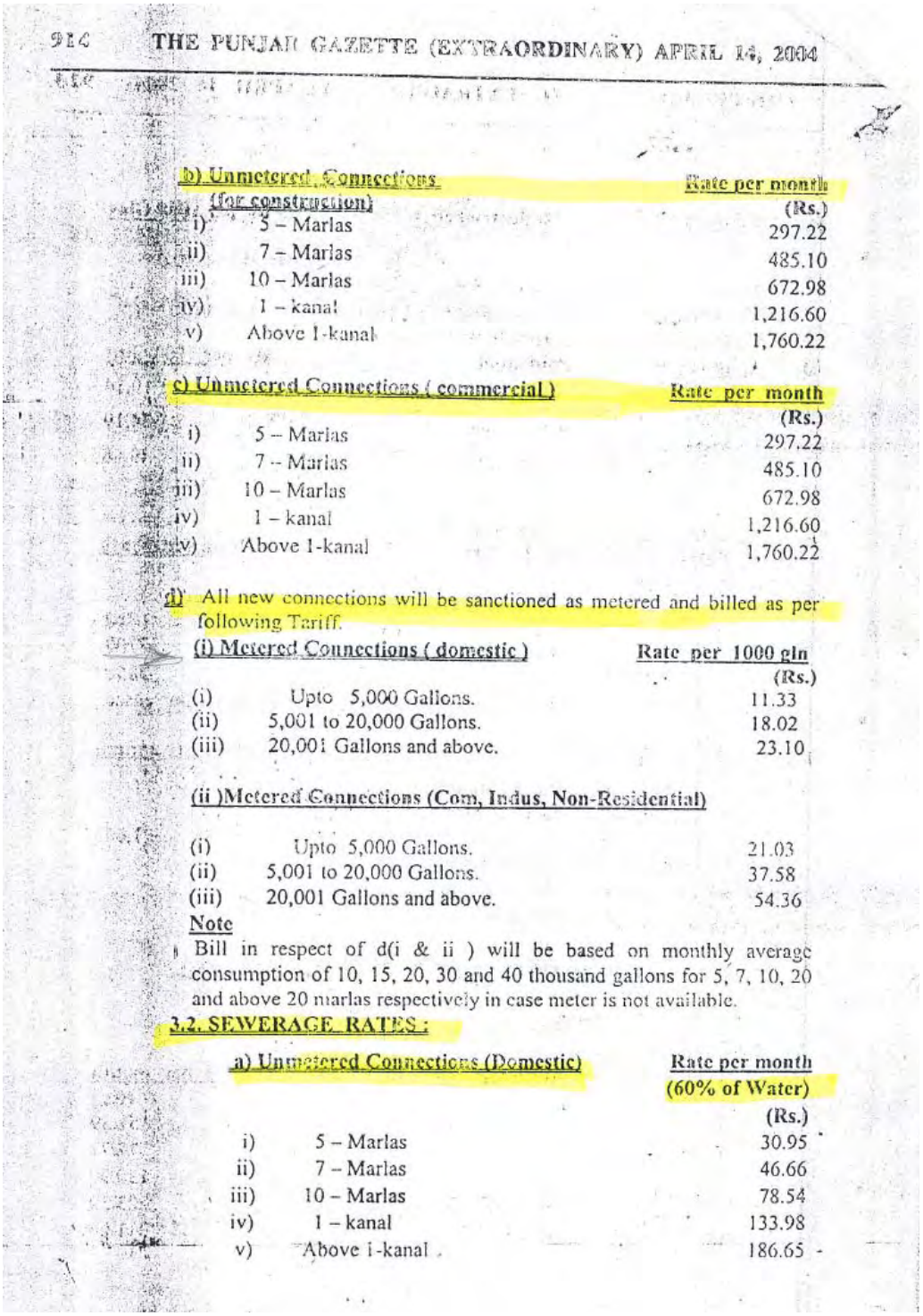
Rates to increase or decrease in proportion to the rate of One cusec.

		Rs. per acre per annum
f).	**DRAINAGE :**	
	For industries, commercial, Non-Residential Govt. & Semi Govt. organizations, Corporate Bodies not directly connected with WASA Water / Sewerage system but disposing sewage through drainage system.	1,663

3. TARIFF FOR QUAID-E-AZAM TOWN (TOWN SHIP) : *

3.1 WATER RATES :

	a) Unmetered Connections (Domestic)	Rate per month (Rs.)
i)	5 – Marlas	51.59
ii)	7 – Marlas	77.77
iii)	10 – Marlas	130.90
iv)	1 – kanal	223.30
v)	Above 1-kanal	311.08



914 THE PUNJAB GAZETTE (EXTRAORDINARY) APRIL 14, 2004

b) Unmetered Connections (for construction)

		Rate per month (Rs.)
i)	5 – Marlas	297.22
ii)	7 – Marlas	485.10
iii)	10 – Marlas	672.98
iv)	1 – kanal	1,216.60
v)	Above 1-kanal	1,760.22

c) Unmetered Connections (commercial)

		Rate per month (Rs.)
i)	5 – Marlas	297.22
ii)	7 – Marlas	485.10
iii)	10 – Marlas	672.98
iv)	1 – kanal	1,216.60
v)	Above 1-kanal	1,760.22

d) All new connections will be sanctioned as metered and billed as per following Tariff.

(i) Metered Connections (domestic)

		Rate per 1000 gln (Rs.)
(i)	Upto 5,000 Gallons.	11.33
(ii)	5,001 to 20,000 Gallons.	18.02
(iii)	20,001 Gallons and above.	23.10

(ii)Metered Connections (Com, Indus, Non-Residential)

(i)	Upto 5,000 Gallons.	21.03
(ii)	5,001 to 20,000 Gallons.	37.58
(iii)	20,001 Gallons and above.	54.36

Note

Bill in respect of d(i & ii) will be based on monthly average consumption of 10, 15, 20, 30 and 40 thousand gallons for 5, 7, 10, 20 and above 20 marlas respectively in case meter is not available.

3.2. SEWERAGE RATES :

a) Unmetered Connections (Domestic)

		Rate per month (60% of Water) (Rs.)
i)	5 – Marlas	30.95
ii)	7 – Marlas	46.66
iii)	10 – Marlas	78.54
iv)	1 – kanal	133.98
v)	Above 1-kanal	186.65

(b) Unmetered Connections (commercial)		Rate per month (Rs.)
i)	5 – Marlas	178.33
ii)	7 – Marlas	291.60
iii)	10 – Marlas	403.79
iv)	1 – kanal	729.96
v)	Above 1-kanal	1,056.13

(c) All new sewerage connections will be billed on following rates: -

Sewerage (Domestic)		Rs. Per 1000 Gls. (60% of Water)
(i)	Upto 5000 Gallons.	6.80
(ii)	5,001 to 20,000 Gallons.	10.81
(iii)	20,001 Gallons and above.	13.86

Sewerage (Commercial Non-Residential)		
(i)	Upto 5000 Gallons.	12.62
(ii)	5,001 to 20,000 Gallons.	22.54
(iii)	20,001 Gallons and above.	32.62

3.3 SEWERAGE / DRAINAGE FOR PRIVATE TUBEWELLS: (Non-Residential)	Rate per month (Rs.)
- 1 Cusec	7,700
- 1/2 Cusec	3,850

Rates to increase or decrease in proportion to the rate of One cusec.

DRAINAGE :	Rs. per acre per annum
For industries, commercial, Non-Residential Govt. & Semi Govt. organizations, Corporate Bodies not directly connected with WASA Water / Sewerage system but disposing sewage through drainage system.	1,663

4. Metered Connections (Commercial/Industrial/Non-Residential & Residential)

Subject to minimum of:

- 1/2" size of meter = 5,000 Gallons p/month.
- 3/4" size of meter = 20,000 Gallons p/month.
- 1" size of meter = 33,334 Gallons p/month.

Above 1" minimum consumption to increase in proportion to 1" size of meter (both for at Sr.1 b & c).

5.	RELIGIOUS AND CHARITABLE INSTITUTIONS:	Half of domestic rate.
6.	METER R&M (for Repair)	

Size of meter	Rate per month (Rs.)
1/2 "	12.00
3/4 "	14.00

Meter rent to increase in proportion to ½" rent for higher size. Owner's Meter to be charged half of the rent.

7.	SULLAGE RATE :	Rs. Per acre per half year 105.00 (Auction subject to minimum) -(Rs.)
8.	SECURITY OF NEW CONNECTION :	50.00
9.	MISCELLANEOUS FEES :	

(a). New Connection Fees (Water)

		(Rs.)
i)	1/4 "	300.00
ii)	3/8 "	600.00
iii)	1/2 "	1,200.00
iv)	3/4 "	1,500.00
v)	1 "	3,600.00
vi).	Above 1" (fee for higher sizes to be in proportion to 1" size).	

	(Rs.)
- Disconnection fee on consumer's request	100.00
- Reconnection fee on consumer's request	150.00
- Reconnection fee (Defaulter's connection)	200.00
- Ferrule shifting fee	100.00
- Ferrule cleaning fee	75.00
- Meter testing fee	50.00

(b). New Connection Fees (Water)

QUAID-E-AZAM TOWN:		(Rs.)
i)	1/4 "	250.00
ii)	3/8 "	560.00
iii)	1/2 "	1,050.00
iv)	3/4 "	1,500.00
v)	1 "	3,600.00
vi)	Above 1" (fee for higher sizes to be in proportion to 1" size).	
- Disconnection fee on consumer's request		100.00
- Reconnection fee on consumer's request		150.00
- Reconnection fee (Defaulter's connection)		200.00
- Ferrule shifting fee		90.00
- Ferrule cleaning fee		60.00
- Meter testing fee		50.00

(c). New Connection Fee Sewer (For all) :

	(Rs.)
- Domestic connection	400.00
- Industrial and Commercial	
- General Stores, Cloth Merchants, Tailoring Shops, Sanitory & Harware Stores, Electric Shops, Vegetable & Meat Shops, Books & Stationery Shops, Beauty Parlours, Godowns, Photograph Studios & Laboratories, Clinics / Laboratory, Lohar Khana/Electric Parts Manufacturing, Lath Machine Workshops, Nonby shops, printing Press, Barber Shop without bath, Petrol Pumps without service stations, Pan/Cigarettes shops, Dying shops, Sweet manufacturers and Bakeries, Scooter / Rikshaw repair shops (without service facilities), Milk Shop, Shoes Shops, Tea Stalls, Plastic Stores, Kabab Tikka Shops, Chemists/Druggists, Offices having one Tap/Washroom, Academies, Private Schools less than 100 students, Show room having one wash room. Any small business activity where water is not used for as material manufacturing but used in washrooms only.	500.00

	(Rs.)
- Restaurants including Chargha Houses (without air conditioning), Plastic Inudstries, Shoes Industries, Power Loom Industries, Pharamaceautical industries, Match Factory, Soap Factory, Nickle and Polish factory, Gujjars with less than 20 animals, Hamams with one or two baths, Cement Jali factory, Dhobi Ghates (upto two ghats).	7,500.00
- Plazas, Commercial Markets, Shopping Centres etc.	9,000.00
- Hotel (B-Class), Restaurant, Ice Cream manufacturers, , Foundry steel mills, Hamams with three or more baths, Gujjar with more than twenty animals, Chemical and Rubber factories.	12,000.00
- Carpet washing and dying addas, Petrol Pumps or workshops with service station, Hotel (A-Class), Ice factories, Cement Pipe factories, Ghee Mills, Dairy farms, Dhobi Ghats (more than three ghats), Private Hospital, Beverage factories.	15,000.00

5. SURCHARGE FOR LATE PAYMENT :

10% surcharge if payment is not made by the due date specified in the bill.

6. Government Notification NO.M.D/78 dt.11.02.1998 has been withdrawn w.e.f 01-05-2004.

16.4.2004

DIRECTOR GENERAL
ON BEHALF OF
LAHORE DEVELOPMENT AUTHORITY

Appendix 6.7.7 Composition of Water Tariff

Water tariff together with sewerage/wastewater charge were lumped as water tariff to the users in accordance with water tariff revised on May 2005

In addition, charge on wastewater to be discharged into sewer pipes and effluent aqueducts were evaluated by the water tariff as a standard.

Water tariff list is consisted of the following items.

a) Water Rate
- Unmetered connections (domestic), ARV slabs, rate per month
- Metered connections (domestic), consumption slabs per month, Rs. per 1000gallons
- Metered connections (commercial/industrial/non-residential), consumption slabs per month, Rs. per 1000gallons

b) Sewerage/Drainage
- Unmetered connections (domestic), ARV slabs, rate per month (70% of water)
- Metered connections (domestic), consumption slabs per month, Rs per 1000gallons
- Metered connections (industrial etc), Rs per 1000gallons
- Commercial/non-residential, Rs per 1000gallons
- Sewerage/drainage for private tube-wells (non-residential), Rs per 1000gallons
- Drainage, Rs per acre per annum

c) Tariff for Quaid-E-Azam Town (township: Green Town & Industrial Area in Nishtar Town)
- Water rates
  - Unmetered connections (domestic), rate per month
  - Unmetered connections (for construction), rate per month
  - Unmetered connections (commercial), rate per month
  - Metered connections (domestic), rate per month
  - Metered connections (commercial, industrial, non-residential), rate per month
- Sewerage rates
  - Unmetered connections (domestic), rate per month (60% of water)
  - Unmetered connections (commercial), rate per month
  - Sewerage (domestic), Rs per 1000gallons (60% of water)
  - Sewerage (commercial, industrial, non-residential), Rs per 1000gallons
  - Sewerage/drainage for private tube-wells (non-residential), Rs per 1000gallons
  - Drainage (industrial, commercial, non-residential, government & semi-government organization etc.), Rs per acre per annum

d) Metered connections (commercial, industrial, non-residential & residential)

e) Religious and charitable institutions, half of domestic rate

f) Meter repair and maintenance (R&M)

g) Sullage rate (reuse of wastewater for agriculture), Rs per acre per half year

h) Security of new connections, Rs

i) Miscellaneous fees
- New connection fees (water), Rs
- New connection fees (water) Quaid-E-Azam Town (township: Green Town & Industrial Area in Nishtar Town), Rs
- New connection fees on sewer (for all), Rs
- Commercial connections, Rs

j) Surcharge for late payment, 10% of total due payment

Appendix 6.7.8 Estimate Method on Billed Amounts of User Charge

The adopted water tariff by WASA was set up by reflecting the history of that time in which water pipe was laid underground in 1883.

Tariff unit price on water consumption was shown as below.

1) Unmetered Connections (Domestic)

Water tariffs for the connection to the buildings constructed before 1997 without the installation obligation of water meter were classified by nine (9) classes according to the building grade with from one (1) up to nine (9) following the Annual Rental Value (ARV) on building in 2004 noticed by the Department of Excise & Taxation.

Table (1) shows water rates per month for domestic unmetered connections.

Table (1) Water Rates for Unmetered Connections (Domestic)

DESCRIPTION			1998			2004			Increase over the previous Water tariff(times)
DOMESTIC-UN-METERED: ARV SLABS (Rs) As Flate Rate			Water Rate (Rs. per Month)	Sewerage/Drainage Rate (Rs. per Month)	Total Rate (Rs. per Month)	Water Rate (Rs. per Month)	Sewerage/Drainage Rate (Rs. per Month)	Total Rate (Rs. per Month)	
1.00	-	400.00	41.50	29.05	70.55	58.10	40.67	98.77	1.40
401.00	-	500.00	64.00	44.80	108.80	89.60	62.72	152.32	1.40
501.00	-	720.00	109.00	76.30	185.30	152.60	106.82	259.42	1.40
721.00	-	1000.00	190.00	133.00	323.00	266.00	186.20	452.20	1.40
1001.00	-	1500.00	268.00	187.60	455.60	375.20	262.64	637.84	1.40
1501.00	-	2388.00	282.00	197.00	479.00	394.80	276.36	671.16	1.40
2389.00	-	4370.00	300.00	210.00	510.00	420.00	294.00	714.00	1.40
4371.00	-	4499.00	314.00	219.80	533.80	439.60	307.72	747.32	1.40
4500.00	&	Above	(84% of ARV)	(70% of Water)	-	(84% of ARV)	(70% of Water)	-	-
Remarks			-			All New connections shall be sanctioned as metered			

Source: 2004 Water Tariff, Water Rates-1-a & 2-a

In addition, ARV average level be explicitly stated as below according to the "Office Order, No.MD/4072, signed by Director of Revenue" issued on 7th October 1981.

- Wall city as old bastide belongs to Area-1 and ARV average level was frozen from 30th June 1980.
- Other cities belong to Area-2 and ARV average level was frozen on 30th June 1981.

WATER & SANITATION AGENCY, LDA.

OFFICE ORDER

1 As decided in the meeting presided over by the Governor on 6-10-1981 the A.R.V of the properties located within the wall city rating area-1 shall stand frozen as of 30-6-80 and that of rating area-2 (remaining city) that of 30-6-81 for the propose of water bills.

2 The bills already issued for rating area on revised A.R.V shall also be reversed and payments received on revised A.R.V during the interim period will be adjusted accordingly. Any revision of A.R.V upwards or downwards, after above dates, shall not be admitted, for revision of water bills.

3 For all new connections, the latest A.R.V will be applicable in case the consumer prefers to have unmetered connection.

MANAGING DIRECTOR,
WASA, LDA, LAHORE

DIRECTOR REVENUE.
No. MD/4072 Dated 7-10-81

Copy to D.G for his kind information.

MANGING DIRECTOR,
WASA, LDA, LAHORE

Figure 6.7.3 Official Order on October 1981 Issued by WASA's Director of Revenue

2) Metered Connections (Domestic)

Connection to the buildings constructed after 1998 had obligation to install water meter; however, service pipe was directly connected without water meter for some time because no more stock of water meter in WASA.

Estimate method on such water tariff was appraised by the water consumption with 5-step classification by lot area of water service obtained from internal information of WASA and connection application documents (Calculation on tariff was done by multiplying respective water consumption by unit price per 1,000gallons.).

Appraisal criteria were explicitly stated as below according to "Office Order, No.774-97, signed by WASA Managing Director" issued on 31st January 2006.

(a) For Domestic

Table (1) shows the tariff unit price on water consumption for domestic metered connections.

Table (2) Water Rates for Metered Connections
(No-Meter Installed for Domestic Users)

Plot Size of Property	Average Consumption / Month	Water Rates	
		Gallon/Month	Rs/1000Gallon
0.1-5.0 Marlas	10,000 Gallons/Month	Up to 5,000	12.88
5.1-10.0 Marlas	15,000 Gallons/Month	5,001 to 20,000	20.86
10.1-20.0 Marlas	20,000 Gallons/Month	20,001 and Above	27.30
20.1-40.0 Marlas	25,000 Gallons/Month	-	-
40.1 & Above	30,000 Gallons/Month	-	-

Note: 1 Marlas =225ft^2

(b) Non –Domestic Building

Table (3) shows the tariff unit price on water consumption for non-domestic metered connections.

Table (3) Water Rates for Metered Connections
(No-Meter Installed for Commercial, Industrial Users)

Type of Business	Average Consumption/ Month	Water Rates	
		Gallon/Month	Rs/1000Gallon
General Store, Shop, etc	10,000 Gallons/Month	Up to 5,000	27.34
A:Clinic with Laboratory, etc	15,000 Gallons/Month	5,001 to 20,000	48.85
B:Restaurant, etc	20,000 Gallons/Month	20,001 and Above	70.67
C:Hotels, etc	25,000 Gallons/Month	-	-
D:Cement pipe factory, etc	30,000 Gallons/Month	-	-
E:Carpet Washing, Hotels, etc	50,000 Gallons/Month	-	-

Source: Office Order Jan 2006 issued by WASA's Managing Director

3) Metered Connections (Domestic)

Water tariff was calculated in accordance with the measure by water meter.

Calculation method described in the universal tariff was shown as below.

- Water Demand + Sewer/Drainage + Arrears = Amounts Payable: within in Date
- Surcharge + Amounts Payable within in Date = Amounts Payable: after due Date
- Water Demand = Water Charge + Fixed Charge + Meter (R&M)

Table (4) Water Rates for Metered Connections

(Meters Installed for Domestic, Commercial, Industrial and Other Users)

DESCRIPTION			1998			2004			Increase over the previous Water tariff(times)
DOMESTIC-METERED Connections, Consumption SLABS			Water Rate (Rs. Per 1000Gallon)	Sewerage/Drainage Rate (Rs. Per 1000Gallon)	Total Rate (Rs. Per 1000Gallon)	Water Rate (Rs. Per 1000Gallon)	Sewerage/Drainage Rate (Rs. Per 1000Gallon)	Total Rate (Rs. Per 1000Gallon)	
UPTO	-	5000.00	9.20	6.44	15.64	12.88	9.02	21.90	1.40
5001.00	-	20000.00	14.90	10.43	25.33	20.86	14.60	35.46	1.40
20001.00	&	ABOVE	19.50	13.65	33.15	27.30	19.11	46.41	1.40
Commercial/Non-Residential, Consumption Slabs			Water Rate (Rs. Per 1000Gallon)	Sewerage/Drainage Rate (Rs. Per 1000Gallon)	Total Rate (Rs. Per 1000Gallon)	Water Rate (Rs. Per 1000Gallon)	Sewerage/Drainage Rate (Rs. Per 1000Gallon)	Total Rate (Rs. Per 1000Gallon)	Increase over the previous Water tariff(times)
UPTO	-	5000.00	19.53	13.67	33.20	27.34	19.14	46.48	1.40
5001.00	-	20000.00	19.53	13.67	33.20	48.85	34.19	83.04	2.50
20001.00	&	ABOVE	19.53	13.67	33.20	70.67	49.48	120.15	3.62
Remarks			Industrial Wastewater 21.30Rs per 1000 Gallon			Industrial Wastewater is the same as Above			-
Private Tubewell, Non-Residential			-	Sewerage/Drainage Rate (Rs. Per Month)	-	-	Sewerage/Drainage Rate (Rs. Per Month)	-	Increase over the previous Water tariff(times)
1.00		m^3/sec	-	5500.00	-	-	7700.00	-	1.40
0.50		m^3/sec	-	2750.00	-	-	3850.00	-	1.40

Source: 2004 Water Tariff, Water Rates-1-b & c, 2-b

Appendix 6.7.9 Terminology Definition on Water Tariff

1) Annual Rental Value (ARV)
   Department of Excise & Taxation reviewed the ARV every year. ARV appraisal value on the building constructed before 1990 was not revised applying the same in 1980/81 as an average level according to Office Order (No.4072). However, review on unit price was revised if required.
   ARV appraisal on other buildings adopted the figure issued by the Department of Excise & Taxation and was also reviewed while the tariff was revised.
2) Domestic
   Shows the service area covers the dwelling-ground
3) Commercial, industry, and non-residential
   Shows the service area covers commercial water, industrial water, and domestic water within these area
4) Quaid-E-Azam Town (township: Green Town & Industrial Area in Nishtar Town)
   Industrial, commercial and residential complex developed by the Government of Punjab and was transferred to WASA in 1993, and existing connections were as counted with numbers of roughly 16,000.
5) Religious & charitable
   Water service to the religious facilities and charitable organization facilities
6) Sewerage
   Sewerage was discharged into wastewater pipe laid by WASA.
7) Drainage
   Wastewater from industrial, commercial and governmental structure concerned was directly discharged into the open channel without dewatering into the wastewater pipeline network.
8) Unmetered connections (domestic)
   Shows the conditions by domestic unmetered connection
9) Metered connections
   Shows the conditions by domestic metered connection
10) Unmetered connections (for construction)
    Water tariff on construction was further added in case that water for construction is required for the area with unmetered connections.
11) Water rate
    Unit price was reviewed in accordance with the user's payment by connection, area and ARV etc.
12) Sewer rate
    Unit price was reviewed by the amounts of sewerage charge in accordance with the water consumption and appraisal water volume.
13) Mater R & M

Shows the expense by the payment per month on repair/manage the water meter

14) Sullage rate

Shows the user charge in case of sewage-treated water to be utilized for irrigation water; however, no past results on reuse available nowadays. Accordingly, item was remained for potentially reuse in the future.

15) Security of new connection

Payment recorded on connection application for security to be paid once only

16) New connection fees (water)

Payment recorded on connection application for new connection fees of water to be paid once only

17) New connection Fees (sewer)

Payment recorded on connection application for new connection fees of sewer to be paid once only

18) Meter cost

Payment recorded on connection application for installation fees of water meter to be paid once only

19) Advance payment

Payment recorded on connection application to be paid once only and was returned to the applicant and/or was adjusted by water tariff at a future date.

20) Surcharge for late payment

Surcharge was 10% of total payment including sewerage charges in case that time for payment was delayed within term of payment.

21) Fixed charge

Basic charge

22) Category of commercial connection

- Carpet washing and dying add, petrol pumps or workshops with service station, hotel (A-class), ice factories, cement pipe factories, ghee mills, dairy farms, dhobi ghates (more than three ghats)
- Hotel (B-class), restaurants, ice cream manufacturers, shopping centres, foundry steel mills, hamams with three or more baths, gujjar with more than twenty animals, chemical and rubber factories
- Plazas, commercial markets etc.
- Tea stall, restaurants including chargha houses (without air conditioning), plastic industries, shoe industries, power O&M industries, pharmaceutical industries, match factory, soap factory, nickel and polish factory, gujjar with less than 20 animals, hamam with one or two bath, milk shops, private schools offices, motor show-room, cement jali factory, Lohar khanas, dhobi ghats (up to two ghats)
- Clinic/laboratory, nanbuy shops, printing press, dispensaries, hamam without bath, petrol pumps without service stations, cigarettes shops, fying shops, sweet manufacturer and bakeries, cooker/ riksha repair shops (without service facilities)

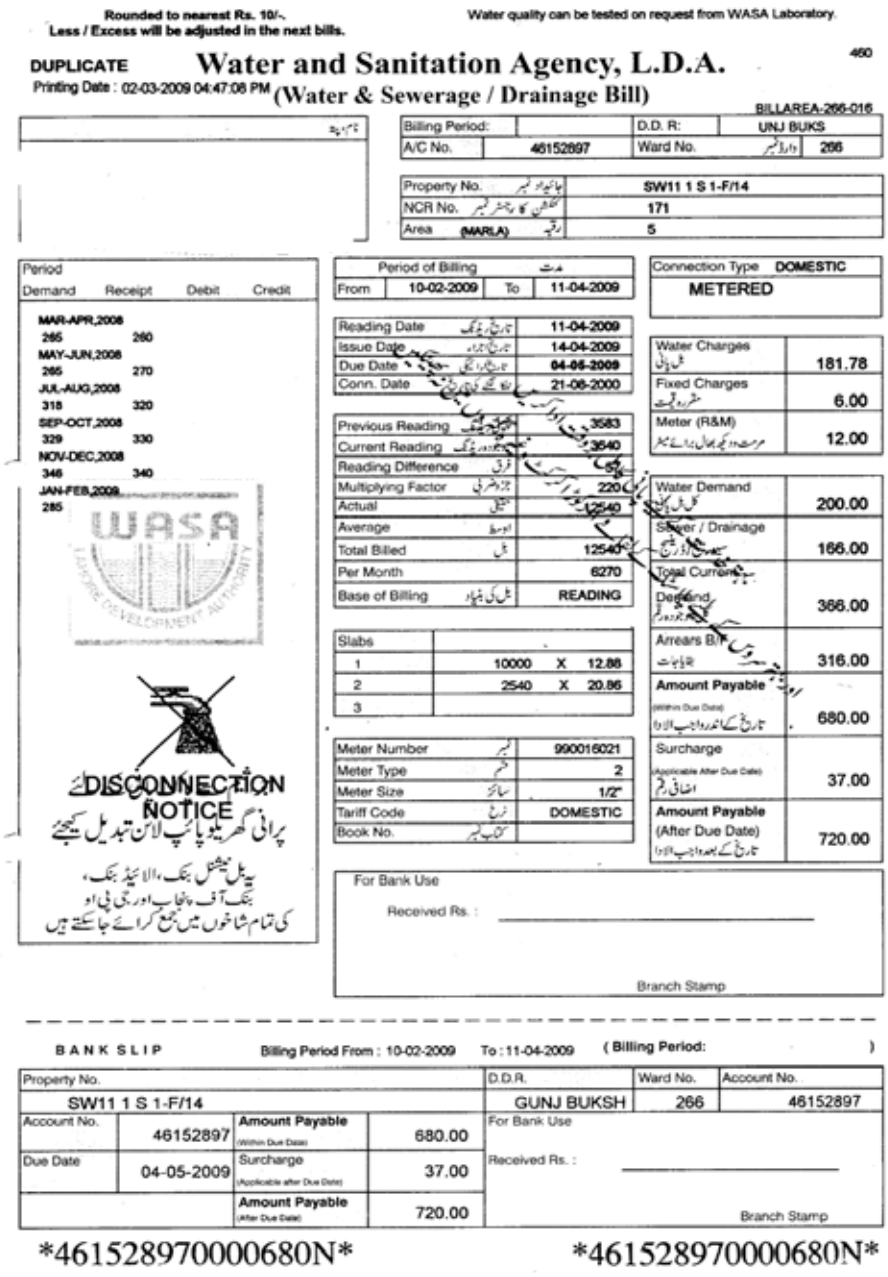
23) Industrial
24) Religious/charity
25) Others etc.

Appendix 6.7.10 Water Bill

Major recording items on domestic and commercial bills are shown as below.

- Property no.
- Name of town, ward no.
- Account no.
- Connection type (domestic or non-domestic)
- Period of billing
- Issued date & due date
- Slab size & metered (previous/current readings)
- Meter no. (type/size/tariff code/book No.)
- Water charge (fixed or meter)
- Sewer/drainage charge
- Surcharge/arrear/meter charger (meter R&M)
- Amounts payable

Figure (1) illustrates the example on domestic water tariff bill with meter reading.



Rounded to nearest Rs. 10/-.
Less / Excess will be adjusted in the next bills.

Water quality can be tested on request from WASA Laboratory.

DUPLICATE

Water and Sanitation Agency, L.D.A.

Printing Date : 02-03-2009 04:47:08 PM **(Water & Sewerage / Drainage Bill)**

460

BILLAREA-266-016

Billing Period:		D.D. R:	UNJ BUKS
A/C No.	46152897	Ward No. وارڈ نمبر	266

Property No. جائیداد نمبر	SW11 1 S 1-F/14
NCR No. کنکشن کا رجسٹر نمبر	171
Area (MARLA) رقبہ	5

Period	Demand	Receipt	Debit	Credit
MAR-APR,2008	265	260		
MAY-JUN,2008	265	270		
JUL-AUG,2008	318	320		
SEP-OCT,2008	329	330		
NOV-DEC,2008	346	340		
JAN-FEB,2009	285			

WASA

DISCONNECTION NOTICE

پرانی گھریلو پائپ لائن تبدیل کیجئے

یہ بل نیشنل بنک، الائیڈ بنک، بنک آف پنجاب اور ٹی پی او کی تمام شاخوں میں جمع کرائے جا سکتے ہیں

Period of Billing مدت			
From	10-02-2009	To	11-04-2009

Reading Date تاریخ ریڈنگ	11-04-2009
Issue Date تاریخ اجراء	14-04-2009
Due Date تاریخ ادائیگی	04-05-2009
Conn. Date کنکشن کی تاریخ	21-06-2000
Previous Reading پچھلی ریڈنگ	3583
Current Reading موجودہ ریڈنگ	3640
Reading Difference فرق	57
Multiplying Factor ضرب	220
Actual حقیقی	12540
Average اوسط	
Total Billed بل	12540
Per Month	6270
Base of Billing بل کی بنیاد	READING

Slabs			
1	10000	X	12.86
2	2540	X	20.86
3			

Meter Number نمبر	990016021
Meter Type قسم	2
Meter Size سائز	1/2"
Tariff Code نرخ	DOMESTIC
Book No. کتاب نمبر	

Connection Type **DOMESTIC**

METERED

Water Charges نل پانی	181.78
Fixed Charges مقررہ قسط	6.00
Meter (R&M) مرمت و دیکھ بھال برائے میٹر	12.00
Water Demand کل نل پانی	200.00
Sewer / Drainage سیوریج / نکاسی آب	166.00
Total Current Demand	366.00
Arrears Bill بقایاجات	316.00
Amount Payable (Within Due Date) تاریخ کے اندر واجب الادا	680.00
Surcharge (Applicable After Due Date) اضافی رقم	37.00
Amount Payable (After Due Date) تاریخ کے بعد واجب الادا	720.00

For Bank Use

Received Rs. : _____

Branch Stamp

BANK SLIP Billing Period From : 10-02-2009 To : 11-04-2009 (Billing Period:)

Property No.				D.D.R.	Ward No.	Account No.
SW11 1 S 1-F/14				GUNJ BUKSH	266	46152897
Account No.	46152897	**Amount Payable** (Within Due Date)	680.00	For Bank Use		
Due Date	04-05-2009	Surcharge (Applicable after Due Date)	37.00	Received Rs. : _____		
		Amount Payable (After Due Date)	720.00	Branch Stamp		

461528970000680N *461528970000680N*

Figure (1) Billing Form

Appendix 6.7.11 Performance of Commissioned Banking Facilities

Performance and Mistakes of Commissioned Banking Facilities (2008)

Name of Banking Facilities	2008 July				2008 August				2008 September				2008 October				2008 November			
	Actual Collected revenue(Rs)	Input Billing Amount (Rs)	Diff Amount (Rs)	Times of Diff day (27days)	Actual Collected revenue(Rs)	Input Billing Amount (Rs)	Diff Amount (Rs)	Times of Diff day (25days)	Actual Collected revenue(Rs)	Input Billing Amount (Rs)	Diff Amount (Rs)	Times of Diff day (25days)	Actual Collected revenue	Input Billing Amount	Diff Amount	Times of Diff day (25days)	Actual Collected revenue(Rs)	Input Billing Amount (Rs)	Diff Amount (Rs)	Times of Diff day (25days)
NBP	24,283,150	24,283,150	0	0	29,474,609	29,474,609	0	0	21,864,728	21,902,092	-37364	4	28,284,733	28,203,485	81248	4	25,486,506	25,529,134	-42628	4
ABL(Incd. NADR	33,161,743	34,833,786	-1672043	23	49,384,697	49,358,420	26277	18	33,645,842	34,417,287	-771445	23	57,592,366	56,927,225	665141	23	38,421,695	38,470,078	-48383	25
BOP	22,699,088	22,699,088	0	0	27,451,260	27,453,876	-12616	3	25,681,383	25,739,073	-57690	8	28,826,820	28,846,669	-19849	16	25,609,181	25,796,843	-187662	8
GPO	29,584,624	29,584,624	0	0	36,222,819	35,758,341	464478	10	34,967,201	34,994,911	-27710	8	36,648,604	36,644,774	3830	10	30,259,803	30,259,803	0	0
Total	109,728,605	111,400,648	-1,672,043	**23**	142,533,385	142,045,246	478,139	**31**	116,159,154	117,053,363	-894,209	**43**	151,352,523	150,622,153	730,370	**53**	119,777,185	120,055,858	-278,673	**37**
Ave. of miss day monthly	27,432,151	27,850,162	-418,011	6	35,633,346	35,511,312	119,535	8	29,039,789	29,263,341	-223,552	11	37,838,131	37,655,538	182,593	13	29,944,296	30,013,965	-69,668	9
% of diff Amount Vs Actual Vs Input	**98.5%**				**100.3%**				**99.2%**				**100.5%**				**99.8%**			

Name of Banking Facilities	2008 December				2009 January				2009 February				2009 March				2008-2009 Total			
	Actual Collected revenue(Rs)	Input Billing Amount (Rs)	Diff Amount (Rs)	Times of Diff day (25days)	Actual Collected revenue(Rs)	Input Billing Amount (Rs)	Diff Amount (Rs)	Times of Diff day(25days)	Actual Collected revenue(Rs)	Input Billing Amount (Rs)	Diff Amount (Rs)	Times of Diff day (25days)	Actual Collected revenue(Rs)	Input Billing Amount (Rs)	Diff Amount (Rs)	Times of Diff day (25days)	Actual Collected revenue(Rs)	Input Billing Amount (Rs)	Diff Amount (Rs)	Times of Diff day Yearly
NBP	24,297,451	24,310,873	-13422	2	25,805,703	25,810,363	-4660	3	27,296,488	27,304,840	-8352	2	27,264,936	27,266,112	-1176	2	234,058,304	234,084,658	-26354	21
ABL(Incd. NADR	48,540,204	48,570,562	-30358	21	42,089,106	42,041,942	47164	24	64,725,397	65,105,644	-380247	23	49,335,398	48,885,463	449935	24	416,896,448	418,610,407	-1713959	204
BOP	25,236,804	25,382,459	-145655	13	27,003,327	27,239,941	-238614	21	33,515,467	33,836,808	-321341	21	25,636,346	26,283,696	-647350	23	241,659,676	243,278,453	-1630777	113
GPO	31,291,681	31,292,205	-524	4	31,253,085	31,250,895	2190	2	41,664,151	41,678,371	-14220	4	33,559,425	33,557,297	2128	6	305,451,393	305,021,221	430172	44
Total	129,366,140	129,556,099	-189,959	**40**	126,151,221	126,343,141	-193,920	**50**	167,201,503	167,925,663	-724,160	**50**	135,796,105	135,992,568	-196,463	**55**	1,198,065,821	1,200,994,739	-2940918	**382**
Ave. of miss day monthly	32,341,535	32,389,025	-47,490	10	31,537,805	31,585,785	-48,480	13	41,800,376	41,981,416	-181,040	13	33,949,026	33,998,142	-49,116	14	299,516,455	300,248,685	-735,230	96
% of diff Amount Vs Actual Vs Input	**99.9%**				**99.8%**				**99.6%**				**99.9%**				**99.8%**			

Source: WASA finance Det. April 25, 2009 26.2

Appendix 6.7.12 Typical Reminder Notice

Water and Sanitation Agency, LDA
(Water and Sewrage/Drainage Bill)

Printing Date: Ward Serial:
Old Account Number: Bill Area:

Billing PeriodUpto	JAN-FEB,2009			D.D.R.	
Account No.				WARD NO.	
Property No.					

Tarif Code		Due For	18-03-2009
Commercial		Ammount Due	61,120.00

• Respected consumers please pay all the arrears stated in this notice immediately, otherwise we are compelled to disconnect water supply connection without any further notice.

• And once your connection is disconnected, you will have to pay arrears, fees for restoration of connection and advance payment of bill for six months.
• If someone illegally restores his disconnected connection then proceedings may be started according to Laws applicable to THEFT OF WATER AND CAUSING DAMAGE TO GOVERNMENT ASSETS.

• If the arrears are not paid forthwith, then this amount will be recovered by getting possession of the defaulter's property.
• SO FINALLY, you are hereby reminded to pay your arrears in your own interest to avoid any untoward situation.

Sincerely Yours,
Deputy Director Revenue

Note:
1. Arrears are payable at all branches of National Bank, Bank of Punjab, NADRA Kiosks and General Post Office.

2. No employee of WASA is authorized to receive any cash payment.

3. This notice only shows arrears upto 02March, 2009. However, if you have already paid this amount, then this notice may be treated as cancelled.

BANK SLIP Billing Period Upto: (JAN-FEB, 2009)

Property No.	
Account No.	
Due For Disc. On	
Total Outstanding Amount	

D.D.R	Ward No.			Account No.
Ganj Buksh	307			

For BankUse

Received Rs. _____

Bank Stamp

Source: WASA finance Det. April 22, 2009

Appendix 6.7.13 Meter Reading Sheet

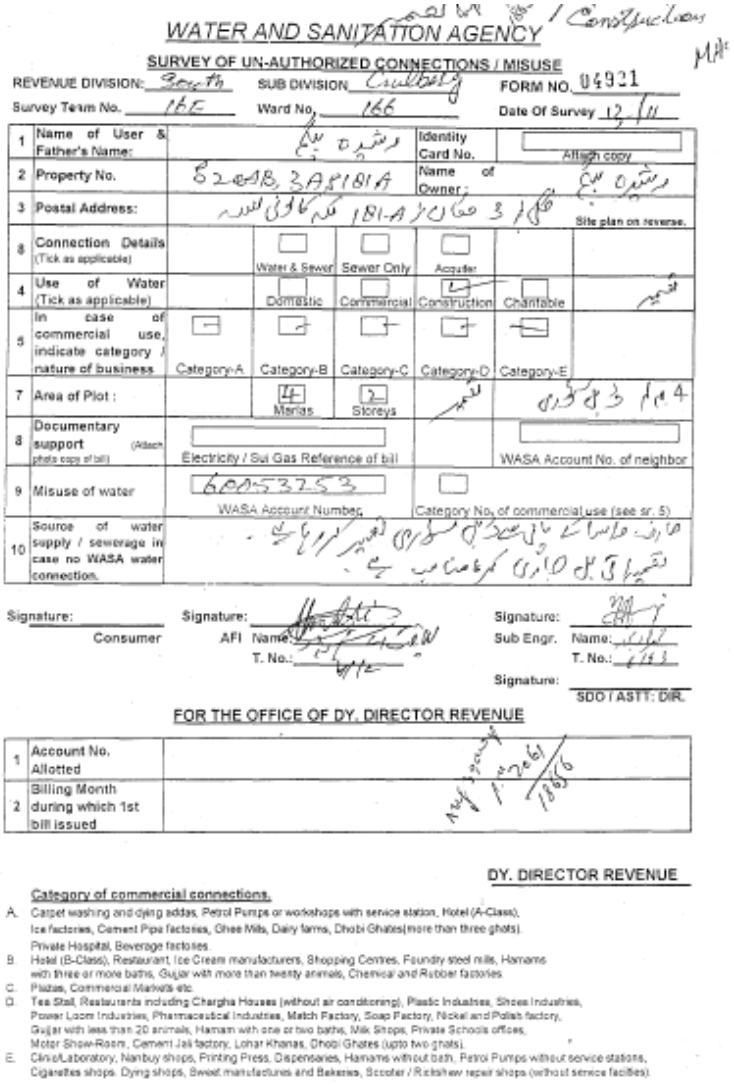
WATER & SANI ATION AGENCY L.D.A. LAHORE METER READING SHEET Page : 1
DDR : GUNJ UKSH Date : 06-05-2009 12:57:50
Rept : SHEET

Meter Reader : RASHID AHMAD (4974) Area : BILLAREA-072-016 Reading Date : 14-05-2009

New A/c Old A/c	Property No. Name	Walk Sort	Category Meter No.	Status	Previous Reading	M/R Status	Curr. Reading/ Consumption	Changed Conn. Type/ Rmks / Proposed Walk Sort
66074852	S37 10 S 7 SURVEY 200 XYZ	2	DOMESTIC	NO METER	0		N	20000
65013104 030116650	S37 10 S 7 MOHAMMAD LATIF	3	COMMERCIAL-A 6451	READING	7476		7495	
67122356	S37 10 S 44 G3 MUHAMMAD ASGHAR BUTT	5	DOMESTIC	NO METER	0		N	20000
66013117 030069809	S37 10 S 7A MOHAMMAD SHARIF	11	DOMESTIC 0000617318	DEAD METERS	0		D	20000
65013391 030129052	S37 10 S 4B MUHAMMAD ALI	12	DOMESTIC 660929	READING	1765		1771	
66044833	S37 5 S 2 MASOOD AHMAD	13	DOMESTIC 990015807	READING	3173		3246	
65013127 030133053	S37 10 S 13 MUHAMMAD ALAM	17	DOMESTIC	NO METER	0		N	20000
60007801 062018009	S37 10 S 25 TARIQ JAVED	26	DOMESTIC 1938	READING	40		0044	
65013241 030133060	S37 10 S 8A SYED IBRAR HUSSAIN	28	DOMESTIC	NO METER	0		N	20000
66020012	S37 G 3 10 S 35/B MST HAFEEZA BIBI	33	DOMESTIC 990015319	DEAD METERS	0		D	20000
67040814	S32 14 S 2A MUHAMMAD YOUSAF	45	DOMESTIC 2004001046	READING	830		0866	
60005449 036250074	S37 10 S 49 MALIK ALAM DIN	48	DOMESTIC	NO METER	0		N	20000
66009050	S37 10 S 49 MALIK ILAM DIN	49	DOMESTIC	NO METER	0		N	20000
65013133 030116447	S37 10 S 16 MR JAN MOHAMMAD	50	DOMESTIC 91P614394	READING	1330		1500	
65013146 030143218	S37 10 S 16 MOHAMMAD ISMAIL	51	DOMESTIC 78015678	DEAD METERS	0		D	20000
65013409 030003712	S37 10 S 16A MST MEHRAJ BIBI	53	DOMESTIC	NO METER	0		N	20000
65013159 030117321	S37 10 S 20 MST SHEHNAZ BANO	56	DOMESTIC 8791	DEAD METERS	0		N	20000
65013175 030117462	S37 10 S 22 MALIK DIN MUHAMMAD	58	DOMESTIC 0000626283	NO METER	0		N	19999
60007751 078726106	S37 10 S 22 KHALIL AHMAD	59	DOMESTIC 19184	DEAD METERS	0		D	15721
65013162 030111765	S37 10 S 22 SHER MOHAMMAD	60	DOMESTIC 139432	NO METER	0		N	20000

Figure 6.7.9 Typical Meter Reading Sheet

Appendix 6.7.14 Check Sheet for Survey of Unauthorized Connection/Misuse



WATER AND SANITATION AGENCY / Constructions

SURVEY OF UN-AUTHORIZED CONNECTIONS / MISUSE

REVENUE DIVISION: South SUB DIVISION: Cantt FORM NO. 04921

Survey Team No. 18E Ward No. 166 Date Of Survey 12/11

1	Name of User & Father's Name:				Identity Card No.		Attach copy
2	Property No.	52-18, 3A-181A			Name of Owner:		
3	Postal Address:						Site plan on reverse.
8	Connection Details (Tick as applicable)		Water & Sewer	Sewer Only	Acquifer		
4	Use of Water (Tick as applicable)		Domestic	Commercial	Construction	Charitable	
5	In case of commercial use, indicate category / nature of business	Category-A	Category-B	Category-C	Category-D	Category-E	
7	Area of Plot :		Marlas 4	Storeys 2			
8	Documentary support (Attach photo copy of bill)		Electricity / Sui Gas Reference of bill			WASA Account No. of neighbor	
9	Misuse of water		60053753 WASA Account Number		Category No. of commercial use (see sr. 5)		
10	Source of water supply / sewerage in case no WASA water connection.						

Signature: Consumer

Signature: AFI Name: T. No.:

Signature: Sub Engr. Name: T. No.:

Signature: SDO / ASTT: DIR.

FOR THE OFFICE OF DY. DIRECTOR REVENUE

1	Account No. Allotted	
2	Billing Month during which 1st bill issued	

DY. DIRECTOR REVENUE

Category of commercial connections.

A. Carpet washing and dying addas, Petrol Pumps or workshops with service station, Hotel (A-Class), Ice factories, Cement Pipe factories, Ghee Mills, Dairy farms, Dhobi Ghates(more than three ghats), Private Hospital, Beverage factories.

B. Hotel (B-Class), Restaurant, Ice Cream manufacturers, Shopping Centres, Foundry steel mills, Hamams with three or more baths, Gujjar with more than twenty animals, Chemical and Rubber factories.

C. Plazas, Commercial Markets etc.

D. Tea Stall, Restaurants including Charpha Houses (without air conditioning), Plastic Industries, Shoes Industries, Power Loom Industries, Pharmaceutical Industries, Match Factory, Soap Factory, Nickel and Polish factory, Gujjar with less than 20 animals, Hamam with one or two baths, Milk Shops, Private Schools offices, Motor Show-Room, Cement Jali factory, Lohar Khanas, Dhobi Ghates (upto two ghats).

E. Clinic/Laboratory, Nanbuy shops, Printing Press, Dispensaries, Hamams without bath, Petrol Pumps without service stations, Cigarettes shops, Dying shops, Sweet manufactures and Bakeries, Scooter / Rickshaw repair shops (without service facilities).

Figure 6.7.10 Typical Check Sheet for Survey of Un-Authorized Connection /Misuse

Appendix 6.8.1 Detail of Annual Projects Schedule

Detail of Annual Projects Schedule

SR. No.	NAME OF THE SCHEME		2007-2008
		Cost	REVISED
1	**ANNUAL DEVELOPMENT PROGRAMME ON GOING SCHEMES:**		
1-1	Laying of Trunk & Secondary sewers from Gujjar Pura Drain Bhogiwal Road to Wheetman Road, Jamilabad, Munawar Sultana Road & Dars Barey Mian, Lahore.	157.000	97.000
1-2	Remodelling of Railway Drain from Chamra Mandi to Shad Bagh.	155.700	25.000
1-3	Construction of Lift Station in Bouban Pura and Laying of Sewerage System in Mustafa Park, Shahbaz Park and Sadaqat Park, Douban Pura in Sabza Zar Division, Lahore.	38.651	33.651
1-4	Area Drainage Scheme in M.M.Alam Road and Replacement of Water Supply Lines and Construction of Rider	208.000	-
1-5	Outfall Drain from Shoukat Khanum Hospital to Sattu Katla Drain.	35.000	26.149
1-6	Main & Branch Sewer from Badami Bagh to Karim Park to Bagh Munshi Ladha.	95.131	-
1-7	Changa Pani Programme-Integerated Sewerage System for Badar Colony - UC 60	104.840	30.000
	TOTAL (ON-GOING):		**211.800**
	Fund Surrendered		-139.000
	G. TOTAL :		**72.800**

	NEW SCHEMES:	**Cost**	**REVISED**
1-8	Separation of sewerage from Cantonment Drain.	400.000	-
1-9	Replacement of outlived Tubewells of 4 and 2 Cfs capacity in different areas of Lahore City. (69 Nos.)	170.000	-
1-10	Laying of Trunk Sewer from Home Economics College to Linear Park Sattu Katla Drain.	483.000	-
1-11	Construction of South West Waste Water Treatment Plant, Lahore.	8917.000	-
1-12	Water supply, Sewerage & Drainage works and const. /Rehab. Of Overhead Reservoir in different Towns.	1068.00	-
1-13	Preperation of Master Plan for Water Supply, Sewerage & Drainage System of Lahore.	120.000	-
1-14	Trunk sewer from Shadi Pura to Salamat Pura	450.000	-
1-15	Procurement of Water Meters - Domestic & Bulk	-	-
	TOTAL (NEW):		**0.000**
	G. TOTAL :		**72.800**
2	**NON-ADP/SUPPLEMENT GRANTS**	**Cost**	**REVISED**
2-1	Const. of Disposal Station in Shahdara	53.000	53.000
2-2	Imp. Of Sewerage System for UC-126	50.000	50.000
2-3	Procurement of 12 Tractor and Trollies	12.012	12.012
2-4	Sewerage-M/Pura,Targar,Hanif & Faisal Park, UC:4& 8	6.254	5.291
2-5	Drainage around HQ and Adjoining areas (UC-60)	23.192	23.192
2-6	Development Works in PP-147:		
2-7	Imp. Of Sew. System in Katchi Abadi, Jameelabad	3.698	1.965
2-8	Imp. Of Sew. System Samanzar St. Begumpura UC-31	0.876	0.476
2-9	Imp. Of Sewerage System in UC75, 76, 78 and 96	9.258	9.258
2-10	Sewer Line Hoop Road with link Streets UC-31	1.185	0.139
2-11	Inst. Of 2 CFs T/Well in Jamilabad UC-31	4.485	0.835
2-12	Inst. Of 4 CFs T/Well G/Shahu Police Station UC-76	5.574	5.574
2-13	Inst. Of 4 CFs T/Well Rly.Park near Rly. St. UC-75	5.574	5.574
2-14	Inst. Of Sew. System in areas of UC-75,76 and 96	3.377	3.377
2-15	Sewerage System at Shahi Guzargah from Dehli Gate to Masti Gate, Lohari (Scheme under Sustainable Development of Walled City Project, Lahore)	77.450	57.450
2-16	Installation of Water Filtration Plant-Welfare of Staff	4.661	4.661
2-17	Improvement of sewerage system at Kamran Park, Bara Dari etc. UC-08 in Farrukhabad	8.324	8.324
	TOTAL :		**241.128**
	Fund Surrendered		**-57.450**
	G. TOTAL :		**183.678**
3	**REPL:OF OUTLIVED W/SUPPLY LINES-GASTROENTERITIS**	**Cost**	**REVISED**
3-1	Replacement if Outlived Water Supply Lines - Gastroenteritis	1,367.170	-
	TOTAL :		**0.000**

SR. No.	NAME OF THE SCHEME	Cost	2007-2008 REVISED
4	**COMMUNITY UPLIFT PROGRAMME**		
4-1	Inst. Of 4 Cfs T/Well - Yakki Gate UC 27	5.372	2.659
4-2	Inst. Of 4 Cfs T/Well - Shahalm Market UC 28	5.372	2.629
4-3	Inst. Of 4 Cfs T/Well - Mori Gate UC 29	5.372	-
4-4	Inst. Of 4 Cfs T/Well - Tehsil Garden UC 30	5.372	-
4-5	Inst. Of 4 Cfs T/Well - Pak Nargus Block, A.I. Town	5.670	-
4-6	W/Supply System, Badar Block, A.I.Town UC-104	0.494	-
4-7	Inst. Of 4 Cfs T/Well - College Block, A.I. Town	3.655	-
4-8	Inst. Of 4 Cfs T/Well - Neelam Block, A.I. Town	4.686	-
4-9	Imp. Of Sewerage System for UC-126	50.000	-
4-10	Imp. Of Sewerage/Drainage Sustem in UC-84	9.950	4.950
4-11	Imp. Of 4 Cfs T/Well - Gowal Mandi UC-73	5.527	2.764
4-12	Inst. Of 2 Cfs T/Well - Peco Rd., KLP. Ind. Area UC 130	3.242	3.242
4-13	Inst. Of 2 Cfs T/Well - Chungi Amar Sadhu, UC 134	3.582	3.582
4-14	Imp. Of Sewerage - Mohra Sharif, 60' road,GBT. UC 91	3.645	3.645
	TOTAL :		**23.471**

5	**CITY DISTRICT GOVERNMENTS FUNDS**	**Cost**	**REVISED**
1	S/L-Lither Main Bazar, Bahishti Gate (ABT - Wagha)	0.400	0.400
2	4 Cfs T/W at Babu Sabu UC-90	6.475	6.475
3	2 Cfs T/W at Begum Kot, Shahdara UC-1	4.000	4.000
4	S/S at Madina St., New Shalimar & Firdous Colony	2.267	2.267
5	Laying of Sewer Line in Mushraqi Muhallah UC-40	1.500	1.500
6	Provision of Sewerage System in Amar Town UC-41	1.000	1.000
7	Lay: of S/L in St.3, Saman St., Murad Pura UC-43	1.500	1.500
8	Provision of Sewerage Line in Bilal Park UC-44	1.500	1.500
9	Lay: of S/L in Main Road No.1, salamat Pura UC-430	2.984	2.984
10	Imp. Of W/Supply & sewer-K Block, M.A. Johar Town	0.393	0.393
11	Inst./Const. of 4 Cfs Capacity Tubewell at Kamran Block, in A.I.Town, Lahore. UC-109	6.199	6.199
12	Inst./Const. of 4 Cfs Capacity Tubewell at Raza Block, in A.I.Town, Lahore & Laying of Transmission Main to improve Water Supply System . UC-109	7.725	7.725
	TOTAL :		**35.94**

6	**DEVELOPMENT RECEIPTS-OWN SOURCES**	**Cost**	**REVISED**
6-1	Sewer Augmentation /Sewer Infrustructure charge		7.000
6-2	Capital receipts - Sale of Water meters		10.000
	TOTAL :		**17.00**

7	**LDA (UDWING) DEPOSIT WORKS FUNDS**	**Cost**	**REVISED**
7-1	W/S & Sew. works - LDA Avenue - I		-
7-2	Const of Outfall Drain, Journalist Colony		-
7-3	Shifting A.C.Pipe 4" Dia WS Line, Johar Town-TEPA	2.758	2.758
	TOTAL :		**2.758**

8	**OTHER DEPOSIT WORKS FUNDS**	**Cost**	**REVISED**
8-1	Drainage around Shalimar Garden- Archaeology Deptt.	43.742	-
8-2	Highway Under Pass - Muslim Town	3.754	0.990
8-3	Sewerage from Baba Chatri Wala to Niazi Chowk	0.238	0.238
8-4	Road Remodelling & Traffic circulation of Govt. Complex, Jain Mandar	4.744	2.926
8-5	Imp. Of Drainage- Both sides of Ring Road - Highway	12.416	12.416
8-6	Lay:/Replacement of Sewerage - Services Hospital	60.430	66.430
8-7	Sewer Connection of Dairy Farm - Governor House	1.701	1.701
8-8	Laying of Adequate Sewer / Drainage Outlet for Civil Secretariate - C&W Department	2.228	2.228
	TOTAL :		**86.929**
9	**OPENING BALANCE**		**2,778.268**

Source : WASA Revenue Dep. April 15, 2009 Budget 2008-2009

Appendix 6.9.1 Political Goals of the WASA

a) Policy-1: Cooperative operation and coexistence with community

Policy 1-1: To enforce precise business operation

- To promote the setup on business management goal
- To promote the completion on fiscal plan
- To promote the improvement on benchmark
- Business undertaking based on management goal
- To promote the formulation on management index monitoring system
- To promote the enforcement on operating efficiency based on intensive reform plan
- To promote the enforcement on customer's questionnaire

Policy 1-2: To reform organization

- To promote the study on organization's simplification
- To promote the clarification on responsibility/role/tasks burden
- To promote the balance on employee deployment
- To promote the reconfirmation on command structure
- To promote the study on employee grade allocation
- To promote the study on organization's activation
- To promote the realization on gradual alternation of generations
- To promote the study on reemployment of excellent retired employees
- To promote the employment on supervisory personnel, treasurer/ manager/general clerk and engineer with work experience/ knowledge

Policy 1-3: To formulate partnership with customers

- To promote the enforcement on public relations
- To promote the arrangement on exemption measures for the weak
- To disclose information on management index etc.
- To promote the study on making water & wastewater facilities tours
- To promote the study on water tariff presentation meeting
- To promote the accountability for challenges before WASA to town people and communization with these challenges
- To respond the complaint in term of tariffs/charges by upstanding town people with soft considerations
- To promote the provision on malicious illegal information from town people
- To promote the enforcement on testimonial events for excellent proposals
- To promote the customer service

b) Policy-2: To improve revenue/benefit by effective operation

Policy 2-1: To study the reduction on unaccounted-for water

- To promote the study on water balance
- To promote the study on augmentation measure of accounted-for water

Policy 2-2: To collect water tariff by water consumption

- To promote the improvement on growth/augmentation of water meter's number to be installed
- To promote the study on water tariff by water consumption
- To promote the securement on water consumption by users
- To promote the progress on numbers of sewer connections

Policy 2-3: To promote effective O&M

- To promote the payroll reduction
- To upgrade the quality of employee experience/education level
- To promote the private consignment on O&M tasks
- To promote the study on prolongation of retirement year for excellent employees

Policy 2-4: Efficiency on water meter readings/billing

- To promote the study on payroll reduction by partial mechanization to water reading/billing/delivery tasks
- To promote the improvement on water tariff payment system
- To promote the replacement on aging computer system for paperwork
- To promote the complaint case reduction measures in term of paperwork mistakes and tariffs/charges

Policy 2-5: To complete financial report by business

- To promote the studying on financial/management reports for respective water & wastewater project

Policy 2-6: To strengthen penalty

- To enforce the strengthening on penalty/publication to malicious illegal connections

c) Policy-3: To supply stable water

- To promote the study on replacement of asbestos pipes
- To promote the securement on laying distance service and wastewater pipes
- To promote the study on reinforcing service pipes crossing wastewater pipes
- To promote the study on leakage/breakage investigation to service pipes
- To promote the rehabilitation on chlorine feeding facility by pump pressure method
- To promote the study on making installation of inspection appliance obligatory to chlorine concentration of tube-well's discharge side
- To promote the study on installation by automatic water quality monitoring apparatus to the outlet of wastewater/effluent
- To promote the improvement on chlorine feeding ledger

c) Policy-4: To service stable water

Policy 4-1: To secure water sources

- To promote the study on alternative water sources
- To promote the study on whole quantity to groundwater sources

- To promote the study on water table fluctuation
- To promote the investigation on groundwater quality
- To promote the investigation on location & scale to aquifer/impermeable layer
- To promote the investigation on quantity/quality for recharge/flowage/storage of groundwater
- To promote the formulation on preservation plan
- To promote the reuse on treated sewage

Policy 4-2: To reduce temporal water supply

- To promote the improvement by second incoming circuit
- To promote the improvement on optimum private power generation for pump capacity
- To promote the reinforcement on O&M system for failure prevention

Policy 4-3: To rehabilitate/improve creaky facilities

- To promote the rehabilitation/improvement on tube-wells
- To promote the improvement on chlorine feeding facilities
- To promote the improvement on wastewater pump and screen equipment
- To promote the improvement on replacement works of electric facilities
- To promote the improvement on replacement works of wastewater pump station house
- To promote the improvement on improvement works of tube-well floor crack parts
- To promote the improvement on facility monitoring system by aggregated operation

Policy 4-4: To replace/improve water meter

- To promote the replacement/improvement on BFM
- To promote the replacement/improvement on service water meter
- To promote the improvement on intermediate water meter

Policy 4-5: To rehabilitate/improve pipeline network

- To promote the enforcement on replacement laying works for aging pipes such as service water pipes
- To promote the enforcement on replacement works of service pipe materials
- To promote the acceleration on water supply system

Policy 4-6: To improve leakage measures on water pipes

- To promote the enhancement on leak detection equipment
- To promote the enhancement on leak detection
- To promote the enhancement on employees in charge of leak detection
- To promote the enhancement on securing leakage volume

Policy 4-7: To reduce complaint cases

- To promote the study on computerized processing for complaint response ledger
- To promote the study on computerized processing for debrief report by complaint processing
- To promote the study on filling/statistics for complaint contents

- To promote the establishment on reduction plan for complaint cases
- To promote the improvement on vehicles used for complaint measures

e) Policy-5: Too improve equipment/materials for O&M

Policy 5-1: To promote the improvement on water meter workshop

- To promote the augmentation on repair technicians
- To promote the improvement on workplace
- To promote the improvement on sourcing/stock status
- To promote the improvement on calibration apparatus

Policy 5-2: To promote the improvement on workshop for inundation measure equipment/materials

- To promote the replacement on aging small pumps
- To promote the replacement on aging trucks and augmenting numbers of truck
- To promote the improvement on portable lighting tower with engine
- To promote the improvement on portable private power generator
- To promote the improvement on handy machine tools

Policy 5-3: To promote the improvement on heavy machine to remove deposits within water conduits/waste pipes

- To promote the replacement on aging equipment & materials
- To promote the enrichment on small bulldozer
- To promote the enrichment on bucket crane with long boom
- To promote the replacement on aging trucks and augmenting numbers of truck
- To promote the improvement on downsized two-wheel vehicle
- To promote the improvement on toxic gas detector appliance and safety musk etc.
- To promote the improvement on fall prevention appliance, helmet, safety glasses and glove etc.

Policy 5-4: To promote the improvement on water quality analysis function

- To promote the replacement on aging analysis equipment/materials
- To promote the replacement on analysis equipment/materials
- To promote the replacement on aging vehicles for sampling and augmenting numbers of vehicle
- To promote the improvement on wastewater analysis equipment/materials
- To promote the augmentation on employee in charge of analysis
- To promote the computerized processing on analyzed data

Policy 5-5: Inventory control

- To promote the computerized processing on warehousing ledger
- To promote the computerized processing on delivery ledger
- To promote the centralization on inventory control

f) Policy-6: To upgrade employee

Policy 6-1: To prepare training plan

- To promote the setup on training benchmark/effect
- To promote the reinforcement on employee personal information
- To promote the upgrading on management/application capacity of supervisory personnel
- To promote the upgrading on technological level of managerial engineer
- To promote the upgrading on employee level for labor health/safety education
- To promote the preparation on training benchmark by trainee
- To promote the preparation on training menu
- To promote the reinforcement/improvement on instructor
- To promote the review on instructor's qualification /payroll system

Policy 6-2: Promotion on changes in the consciousness of employee

- To promote the issuance on training certification of termination
- To promote the review on pay raise/payroll system
- To promote the studying on bonus system for working improvement proposals

Policy 6-3: Improvement on training facilities

- To promote the improvement on training equipment/materials in WASA's Training Center
- To promote the improvement on training room
- To promote the improvement on lodging/canteen facilities

Policy 6-4: Improvement on appraisal method of outcome

- To promote the appraisal on benchmark achievement/review reports by trainee
- To promote the appraisal on working improvement (safety, efficiency and improvement) proposal by trainee
- To promote the enforcement on training termination test (written, orally)
- To promote the verification on training attended days
- To promote the appraisal on performance before and after training
- To promote the appraisal on special technology/knowledge before and after training
- To promote the appraisal on application ability/problem-solving skill on duty

g) Policy-7: To secure the pleasant and safe living environment

Policy 7-1: To promote the improvement on wastewater

- To promote the improvement by separate system
- To promote the improvement on sanitary sewer
- To promote the functional strengthening on wastewater and storm water pump stations
- To promote the improvement on odor measures
- To promote the improvement on manhole

Policy 7-2: Favorable maintenance on facilities

- To promote the replacement on aging tube-wells

- To promote the replacement on aging pump stations
- To promote the computerize processing on tube-well O&M records
- To promote the computerize processing on pump station O&M records

Policy 7-3: To promote the inundation measures

- To promote the completion/publication on inundation-prone hazard maps
- To promote the improvement on aqueducts

Policy 7-4: Favorable maintenance on aqueducts/waste pipes

- To promote the enforcement on clearing/removal of deposits/sediments

h) Policy-8: To create clean rivers

Policy 8-1: To promote the water quality in public waters

- To promote the screen installation to storm water outlet chamber
- To promote the regulation/monitoring on industrial wastewater
- To promote the monitoring on disposal by illegally-dumped items
- To promote the improvement on storm water drainage system
- To promote the strengthening on offender's penalty and publication on offender/blacklist

i) Policy-9: Educational campaign on town people

Policy 9-1: Saving water

- To promote the leakage measures resulted from water tanks
- To promote the leakage measures resulted from service pipes
- To promote the effective utilization of water

Policy 9-2: Water quality contamination measures

- To promote the waterborne infectious disease measures caused by broken water pipes
- To promote the cleanup roof/underground tanks

Policy 9-3: Environmental preservation

- To promote the reduction on uncollected volume of wastes

Policy 9-4: Inhabitant's manners

- To promote the prohibition on garbage (domestic, industrial wastes) dumping to rivers/drainage channels
- To promote the reduction on illegal garbage disposal to manholes
- To promote the education on garbage collection manners
- To promote the prohibition on booster pump installation directly from service pipes

Policy 9-5: PR on WASA's activities

- To promote the publication on amount of water supply
- To promote the publication on financial condition
- To promote the publication on WASA's tasks

6.9.2 Augmentation on Operation Organization

Operation objectives on water and wastewater utility are returning water supply finance more sound consequent upon the effective organized management.

Existing organization was established following the system around 1991 as a fundamental form. Furthermore, the jurisdiction on O&M was segmented into six (6) towns from two (2) areas by the leading of military regime in those days around 2002. Each town respectively conducted the water & wastewater facilities and cleanup on waterways.

Business implementation status by existing organization was shown as below.

- Preparation tasks on financial control, revenue/cost management and auditing information were directly carried out.
- Tasks on service water meter reading and computer processing such as billing, delivery and credit control were directly carried out.
- Approval tasks and construction supervision were directly carried out.
- O&M on water & waster facilities and water quality inspection were directly carried out.
- Removal task on deposits was partially carried out by outsourcing.
- Tasks on Storm water/drainage were partially carried out by outsourcing.
- Maintenance on equipment/materials and vehicles were cared by outsourcing.

Appendix 7.1 Outline of Existing Studies and Development Plans

WATER SUPPLY	SEWERAGE	DRAINAGE
(1) Lahore Water Supply, Sewerage and Drainage Project Camp Dresser & Mckee Ltd. (CDM), September 1975 Review of the M/P for Water Supply, Sewerage and Drainage in Greater Lahore prepared in October 1969 including a hydrological study.		
● The study area population was approximately 2,227,000 in 1974 and is expected to increase to about 3,700,000 by 1986. The population that could potentially be served by the LIT/WW water supply system is expected to increase from 1,300,000 (58%) to 3,330,000 (90%) during the same period. ● The basic supply will continue to be from groundwater even in the long term through the comparative study of five alternatives including surface water supply systems. ● Wells of 4 cusec capacity spaced at approximately 4,000 ft centers within the served area will provide the least cost supply.	● The wastewater be treated as soon as it is financially feasible. Comparison of relevant treatment methods shows a combination of anaerobic, facultative and aerobic lagoons to be the most economical treatment method. This conclusion is based on the availability of low value land outside the bund and on the feasibility of constructing separate treatment facilities for each of the several drainage areas. ● It is feasible to obtain significant benefits from sewerage beyond those attainable by the direct connection of premises. These benefits relate to the removal of overland flows of sullage water and ponded rainwater. They can be achieved without providing any sewer capacity beyond that needed to convey peak sanitary sewage flow.	● While the expansion of the partially combined sewer system will provide certain flood alleviation benefits, it will still be necessary to provide major drainage channels and pump stations of adequate capacity to dispose of storm runoff from the city without serious flooding, including during periods when the water level in the Ravi River is high.
(2) Lahore Water Supply System Computer Study and Design of New Tube-wells National Engineering Services Pakistan (Pvt.) Limited (NESPAK), October 1986 ● The economic analysis indicates the minimum annual cost when the water is pumped at the rate of max period demand and 10 reservoirs each of 1 million gallon are provided in year 1986. This alternative will meet all the demand and its fluctuations including peak hour demand The tube-wells will have to be increased up to 148 and the reservoirs upto 15 in the year 1995.	**(3) Lahore Wastewater Treatment Project** Balfours Consulting Engineers, September 1987 Identification of the service area of the **Southwest WWTP** and study on its treatment process ● Wastewater arising from the Central and South Civil Lines Sewerage Districts currently flow to Chota Ravi Drain, Main Outfall Pumping Stations and Gulshan-e-Ravi Pumping Station. These flows would be collected in an open channel and be pumped through an inlet pumping station of the	

Appendix 7.1 Outline of Existing Studies and Development Plans

WATER SUPPLY	SEWERAGE	DRAINAGE
● It is recommended to provide additional 50 tube-wells of 4 cfs each and initiate the construction of one million gallon welded steel ellipsoidal storage reservoirs. 10 such reservoirs costing Rs. 150 million should be installed at the strategic locations. To surmount the difficulties of foreign exchange if any, one such tank can be imported and the "others can be fabricated in the country through the construction of Steel Mill. This will provide an ideal system of supply for 24 hours and on the other hand, reduce the cost of transmission lines. ● Demand investigation was carried out on short term basis throughout the city and the results are comparable with the average annual consumption recorded on the meters. n1e per capita consumption observed in high, medium and low density areas is 50,80 and 100 gallons respectively. Unaccounted water is estimated as 30 %. The average demand for the city is worked out as 81 gpcd. The max day, max period and peak hour factors are worked out as 1.34, 2.0 and 2.5 respectively. ● Some of the 4 cfs tube-wells are connected through 8"/10" dia lines which cause very high head losses. Similarly 2 cfs tube-wells are connected through 6" and 8" dia lines causing high head losses. It is recommended that 4 cfs and 2 cfs tube-wells should be connected through 12" and 10" dia lines respectively.	wet well/dry well type to the Southwest WWTP for treatment. ● Waste water arising from the South West sewerage district flowing to Multan Road Pumping Station would also be discharged to the Southwest WWTP. ● Wastewater treatment would be of anoxic pond design in the initial development plan with facultative ponds added later. The treatment plant and collector channel need protection from flood flows in the River Ravi.	
(4) Groundwater Resources Evaluation and Study of Aquifer under Lahore National Engineering Services Pakistan (Pvt.) Limited (NESPAK), June 1991 The field investigations and studies for the Project, including the following works were conducted: ● To carry out studies, investigations etc., required for the understanding of the aquifer with the assistance of Hydrology Cell of WASA. ● To advise Hydrology Cell in collecting the relevant data and running computer model to predict the behaviour of the aquifer due to addition of more wells and reduced recharging of aquifer due to closure/reduction of	**(6) Punjab Urban Development Project Lahore Wastewater Treatment Plants and Sewage Pumping Stations** Balfour Maunsell & Engineering Consultants, July 1993 The report describes the facilities, both civil and electrical/mechanical, that are to be constructed under the following contract: Civil Contracts a) Punjab Urban Development Project ● Mahmood Booti Pumping Station; and	**(5) Lahore Urban Drainage - Design Report** Mott MacDonald International Limited & ACE (Pvt.) Limited, February 1992 The report presents various design criteria which are to be adopted in the detailed design. These criteria include an outline sizing exercise, in order to check there is sufficient space available on the proposed drain routes, checking for the availability of possible storage reservoirs, and the evaluation of

Appendix 7.1 Outline of Existing Studies and Development Plans

WATER SUPPLY	SEWERAGE	DRAINAGE
flow in River Ravi. ● To train WASA designated one staff member for using the Computer Model for a period of 15 days at London. ● To provide WA SA the Computer Model used in the Project along with all relevant data files after the completion of the Project. ● To advise Hydrology Cell for monitoring the quality of groundwater and to plan and design the monitoring of wells. ● To revise the design and technical specifications of WASA tube-wells and suggest improvements. ● To suggest improvements in the construction techniques and procedures for tube-well s. ● To introduce the latest techniques for preventive maintenance/rehabilitation of tube-wells, and to give practical, demonstration on at least three tube-wells having screens of different materials' like brass, stainless steel and fibre glass. ● Possibilities of introducing artificial recharge system. If so, to suggest most economical methods suitable to the existing environments. ● To conduct six pumping tests and interpret the data and the calculation of the values of transmissivity and storage co-efficient. ● Inventory of all the existing tube-wells in Lahore including their discharge measurement on quarterly basis. ● Water level observations on selected wells on monthly basis, selection of an observation well network to be monitored by WA SA in future. ● Extension of the Groundwater Model beyond Ravi River in the north-west and upto BRBD in the south-east; and ● Experimental rehabilitation of deteriorated WASA tube-well(s) which could not be arranged during the currency of Project Study due to certain constraints.	● Khokhar Rood, Shadbagh and Gulshan-e-Ravi Pumping Stations. b) Punjab Urban Environmental Project ● Works Inlet and Multan Road Pumping Stations; ● Collector Channel; and ● Southwest Wastewater Treatment Plant. Electrical/Mechanical Contracts a) Punjab Urban Development Project ● Mahmood Booti Pumping Station; and ● Khokhar Rood, Shadbagh and Gulshan-e-Ravi Pumping Stations. b) Punjab Urban Environmental Project ● Works Inlet and Multan Road Pumping Stations. Consideration is also being given to the funding of modifications to Main Outfall Pumping Station and the construction of the Shadbagh Wastewater Treatment Plant under PUEP. Both of these are at outline design stage only in mid-1993.	different drain cross sections
	(7) Punjab Urban Environmental Project **Lahore Southwest Wastewater Treatment Plant** Balfour Maunsell, October 1994	

Appendix 7.1 Outline of Existing Studies and Development Plans

WATER SUPPLY	SEWERAGE	DRAINAGE
	Review of Sewerage Master Plan The implementation of the 1975 master plan by CDM and its proposals have been reviewed in the light of new projections for populations and wastewater flows in the Central, South Civil Lines and Southwest Sewerage Districts. The existing sewerage systems have been analysed to consider their fitness to transport future sewage flows, and outline proposals for their augmentation have been prepared where necessary. These proposals assume that flows from the) Cantonment which currently discharge to Mian Mir Drain would be transferred to the South Civil Lines Sewerage District for treatment at the proposed plant. It is estimated that 45% of the sewer network would require augmentation by 2005, and a further 28% by 2017. **Cost Comparison of Treatment Systems** A financial comparison of four wastewater treatment systems which could be used at the Southwest WWTP made. Outline designs for high-rate activated sludge, high-rate biological filtration, aerated lagoons and waste stabilization pond systems were prepared and assessed, taking into account both capital and running costs over 40 years. The wastewater stabilization pond system using anoxic and facultative ponds was shown to have a significantly lower net present cost than the other systems.	
	(8) Integrated Master Plan for Lahore – 2021 National Engineering Services Pakistan (Pvt.) Limited (NESPAK), November 2002	
Population Distribution	**General**	**General**

Appendix 7.1 Outline of Existing Studies and Development Plans

WATER SUPPLY

District	Area	2001	2011	2021
Lahore	Urban	4,831,658	6,337,424	8,025,765
	Cantonment	652,379	992,364	1,416,123

Per capita Water consumption

It is right time to reduce per capita consumption from 80 gpcd to 50 gpcd. Remedial measures with the following objectives are suggested:

- To reduce lpcd figure
- To check decline in water table.
- To reduce pumping cost.
- To make WASA financially viable organization

Supply Hours

WASA is pumping water up to 16 hours, a day. Any reduction in pumping hours will substantially reduce un-accounted for wastage of water.

Overhead Reservoirs

Five overhead tanks each 4.5 million liters (one million gallon) capacity, 24 m (80 ft.) high and 12 m (40 ft.) deep (ellipsoidal welded steel tanks) are proposed on experimental basis in the initial stage up to the year 2007. The location of other tanks has to be determined through the detailed computer modeling of water distribution system considering the available water sources, their location, pipe network, water demands etc.

Tube-well Requirements

District	Unit	2001	2011	2021
Tube-well	Unit	347	444	669
Water supply	MGD	290	639	964

It has been experienced that discharge of 4 cusec tube-well rapidly reduces to two cusecs in a span of 5 to 8 years inspite of the fact that the strainers of different material has been tried. Average life of a 4 cusec well works out to be 15 years. A regular periodic air blowing once a year of each tube-well will definitely enhance the average life of a tube-well to 20-25 years.

Water Budget

It is now high time to plan water budgeting to check rapid decline in static water table. It is proposed that at least 300 mgd must be added to the water

SEWERAGE

Yet the development of sewerage system in Lahore lagged behind due to rapid increase in population. There are built up areas which are deficient of lateral sewers, trunk sewers and pumping stations. Some of the areas have system but due to inadequate capacity of trunk and lateral sewers and pumping capacity, have overflow problems. It is estimated that on the average 45.83% of population is still to be served with sewerage system.

Sewerage District

WASA is operating its sewerage system in the following 9 districts.

1. Shahdara Sewerage District
2. North Sewerage District
3. North-East Sewerage District
4. Central Sewerage District
5. South Civil Line Sewerage District
6. South-West Sewerage District
7. South-East Sewerage District
8. Nishtar Town Sewerage District
9. Johar Town Sewerage District

The above sewerage districts cover 54% (connected directly) of Lahore urban area. The expansion has necessitated to develop the following sewerage districts:

1. North Far-East Sewerage District
2. East Sewerage District
3. Far-South West Sewerage District

Wastewater Treatment Plant

WASA has plans to treat waste water at five places that is Shahdara, Shadbagh, Babu Sabu, Ferozepur Road and Hudiara Drain. 900 acres of land near Babu

DRAINAGE

The city of Lahore is generally flooded during the rainy season causing inconvenience to the residents and damage to the roads and property. The main drains in some of the areas were constructed but due to encroachments their rights of way have drastically been reduced whereas the storm run-off has increased manifold due to urbanization. The problems of the main drains also affect the functioning at the secondary and tertiary drains joining these main channels.

At present most of the storm water drains are being used as sullage carriers which is not only hindering the storm water disposal but also creating environmental hazards. The industrial effluent is also being disposed off in these drains.

The sewerage and drainage systems for Lahore are partially combined. Their operation as separate systems is only possible if it starts from residences where waste water, and rain water arrangement should be separated. This can now be implemented in new housing schemes.

Problems in Urban Drainage

It is advisable that WASA should prepare drainage schemes that would address the following problems.

- The dumping or solid wastes into the drains is eliminated.

Appendix 7.1 Outline of Existing Studies and Development Plans

WATER SUPPLY	SEWERAGE	DRAINAGE
supply system from the North East side by treating the surface water and 300 mgd transported from the North and North West well centers. Thus treated and transported water must be brought to the center of the city. The Northern area must be served from independent tube-wells. For implementation of this plan 600 cusecs of surface water has to be arranged through an independent canal. Similarly a chain of 185 tube-wells of 4 cusec capacity each has to be installed along River Ravi.	Sabu west of Lahore Bypass has already been purchased. Construction is held up due to lack of funds. It is recommended that an economical solution for treatment of waste water based on oxidation ponds (on already purchased land) be designed and implemented for immediate relief.	● The existing encroachments are removed and future tendency is checked. ● Prepare economical proposals. ● Plan the disposal of rain water of at least 5 years frequency storm. ● The maintenance of drain is facilitated. ● 1t should be self financing drainage scheme. ● It should be practically self cleaning drain.
	(9) Master Plan for Improvement of Sewerage and Drainage System of Central Zone, Lahore – Detailed Engineering Design Report National Engineering Services Pakistan (Pvt.) Limited (NESPAK), August 2005 This report includes detailed analysis of the recommended alternative for the improvement of sewerage and drainage system of Lahore Central Zone, the technical and economical viability of the recommended alternative based on detailed survey and evaluation, the detailed calculations of sewage and storm flows and the design principles to be adopted during detailed design stage, the preliminary cost estimates, operation and maintenance cost and the project benefits. ● The construction cost is estimated at Rs.614 M for trunk and branch sewers, and Rs.821 M for drains (Package A) and Rs.821 M for drains (Package B).	
	(10) Preparation of Comprehensive Sewerage & Drainage Scheme for South Lahore – Feasibility Report National Engineering Services Pakistan (Pvt.) Limited (NESPAK), November 2005 **Project Area** The Project Area includes the southwestern part of the City i.e. South Lahore. Limits of Project Area for sewerage and drainage systems are described as under: Project Area for sewerage and drainage system includes the area delin1ited by Multan Road and Bund Road in the northwest, Pakistan Railway Line in the southeast and Buchar Khana Distributary along with Ramkot Minor in the southwestern part. Total Project Area is approximately 50,000 acres. **Plan**	

Appendix 7.1 Outline of Existing Studies and Development Plans

WATER SUPPLY	SEWERAGE	DRAINAGE
	The main concepts involved in the Plan are: ● Complete elimination of the existing disposal stations operated by WASA. ● An intermediate pumping station will be constructed at Sattukatla Drain near Tariq Gardens. ● The additional sewage flow of Gulberg area, which is in excess to the capacity of the existing system, will be diverted to the proposed intermediate pumping station at Sattukatla Drain. ● Separation of sewage from storm water. ● Trunk sewers will be laid along both sides of Sattukatla Drain. ● The areas bounded by Hudiara Drain and the Butcher Khana Distributary along with Ramkot Minor will be served by the trunk sewer laid along the left bank of Hudiara Drain. ● The proposed trunk sewers, to the existing Multan Road Sewage Pumping Station, will carry the flows of the areas bounded by Lahore Branch Canal and Bund Road. ● Trunk sewers are provided up to maximum size of 90" diameter and when flow increases beyond the carrying capacity of 90" diameter conduit of appropriate size will be proposed instead of sewer. ● The construction cost is estimated at Rs.8,250 M for sewers and conduits excluding a wastewater treatment plant, and Rs.7,507 M for covered drains and Rs.4,181 M for uncovered drains.	
	(11) Preparation of Comprehensive Sewerage & Drainage Scheme for South Lahore – Preliminary Design Report National Engineering Services Pakistan (Pvt.) Limited (NESPAK), November 2005 **Sewerage System** Sewage flows generated by different portions of project area shall be carried by a series of trunk sewers. Its salient features are as given hereunder: ● Sewage flows from Gulberg, Model Town and areas adjacent to Ferozepur Road shall be carried by a conduit and ultimately disposed off into Hudiara Drain. ● Sewage flows from the area bounded by southern boundary of Allama lqbal Town and Lahore branch canal, shall be carried towards Multan Road Pumping station. ● Sewage flows from areas on both sides of Sattukatla Drain, housing societies around Raiwind Road, Green Town, Johar Town, Township and areas below green town upto Hudiara Drain shall be carried by a conduit uptil lift station near Mohlanwal. ● The areas bounded by Hudiara Drain and the Butcher Khana Distributory along with Ramkot Minor will be served by the trunk sewer laid along the left bank of Hudiara Drain. ● Pumping capacity of G-Block Disposal Station shall not have to be enhanced to cater for future flows as	

Appendix 7.1 Outline of Existing Studies and Development Plans

WATER SUPPLY	SEWERAGE	DRAINAGE
	a new conduit has been proposed to take additional flows towards Ferozepur Road. ● Sewerage flows shall be separated from drainage flows throughout the project area. ● O&M cost of various temporary disposal stations will be saved. ● Environmental nuisance created by temporary disposal stations scattered in the Project Area will be overcome, ● Trunk sewers are provided up to maximum size of 72" diameter and when flow increases beyond the carrying capacity of 72" diameter, a conduit of appropriate size has been proposed instead of sewer. **Drainage System** ● The adopted run-off for the design of drains is based on 2 years Return Period. However, runoff at 5 years Return Period has also been assessed, which was found to produce bigger and uneconomical results. Rational Method is generally used for calculating run-off at various reaches in case of relatively small catchll1ent areas whereas for large drainage areas. Hydrograph method is preferred and as such Hydrograph method has been used for this project. ● In order to provide relief to· drainage problems of South Lahore, an overall proposal has been worked out including basic network of existing and proposed drains. New drains are proposed along the existing and future planned roads covering the whole Project Area, keeping in view the vital and key role of Sattukatla Drain. **Cost** ● The construction cost is estimated at Rs.12,570 M for sewers and conduits excluding a wastewater treatment plant, and Rs.9,988 M for covered drains.	
(12) Identification Study for Provision of Water Supply and Sewerage Services in Lahore City Seueca, August 2007 The objectives of the project were to: ● Conduct an audit of the existing sewerage system, produce recommendations for improvement and define an investment plan. ● Provide technical assistance and guidance to implement an UFW pilot area of 1,500 connections in Johar Town. Supervise field activities conducted by WASA, LDA. ● Define a UFW reduction strategy together with an action and investment plan, Carry out an audit of WASA's operation & maintenance procedures and equipment and produce costed recommendations of the investment required.		
The main conclusions that can be made from the desktop assessment of **UFW** are as follows:	The audit of the sewage system showed that the main challenges and issues faced by Lahore WASA are as	

Appendix 7.1 Outline of Existing Studies and Development Plans

WATER SUPPLY	SEWERAGE	DRAINAGE
● Lack of metering infrastructure makes a comprehensive and robust water balance difficult to achieve. Components of Production, Accounted for Water and Unaccounted for Water can only be estimated to a confidence interval of +-20%. In these conditions, the level of UFW can be anywhere between 33% and 53% of distribution input. ● Leakage estimates based on a bottom-up BABE type assessment concur with the top-down estimate made under the Mott Macdonald study, namely 19%. ● No active leakage control is being conducted, resulting in relatively high levels of leakage, when expressed as volumes lost per km of distribution main (77 m^3/km/day) and considering the low levels of pressure in the system. To put this figure into international context Riyadh Saudi Arabia has a similar, low pressure intermittent supply and reports losses of 39m^3/km/day. In order to implement successfully UFW reduction throughout the city and within a reasonably good time frame, it will be therefore vital to: ● Deploy sufficient resources and provide incentives to local contractors to complete their assignment in time ● Supervise very closely the local contractors and the field activities, especially the consumer connection survey, ● Implement communication campaigns to inform and educate the public and reduce its resistance towards metering, ● Carry out a detailed mapping of the system to understand its configuration ● Strengthen the quality of the information provided by the consumer information system through consumer survey, The detailed action plan for UFW reduction production is proposed therein.	follow: ● The use of open drainage canals for sewage collection and discharge leads to serious sanitation and environmental issues within the city. ● The discharge capacity of the existing sewers is insufficient due to lack of gradient, high level of sedimentation and under-sizing of the pipes. ● Heavy sedimentation and disposal of solid waste into the sewers causes high level of blockages (2500 blockages/100 km of sewer/year) and water logging. ● The pumping facilities are insufficient especially during the monsoon season and in poor conditions due to lack of maintenance. ● The sewage from Lahore is discharged directly into the Ravi River without treatment; this is a very serious environmental issue. In view of these challenges and in order to improve the existing situation, it is recommended to: ● Separate sewage from drainage by decommissioning 30 lifting stations and upgrading 16 out of 46 permanent stations. ● Rehabilitate and/or reinforce approximately 39 km of trunk sewers (out of 570 km) ● Carry out intensive de-silting and cleaning of sewers which are currently operating at 1/3 of capacity through improved operational and maintenance practices and use of effective equipment and by extending the lessons learned from the Project for the retrieval of sewage and drainage system in Lahore. Consider the	

Appendix 7.1 Outline of Existing Studies and Development Plans

WATER SUPPLY	SEWERAGE	DRAINAGE
	outsourcing of sewer cleaning. ● Work with solid waste authorities to reduce the amount of solid waste entering the sewerage system ● Upgrade and rehabilitate the main pumping stations with pump replacement and installation of mechanical screening. ● Treat the sewage at three locations (North, Southwest and South) to avoid the pumping of the intercepted effluent over a long distance, consider activated sludge technologies and water reuse. The total capital investment plan required to rehabilitate and upgrade the existing sewerage system amounts to Rs. 2,944 M (37 M Euros) over 10 years excluding the cost of construction of the waste water treatment plants.	
	(13) Laying of Trunk Sewer along Cantonment Drain Lahore National Engineering Services Pakistan (Pvt.) Limited (NESPAK), June 2008 Cantonment Drain is a natural storm water drain. It starts from Jorey Pul and ends at Babu Sabu pumping station covering a distance of 65,620 ft (20 km). Due to the inadequacy of the trunk sewers in the Project Area, Cantonment Drains is being used as sullage carrier. Currently, the sewage from Cantonment and WASA service area is being disposed off into Cantonment Drain without any treatment through eighteen (18) different disposal points. Out of eighteen (18) disposal	

Appendix 7.1 Outline of Existing Studies and Development Plans

WATER SUPPLY	SEWERAGE	DRAINAGE
	stations six (6) are being operated by Cantonments Boards whereas the remaining twelve (12) fall under the jurisdiction of WASA. The respective disposal capacities of Cantonment and WASA disposal stations are 72 and 897 cusecs. ● Trunk sewerage system has been proposed to improve existing environmental conditions of Cantonment Drain by separating sewage and storm water flows. In this system, Sewage of project area is proposed to be finally disposed off into Gulshan-e-Ravi Disposal Station except the Jorey Pull area which will be connected to Cantt Board trunk sewer along Charar Drain. ● Proposed trunk sewerage system has been designed in such a way that all the existing disposal stations along Cantonment Drain will be eliminated except Gulshan-e-Ravi and Kharak. disposal stations. Sewage flow of Gulshan-e-Ravi Disposal Station will be catered by the Collector Channel proposed by WASA from Chotta Ravi Drain to proposed Southwest Sewage Treatment Plant. While it has planned by WASA that the sewage flows from Kharak Disposal Station will directly be disposed off into the said Treatment Plant through an open channel. ● A new disposal facility has been proposed in the premises of Gulshan-e-Ravi Disposal Station to accommodate the design flow of proposed trunk sewer along Cantonment Drain. The installed capacity (480 cusecs) of Gulshan-e-Ravi Disposal Station is hardly sufficient for existing sewage flows as it has a tendency to overflow during	

Appendix 7.1 Outline of Existing Studies and Development Plans

WATER SUPPLY	SEWERAGE	DRAINAGE
	heavy rains. ● The estimated cost of proposed trunk sewers is Rs. 1,377 million.	

Appendix 9.1 Population Projection

Population projection is based on the following assumptions.

- Future population projected by Integrated Master Plan in Ex-MCL area is nearly equal to current population in WASA area including south area.
- Population projection in Integrated Master Plan is extended to 2035. This projected population is assumed to future Population in WASA area at 2035.
- Future population in WASA area at 2035 is distributed to each area on the following assumptions.

Water service area

- Current served population is 5,670,911 (information provided by WASA).
- Distribution to each area is based on the distribution ratio in 2009.

Town	Distribution Ratio (2009)
SHALIMAR	20.1 %
AZIZ BHATTI	4.7 %
NISHTAR	11.3 %
ALLAMA IQBAL	22.9 %
RAVI	22.7 %
DATA GUNJ BUKSH	18.3 %
Total	100 %

Sewerage service area

- Current served population is 6,103,852 (information provided by WASA).
- Distribution to each area is based on the distribution ratio in 2009.

Treatment Area		Distribution Ratio (2009)
Shahdara		8.7 %
Khokhar		18.3 %
Mehmood Booti		17.6 %
South West		48.0 %
South East		4.0 %
South	LMP Block	3.4 %
	Future Areas	-
Total		100 %

- Population of future area in South treatment area in where population is increasing rapidly is assumed based on the information in the Integrated Master Plan. (20,000 + 85,000) households × 7.2 person/households = 2,055,600 Persons

(1) Current WASA area total

Calculation 0f Minimum Square Metod

	Year x	Population y	x^2	xy	ln(y) Y	Remarks
1	1,998	4,385,960	3,992,004	8,763,148,080	15.29392	
2	2,001	4,831,654	4,004,001	9,668,139,654	15.39070	
3	2,006	5,557,841	4,024,036	11,149,029,046	15.53072	
4	2,011	6,337,420	4,044,121	12,744,551,620	15.66198	
5	2,016	7,163,218	4,064,256	14,441,047,488	15.78447	
6	2,021	8,025,762	4,084,441	16,220,065,002	15.89817	
Total	12,053 Σx	36,301,855 Σy	24,212,859 Σx^2	72,985,980,890 Σxy	93.55996 ΣY	

n= 6

Linear

$Y=aX+b$

$a=(n\Sigma xy-\Sigma x\Sigma y)/(n\Sigma x^2-\Sigma x\Sigma x)$
= 157623.5

$b=(\Sigma x^2\Sigma y-\Sigma x\Sigma xy)/(n\Sigma x^2-\Sigma x\Sigma x)$
= -3.11E+08

Exponential

$Y=ab^X$

The following equation is obtained by logalithm of both side of the equation
$\ln(y)=x\cdot\ln(b)+\ln(a)$ where $Y=\ln(y)$
$Y=x\cdot\ln(b)+\ln(a)$

The coefficient and intercept are obtained since it is a linear equation.

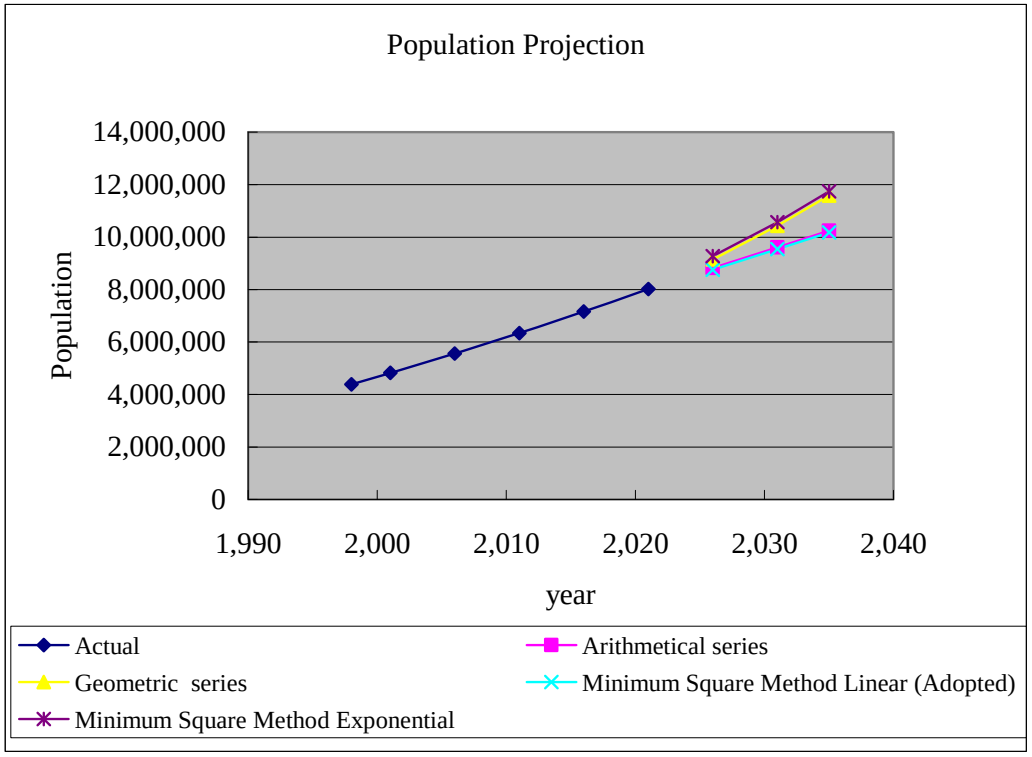
x coefficient

$\ln(b)=(n\Sigma xY-\Sigma x\Sigma Y)/(n\Sigma x^2-\Sigma x\Sigma x)$
= 0.026189
b= 1.026535

y intercept

$\ln(a)=(\Sigma x^2\Sigma Y-\Sigma x\Sigma xY)/(n\Sigma x^2-\Sigma x\Sigma x)$
= -37.01697
a= 8.39E-17

Year	Actual	Arithmetical series	Geometric series	Minimum Square Method	
				Linear (Adopted)	Exponential
1,998	4,385,960				
2,001	4,831,654				
2,006	5,557,841				
2,011	6,337,420				
2,016	7,163,218				
2,021	8,025,762				
2,026		8,817,024	9,151,506	8,756,179	9,275,735
2,031		9,608,285	10,435,154	9,544,296	10,573,482
2,035		10,241,294	11,590,547	10,174,790	11,741,236
x	y	y=ax+b	$y=ab^{(X-1998)}$	y=ax+b	$y=ab^{X}$
a		158252.3	8,025,762	157623.4648	8.3895E-17
b		-311802136.3	1.0266	-310588961.1	1.026535434



Note:
In the "Integrated Master Plan for Lahore-2021", it is mentioned that population density in the Ex-MCL area has run up to saturation state. Therefore, 70 % of increase population up to 2021 in the Ex-MCL area is based on the development of large scale residential estate.
To avoid the excessive population projection, the smallest projectition which is estimated by minimum square method linear is adopted for future population projection.

(2) Population by water supply service area

	2009	2010	2011	2016	2021	2026	2031	2035
SHALIMAR	1,139,679	1,154,178	1,183,290	1,337,479	1,498,528	1,634,908	1,782,061	1,899,784
AZIZ BHATTI	266,159	269,545	276,344	312,353	349,964	381,814	416,180	443,673
NISHTAR	641,008	649,163	665,537	752,260	842,842	919,548	1,002,313	1,068,526
ALLAMA IQBAL	1,298,920	1,315,445	1,348,624	1,524,357	1,707,909	1,863,344	2,031,058	2,165,229
RAVI	1,289,374	1,305,777	1,338,713	1,513,154	1,695,357	1,849,650	2,016,131	2,149,316
DATA GUNJ BUKSH	1,035,770	1,048,947	1,075,405	1,215,536	1,361,902	1,485,847	1,619,584	1,726,573
Total	5,670,911	5,743,055	5,887,912	6,655,137	7,456,502	8,135,111	8,867,327	9,453,101

Note: Water supply service area doesn't include the cantonment area, private housing schemes, Model Town and other localities

(3) Population by sewerage service area

		2009	2010	2011	2016	2021	2026	2031	2035
Shahdara		468,052	470,397	479,566	529,442	582,523	624,082	670,672	707,945
Khokhar		984,932	989,867	1,009,162	1,114,117	1,225,815	1,313,269	1,411,311	1,489,744
Mehmood Booti		942,386	947,108	965,569	1,065,991	1,172,863	1,256,540	1,350,346	1,425,392
South West		2,574,676	2,587,576	2,638,014	2,912,374	3,204,359	3,432,971	3,689,257	3,894,287
South East		217,042	218,129	222,381	245,510	270,124	289,395	311,000	328,284
South	LMP Block	180,848	181,754	185,297	204,568	225,078	241,136	259,137	273,539
	Future Areas	735,916	786,673	837,430	1,091,216	1,345,001	1,598,786	1,852,572	2,055,600
Total		6,103,852	6,181,504	6,337,420	7,163,218	8,025,762	8,756,179	9,544,296	10,174,790

Note: Sewerage service area include private housing schemes, Model Town and other localities.
This table doesn't include the cantonment area

Appendix 9.2 Water Demand

Three scenarios of future water demand have studied.

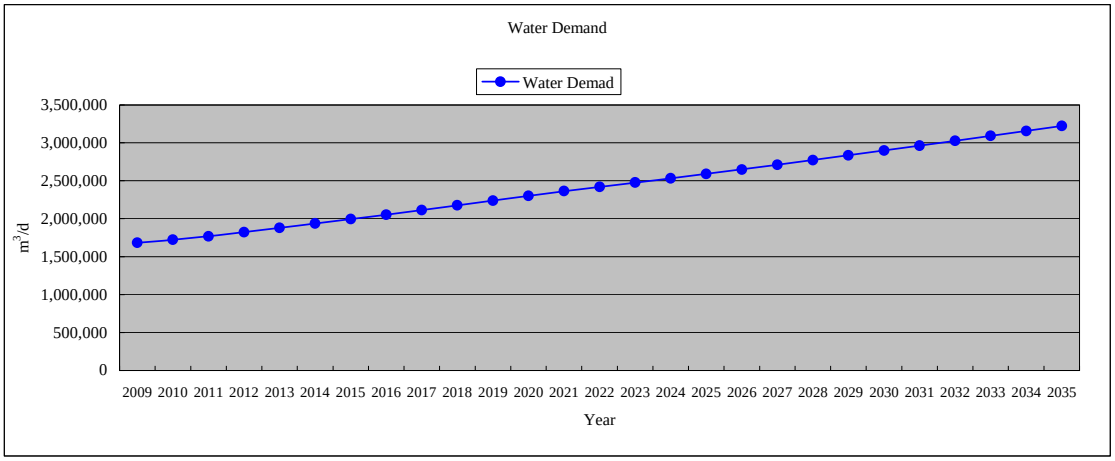
Scenario 1 : 75 gpcd (Keep the Water Production per Capita)

Scenario 2 : 62 gpcd (Keep the Water Consumption per Capita)

Scenario 3 : 45 gpcd (Keep the Total Water Production)

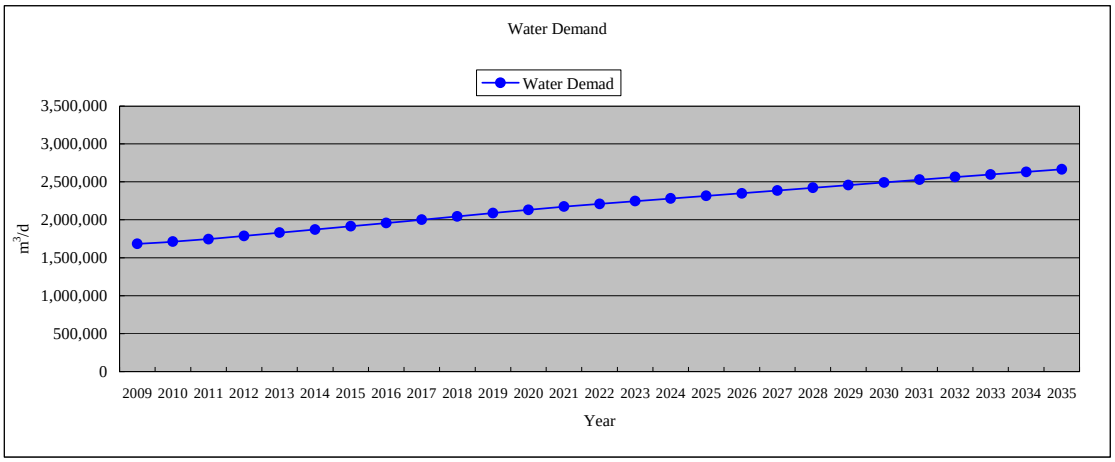
(1) Scenario 1: Water Production per Capita 75 gpcd

			2009	2011	2016	2021	2026	2031	2035
Water Demand									
Population	Current Wasa Area	Person	5,670,911	5,887,912	6,655,137	7,456,502	8,135,111	8,867,327	9,453,101
	Cantonment Area	Person	0	0	0	0	0	0	0
Service Ratio		%	87.0	88.0	90.5	93.0	95.5	98.0	100.0
Served Population		Person	4,933,693	5,181,363	6,022,899	6,934,546	7,769,031	8,689,981	9,453,101
Water Demand per Capita		gpcd	75	75	75	75	75	75	75
Water Demand		(m^3/d)	1,682,179	1,766,624	2,053,553	2,364,386	2,648,909	2,962,914	3,223,106
Unacconted for Water		%	34.0	33.0	30.5	28.0	25.5	23.0	20.0
Water Consumption		(m^3/d)	1,110,238	1,183,638	1,427,219	1,702,358	1,973,437	2,281,444	2,578,485
Water Consumption per Capita		lpcd	225	228	237	245	254	263	273



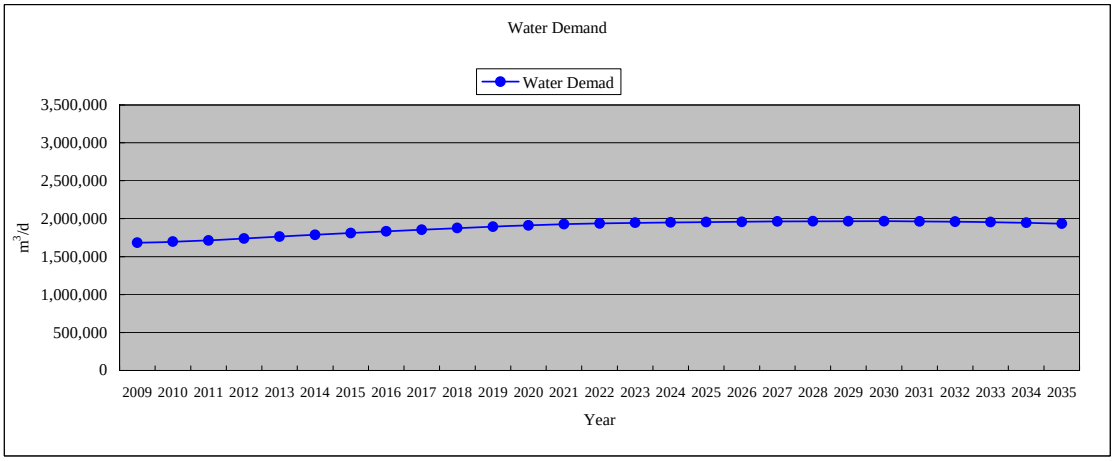
(2) Scenario 2: Water Production per Capita 62 gpcd

			2009	2011	2016	2021	2026	2031	2035
Water Demand									
Population	Current Wasa Area	Person	5,670,911	5,887,912	6,655,137	7,456,502	8,135,111	8,867,327	9,453,101
	Cantonment Area	Person	0	0	0	0	0	0	0
Service Ratio		%	87.0	88.0	90.5	93.0	95.5	98.0	100.0
Served Population		Person	4,933,693	5,181,363	6,022,899	6,934,546	7,769,031	8,689,981	9,453,101
Water Demand per Capita		gpcd	75	74	72	69	67	64	62
Water Demand		(m^3/d)	1,682,179	1,743,069	1,957,720	2,175,235	2,348,700	2,528,353	2,664,434
Unacconted for Water		%	34.0	33.0	30.5	28.0	25.5	23.0	20.0
Water Consumption		(m^3/d)	1,110,238	1,167,857	1,360,616	1,566,169	1,749,781	1,946,832	2,131,547
Water Consumption per Capita		lpcd	225	225	226	226	225	224	225



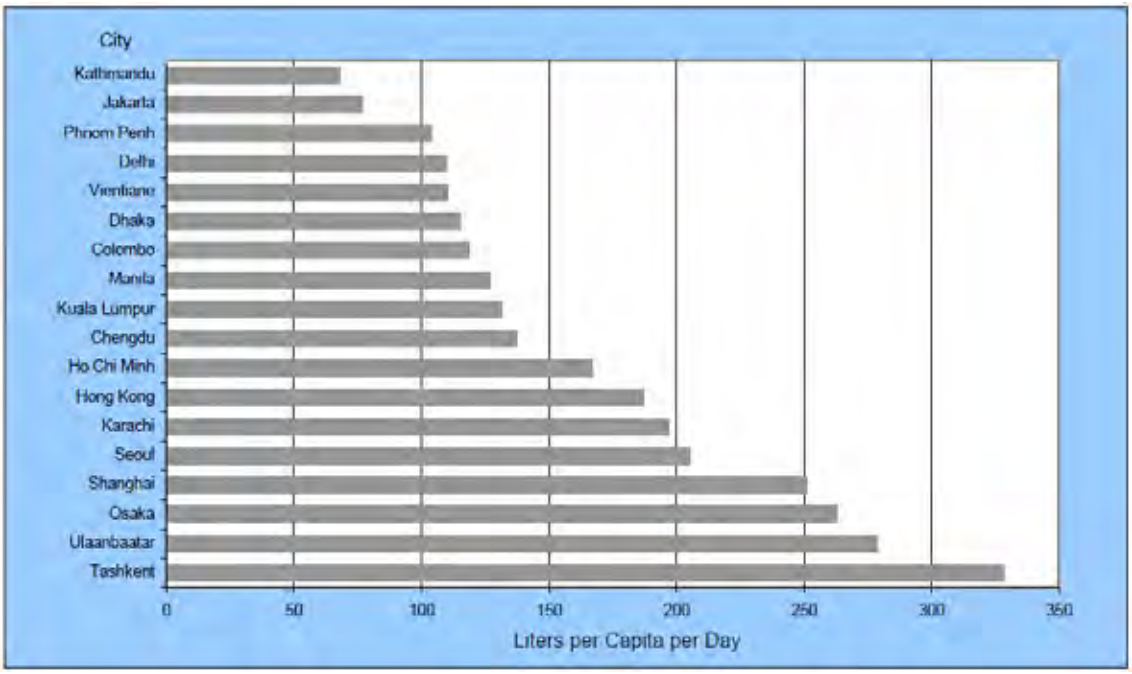
(3) Scenario 3: Water Production per Capita 45 gpcd

			2009	2011	2016	2021	2026	2031	2035
Water Demand									
Population	Current Wasa Area	Person	5,670,911	5,887,912	6,655,137	7,456,502	8,135,111	8,867,327	9,453,101
	Cantonment Area	Person	0	0	0	0	0	0	0
Service Ratio		%	87.0	88.0	90.5	93.0	95.5	98.0	100.0
Served Population		Person	4,933,693	5,181,363	6,022,899	6,934,546	7,769,031	8,689,981	9,453,101
Water Demand per Capita		gpcd	75	73	67	61	55	50	45
Water Demand		(m^3/d)	1,682,179	1,712,448	1,833,138	1,929,339	1,958,427	1,963,424	1,933,863
Unacconted for Water		%	34.0	33.0	30.5	28.0	25.5	23.0	20.0
Water Consumption		(m^3/d)	1,110,238	1,147,340	1,274,031	1,389,124	1,459,028	1,511,837	1,547,091
Water Consumption per Capita		lpcd	225	221	212	200	188	174	164



Appendix 9.3 Water use per capita in other countries

Water consumption in other countries is shown in following drawing provided by ADB. Comparing these data, current water consumption in Lahore of 225 liter per capita per day is considerably high.



Appendix 9.4 Existing wastewater discharge volume in WASA area

Pumping Station	Discharge Volume (m^3/d)	Population (Person)	Discharge Volume per Capita (lpcd)	Remarks
FARARKHABAD	100,119	468,052	214	
MEHMOOD BOOTI	68,001	942,386	72	
Chota Ravi	64,000			Drainage PS
SHAD BAGH	326,660	484,888	674	
KHOKHAR ROAD	180,306	500,044	361	
BHATTI GATE	19,553	114,800	170	
MAIN OUTFALL-I	111,194	1,259,776	184	
MAIN OUTFALL-II	89,510			
MAIN OUTFALL-III	30,672			
GULSHAN-E-RAVI	235,537	891,803	264	
MULTAN ROAD	180,823	308,297	587	
Bab Sab	394,000			Drainage PS
LMP BLOCK	66,874	180,848	370	
NISHTAR COLONY	77,123	217,042	355	
		250,000		from Cantonment
Total × 0.9 (evaluate by Study Team)	1,749,935	5,617,936		
Industrial discharge	450,000			
Total excl.Industrial discharge	1,299,935	5,617,936		
	Discharge Volume per Capita(2009)		231	
Water Use Consumption per Capita(2009)			225	
Conversion Rate from Water Use to Sewage			**102.7%**	

Source: Information hearing from stuff pumping station stuff and surveyed by JICA Study Team

Appendix 10.1 Abstract of Water Services Industry Act (Malaysia)

1. Short title, application and commencement

(1) This Act may be cited as the Lahore Water And Sanitation Agency Act 2010 (Lahore WASA Act 2010).

(2) This Act applies to the service area of the Lahore WASA.

(3) This Act comes into operation on a date to be appointed by the Secretary of HUD&PHED by notification in the *Gazette,*

2. Interpretation

33. Dealing with consumers

The WASA providing water supply services or sewerage services has a general duty to-

(a) deal reasonably with consumers; and

(b) adequately address consumer complaints.

34. Security, integrity and safety of water supply system and sewerage system

It shall be the duty of every licensee to maintain at all times the security, integrity and safety of its water supply system and sewerage system and all other assets in relation to the systems.

36. Developing and maintaining water supply system

(1) It shall be the duty of every the WASA supply services to maintain an efficient and economical water supply system.

(2) The WASA shall ensure that all arrangements have been made-

(a) for providing water supply to premises within its water supply distribution area and for making such supply available to persons who demand them; and

(b) for maintaining, improving and extending the water supply system in relation to the distribution of water,

such that the water distribution licensee is and continues to be able to meet its obligations under this Act.

(3) The duty of the WASA to maintain a public water supply system shall be up to the end of the communication pipe.

(4) The cost of repairing, replacing and maintaining the communication pipe shall be borne by the water distribution licensee.

37. Supply of water

(1) Subject to subsection (2), the WASA shall, on application in writing by the owner or occupier of any premises, supply water to the premises.

(2) No WASA shall be required to supply water to any premises if-

(a) any building on the premises has been erected in contravention of any written law or is in a ruinous or dangerous condition;

(b) the supply of water is already given to the premises by another organizations;

(c) the WASA is prevented from doing so by circumstances beyond the WASA' control;

(d) the supplying of the water will cause the WASA to be in breach of this Act or its subsidiary legislation;

(e) the supply of water had been previously disconnected as a result of a breach of this Act or its subsidiary legislation and the breach has not been remedied;

(I) the previous supply of water has been disconnected in accordance with this Act or its subsidiary legislation; or

(g) the refusal to supply water is approved by the Commission.

38. Connecting public mains and premises to be supplied with water

(1) When an application for the supply of water has been approved by the WASA, the WASA shall install the necessary communication pipe to connect the public mains and the premises to be supplied with water, and the WASA may also supply and adjust all water fittings but the cost of such connection and of all the water fittings for such supply shall be borne by the owner or occupier of the premises.

(2) No connection shall be made to the public mains until the estimated cost of making the connection has been deposited with the water distribution licensee and until all the water fittings requisite for the supply of water have been previously erected and completed in accordance with any requirement of any subsidiary legislation made under this Act in respect of the same.

39. Supply of water through public pipes

(1) The WASA shall, on the request of the Commission after consultation with the relevant local authority, supply water to a designated area for use by members of the public through public pipes installed within such designated area.

(2) Such supply shall be subject to such terms and conditions as the WASA and the Commission WASA, in consultation with the local authority, may mutually agree provided that the charges for the supply of such water shall be approved by the Commission.

40.Maintaining water pressure

(1) It shall be the duty of a water distribution licensee to cause the water in its water mains and other pipes-

(a) used for the supply of water; or

(b) having a fire-hydrant fixed on them, to be maintained at such pressure as may be set out in the subsidiary legislation made under this Act.

(2) The WASA who contravenes subsection (1) commits an offence and shall, on conviction, be liable to a fine not exceeding one hundred thousand ringgit.

41. Water quality

(1) The WASA shall, when supplying water to any premises, ensure that at the time of supply the quality of water supplied complies with the minimum quality standards as prescribed by the Secretary.

(2) The WASA shall ensure, as far as it is reasonably practicable, in relation to each source 01' combination of sources from which the WASA supplies water to any premises, that there is no deterioration in the minimum quality standards of the water which is supplied from time to time from that source or combination of sources.

(3) For the purposes of this section, water supplied by the WASA to any premises shall not be regarded as not complying with the prescribed minimum quality standards at the time of supply where the water has ceased to comply with the minimum quality standards only after leaving the WASA's pipes.

(4) The WASA who contravenes subsection (1) or (2) commits an offence and shall, on conviction, be liable to a fine not exceeding three hundred thousand ringgit or to imprisonment for a term not exceeding three years or to both.

42. Supply of water for fire-fighting

(1) The WASA shall allow the Fire Services Department or any other person authorized by the Commission or under any written law to take water for extinguishing fires from any of its water mains or other pipes on which a fire

hydrant is fixed. (2) The cost for utilizing the water from the fire hydrant shall be borne by the WASA. (3) The WASA who contravenes subsection (1) commits an offence and shall, on conviction, be liable to a fine not exceeding two hundred thousand ringgit. (4) In this section, "Fire Services Department" shall have the same meaning as in the Fire Services Act 1988 *[Act 341]*.
43.Operating and maintaining public sewerage system It shall be the duty of the WASA operating and maintaining a public sewerage system- *(a)* to manage, operate, maintain, inspect, repair, alter, arch over or otherwise improve the public sewerage system and to treat and dispose of the contents thereof; and *(b)* to properly desludge the public sewerage system and for such purposes the WASA may cause the construction or placing, either above or under ground, such sewers, pumps and other works as are necessary.
52. Supply agreement with consumers (1) A person who is supplied water by, or who has requested for a supply of water from, the WASA shall, if required by the WASA, enter into an agreement with the WASA for the supply of water on such terms and conditions as may be specified in the agreement before water is supplied. (2) An agreement referred to in subsection (1) shall be in the form and substance which is in compliance with any rules made by the Commission under section 180.
54. Reduction or cessation of supply (1) the WASA may, with the approval of the Commission- *(a)* reduce the quantity 01' pressure of water supplied to any consumer if by reason of any circumstances beyond its control there is insufficient water to enable the full quantity to be supplied; or *(b)* temporarily cease the supply of water. (2) the WASA shall not be liable for any damage to any person or property or for any reduction or cessation of the supply of water which- *(a)* is approved by the Commission; *(b)* is due to circumstances or accident which is not a result of its own doing or conduct; or *(e)* is due to the unauthorized connection of equipment or water fittings. (3) Unless otherwise exempted or permitted under this Act or its subsidiary legislation, the WASA shall take all necessary steps as may be required, including the supply of water by water tankers, to ensure that a consumer within its water supply distribution area is supplied with water.
55. Restriction of water supply (1) If it appears to the Commission that there is reasonable cause to believe that any premises have been used or are about to be used for the commission of an offence under this Act or its subsidiary legislation or under any other written law or on such other grounds as the Commission may deem fit, the Commission may direct the WASA to disconnect the supply of water to the said premises. (2) the WASA may, in accordance with requirements and procedures set out in the rules made by the Commission under section 180-

(a) temporarily cease the supply of water to any premises; or

(b) reduce or divert wholly or in part any of its pipe or any part of its pipe, for the purpose of carrying out essential maintenance of and repairs or alteration to any water supply system or part of the system.

(3) Notwithstanding subsection (2), where in the opinion of the WASA, the supply of water is unsafe for the purposes of normal supply to the public or poses a health risk to the public, the WASA shall immediately undertake the measures under subsection (2) and shall notify the Commission as soon as practicable of the measures taken.

(4) If the WASA knows or has reason to believe that the supply of water is unsafe for the purposes of normal supply to the public or poses a health risk to the public and fails to-

(a) temporarily cease the supply of water to any premises; or

(b) reduce or divert wholly or in part any of its pipe or any part of its pipe, the water distribution licensee commits an offence and shall, on conviction, be liable to a fine not exceeding five hundred thousand ringgit or to imprisonment for a term not exceeding five years or to both.

Chapter 3 ***Sewerage system and services***

57. Power to require premises to be connected to public sewerage system

(1) The Commission may direct the owner or management corporation, or if the owner or management corporation cannot with reasonable diligence be traced, the occupier of any premises not connected to a public sewerage system, to construct or install for the premises, within the period specified in the direction, a private connection pipe of such material or size and at such level as to enable the premises to be properly and effectively connected to any public sewer or public sewerage system located within thirty meters from the boundary of the premises.

(2) If the owner, management corporation or occupier to whom a direction under subsection (1) has been issued fails to comply with the direction within the period specified in the direction, the Commission or any person authorized by the Commission may construct or install the private connection pipe or cause the pipe to be constructed or installed and recover the expenses incurred in the construction and installation of such pipes from the owner, management corporation or occupier.

58. Power to require developer to connect development to public sewerage system

(1) The Commission may direct the developer of any development not connected to a public sewerage system, to construct or install for the development, within the period specified in the direction, a connection pipe of such material or size and at such level as to enable the development to be properly and effectively connected to any public sewer or public sewerage system.

(2) If the developer to whom a direction under subsection (1) has been issued fails to comply with the direction within the period specified in the direction, the Commission or any person authorized by the Commission may construct or install the connection pipe or cause the pipe to be constructed or installed and recover the expenses incurred in the construction and installation of such pipes from the developer.

59. Requirement that proper drainage for sewage be made

(1) If any premises is at any time not properly drained for sewage in accordance with this Act or its subsidiary legislation or otherwise to the satisfaction of the Commission by a sufficient private connection pipe communicating with a public sewer or public sewerage system, the Commission may give notice in writing requiring the owner or management corporation of the premises or, if the owner or management corporation

cannot with reasonable diligence be traced, the occupier thereof to construct or install from such premises a pipe of such material or size and at such level and with such gradient as the Commission deems necessary for the draining of sewage from the premises or to construct such other system as the Commission deems necessary.

(2) If the owner, management corporation or occupier to whom a notice under subsection (1) has been issued fails to comply with the notice within the period specified in the notice, the Commission or any person authorized by the Commission may construct or install the pipe or such other system as the Commission deems necessary or cause the pipe or system to be constructed or installed and recover the expenses incurred in the construction and installation of the pipe or system from the owner, management corporation or occupier.

(3) A person who fails to comply with the notice given under subsection (1) commits an offence and shall, on conviction, be liable to a fine not exceeding fifty thousand ringgit or to imprisonment for a term not exceeding six months or to both.

60. Unauthorized connection to public sewer, *etc.*

(1) No person shall, without the prior written permission of the Commission-

(a) make or cause or permit any private connection pipe, drain or sewer to connect directly or indirectly to any public sewer or public sewage treatment works; or

(b) close up, obstruct, stop or deviate any public sewer.

(2) The Commission may-

(a) order any person contravening subsection (1) to discontinue the use of, or demolish or otherwise remove, any obstruction, private connection pipe, drain or sewer in contravention of that subsection; or

(b) demolish or otherwise remove the obstruction, private connection pipe, drain or sewer and recover the expenses incurred in doing so from the person.

(3) The Commission may refuse to permit any person to make a connection to any public sewer or public sewage treatment works if-

(a) the public sewer or public sewage treatment works do not or will not have the necessary capability or capacity to receive the sewage which will be discharged through the proposed connection; or

(b) it appears to the Commission that the mode of construction or the condition of the public sewer or public sewage treatment works is such that the making of the connection is likely to be prejudicial to the public sewerage system.

(4) A person who contravenes subsection (1) or fails to comply with an order issued under subsection (2) commits an offence and shall, on conviction, be liable to a fine not exceeding fifty thousand ringgit or to imprisonment for a term not exceeding six months or to both.

61. Prohibited effluent or noxious matter not to be discharged into public sewer, *etc*.

(1) No person shall discharge into or allow to be discharged into any public sewer or public sewage treatment works-

(a) any prohibited effluent, without the approval of the Commission;

(b) any noxious, volatile or inflammable substance or any other matter likely to damage or impair the functioning of any public sewer or public sewage treatment works or to interfere with the free flow of its contents or to affect prejudicially the treatment or disposal of its contents; or

(*c)* any effluent, matter or substance from a garbage grinder or such other device determined by the Commission, without the approval of the Commission.

(2) A person who contravenes subsection (1) commits an offence and shall, on conviction, be liable to a fine not exceeding one hundred thousand ringgit or to imprisonment for a term not exceeding one year or to both.

RATES, CHARGES AND DEPOSITS

84. Regulations regarding rates, charges and deposits

(1) The Minister may, on the recommendation of the Commission, make regulations to prescribe the level of rates to be charged for the water supply services and sewerage services.

(2) Without prejudice to the generality of subsection (1), regulations may be made-

(a) to prescribe the rates for water supply services and sewerage services including bulk water supply;

(b) to prescribe the different levels of rates for water supply services and sewerage services based on category of users, consumption, type of use and geographical location or in such other manner as the Commission deems appropriate;

(c) to prescribe the connection, reconnection or any other charges, and deposits, relating to the water supply services and sewerage services;

(d) to provide for the publication or disclosure of rates for water supply services and sewerage services; or

(e) to prescribe the billing and charging rates through meters and sub-meters for buildings.

85. Power to exempt from rates, charges or deposits

The Minister may exempt any person or organization from the payment of any rates, charges or deposits in relation to water supply services or sewerage services on such terms and conditions as he thinks fit.

86. Prescribed rates and charges may be collected and retained by licensee

(1) The WASA may demand, collect and retain all prescribed rates and charges in respect of the supply of water or provision of sewerage services to any consumer premises.

(2) The WASA shall be permitted to demand, collect and retain all prescribed rates and charges for and on behalf of a service licensee providing sewerage services, if so authorized by the service licensee providing sewerage services.

(3) The WASA who demand, collect and retain all prescribed rates and charges for and on behalf of a service licensee providing sewerage services under subsection (2) shall be entitled to exercise all rights and remedies under sections 88 and 89 with respect to the non-payment of sewerage services.

(4) A copy of the authorization provided by the service licensee providing sewerage services shall be provided by the water distribution licensee to the applicable customer of the WASA providing sewerage services prior to demanding, collecting and retaining all applicable rates and charges.

87. Powel' to require deposit

(1) the WASA may, subject to any subsidiary legislation made under this Act, require any person requesting any supply of water or sewerage services to deposit with the licensee such amount of money as may be prescribed before water or sewerage services can be supplied to any premises.

(2) The deposit, when made, shall bear no interest upon reimbursement and shall not relieve the depositor or consumer from the liability to settle any bill for the supply of water or sewerage services provided to him by the WASA.

(3) Where a supply of water is disconnected by the WASA due to the failure of the depositor or consumer to settle any bill under section 89, the amount stated in the bill from the date of such billing to the date when the supply of

water is disconnected may be deducted from the deposit.

88. Recovery of money due

(1) Any sum of money in respect of-

(a) water supplied or services rendered in connection with such supply; or

(b) the provision of sewerage services, shall be payable, within thirty days from the date of presentation of the bill, to the WASA and if such sum is not so paid, the sum shall be recoverable by the WASA through civil action in court.

(2) A written statement by an employee of the WASA duly certified by the WASA or any person authorized by the WASA specifying the amount due shall be *prima facie* evidence of the payment that has to be made by the consumer under subsection (1).

(3) The exercise of powers conferred by this section shall be without prejudice to the powers of the WASA under section 89.

89. Disconnection of water supply

(1) Subject to subsection (2), a water distribution licensee may-

(a) disconnect the supply of water to a consumer by severing the service water pipe or cut off the water supply including the right to reduce the supply of water or pressure of the water supply; and

(b) take such other means as it deems fit and proper.

(2) the WASA may exercise its powers under subsection (1) if the owner, management corporation, occupier or consumer-

(a) fails to settle the amount for the

(i) water supplied;

(ii) services rendered in connection with the supply of water;

(iii) sewerage services rendered; or

(iv) deposit required under section 87, within thirty days from the date of presentation of the bill;

(b) who, having a contract with the WASA for the supply of water, allows or causes any such supply of water to be carried or conveyed or used outside such premises for purposes other than the purposes of the contract except for the extinguishment of a fire;

(*c)* misuses or wastes or causes or permits to be misused or wastes any water supplied to his premises;

(d) having agreed to use the water supplied for a particular purpose only, uses or causes or permits the use of water for a different purpose other than the extinguishment of a fire; or

(*e)* has contravened any provisions of this Act or its subsidiary legislation.

(3) Before exercising its powers under subsection (1), the WASA shall give a written notice to the owner, management corporation or occupier of the premises or the consumer to remedy or rectify the default or contravention within fourteen days from the receipt of the notice.

(4) If on the expiry of the period specified in the notice given under subsection (3), the owner, management corporation or occupier of the premises or consumer, as the case may be, fails to remedy or rectify the default or contravention, the WASA may proceed to exercise its powers under subsection (1).

(5) Nothing in this Act shall require the water distribution licensee to exercise its rights and remedy under paragraph *(1)(b)* prior to exercising its rights and remedy under paragraph (1) (*a).*

(6) Where-

(a) a water distribution licensee exercises its power under subsection (1) with respect to any premises; and

(b) a supply of water or sewerage services is provided to the premises and also other premises wholly or partly by the same service water pipes, the WASA may exercise those same powers to the other premises only if the same person is the occupier of the premises and of the other premises.

(7) the WASA shall, within twenty-four hours and in any event not later than two days from the date of the full payment of the sums due under sections 87 and 88, reconnect the supply of water to the premises provided that the owner or occupier grants the water distribution licensee access to its premises to carry out the reconnection works.

(8) Notwithstanding subsection (7), the water distribution licensee shall be entitled to recover from the owner or occupier of the premises the cost of disconnecting the water supply and reconnecting the water supply after disconnection. The WASA shall not be held liable for any damage to any consumer or person or property as a result of such disconnection.

(9) Where the supply of water to any premises has been disconnected by the WASA and it is found that the supply has been reconnected without the permission of the WASA, the occupier of such premises shall be presumed, until the contrary is proved, to have reconnected or authorized the reconnection of the water supply and he commits an offence and shall, on conviction, be liable to a fine not exceeding fifty thousand ringgit or to imprisonment for a term not exceeding six months or to both.

GENERAL OFFENCES AND PENALTIES

121. Offence of contamination of water

(1) A person who contaminates or causes to be contaminated any watercourse or the water supply system or any part of the watercourse or water supply system with any substance-

(a) with the intention to cause death;

(b) with the knowledge that he is likely to cause death; or

(c) which would likely endanger the life of any person, commits an offence.

(2) A person found guilty of an offence under subsection (1), on conviction-

(a) where death is the result of the act, shall be punished with death or imprisonment for a term which may extend to twenty years, and where the punishment is not death, he shall also be liable to whipping;

(b) where death is not the result of the act but the substance which is used to contaminate the watercourse or water supply system or any part of the watercourse or the water supply system is a radioactive or toxic substance, shall be liable to imprisonment for a term not exceeding ten years or to a fine not exceeding five hundred thousand ringgit or to whipping or to all three; or

(c) in any other case, shall be liable to a fine not exceeding one hundred thousand ringgit or to imprisonment for a term not exceeding one year or to both.

(3) It shall not be a defence for the person who is charged with an offence under this section that the licensee who owns the water supply system or who provides the water supply services did not take any action to stop the supply of water as soon as it became aware that the watercourse or the water supply system had been contaminated.

122. Wrongful acts

(1) A person who-

(a) wilfully, negligently or recklessly damages or causes to be damaged any pipe, channel, conduit or structure, sewer, manhole, chamber, fixture, equipment, reservoir, cistern, pump, hydrant, valve, meter, sub-meter or any part of any public water supply system or public sewerage system;

(b) flushes, draws off, diverts or takes water from any public water supply system or part of the system, unless the person is otherwise permitted under this Act or any other written law;

(c) bathes, wastes or throws any rubbish or creature, dead or alive, into any public water supply system or part of the system; or

(d) trespasses on any area of a service reservoir or booster station of a public water supply system or on any area of a sewage pumping station or sewage treatment works of a public sewerage system, commits an offence and shall, on conviction, be liable to a fine not exceeding fifty thousand ringgit or to imprisonment for a term not exceeding six months or to both.

(2) A person who is convicted for an offence under paragraph *(1)(a)* shall be liable to pay compensation for such damage and such compensation shall be recoverable from such person by the licensee in the manner provided under section 88.

123. Unlawful connection of water supply

(1) No person other than a licensee shall make any connection to a public mains or service water pipe.

(2) Where a service water pipe to any premises has been unlawfully connected to a public mains or to another service water pipe serving another premises, it shall be presumed until the contrary is proved that the unlawful connection was made by the owner or the occupier of the first-mentioned premises.

(3) A person who contravenes subsection (1) commits an offence and shall, on conviction, be liable to a fine not exceeding one hundred thousand ringgit or to imprisonment for a term not exceeding one year or to both.

124. Tampering with meter or sub-meter

A person who tampers with a meter or sub-meter or causes the tampering of a meter or sub-meter used for the measurement of water supplied to any premises in such a manner so as to cause the meter 01' sub-meter to show incorrect readings commits an offence and shall, on conviction, be liable to a fine not exceeding fifty thousand ringgit or to imprisonment for a term not exceeding six months or to both.

125. Tampering of water supply system or sewerage system or part of the systems

A person who tampers with any pipe, channel, conduit or structure, sewer, manhole, chamber, fixture and equipment, including any valve, hydrant or any part of a water supply system or sewerage system commits an offence and shall, on conviction, be liable to a fine not exceeding fifty thousand ringgit or to imprisonment for a term not exceeding six months or to both.

126. Taking of water from fire hydrant

(l) No person other than the persons referred to in subsection 42(1) shall take water from a fire hydrant.

(2) A person who contravenes subsection (1) commits an offence and shall, on conviction, be liable to a fine not exceeding fifty thousand ringgit or to imprisonment for a term not exceeding six months or to both.

127. Penalty for obstructing

A person who at any time-

(a) hinders or obstructs the licensee or any person authorized by the Commission under this Act or any of the

licensee's or Commission's officers, employees, agents or contractors in the performance and execution of its duty or of anything which it is respectively empowered or required to do by virtue of or in consequence of this Act; or

(b) removes any mark set up for the purpose of indicating any level or direction necessary to the execution of works authorized by this Act or its subsidiary legislation, commits an offence and shall, on conviction, be liable to a fine not exceeding fifty thousand ringgit or to a term of imprisonment not exceeding six months or to both.

128. Proceedings if occupier opposes the execution of works

(1) If the occupier of any premises prevents the owner or the management corporation of the premises from carrying into effect in respect of the premises any of the provisions of this Act or its subsidiary legislation after notice of the owner's or the management corporation's intention to do so has been given by the owner or the management corporation to that occupier, a Magistrate's Court, upon proof thereof and upon application of the owner or the management corporation, may make an order requiring the occupier to permit the owner or the management corporation to execute all such works with respect to that premises as are. necessary for carrying into effect the provisions of this Act or its subsidiary legislation and may also, if it thinks fit, order the occupier to pay to the owner or the management corporation the costs relating to the application or order.

(2) The occupier of any premises who continues, after the expiration of eight days from the date of an order made under subsection (1), to refuse to permit the owner or the management corporation of the premises to execute the works specified in the order commits an offence and shall, on conviction, be liable to a fine not exceeding ten thousand ringgit, and the owner or the management corporation shall, during the continuance of the occupier's refusal, be discharged from any penalty to which the owner or the management corporation might otherwise be liable by reason of his or its default in executing the works.

129. Unlawful use or supply of non-standard equipment, device, material, system or facilities

(1) A person who uses or supplies any non-standard equipment, device, material, system or facility that he knows or has reason to believe is a non-standard equipment, device, material, system or facility to be used for any purpose of installing, working or operating the equipment, device, material, system or facility commits an offence and shall, on conviction, be liable to a fine not exceeding fifty thousand ringgit or to imprisonment for a term not exceeding six months or to both.

(2) In any proceedings under this Act or its subsidiary legislation, any document purporting to be a certificate given by an authorized officer certifying that any particular equipment, device or material is a non-standard equipment, device or material shall be admissible as *prima facie* evidence of the facts stated in it until the contrary is proved.

130. Offence for giving false or misleading information

A person who discloses or provides information to the Commission or its authorized officers that he knows or has reason to believe is false or misleading commits an offence and shall, on conviction, be liable to a fine not exceeding two hundred thousand ringgit or to imprisonment for a term not exceeding two years or to both.

131. Power to take action

Nothing in this Act shall prevent or shall be held to prevent a licensee from instituting any action or suit against any person for damage caused to any water supply system or sewerage system or any part of the systems, or to prevent any person from being prosecuted for an offence in respect of any water supply system or sewerage system or part of the systems which is under the control or management of the licensee.

Chapter 2 *Powers of entry*

140. Power to enter on and examine land

(1) Whenever it appears to a licensee that it will be necessary for the licensee to exercise the powers conferred upon the licensee by this Act in respect of any land other than State land for the purpose of constructing a water supply system or a sewerage system or part of the systems, the licensee or any person authorized by the licensee may, after giving not less than twenty-four hours notice to the occupiers of the land, if any, enter upon the land, survey and take levels and do any other acts necessary to ascertain the suitability of the land, in so far as the same may be possible without causing damage or disturbance.

(2) Nothing contained in this section shall be deemed to authorize any person to cut down or clear away any vegetation or fence or other erection or to enter into any building or upon any enclosure attached to any building.

(3) In the case of reserved land, the notice under subsection (1) may be given to the person in charge of the reserved land or, in the absence of any such person, to the Land Administrator.

141. Power to enter on land for purposes of construction

(1) Subject to the provisions of this Chapter, whenever it is necessary so to do for the purpose of installing any water supply system or sewerage system or part of the systems under this Act, a licensee may install, place or carry on, under or over any land, other than State land, such pipe, channel, conduit or similar structure, sewer, manhole, chamber, fixture or any other equipment forming part of a water supply system or sewerage system as may be necessary or proper for the purposes of the installation, as the case may be, and may take such other action as may be necessary to render the installation safe and efficient, and shall pay full compensation in accordance with section 146 to all persons interested for any disturbance, damage or disability that may be caused by such works.

(2) Before entering on any land for the purpose specified in subsection (1), the licensee shall give a notice stating as fully and accurately as possible the nature and extent of the acts intended to be done.

(3) The notice shall substantially be in the form to be specified by the Commission and the Land Administrator shall specify a date upon which the State Authority shall inquire into any objection that may have been made as provided in this Chapter.

(4) The notice under subsection (2) shall be given-

(a) in the case of alienated land, to the owner, management corporation or occupier;

(b) in the case of reserved land, to the person in charge of the reserved land or, in the absence of any such person, to the Land Administrator, and may be sent by registered post or be left at the last known address of the person to whom it is to be given or served by the licensee or the Land Administrator at the expense of the licensee, either in the manner provided in this Chapter or in the manner provided for the service of notices under any written law relating to land in force in the State where the land is situated.

(5) Any of the persons mentioned in subsection (4) may, within fourteen days of the receipt of the notice referred to in subsection (2), lodge an objection to the intended acts of the licensee.

(6) The objection shall be made in writing to the Land Administrator and the licensee, and the Land Administrator shall give notice of the objection to the State Authority.

(7) If no objection is lodged within the time specified in subsection (5), the licensee may forthwith enter on the land and do all or any of the acts specified in the notice given under subsection (2).

(8) If an objection is lodged and is not withdrawn before the date fixed for the hearing of the objection, the Land

Administrator shall hold an enquiry, giving all parties an opportunity to be heard.

(9) Upon the conclusion of the enquiry the Land Administrator may, either unconditionally or subject to such terms, conditions and stipulations as he thinks fit, make an order authorizing or prohibiting any of the acts mentioned in the notice given under subsection (2).

142. Appeal against order of Land Administrator

(I) Any party who is dissatisfied with the order of the Land Administrator under subsection 141(9) may within twenty-one days after the order appeal against such order to the State Authority which may then uphold, set aside or vary the order upon such terms, conditions and stipulations as it thinks fit.

(2) The State Authority may, if it thinks fit, in lieu of making an order under subsection (1), direct the acquisition of any land or part of any land included in a notice given under subsection 141(2) in accordance with the Land Acquisition Act *1960 [Act* 486].

(3) The licensee shall pay the compensation for any acquisition of land made by the State Authority under subsection (2).

(4) The decision of the State Authority under this section shall be final.

(5) Notwithstanding any written law relating to land matters, the Registrar-

(a) upon the production to him of the notice issued by the licensee under subsection 141(2) together with the statement by the Land Administrator that no objection had been lodged by any of the persons mentioned in subsection 141(4); or

(b) upon the production to him of the original order made under subsection 141(9) and upon the deposit with him of a certified true copy of the original order, shall cause to be made on the register document of title relating to the land affected by the notice or order a note of the existence of the rights under such notice or order.

143. Installation of pipe, *etc*., on State land

Subject to the approval of the State Authority and to such conditions as the State Authority may deem proper, a person holding an individual licence may install, place or carry on, under or over State land, to the extent permitted by its individual licence, such

pipe, channel, conduit or similar structure, sewer, manhole, chamber, fixture or any other equipment forming part of a public water supply system or public sewerage system as may be necessary or proper for the purposes of the public water supply system or public

sewerage system.

144. Maintenance, repair and upgrading of installation

Whenever it is necessary so to do for the purpose of maintaining, repairing or upgrading any water supply system, sewerage system or any part of the systems, the licensee or any person authorized by the licensee in that behalf may at all reasonable times enter upon any land on, under or over which pipe, channel, conduit or similar structure, sewer, manhole, chamber, fixture or any other equipment forming part of a water supply system or sewerage system has been installed, and may carry out all necessary repairs, and may, in the course thereof, fell or lop trees, remove vegetation and do all other things necessary to the purpose, causing as little damage as possible and paying full compensation in accordance with section 146 to all persons interested for any damage that may be caused thereby for which compensation has not already been assessed under section 141.

145. Saving of way leave agreement

(l) Nothing in section 141 or 144 shall-

(a) affect the right of a licensee to enter into a way leave agreement with the owner or occupier of any land for the purpose of carrying any pipe, channel, conduit or similar structure, sewer, manhole, chamber, fixture or any other equipment forming part of a water supply system or sewerage system across the land; or

(b) affect any such way leave agreement subsisting at the commencement of this Act.

(2) Notwithstanding any written law relating to land, the Registrar, upon production to him of the original and the deposit with him of a certified copy of any such way leave agreement as is referred to in subsection (1), shall cause to be made on the register document of title relating to the land affected by the way leave agreement a note of the existence of the way leave agreement.

(3) Where a way leave agreement related to land which is a holding included in the Interim Register-

(a) subsection (2) shall apply as if "Commissioner" and "appropriate folio of the Interim Register" were substituted for "Registrar" and "register document of title" respectively; and

(b) when final documents of title are issued for the land under section 39 of the National Land Code (Penang and Malacca Titles) Act 1963 *[Act* 518], any note made pursuant to that subsection as varied by paragraph *(a)* shall (if it is still effective immediately before the issue of those documents) be entered by the Commissioner on the register document of title and shall continue to have effect as if it had been entered under that subsection.

(4) So long as there remains on the register document of title or the appropriate folio of the Interim Register a note made pursuant to subsections (2) and (3), all dealings with the land to which the note relates shall be deemed to be subject to the rights of the licensee under and by virtue of the way leave agreement in respect of which the note has been made.

(5) In this section, the words "Commissioner" and "Interim Register" have the meanings assigned to them respectively by the National Land Code (Penang and Malacca Titles) Act 1963.

146. Compensation

(1) The amount of compensation, if any, payable under section 141 or 144 shall be assessed by the Land Administrator after such enquiry as he thinks sufficient.

(2) A person aggrieved with the Land Administrator's assessment may within twenty-one days after the assessment appeal to the State Authority whose decision shall be final.

Appendix 10.2 Role of Departments/Divisions

(1) Planning & Evaluation Department

1) Corporate Planning Division

May be responsible for:

a) Acquiring and use statistics of all departments.
b) Maintenances of official documents and record.
c) Evaluation of work and achievements of all departments.
d) Public-relations and public hearing.
e) Improvement of the organization/office work of all department.
f) Internal financial audit.

2) Research & Development Division

May be responsible for:

a) Improvement in water-and-sewage technology.
b) Development of new technology, information gathering, and renewal technology.

3) Management Information Center Division

May be responsible for:

a) Management information/statistical information system.
b) Statistical work of system information.
c) Surveillance of an O/M situation.
d) Management of various ledgers.

4) Social Mobilization Relations Division

May be responsible for:-

a) Improvement in serving the citizens.
b) Maintenance of record relating to complaints received and redressed and detail of the work done to redress the complaint.

(2) Engineering Department

1) Procurement & Store Directorate

May be responsible for:-

a) Electronization of construction contract document.
b) Documentation of Construction contract.
c) Examination of bidding qualifications.
d) Preparation of contract specification.
e) Evaluation of bids.

f) Comparison of bids and contractual price.

2) Planning & Design Directorate

May be responsible for:

a) Electronization of the drawing and specification of a water and sewerage facility.
b) Plan/design of a water and sewerage facility.
c) Design of an improvement work.
d) General management of environmental measure during construction work of water supply and sewerage system.

3) Construction Directorate-1 (WASA Works)

May be responsible for:-

a) Electronization of construction logging of projects.
b) Field management and supervision of contracts.
c) Ensure implementation of projects according to design and specification.
d) Expropriation/acquisition of a business lot, a lot advance, lot disposal, and asset-management.
e) Design and enforcement of a public sewerage pipe line and water supply line for maintenance/ repair work.

4) Construction Directorate – 2 (Private Schemes)

May be responsible for:-

a) Electronization of construction logging of projects.
b) Examination of construction application of private enterprises and recognition.
c) Field management and supervision of projects.

5) Hydrology Directorate

May be responsible for:-

a) Monitoring of underground water table and draw down of tubewells
b) Execution/management of construction of tube-wells.
c) Discharge measurement of tube-wells by bulk flow meters and monitoring.

6) Central Store Division

May be responsible for:-

a) Maintenance of ledger to manage stock.
b) Management of purchase orders, receipt of goods according to contracts and

specification.

c) Upkeep and maintenance of equipment and materials in stores.

d) Scrap disposal.

7) UFW control Division

May be responsible for:-

a) Analysis of statistical data and information of UFW.

b) Investigation of water-leakage from a service pipe or a pipe line and assist in repair work.

c) Application and upkeep of tools and instruments of water leakage detection.

(3) Business Department

1) Administration Directorate

May be responsible for:-

a) Statistics of general-affairs management of the organization.

b) Complaint office at Head Office which carries out classification of complaints, given directions, and measure a ledger of complaint received and attended.

c) Management of a WASA's vehicles.

d) Management of a WASA's residences.

e) Employment of the personnel, dismissal, rewards and penalties, etc.

f) Personnel salary, rise in pay, office hours, conditions of employment, and a personnel evaluation.

g) Labor-union affairs / negotiation.

h) Staff training.

i) Health & Safety of the personnel.

j) Adjustment and communication in the WASA office administration.

k) Office work which does not come under the purview/supervision of other directorates of WASA.

2) Finance Directorate

May be responsible for:

a) Preparation and organization of annual budget, and a business plan.

b) Financial planning.

c) Cash planning.

d) Settlement of accounts.

e) Cash receipts and disbursements, and cash storage.

f) Maintenance of authorized financial transaction.

g) Accounts management of fixed assets.

h) Management of an inventory.

i) Subsidy applications.
j) Management of a waterworks / sewer ledger.

3) Revenue Directorate

May be responsible for:

a) Statistics of the water meter reading, billing, and charge recovery.
b) Implementation of procedure/regulation for water supply and sewer connection application.
c) Reading of water meter and billing against the water use.
d) Charge collection of water rates, sewer usage fee, etc.
e) Adopting ways & means for collection of arrears and action against defaulter.
f) Action against unauthorized use of water and sewerage.
g) Replacement of defective water meter.

4) Inquiry counter Division

May be responsible for:-

a) Statistics of water supply.
b) Reply to queries regarding water service installation, sewer work, survey including laying & cost of connection.
c) Consultation of water pipe and drainage pipes.
d) Queries regarding service line and sewer pipes (drawing of pipe line and specification).
e) Amount to be deposit for water supply connection, sewer connection etc.
f) Information regarding authorized plumbers.
g) Information about qualified technicians for sewer connections.
h) Information regarding arrangement of domestic water reservoir.
i) Information about WASA's water supply line, sewerage system and related offices.
j) Information regarding design of lateral sewer construction, and enforcement.

(4) Operation & Maintenance Department

1) Complaint Receptionist Division

May be responsible for:-

a) Information regarding procedure of attending O/M complaints, classification, directions and management of a complaint register.

2) Maintenance Directorate North (Ravi Town, Shalimar Town & Aziz Bhatti Town)

May be responsible for:-

a) Repair & Maintenance work of Tube wells.
b) Repair & Maintenance work of Lift pumping stations.
c) Operation, maintenance & repair work of Drainage pumping stations and Disposal pumping stations.

3) Maintenance Directorate South (Gunj Buksh Town, Iqbal Town & Nishtar Town)

May be responsible for:

a) Repair & Maintenance work of Tube wells.
b) Repair & Maintenance work of Lift pumping stations.
c) Operation, maintenance & repair work of Drainage pumping stations and Disposal pumping stations.

4) Operation Directorate (Ravi Town)

May be responsible for:-

a) Operation of tubewells.
b) Operation of Lift pumping stations.
c) Maintenance and repair of water supply lines, grid system, reservoirs disinfected of lines and reservoirs.
d) Maintenance and repair of sewerage pipe line/sewerage network, desilting of sewer pipe lines, desiliting of collection tanks of disposal station and proper disposal of silt at the dumping site.
e) Repair & Maintenance of all civil structures.
f) Arrangement for providing water to all consumers in sufficient quantity and at adequate pressure.
g) Maintenance of water quality as per EPA/WHO guide lines.
h) Prompt action to provide water connection and sewer connection on application form citizens.
i) Control over UFW (Unaccounted for Water), leakages and illegal connections.
j) Promote revenue collection.
k) Maintain good relation with consumers and citizens.
l) Maintenance of Chlorinators and ensuring chlorination at adequate dosage.
m) Operation of dewatering sets and elimination of pounds created due to rain.
n) General management of countermeasures against calamities.
o) Suspension of water supply and cutbacks in water supply.
p) Emergency water supply.
q) Maintaining and updating of maps of water supply and sewerage network and other installations.

5) Operation Directorate (Shalimar Town)

May be responsible for:

a) Operation of tubewells.
b) Operation of Lift pumping stations.
c) Maintenance and repair of water supply lines, grid system, reservoirs disinfected of lines and reservoirs.
d) Maintenance and repair of sewerage pipe line/sewerage network, desilting of sewer pipe lines, desiliting of collection tanks of disposal station and proper disposal of silt at the dumping site.
e) Repair & Maintenance of all civil structures.
f) Arrangement for providing water to all consumers in sufficient quantity and at adequate pressure.
g) Maintenance of water quality as per EPA/WHO guide lines.
h) Prompt action to provide water connection and sewer connection on application form citizens.
i) Control over UFW (Unaccounted for Water), leakages and illegal connections.
j) Promote revenue collection.
k) Maintain good relation with consumers and citizens.
l) Maintenance of Chlorinators and ensuring chlorination at adequate dosage.
m) Operation of dewatering sets and elimination of pounds created due to rain.
n) General management of countermeasures against calamities.
o) Suspension of water supply and cutbacks in water supply.
p) Emergency water supply.
q) Maintaining and updating of maps of water supply and sewerage network and other installations.

6) Operation Directorate (Gunj Buksh Town)

May be responsible for:-

a) Operation of tubewells.
b) Operation of Lift pumping stations.
c) Maintenance and repair of water supply lines, grid system, reservoirs disinfected of lines and reservoirs.
d) Maintenance and repair of sewerage pipe line/sewerage network, desilting of sewer pipe lines, desiliting of collection tanks of disposal station and proper disposal of silt at the dumping site.
e) Repair & Maintenance of all civil structures.
f) Arrangement for providing water to all consumers in sufficient quantity and at adequate pressure.
g) Maintenance of water quality as per EPA/WHO guide lines.

h) Prompt action to provide water connection and sewer connection on application form citizens.
i) Control over UFW (Unaccounted for Water), leakages and illegal connections.
j) Promote revenue collection.
k) Maintain good relation with consumers and citizens.
l) Maintenance of Chlorinators and ensuring chlorination at adequate dosage.
m) Operation of dewatering sets and elimination of pounds created due to rain.
n) General management of countermeasures against calamities.
o) Suspension of water supply and cutbacks in water supply.
p) Emergency water supply.
q) Maintaining and updating of maps of water supply and sewerage network and other installations.

7) Operation Directorate (Iqbal Town)

May be responsible for:

a) Operation of tubewells.
b) Operation of Lift pumping stations.
c) Maintenance and repair of water supply lines, grid system, reservoirs disinfected of lines and reservoirs.
d) Maintenance and repair of sewerage pipe line/sewerage network, desilting of sewer pipe lines, desiliting of collection tanks of disposal station and proper disposal of silt at the dumping site.
e) Repair & Maintenance of all civil structures.
f) Arrangement for providing water to all consumers in sufficient quantity and at adequate pressure.
g) Maintenance of water quality as per EPA/WHO guide lines.
h) Prompt action to provide water connection and sewer connection on application form citizens.
i) Control over UFW (Unaccounted for Water), leakages and illegal connections.
j) Promote revenue collection.
k) Maintain good relation with consumers and citizens.
l) Maintenance of Chlorinators and ensuring chlorination at adequate dosage.
m) Operation of dewatering sets and elimination of pounds created due to rain.
n) General management of countermeasures against calamities.
o) Suspension of water supply and cutbacks in water supply.
p) Emergency water supply.
q) Maintaining and updating of maps of water supply and sewerage network and other installations.

8) Operation Directorate (Aziz Bhatti Town)

May be responsible for:-

a) Operation of tubewells.
b) Operation of Lift pumping stations.
c) Maintenance and repair of water supply lines, grid system, reservoirs disinfected of lines and reservoirs.
d) Maintenance and repair of sewerage pipe line/sewerage network, desilting of sewer pipe lines, desiliting of collection tanks of disposal station and proper disposal of silt at the dumping site.
e) Repair & Maintenance of all civil structures.
f) Arrangement for providing water to all consumers in sufficient quantity and at adequate pressure.
g) Maintenance of water quality as per EPA/WHO guide lines.
h) Prompt action to provide water connection and sewer connection on application form citizens.
i) Control over UFW (Unaccounted for Water), leakages and illegal connections.
j) Promote revenue collection.
k) Maintain good relation with consumers and citizens.
l) Maintenance of Chlorinators and ensuring chlorination at adequate dosage.
m) Operation of dewatering sets and elimination of pounds created due to rain.
n) General management of countermeasures against calamities.
o) Suspension of water supply and cutbacks in water supply.
p) Emergency water supply.
q) Maintaining and updating of maps of water supply and sewerage network and other installations.

9) Operation Directorate (Nishtar Town)

May be responsible for:

a) Operation of tubewells.
b) Operation of Lift pumping stations.
c) Maintenance and repair of water supply lines, grid system, reservoirs disinfected of lines and reservoirs.
d) Maintenance and repair of sewerage pipe line/sewerage network, desilting of sewer pipe lines, desiliting of collection tanks of disposal station and proper disposal of silt at the dumping site.
e) Repair & Maintenance of all civil structures.
f) Arrangement for providing water to all consumers in sufficient quantity and at adequate pressure.

g) Maintenance of water quality as per EPA/WHO guide lines.
h) Prompt action to provide water connection and sewer connection on application form citizens.
i) Control over UFW (Unaccounted for Water), leakages and illegal connections.
j) Promote revenue collection.
k) Maintain good relation with consumers and citizens.
l) Maintenance of Chlorinators and ensuring chlorination at adequate dosage.
m) Operation of dewatering sets and elimination of pounds created due to rain.
n) General management of countermeasures against calamities.
o) Suspension of water supply and cutbacks in water supply.
p) Emergency water supply.
q) Maintaining and updating of maps of water supply and sewerage network and other installations.

10) Dewatering Division

May be responsible for:-

a) Maintenance and upkeep of all dewatering pumps required to meet rain emergency.
b) Repair of dewatering pumps & engines in workshop.
c) Arrangement of adequate number of dewatering sets to meet requirements of monsoon rains and flooding.

11) Drainage Directorate

May be responsible for:-

a) Preparation of annual program of desiliting of drains.
b) Implementation of desiliting program with machines and manual labor.
c) Removal of encroachments on drains and prevention of encroachments.
d) Proper disposal of silt remove from drains.
e) Repair and maintenance of all desiliting machinery and vehicle.
f) Establishment and Maintenance of a workshop for desiliting machinery.

12) Work-shops Division (Maintenance & Repair）

May be responsible for:-

a) Repair of dewatering sets.
b) Repair of water meters and calibration.
c) Maintenance and repair of O/M vehicles.

13) Water Chemical Laboratory Division

May be responsible for:

a) Monitoring of drinking water quality.
b) Monitoring of chlorination at all tubewells in the water supply system.
c) Monitoring of waste water quality as and when required.
d) urveillance/instruction/water testing on the effluent quality from specific industrial plants and preventing obstacles for treatment.

14) Wastewater Treatment Directorates

May be responsible for:

a) Security of land acquired for wastewater treatments plant.
b) Liaison with design work for future treatments plan.
c) Acutance with operation of maintenance treatments plants Sludge handling after construction of treatment plants.

Appendix 10.3 Ability and Stance on the Working Posture, Ability Requested by Grade and Ratio on Requested Ability by Positions

(1) Ability and stance on the working posture

Classification		Definition
Operation Ability	Knowledge & technology	Ability promptly and exactly with to transact the duties with professional knowledge/technology for the assignment. - Ability of using IT (Information Technology). - Comprehension on law term, etc.
	Information collection & applied ability	Ability to collect data / information, analysis, and utilizing for assignment, etc.
	Problem finding ability	Ability to discover the issue which should be solved, etc.
	Self-supervision ability	Ability to carry through the duties in stable manners by dispassionately corresponding without missing himself even under difficult conditions, etc.
	Comprehension/judgment ability	Ability to correspond appropriately by grasping the circumstances
Implementation Ability on Policy	Planning ability	Ability to build up and perform the preparatory plans for realization by finding out a policy for problem-solving, etc.
	Result management ability	Ability to be applied to procedure to next duties by evaluating the results with goal setting, plan setting and conducting in term of assignment, etc.
Interpersonal Skills	Negotiation /presentation ability and Adjustability	Ability to tell an intention intelligibly, to persuade it and to convince the personnel of it, etc.
Management Ability	Customer's responding ability	Ability to correspond sincerely and to explain to the costumer, etc.
	Management ability	Ability to lead an organization to goal achievement while grasping ability as a subordinate being proper and striving for an upsurge and maintenance of morale, etc.
	Human resource development ability	Ability to improve the personnel's genius suitable for individuality, etc.

(2) Ability requested by Grade

Classification	Definition
Deputy Managing Directors (DMD)	Ability to i) discuss the evaluation and operation on waterworks by conducting the policy judgment based on long-range outlook; and ii) adopt the direction to be proceeded in parallel with the project operation, etc.
Directorate (Det) & Directors (Dir)	Ability to determine the goal/strategy for the section based on comprehensive value judgment and effective performance of the duties to attain the organization goal together with promoting the scheming instruction/education for the section staff and office's vitalization, etc.

Deputy Directors (DD) & Executive Engineers (XEN)	Ability to i) advise and propose the section chief if needed; ii) operate as a manager's vicarious execution; and iii) to coordinate appropriately with other sectors in term of duties together with comprehensive coordination, etc.
Sub Division Officers (SDO)	Ability to: i) be being expert in business in its charge: ii) always has an awareness of the issues, and an operation carried out, considering the corrective strategy of an operation, and iii) be performed intentionally of promotional management., etc.
Sub Engineers (sub E)	Ability to promote smoothly and effectively the duties concerned through the practical instruction to the juniors staffs through performing their duties with the required /appropriate expertise, etc.
Assistant Sub Engineers (ASE) & Employees	Ability to i) handle accurately and promptly the duties in charge as a member of organization; and ii) tackle the problem-solving relation to the duties to be assigned with problem consciousness, etc.

(3) Ratio on requested ability by positions

Positions	Management Ability (%)	Project Implementation Ability (%)	Interpersonal Skills (%)	Ability to Performing Task (%)	Total (%)
DMD	30	30	30	10	100
Dir	20	30	30	20	100
DD/XEN	10	30	30	30	100
SDO	5	30	30	35	100
Sub E	0	30	30	40	100
ASE/Employees	0	20	30	50	100

Appendix 10.4 Knowledge and Ability

Position	Typical Subjects for Education
Managers	Business management, Financial management, Report evaluation, Personnel management: (Improvement on working environment, Evaluation of ACR, Improvement on motivation and Self-development), Handling PC skill, Safety management, Management of security and crisis control, Interpersonal negotiating ability , etc.
Engineers/Business Supervisors	Improvement of Engineering knowledge, Improvement on expertise and specialized technology, Merchandise knowledge on equipment and materials, O&M technology, Interpersonal negotiating ability, Handling PC skill, Preparation of reports/statistics and evaluation , Safety management, Management of security and crisis control.
Administrative Staffs	Interpersonal negotiating ability, Handling PC skill, Preparation of reports/statistics and evaluation , Safety management, Management of security and crisis control, etc.
Personnel at Site	Merchandise knowledge on equipment and materials, O&M technology, Troubleshooting, Interpersonal negotiating ability, Improvement on expertise, Preparation of reports/statistics and evaluation , Safety management, Repairing skills, etc.

Appendix 10.5 Implementation Method on Training Programs

(1) Human resources management

The target of a personnel management is carrying out the maximum exertion of the personnel's capability, and managing an organization effectively through the personnel's recruitment, reshuffling, and promotion.

The Comprehensive items to be examined which considered man-power development and self-education are shown below.

1) Reemployment of retired staffs

Those retired engineers and specialist personnel form WASA can be reemployed and became as their technical assistance for up-and-coming staffs

2) Hireling of qualified personnel

In order to correspond to an alternation of needs flexibly, the large basic knowledge of a field and objective view, and various special knowledgeable personnel with highly motivated are employed.

3) Development on special personnel

Expert staffs that have a highly know-how or specialized expertise (engineers /administrators) are requested to be employed. In addition, introduction of system that staffs can engage in their specific/professional field according to staff’s motivation and qualifications is also required.

4) Job rotation

The promotion of the young personnel's man-power development and self-education needs to establish the planned job rotation which can arrange the right man in the right place.

5) Adoption on more female staffs

Expansion of job categories and/or positive recruitment on female staffs needs be endeavored to bring further policy formulation by their opinions or abilities from female staffs in to play.

6) Reinforcement on personal performance evaluation system

The personnel evaluation by a personnel training type evaluation system is carried out by methods, such as self-evaluation, consultation person, and an interview by the supervisory employees.

On the other hand, in order to increase the personnel's motivation, it is necessary to

examine the evaluation system which can perform a grip of the personnel's aptitude, and a recommendation of man-power development to the personnel.

7) Personnel management in collaboration with training/self-development achievements

Introduction of the system of the self-assessment about man-power development track records, such as rating acquisition, educates the personnel's motivation and the personnel's capability built.

Moreover, it is necessary to examine the personnel management which cooperated with the training history and the man-power development history.

8) Management on pay raise/promotion

Information, including a training track record, the result of a certifying examination, the result of a promotion check, etc., is released to the personnel, and necessity has a system which carries out promotion management based on a merit system.

Reexamination is indispensable in a seniority-based system.

(2) Staff Training

It is necessary to establish a training system that can stretch individual ability of each staff to the utmost in collaboration with new personnel management.

Three training methods are shown as below.

- On-the-job training
- Off-the-job training
- Self-development

1) On-the-job training

On-the-job training can delicately and respectively instruct each staff according to his (her) individuality by directly linking to regular duties and is a highly effective measure for human resource development and/or individual ability development.

Major Action Policies

- Preparation of an on-the-job training manual.
- Implementation of on-the-job training leader training.
- Foundation of a workshop trainer system (targeting new hire / retraining for employees etc.)
- Preparation of an operation manual.

2) Off-the-job training

Off-the-job training consisted of group training, dispatched training, and technical training is the most commonly-used measure on human resource development.

Off-the-job training can provide an intense learning the knowledge and technology in a short period, and also has effects as the promotion on heightening of consciousness due to the training course together with other staffs from different workshops.
For example, seven training courses are introduced as below.

a) To enrich the training on managerial level

This training aims at the working environment improvement, the instruction ability to his staffs, the business management ability, and etc.

Major Action Policies

- Implementation of the training about a personnel evaluation
- Implementation of the training about management by objective
- Implementation of the training about the improvement in executive ability
- Implementation of the training about the improvement in personnel training capacity building.

b) To enrich the training on ability development

Attending on courses can be chosen from several training courses for those staffs with the motivation to be selected from among applicants.

Major Action Policies

- Substantial attendance subject.
- Selection of the training subject which suited customer needs at correspondence or improvement in business operation.
- Public announcement of an annual training schedule.

c) To enrich the training at WASA's workshop

A Technical training system provides those periodically designated staffs in charge of O&M to master the facility maintenance and operation technology within the workshop in WASA.

Major Action Policies

- Substantial technical subject.
- Implementation of the training about the improvement in management ability of existing and new O/M facilities.
- Public announcement of an annual training schedule.

d) To enrich the training of improvement in reception/response consciousness to the customer

Training on receptions is implemented targeting at the managerial staffs for the customer services, complaint handling staffs consciousness/ability to enhance the customer's satisfaction.

Major Action Policies

- Substantial training on customer reception leaders.
- Preparation of a customer representative handbook.

e) To enrich the training on citizen's enlightenment

Training system is to deepen the trusting relationship between citizen and WASA.

Major Action Policies

- Substantial training on citizen's enlightenment leader.
- Preparation of an enlightenment handbook.

f) To enrich the dispatched training by outside training institutions

In order to obtain the newest information, and advanced technical knowledge and skill required for the facility operation, the dispatch training which specialized in a certain operation is an effective means.

Moreover, it is also an opportunity to raise greediness for learning.

Major Action Policies

- Substantial dispatch training to special training machinery
- Substantial inspection training to an advanced governing body.
- Promotion of the dispatch training to private enterprises.
- Promotion of overseas dispatch training
- Promotion of labor health and crisis management training, others.

(3) Self-development

The foundation of man-power development is self-education. Off-the-job training and on-the-job training are effective means to which self-education is urged. On the other hand, it is indispensable that the motivation support for personnel each supports with encouragement positively.

Major Action Policies

- Substantial incentive measure of attendance of the educational lectures in working hours.
- Substantial incentive measure of attendance of an independence training system.
- Substantial incentive measure of the suggestions for improvement in the routine works.

(4) Improvement of environment of a workshop

The management vitality has big influence on the personnel's motivation and volition and the achievement of management goal is deepened on the environment of a workshops or offices.

Although good communication in an office has vigor in a workshop or offices, the

foundation has indispensable promotion of a group's performance-based system (performance-based system an organization's). If the management vitality, as good communication among employees, is bad, it can be hard to achieve the aim of an organization.

In order to aim at the upsurge of the group consciousness, it is the necessity of having a small meeting with the group by group periodically.

Appendix 10.6 Outsourcing Candidates

(1) Business Department (Refer to Figure 4.5.1 and Table 4.5.1)

1) Water meter reading, billing and bill delivery

To implement the business activities, presently about 300-400 persons are engaged in WASA. It is considered necessary that revenue collection department should be made to improve its efficacy.

Corrective strategy is described below.

1) Alternative-1: Water meter reading, billing and bill delivery

A water meter reader changes into a portable type equipment system, a Handy Terminal and printer, from the conventional handwriting system.The concept of the system was shown in **CHAPTER 4.7**, **Figure 4.7.3**.

2) Alternative-2: Partially Contracting Out the Work

Outsourcing of business activities can be promoted by parts. The detail of opportunity is shown in **Table 4-5-1**.

3) Alternative-3: Continuation of WASA's Existing Outsourcing Measures

- WASA has decided in September, 2009 that the printing and delivery of water bills is outsourced to a local private Company as the proposed measure. It costs WASA Rs: 4/- per bill including printing out and delivery service.
- WASA has decided in September, 2009 that the surveillance of the illegal connection be entrusted to four NGOs, (PEARL: Nishtar Town, ASSETS; G.B.T./Iqbal Town, ECC/CAP: Ravi Town/A.B.T./S.T.). It costs WASA Rs. 295 per report.
- According to a news items in the press on August 26, 2009, WASA has collected about Rs. 120 million through a campaign of detecting/regularization 45000 connections. Such exercises should be repeated regularly.

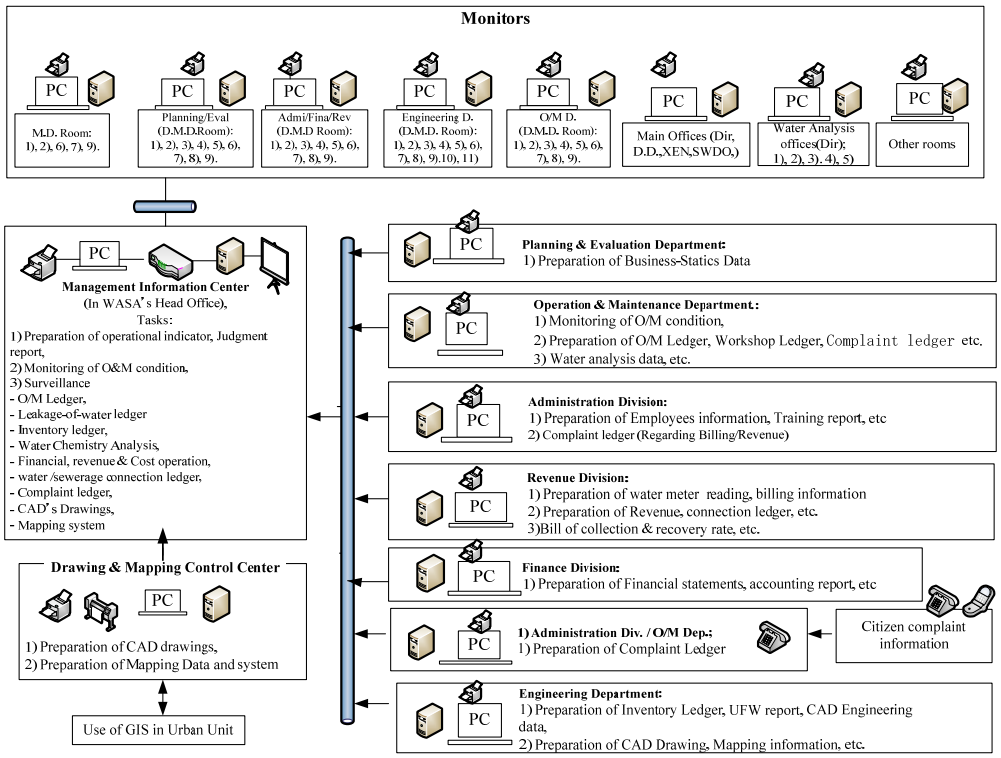


Figure 4.5.1 Draft of the Concept of Information Management System

(2) Planning & Evaluation Department

Some operation, such as O/M of the Management Information System, MIS, can be privatized partly (Refer to **Fig. 4.5.1** and **Table 4.5.2**).

When placing an order with outside, WASA shall evaluate the nature of service of the system. MIS, functioning as central base is one method of aiming at the increase in efficiency of the management of WASA, and shows a review in **Fig. 4-5-1**. The building of information control means carrying out uniform management of the data from many places at the MIC. MIC is the system which offers information required for each post.

- It is important that a system management may contain secret items of management. Hence management information system and a data backup are also included in the maintenance/operation.
- The essential components may include a data-input job of various kinds of information arrangement, a financial related form including an operation-management ledger, a complaint management ledger, and a system plan.
- Construction of a mapping system, others.

(3) Operation & Maintenance Department

Almost all of the O/M operations can be placed for outsourcing. (Refer to **Table 7-5-3**)

1) O/M works

Tube Wells O/M can be outsourced.

All of wastewater pumping station O/M can be outsourced.

2) Drainage works

All of Drainage work can be outsourced.

3) Dewatering Works

All of Dewatering work can be outsourced.

4) Work shop

All of workshop can be outsourced.

5) Wastewater Treatment Plant

a) Wastewater Treatment Plants

Especially the operation/maintenance of a wastewater treatment plant has bad labor conditions and a good technical knowledge is needed. O/M can be outsourced partially. WASA's O/M staff can receive the operational technology and know-how through an everyday supervisory activity.

b) Wastewater quality control & monitoring in the WWT

The operation can be outsourced including WWT's operational checks, routine wastewater quality surveillance, and a sampling periodically.

(4) Others (Lease and Hiring)

Other outsourcing operations are shown below.

1) Repair of O/M vehicles needs to be outsourced.
2) Lease of large-sized construction vehicles.
3) Employment of the dredge employees on contract.
4) Employment of the rain water drainage employees on contract.
5) Employment of sewer maintenance employees on contract.
6) Employment of the engineering work employees on contract.

Table 4.5.1 Examination of the possibility of outsourcing (Regarding Revenue Division & Inquiry Counter Division)

Candidate operation		Enforcement situation	Future direction	Outsourcing , etc	Remarks
1	Water meter reading	WASA staff	-Introduction of the Handy Terminal system.	-Phase in However, WASA manages the SD's memory card.	-Examination of the amount of capital investment. -Confirmation of a cost reduction effect -Examination of staff, 300-400 persons, reassignment.
2	Water-rates bill issuance business	Under outsourcing in a tentative way			
3	Bill delivery operation				
4	Cash control of water rates	-Cash transfer System by WASA	-Promotion of a direct debit and a Credit payment system.	-Institutional customer and those for companies.	-Improvement of a customer file and a system is requested.
5	Management of a customer' ledger	WASA staff	-	-Phase in	- Limits to confidentiality.
6	Arrear bill collection practices	WASA staff	-Employment of a specialized staff and /or outsourcing.	-Phase in	-The measure to prevent occurrence of complaint of the citizen against force collection is needed. -Examination of the payment contract agreement to an incentive fee System.
7	Illegal connection control operation	-WASA staff , -4-Contracted NGO	-Employment of a specialized staff and /or outsourcing. -	-Phase in -WASA's measure	-Verification of the offender's improvement effect. -Examination of the payment contract agreement to an incentive fee System.
8	Pipe connection receptionist operation	WASA staff	-Registered plumbers allow helping making application form. -Cash handling by WASA.	-Phase in	-Customer is burdened for the preparation expense. -Strengthening the Surveillance of inaccurate applications. -Strengthening the Surveillance of inaccurate connections with consumer service line to WASA's Pipe Line.

Table 4.5.2 Examination of the Possibility of Outsourcing (Planning & Evaluation Department)

Candidate business activities		Enforcement situation	Future direction	Outsourcing, etc	Remarks
1	O/M of uniform monitoring system	Future operation	Undecided	Undecided	-Training/employment of WASA
2	Preparation of statistical materials/data	Future operation	Partially or fully outsourcing	Undecided	-Limits to confidentiality
3	Maintenance of MIS	Future operation	Partially or fully outsourcing	Undecided	-Limits to confidentiality
4	A system /PC practical use education	Future operation	Partially or fully outsourcing	Undecided	-Limits to confidentiality
5	Data Input operation	Future operation	Partially or fully outsourcing	Phase in	-Limits to confidentiality
6	Formulation of Mapping System	Future operation	Partially or fully outsourcing	Phase in	-Limits to confidentiality
7	O/M of Mapping System	Future operation	Partially or fully outsourcing	Phase in	-Limits to confidentiality
8	Preparation of CAD drawings	Future operation	Partially or fully outsourcing	Phase in	-Limits to confidentiality

Table 4.4.3 Examination of the Possibility of Outsourcing (Operation & Maintenance Department)

Candidate business activities		Enforcement situation	Future direction	Outsourcing, etc	Remarks
1	O/M T/Wells (about 460 T/wells)	WASA staff	Undecided	Undecided	-Limits to confidentiality
2	O/M of Wastewater pumping Stations	WASA staff	Partially or fully outsourcing	Undecided	-Limits to confidentiality
3	Dredging of Drainage work	WASA staff	Partially or fully outsourcing	Phase in	-Limits to confidentiality
4	Dewatering work	WASA staff	Partially or fully outsourcing	Phase in	-Limits to confidentiality
5	Work shop (Water meter repair shop)	WASA staff	Partially or fully outsourcing	Phase in	-WASA conducts acceptance test.
6	Work shop (Maintenance of Auto/vehicles)	WASA staff	Partially or fully outsourcing	Phase in	-WASA conducts acceptance test.
7	O/M of Wastewater Treatment plants Work	Future operation	Partially or fully outsourcing	Phase in	-WASA conducts acceptance test.
8	Sampling and field tests for WTP	Future operation	Partially or fully outsourcing	Phase in	-WASA conducts acceptance test.
9	Sampling and field tests for Industrial effluent	Future operation	Partially or fully outsourcing	Phase in	-WASA is requested a final test.

Appendix 10.7 Management Information System

5) Main Individual System

a) Examination of Management Information System

i) Data Preparation

Personal in charge of the data preparation is requested to input the information into the computers according to a filing system and then it is sending to the Management Information Center through Internet.

ii) Perusal and Surveillance of Data

All of the data prepared by the Center, for example the statistical materials, the operation situation of institutions, and water analysis (drinking water and sewer water quality), which the management personnel can peruse it with a personal computer for 24 hours.

iii) Monitoring screen

In the Center, the updated operational situation and water quality data is always displayed on the monitor screen for the personnel supervise who is controlling the system for 24 hours.

iv) Available data

The typical available information to be prepared by the Center is shown below.

- Data of Business-statics,
- Data of Operation & Maintenance
  - O/M condition,
  - O/M ledger, Workshop ledger,
  - Water analysis,
  - Complaint ledger (regarding O/M), etc
- Date of Administration
  - Employees information, Training report, etc
  - Complaint ledger (regarding billing & revenue)
- Data of Revenue
  - Water meter reading & billing information
  - Revenue & connection, Bill collection & recovery rate, etc
- Data of Finance
  - Financial statement, Accounting report, etc
- Data of Complaint
  - Regarding O/M, Regarding revenue, etc

- Data of Engineering
  - Inventory ledger, UFW report, procurement, etc
  - CAD drawing & other engineering data, mapping information, etc

b) Examination of Centralized Operation Monitoring System

i) Basic Concept

This system is to monitor the operational condition of all WASA installed facilities, such as the pumping facilities including Tube wells. The collected data of remote stations is arranged into the Statistical data as well as the ON-Off condition shown by lighting on the monitor screen.

Following goals are achieved through this implementation project

- Providing better facilities control,
- Ensuring regular supply of water and regular pumping stations,
- Well organized Operation and Maintenance schedule,
- Keeping record of all the WASA assets and their round the year work
- Save operation cost.

The typical Comprehensive Centralized System of the Operation and Maintenance is shown in **Figures 4.7.1** an **Figure 4.7.2**.

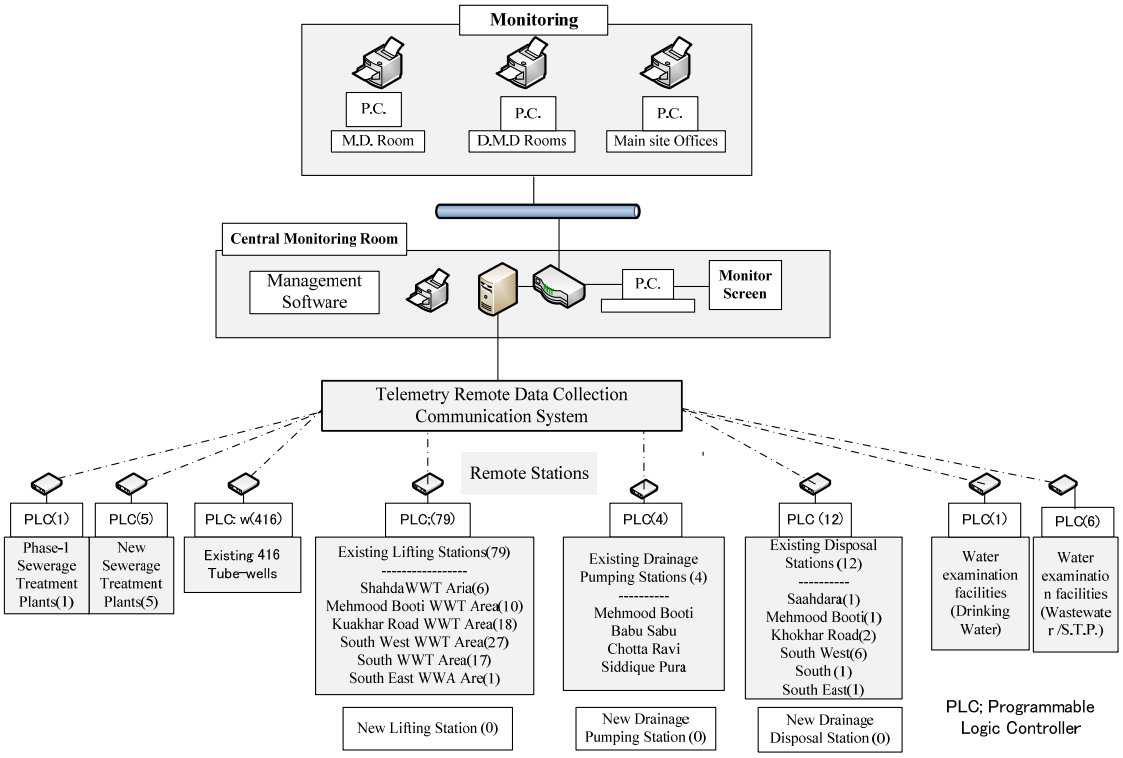


Figure 4.7.2 Typical Comprehensive Centralized Operation Monitoring System

ii) Monitoring factors

The Current operation information from remote on request base as well the emergency stopping is obtained at the Center.

The minimum required monitoring factors are shown below.

- Tube well stations
  - Tube wells and chlorination pumps,
  - Monitoring current, voltage, on/off position, emergency stopping with flashing light and beep sound, power line or on generator,
- Pumping stations
  - Lifting pumps, drainage pumps, disposal pumps,
  - Mechanical screens, belt conveyers,
  - Monitoring current, voltage, on/off position, Water level of basin, emergency stopping with flashing light and beep sound, power line or on generator,
- Sewerage treatment plants
  - Mechanical screens, belt conveyers,
  - Monitoring current, voltage, on/off position, emergency stopping with flashing light and beep sound, power line or on generator,
- Water examination facilities
  - Drinking water, wastewater (Raw-treated sewage)
  - Typical drinking water quality: Turbidity, Color, pH, Total coliforms, etc.
  - Typical wastewater quality: BOD, COD, SS, T-N, Transparency, DO, etc.

iii) Parameter of maintaining log

The items to be analysis are shown below.

- Cost of Operation per water flow,
  - Operation hours (daily, monthly, yearly),
  - Power consumption (daily, monthly, yearly),
  - Fuel and chlorine consumption daily, monthly, yearly),
  - Number of operation staff (daily, monthly, yearly),
  - Ratio of using facilities efficiently,
- History of operation
  - Amount of water extracted (daily, monthly, yearly),
  - Discharge effluent measurement (daily, monthly, yearly),
  - Mechanical faults,
  - Emergency maintenance and increase the response,

- Production performance of each pump.
- Monitoring of pressure, discharge and water quality,
- Chemical dosage amount and its residual chlorine,
- Total hour of power failure and operation of generator.

c) Examination of Water Meter Reading, Billing and Bill Delivery System

i) Basic Concept

The system is the combination with a Handy Terminal and a Portable Printer. A water meter reading staff members is requested only to inputs the consumed water amount, and prints it out by the portable printer on-site as a official bill. This system can abolish the operation by the conventional human power and can raise the operational efficiency improvement.

Following goals shall be achieved through this implementation project.

- Reduction of the number of staffs,
- Improvement in the operating efficiency of water meter reading and the bill issue,
- Increase in efficiency of sharing of the information on water rates,
- Improvement in reduction of the mistakes in office work,

ii) Required Improvement of the existing system

To smooth operation, the following consideration is necessary to be examined.

- Updating existing billing application system,
- Renewal of existing Office equipment,
- Examination of the written item of a water usage bill
- Examination of the revenue collection system,
- Purchase of equipment, and a periodical maintenance,

In addition, meters with transmission are also available in international market, on which a quantity of water consumed can be radio transmitted to the machine. Typical mechanical water meter reading and issuing billing system are shown in **Figure 4.7.3**.

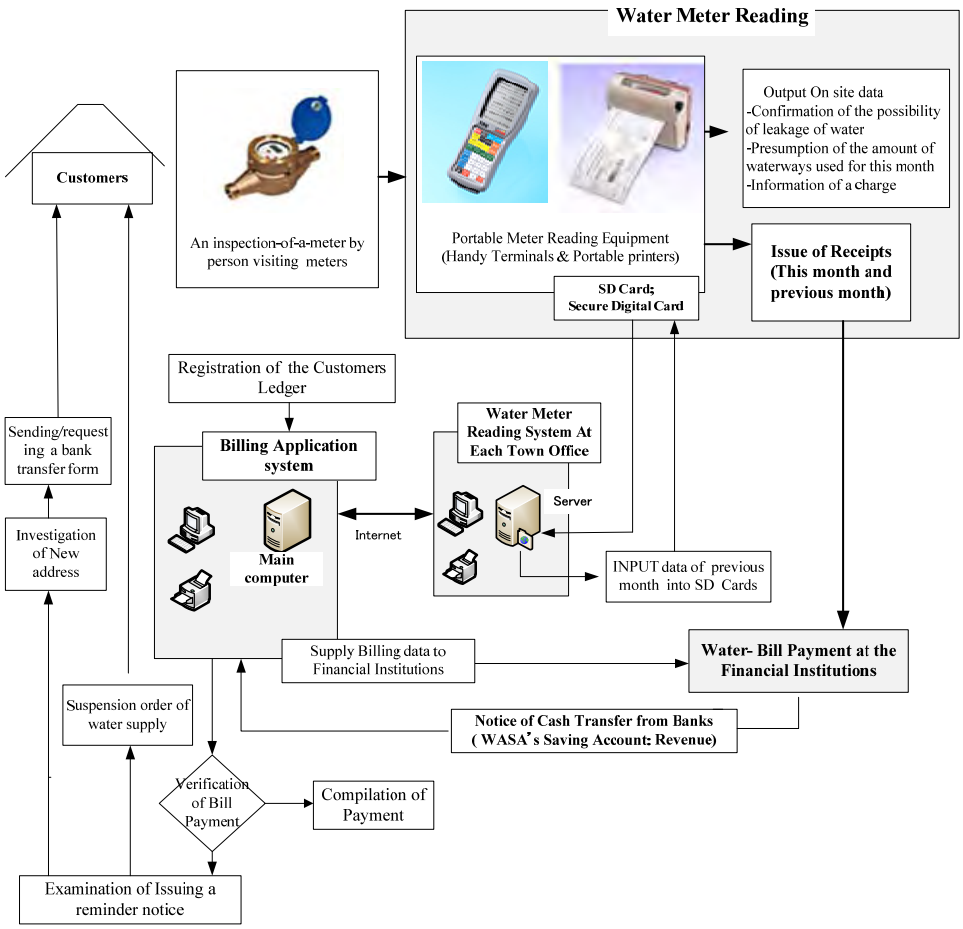


Figure 4.7.3 Typical Water Meter Reading and Billing by Mechanical Devices

d) Examination of Complaint Handing System

The system of the examination and measure against the civil complainants consists of communication equipment, ledger management, a cleaning machine, and the implementation organization. In **Chapter 5.3**, the basic concept of the measure against a complaint is discussed The existing complaint managerial system is on Sub Division base, but the amelioration system is on Town base. (Refer to **Figures 5.3.2 and 5.3.3**). This chapter here the examination is focused on the regarding ledger management and communication equipment.

i) Communication System

It is indispensable to improve the communication equipment in any system. The following fundamental communication equipment is requested shown below.

- Radios,
- Fixed-line telephones and cellular phones,
- Internet circuit,

ii) Office Automation Equipment (O.A. equipment)

Handwriting ledger is carried out now. For this reason, civic voice is not utilized effectively to reduce the number of complaints. It is indispensable to improve the O.A. shown below.

- Improvement of complaint ledger description,
- Desktop computers for perpetration of the complaint ledgers,
- Desktop computers for issue of the Slip form and preparation of report, addition and correction of record,
- Printers,

iii) Requested improvement of the existing system

To build the improvement plan of complaint processing system by on Town base, it is necessary to examine the following items.

- Ensure of an office space,
- Improvement of the cleaning vehicles list,
- Installation of radio equipment on the rerated cleaning vehicles,
- Establishment of an organization, reservation and arrangement of the personnel,

e) Examination of Mapping Information Network System (MINS) for Drinking Water

The facilities currently fixed throughout WASA Lahore exist intricately and variably in quantity with huge water pipe, Tube-wells, valves, and water meter devices. The system manages this huge facility management in a unified manner by using a computer, and it makes the increase in efficiency of business accomplishment. Moreover, the new mapping system can retrieve information only by inputting a user's address or water meter number or registration number, and a service pipe route setup at the time of housing new reconstruction is also known easily.

i) Effect

The improvement effect expected is shown below.

- Unified management of facilities

This system can manage efficiently pipeline information, including a pipeline caliber, pipe class, pipe replacement year, etc., with a pipeline map using a computer. Moreover, various kinds of business can support effectively by processing various information.

- Improvement in citizen service

The newest information can search quickly and it enables speeding up of the

correspondence to the consultation from a citizen, an inquiry, etc., and exact information to provide. Moreover, this information can aim at improvement in much more citizen service.

- The management improvement of drawings

This system can perform easily creation, updating, and search of a drawing, and its accuracy of a drawing improves. If the newest pipeline information is inputted, various kinds of statistical materials can be created easily.

- Speeding up of restoration work

At the time of the occurrence of an accident, I can predict the damage of the number of houses and an area. Moreover, the position of valves which should be controlled is known in an instant, and repair work can carry out quickly.

ii) Composition of databases

A mapping system is used combining geographical feature data, design data, CAD data, and water supply ledger data on a drawing. As a result, design data including materials quantity and earthwork quantity, water supply ledger data, and map data can manage effectively by a system. In addition, since urban unit owns GIS data, it is necessary to use this data effectively. The concept of a mapping system is shown in **Figure 4.7.4**.

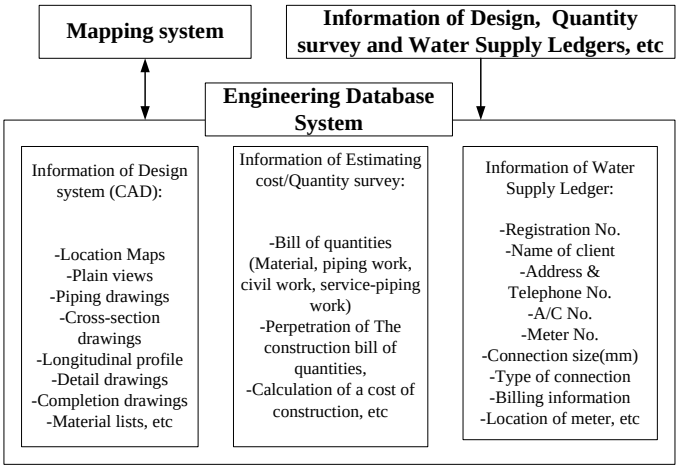


Figure 4.7.4 Typical Preparation Procedure of Mapping System

iii) The main functions of a mapping system

Each function is shown below.

- Data input and updating

This work can improve efficiently a service pipe and water pipe data, geographical feature data, and the input and updating of attribute data, and can always maintain the latest information.

- Browse and retrieve the information

This search is the inputting a user name or/and a meter number or/and an address, etc. into the Search computers, and the drawing and attribute data of related data, such as a service pipe, water meter, a stop cock, a slice valve, a water pipe, and a hydrant, are displayed. The marked data can be printed. Moreover, if conditions are specified, it will be indicated by emphasis and total calculation can also do data easily.

- The function of a drawing output

According to a use, a service pipe, a water pipe, and the data of geographical feature are outputted with 1/500 or arbitrary reduction drawings by a color plotter. For example, if data processing of the drawing is carried out by software, 1/500 of databases will be reduced and outputted to 1/2500 or 1/10000.

- Support of shutdown work

An input of a construction place and the part of leakage of water will be displayed the related valves which should be operated, the area of suspension of water supply, and customer list on the screen of the Search Computer and it can be printed out. By this function, a prompt action is attained by an emergency.

iv) Required Mapping Office Automation Equipment (O.A. Equipment)

Fundamental mapping O.A. required is shown below.

- Mapping application system,
- Servers
- Desktop computers for Asset Mapping supported by AUTO CAD,
- Digitizer that converts analog information into a digital format; for flat graphic material,such as maps,a digitizer can either be flatbed or scanning,
- Desktop computers for GIS development,
- Desktop computers for Database development and output information and /or monitoring and /or Search of information,
- Large format of Laser Printers and Ink-jet plotters,

Appendix 10.8 Priority Schedule of Operation and Maintenance Equipment

(1) Dewatering Equipment

1) Pump Facilities

As for rainwater drainage, the task is done continuously for 24 hours. Especially required facilities and equipment is drainage pumps with an engine power, equipment conveyance tracks, and a worker's transportation vehicle. The facilities and the required equipment to be installed with the following order of precedence will be considered.

- In Phase-1, about 1/2 to 1/3 of the required number will be provided.
- In Phase-2 and long-term, all of the remaining facilities and equipment will be provided

The order of precedence which should carry out the purchase of the dewatering equipment is shown in **Table 4.8.2**.

Table 4.8.2 Priority of the Dewatering Equipment

1. Pumps		Existing							Renewal (No. of Unit)			
S.No.	Name of Machinery	Capacity	Hp	No. of Unit	Year of Manufact-uring	Condition	Problems	Necessary to replace (Urgent) or Repair	Phase-1	Phase-2	Long Teram	Total
1	Portable Engine Pumps, Dong Feng single Tank	1 m^3/Sec	12 HP	159	1996	Running	50% creates frequent problems	50% needs replacement, 75 New out of 159	0	80	100	180
2	Portable Engine Pumps, Dong Feng Double Tank	1m^3/Sec	12 HP	208	1980	Running	Too old	50% needs replacement	0	60	150	210
3	Mobile Engine Pumps, Lister Peter 6-Cylinder	4m^3/Sec	90 HP	2	1980	Running	Too old	Needs replacement	0	2	0	2
4	Mobile Engine Pumps, Lister Peter 3-Cylinder	2m^3/Sec	45 HP	13	1980	Running	Too old	Needs replacement	0	10	10	20
5	Mobile Engine Pumps, Lister Peter 2-Cylinder	1m^3/Sec	45 HP	4	1980	Running	Too old	Needs replacement	0	4	0	4
6	Mobile Engine Pumps China (2-Cylinder)	2m^3/Sec	24 HP	4	1999	Running	Too old	Two more required	0	2	4	6
7	Mobile Engine Pumps, Deutze 3-Cylinder,2-3 cfs	2m^3/Sec	45 HP	59	2008	Running	20 more required	30 more required	10	20	30	60
8	Portable Engine Pumps, Deutze	½m^3/Sec	6 HP	25	1996	Running	50% needs replacement	50% needs replacement	0	5	10	15
9	Portable Engine Pumps, Deutze-PV-2	2m^3/Sec	16 HP	1	1975	Running	Too old	Needs replacement	0	1	1	2
10	Portable Engine Pumps, Deutze	½m^3/Sec	¼ HP	46	1996, 2005	Running	50% needs replacement	50% needs replacement and 25 Nos. more required	0	25	20	45
11	Submersible Pumps (Elect.), Deutze	½m^3/Sec	2 HP	18	2005	Running	-	-	0	0	20	20
12	Portable Engine Pumps, Deutze	½m^3/Sec	4 HP	6	2005	Running	Needs replacement	Needs replacement	0	2	4	6
	Total	-	-	545	-	-	-	-	10	211	349	570

Source: WASA O/M Dep. September, 2009

2) Generator Facilities

The power generating equipment for outdoor task is indispensable. This power source is used for a pump drive power, illumination of premise, welding/cutoff task, etc. As for the number of the required generator unit to be prioritized, the following points will be considered.

- In Phase-1, all the number needed will be provided

- In Phase-2 and long-term, no replacement generators is required.

The order of precedence which should be followed to carry out the purchase of the generator units is shown in **Table 4.8.3.**

Table 4.8.3 Priority of the Generator Units

1. Generators		Existing							Renewal (No. of Unit)			
S.No.	Name of Machinery	Capacity	Hp	No. of Unit	Year of Manufact-uring	Condition	Problems	Necessary to replace (Urgent) or Repair	Phase-1	Phase-2	Long Team	Total
1	Generator	20 KVA	-	-	-	-	-	1 No. Urgently larger capacity required	1	0	0	1
2	Generator	10 KVA	-	1	-	-	To carry out work during frequent load shedding	1 No. Urgently required before monsoon 2009	1	0	0	1
	Total								2	0	0	2

Source: WASA O/M Dep. September, 2009

3) Vehicle Facilities

In order to meet urgency, dewatering activity may occur at early morning or midnight. Moreover, in order to cope with two or more sites, reservation of the vehicles for equipment and workers becomes indispensable. As for the number of the required transfer vehicles to be prioritized, the following priority points will be considered.

- In Phase-1, even if fields are separated, the minimum required number of the transfer vehicles will be provided so that equipment and employees can be arranged quickly.
- In Phase-2 and long-term, all of the remaining vehicles will be provided

The order of precedence which should be followed to carry out the purchase of the vehicles is shown in **Table 4.8.4**.

Table 4.8.4 Priority of the Vehicle Units

1. Vehicles		Existing									Renewal (No. of Unit)			
S.No.	Name of Machinery	Capacity	Hp	No. of Unit	Name of Manufacturer	Year of Manufacturing	Size/ Model #	Condition	Problems	Necessary to replace (Urgent) or Repair	Phase-1	Phase-2	Long Team	Total
1	Truck Crane	6-Ton	190-HP	2	Japan	-	Latest Model	-	Shifting of dewatering sets	2 Nos. required Urgently before monsoon 2009, 2-ton truck Crane	1	1	0	2
2	Truck Shehzore	2600 cc	90-HP	3	Koria	-	Latest Model	-	2 for dewatering sets mobile squade & one for staff shifting	3 Nos. Urgently required before monsoon 2009, 2600cc	2	2	0	4
3	Land Rover LHO-6083	-	-	1	England	1988	1988	Poor condition	Need frequent repairs	Needs replacement	0	1	0	1
4	Pick up truck 500kg LHO-1765	800 cc	800 cc	1	Pakistan	1988	1988	Poor condition	Need frequent repairs	Needs replacement, 800cc	5	1	5	11
5	Tractor Trolley	2500 cc	2500 cc	1	Pakistan	2007	2007	OK	-	-	0	0	0	0
	Total	-	-	8	-	-	-	-	-	-	8	5	5	18

Source: WASA O/M Dep. September, 2009

4) Machine work shop Facilities

It consist of mechanical tools, hand tools and other machines required for the repair and maintenance work on Water Supply, Sewerage and the drainage equipment. The point of main repair Task is shown below.

- Pumps and Engines overhaul.
- Making of an apparatus required for machine in the field work.
- Maintenance work of vehicles and others equipment.
- Cutoff and welding operation in the field work.

As for the number of required machine tools and equipment to be prioritized, the following will be considered.

- In Phase-1, tools and equipment required for field work will be provided.
- In Phase-2 and long-term, all of the remaining machinery will be provided.

The order of precedence which should carry out the purchase of the tools and the equipment for the Machine shop required is shown in **Table 4.8.5**.

Table 4.8.5 Priority of the Tools and Equipment for Machine Shop

1. Machine Shop		Existing							Renewal (No. of Unit)			
S.No.	Name of Machinery	Capacity	Hp	No. of Unit	Year of Manufacturing	Condition	Problems	Necessary to replace (Urgent) or Repair	Phase-1	Phase-2	Long Team	Total
1	Lathe Machine	16 Ft long	7½-HP	1	1980	OK	-	-	0	0	0	0
2	Lathe Machine	8 Ft long	3-HP	1	1974	Out of order	old	Needs repair	0	0	0	0
3	Shaper Machine	-	5-HP	1	1974	Out of order	old	Needs repair	0	0	0	0
4	Hacksaw Machine	-	1-HP	1	1974	Out of order	old	Needs repair	1	0	0	1
5	Drill Machine	-	-	1	1974	Out of order	old	Needs repair	1	0	0	1
6	Drill Machine	-	-	1	1974	Out of order	old	Needs repair	0	0	0	0
7	Grinder Machine	-	1-HP	1	1974	Out of order	old	Needs repair	1	0	0	1
8	Gas Welding Plant	-	-	1	-	-	old	Needs repair	2	1	0	3
9	AC Welding Plant	-	-	1	1974	Out of order	old	Needs repair	1	1	1	3
Total		-	-	9	-	-	-	-	6	2	1	9
2. Dewatering Shop												
1	Drill Machine	Single Phase	1-HP	1	1971	OK	-	-	0	0	0	0
2	Grinder Machine	Single Phase	1-HP	1	1971	OK	-	-	0	0	0	0
3	Compressor	100 Pound	-	1	1971	OK	-	-	0	0	0	0
	Total	-	-	3	-	-	-	-	0	0	0	0

Source: WASA O/M Dep. September, 2009

(2) Sewer Pipe-line Cleaning Equipment

As for Status of existing Cleaning vehicles, an interview from all the 25-Sub Division was held. As a result, the complaints of blocking sewer were about 1,000 incidents per day, and shortage of water supply was about 170 complaints per day. In addition, the number of complaints where vehicles were used was a total of 111. Existing sewer cleaning vehicles are superannuated and are insufficient for requirement attends the complaint received. Especially, the most needed vehicles are vacuum vehicles, jetting units, water tankers, disposal vehicles (dump trucks) for dredged soil and transfer vehicle of employees, etc.

When the vehicles run short, aid is requested from the neighboring Sub division or PMU or by human work force.

1) Water Tankers meet water shortage

The causes of insufficient water supply are low water pressure and leakage loss from a water pipe, except for the time of a power shutdown. Additionally, the hot season has more serious complaints of water supply. A water tanker is used for delivery of water and means of water supply for a sewer cleaning Jetting unit. As for the number of providing water tanker to be prioritized, the following bases will be considered.

- In Phase-1, the required number of water tankers will be provided in the area where population density are high, and will also be arrayed along with the Jetting units.
- In Phase-2 and long-term, all of the remaining vehicles will be provided.

The overall plan of a water tanker is shown in **Table 4.8.6**.

Table 4.8.6 Priority of the Water Tankers (Units)

Name	Capacity	Phase-1	Phase-2	Long-term	Total
Water Tanker	8 m^3 / capacity with water pump and hose pipe	9	5	0	14

Source: 35-O/M Sub Division, September, 2009

2) Cleaning Vehicles for the remedial action against Sewer Obstruction

Cleaning work is carried out by a vacuum vehicle, Jetting unit, and water tankers. Among this, especially the jetting units are indispensable to remove an obstruction. In addition, the main blocker is the silt, sand and garbage which flow in from the broken manholes, grating and broken house sewerage connection pipe. The order of precedence of the providing facilities required will be considered on the following bases.

- In Phase-1, the Jetting units will be provided in area with many high populated density and large number of complaints.
- In Phase-2 and long-term, all of the remaining vehicles will be provided.

The overall plan of a water tanker required is shown in **Table 4.8.7**, the priority according to Sub division level is shown in **Table 4.8.8**, and detail of priority level is shown in **Table 4.8.9**.

Table 4.8.7 Priority of the Sewer Cleaning Equipment

Name	Capacity	Phase-1	Phase-2	Long-term	Total
Muck Sucker	4 m^3 Tank Cap.	7	17	7	31
Jetting Unit	4.5 m^3 Tank Cap.	22	6	4	32
Truck Crane	3 ton	9	3	0	12
Tractor Trolley	65HP, 2m^3	10	4	0	14
Pick up	800cc	16	9	0	25
Truck	5 ton	11	7	0	18
Vehicle	1500cc	5	0	0	5
Dumped Truck	8 ton	2	0	0	2
Total		82	46	11	139

Source: 35-O/M Sub Division, September, 2009

Table 4-8-8 Priority of the Sewer Cleaning Equipment by Sub Division

Towns	RAVI TOWN						SHALIMAR TOWN						GUNJ BUKSH TOWN						AZIZ BHATTI TOWN					
Population (2009)	1,493,390						1,220,659						1,231,553						273,200					
	Exit	Req	P-1	P-2	L/T	Total	Exit	Req	P-1	P-2	L/T	Total	Exit	Req	P-1	P-2	L/T	Total	Exit	Req	P-1	P-2	L/T	Total
Muck Sucker	6	7	2	5	0	7	1	2	1	1	0	2	3	15	3	6	6	15	1	2	1	1	0	2
Jetting Unit	5	7	3	4	0	7	1	3	1	2	0	3	7	11	3	5	3	11	1	2	1	1	0	2
Water Tanker	4	4	2	2	0	4	0	0	0	0	0	0	5	5	3	2	0	5	1	1	1	0	0	1
Track Crane	2	4	3	1	0	4	1	1	1	0	0	1	3	3	2	1	0	3	1	1	1	0	0	1
Tractor(65HP)+Trolley	2	2	2	0	0	2	3	2	1	1	0	2	7	6	3	3	0	6	1	0	0	0	0	0
Suzuki (800cc)	3	6	6	0	0	6	2	1	0	1	0	1	2	10	5	5	0	10	2	2	2	0	0	2
Mazda Pick up	0	5	3	2	0	5	1	2	1	1	0	2	2	6	3	3	0	6	0	1	1	0	0	1
Toyota Hilux	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dumped moter lorry	3	2	2	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Total	25	38	24	14	0	**38**	9	11	5	6	0	**11**	30	56	22	25	9	**56**	7	9	7	2	0	**9**

Towns	ALLAMA IQBAL TOWN						NISHTAR TOWN						Total					
Population (2009)	1,636,339						927,784						6,782,925					
	Exit	Req	P-1	P-2	L/T	Total	Exit	Req	P-1	P-2	L/T	Total	Exit	Req	P-1	P-2	L/T	Total
Muck Sucker	4	4	3	0	1	4	3	1	1	0	0	1	18	31	11	13	7	31
Jetting Unit	4	5	4	0	1	5	3	4	2	2	0	4	21	32	14	14	4	32
Water Tanker	4	1	1	0	0	1	4	3	2	1	0	3	18	14	9	5	0	14
Track Crane	1	0	0	0	0	0	1	3	2	1	0	3	9	12	9	3	0	12
Tractor(65HP)+Trolley	5	2	2	0	0	2	4	2	2	0	0	2	22	14	10	4	0	14
Suzuki (800cc)	2	1	1	0	0	1	2	5	2	3	0	5	13	25	16	9	0	25
Mazda Pick up	1	2	1	1	0	2	2	2	2	0	0	2	6	18	11	7	0	18
Toyota Hilux	0	3	3	0	0	3	0	1	1	0	0	1	0	5	5	0	0	5
Dumped moter lorry	0	0	0	0	0	0	0	0	0	0	0	0	4	2	2	0	0	2
Total	21	18	15	1	2	**18**	19	21	14	7	0	21	111	153	87	55	11	**153**

Table 4.8.9 Detail of Priority Level by Sub Division

Location			Equipment																					
Sr. No.	Description of Area/ Sub Divisions	Population (2009)	Muck Sucker						Jetting Unit							Water Tanker							
			Existing	Req. Total		Ph-1	Ph-2	L/T	Total	Existing	Req. Total		Ph-1	Ph-2	L/T	Total	Existing	Req. Total		Ph-1	Ph-2	L/T	Total
			4m3	4m3	2m3					4.5m3	4.5m3	2m3					8m3	8m3	5m3				
1	**RAVI TOWN**																						
1	City	280,000	**0**	2	0	1	1	0	2	0	1	0	1	0	0	1	1	1	0	0	1	0	1
2	Shahdra	220,000	**1**	1	0	0	1	0	1	1	2	0	1	1	0	2	1	1	0	0	1	0	1
2	Farakhabad	215,000	**2**	2	0	1	1	0	2	1	1	0	1	0	0	1	0	1	0	1	0	0	1
3	Data Nagar	288,500	**1**	**1**	**0**	0	1	0	1	1	1	0	0	1	0	1	1	0	0	0	0	0	0
4	Misri Shah	259,670	**1**	**1**	**0**	0	1	0	1	1	1	0	0	1	0	1	1	0	0	0	0	0	0
3	Shadbagh	230,220	**1**	**0**	**0**	0	0	0	0	1	1	0	0	1	0	1	0	1	0	1	0	0	1
	Sub total	1,493,390	**6**	7	**0**	**2**	**5**	**0**	**7**	**5**	**7**	**0**	**3**	**4**	**0**	**7**	**4**	**4**	**0**	**2**	**2**	**0**	**4**
2	**SHALIMAR TOWN**																						
6	Mughal Pura	683,420	**0**	1	0	0	1	0	1	1	1	0	0	1	0	1	0	0	0	0	0	0	0
7	Baghban Pura	537,239	**1**	0	1	1	0	0	1	0	1	1	1	1	0	2	0	0	0	0	0	0	0
	Sub total	1,220,659	**1**	**1**	**1**	**1**	**1**	**0**	**2**	**1**	**2**	**1**	**1**	**2**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3	**GUNJ BUKSH TOWN**																						
4	Krishan Nagar	406,825	**0**	2	1	1	1	1	3	1	2	1	0	2	1	3	1	1	0	1	0	0	1
9	Ravi Road	304,888	**0**	1	2	1	1	1	3	0	2	1	1	1	1	3	1	0	1	1	0	0	1
10	Mozang	121,707	**0**	2	2	1	2	1	4	0	2	1	1	1	1	3	1	1	0	0	1	0	1
11	Anarkali	150,700	**1**	2	1	0	1	2	3	3	1	0	1	0	0	1	1	0	1	0	1	0	1
12	Gulberg	133,560	**2**	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0
13	Shimla Hill	113,873	**0**	1	1	0	1	1	2	1	0	1	0	1	0	1	0	1	0	1	0	0	1
	Sub total	1,231,553	**3**	**8**	**7**	**3**	**6**	**6**	**15**	**7**	**7**	**4**	**3**	**5**	**3**	**11**	**5**	**3**	**2**	**3**	**2**	**0**	**5**
4	**AZIZ BHATTI TOWN**																						
14	Mustafabad	99,200	**0**	1	0	1	0	0	1	0	1	0	1	0	0	1	0	1	0	1	0	0	1
15	Tajpura	174,000	**1**	1	0	0	1	0	1	1	1	0	0	1	0	1	1	0	0	0	0	0	0
	Sub total	273,200	**1**	**2**	**0**	**1**	**1**	**0**	**2**	**1**	**2**	**0**	**1**	**1**	**0**	**2**	**1**	**1**	**0**	**1**	**0**	**0**	**1**
5	**ALLAMA IQBAL TOWN**																						
17	Iqbal Town	311576	**1**	1	0	1	0	0	1	1	1	0	1	0	0	1	0	1	0	1	0	0	1
18	Samanabad	425763	**1**	0	0	0	0	0	0	1	0	1	1	0	0	1	1	0	0	0	0	0	0
19	Sabazar	150000	**1**	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
20	Ichra	389,000	**1**	**1**	**0**	1	0	0	1	1	1	0	1	0	0	1	1	0	0	0	0	0	0
21	Johar Town	360,000	**0**	**1**	**1**	1	0	1	2	0	2	0	1	0	1	2	1	0	0	0	0	0	0
	Sub total	1,636,339	**4**	**3**	**1**	**3**	**0**	**1**	**4**	**4**	**4**	**1**	**4**	**0**	**1**	**5**	**4**	**1**	**0**	**1**	**0**	**0**	**1**
6	**NISHTAR TOWN**																						
22	Industrial Area	315,500	**1**	0	1	1	0	0	1	1	0	1	1	0	0	1	1	1	0	1	0	0	1
23	Green Town	200,918	**0**	0	0	0	0	0	0	1	1	0	0	1	0	1	1	1	1	1	1	0	2
24	Garden Town	211,000	**1**	0	0	0	0	0	0	0	1	0	0	1	0	1	1	0	0	0	0	0	0
25	Town Ship	200,366	**1**	0	0	0	0	0	0	1	1	0	1	0	0	1	1	0	0	0	0	0	0
	Sub total	927,784	**3**	**0**	**1**	**1**	**0**	**0**	**1**	**3**	**3**	**1**	**2**	**2**	**0**	**4**	**4**	**2**	**1**	**2**	**1**	**0**	**3**
G. Total	**Total (WASA)**	**6,782,925**	**18**	**21**	**10**	**11**	**13**	**7**	**31**	**21**	**25**	**7**	**14**	**14**	**4**	**32**	**18**	**11**	**3**	**9**	**5**	**0**	**14**

Location			Equipment																					
Sr. No.	Description of Area/ Sub Divisions	Population (2009)	Track Crane						Tractor(65HP)+Trolley						Suzuki (800cc)						Mazda Pick up					
			Existing	Req.	Ph-1	Ph-2	L/T	Total	Existing	Req.	Ph-1	Ph-2	L/T	Total	Existing	Req.	Ph-1	Ph-2	L/T	Total	Existing	Req.	Ph-1	Ph-2	L/T	Total
			2 ton	Total					2m3	Total						Total					1500cc	Total				
1	**RAVI TOWN**																									
1	City	280,000	1	1	0	1	0	1	0	0	0	0	0	0	0	1	1	0	0	1	0	1	1	0	0	1
2	Shahdra	220,000	0	1	1	0	0	1	0	1	1	0	0	1	0	1	1	0	0	1	0	1	1	0	0	1
2	Farakhabad	215,000	0	1	1	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1	0	1	1	0	0	1
3	Data Nagar	288,500	0	1	1	0	0	1	0	1	1	0	0	1	1	1	1	0	0	1	0	1	0	1	0	1
4	Misri Shah	259,670	1	0	0	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	1	0	1	0	1
3	Shadbagh	230,220	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0
	Sub total	1,493,390	**2**	**4**	**3**	**1**	**0**	**4**	**2**	**2**	**2**	**0**	**0**	**2**	**3**	**6**	**6**	**0**	**0**	**6**	**0**	**5**	**3**	**2**	**0**	**5**
2	**SHALIMAR TOWN**																									
6	Mughal Pura	683,420	1	0	0	0	0	0	2	1	1	0	0	1	1	1	0	1	0	1	1	1	0	1	0	1
7	Baghban Pura	537,239	0	1	1	0	0	1	1	1	0	1	0	1	1	0	0	0	0	0	0	1	1	0	0	1
	Sub total	1,220,659	**1**	**1**	**1**	**0**	**0**	**1**	**3**	**2**	**1**	**1**	**0**	**2**	**2**	**1**	**0**	**1**	**0**	**1**	**1**	**2**	**1**	**1**	**0**	**2**
3	**GUNJ BUKSH TOWN**																									
4	Krishan Nagar	406,825	1	0	0	0	0	0	1	1	1	0	0	1	2	2	1	1	0	2	1	1	1	0	0	1
9	Ravi Road	304,888	0	1	1	0	0	1	1	2	1	1	0	2	0	1	1	0	0	1	0	1	1	0	0	1
10	Mozang	121,707	0	1	0	1	0	1	1	1	1	0	0	1	0	4	1	3	0	4	0	4	1	3	0	4
11	Anarkali	150,700	1	1	1	0	0	1	1	1	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0
12	Gulberg	133,560	1	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0
13	Shimla Hill	113,873	0	0	0	0	0	0	2	0	0	1	0	1	0	2	1	1	0	2	0	0	0	0	0	0
	Sub total	1,231,553	**3**	**3**	**2**	**1**	**0**	**3**	**7**	**6**	**3**	**3**	**0**	**6**	**2**	**10**	**5**	**5**	**0**	**10**	**2**	**6**	**3**	**3**	**0**	**6**
4	**AZIZ BHATTI TOWN**																									
14	Mustafabad	99,200	0	1	1	0	0	1	1	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0
15	Tajpura	174,000	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	1	1	0	0	1
	Sub total	273,200	**1**	**1**	**1**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**2**	**0**	**0**	**2**	**0**	**1**	**1**	**0**	**0**	**1**
5	**ALLAMA IQBAL TOWN**																									
17	Iqbal Town	311576	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	Samanabad	425763	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
19	Sabazar	150000	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	Ichra	389,000	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
21	Johar Town	360,000	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	1	0	1	0	1	0	1
	Sub total	1,636,339	**1**	**0**	**0**	**0**	**0**	**0**	**5**	**2**	**2**	**0**	**0**	**2**	**2**	**1**	**1**	**0**	**0**	**1**	**1**	**2**	**1**	**1**	**0**	**2**
6	**NISHTAR TOWN**																									
22	Industrial Area	315,500	1	2	1	1	0	2	1	1	1	0	0	1	1	3	1	2	0	3	0	0	0	0	0	0
23	Green Town	200,918	0	0	0	0	0	0	1	1	1	0	0	1	1	2	1	1	0	2	0	1	1	0	0	1
24	Garden Town	211,000	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
25	Town Ship	200,366	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1
	Sub total	927,784	**1**	**3**	**2**	**1**	**0**	**3**	**4**	**2**	**2**	**0**	**0**	**2**	**2**	**5**	**2**	**3**	**0**	**5**	**2**	**2**	**2**	**0**	**0**	**2**
G.Total (WASA)		**6,782,925**	**9**	**12**	**9**	**3**	**0**	**12**	**22**	**14**	**10**	**4**	**0**	**14**	**13**	**25**	**16**	**9**	**0**	**25**	**6**	**18**	**11**	**7**	**0**	**18**

Location			Equipment																		# of Av. Complaints/day	# of Detail of Problems		
Sr. No.	Description of Area/ Sub Divisions	Population (2009)	Toyota Hilux						Dumped moter lorry						Total									
			Existing	Req. Total	Ph-1	Ph-2	L/T	Total	Existing 5t	Req. Total	Ph-1	Ph-2	L/T	Total	Existing	Req. Total	Ph-1	Ph-2	L/T	Total	Sewer	Water	Sewer Block	Lack of
1	**RAVI TOWN**																							
1	City	280,000	0	1	1	0	0	1	0	0	0	0	0	0	2	8	5	3	0	8	12	17	12	2
2	Shahdra	220,000	0	0	0	0	0	0	1	1	1	0	0	1	4	9	6	3	0	9	35	10	35	2
2	Farakhabad	215,000	0	0	0	0	0	0	0	1	1	0	0	1	3	8	7	1	0	8	35	15	35	2
3	Data Nagar	288,500	0	0	0	0	0	0	0	0	0	0	0	0	5	6	3	3	0	6	80	10	80	2
4	Misri Shah	259,670	0	0	0	0	0	0	0	0	0	0	0	0	6	4	1	3	0	4	40	15	35	2
3	Shadbagh	230,220	0	0	0	0	0	0	1	0	0	0	0	0	5	3	2	1	0	3	40	8	40	1
	Sub total	1,493,390	**0**	**1**	**1**	**0**	**0**	**1**	**3**	**2**	**2**	**0**	**0**	**2**	25	38	24	14	0	38	**242**	**75**	**237**	**11**
2	**SHALIMAR TOWN**																							
6	Mughal Pura	683,420	0	0	0	0	0	0	0	0	0	0	0	0	6	5	1	4	0	5	27	12	27	10
7	Baghban Pura	537,239	0	0	0	0	0	0	0	0	0	0	0	0	3	6	4	2	0	6	40	12	40	20
	Sub total	1,220,659	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	9	11	5	6	0	11	**67**	**12**	**67**	**30**
3	**GUNJ BUKSH TOWN**																							
4	Krishan Nagar	406,825	0	0	0	0	0	0	0	0	0	0	0	0	7	11	5	4	2	11	55	17	55	10
9	Ravi Road	304,888	0	0	0	0	0	0	0	0	0	0	0	0	2	12	7	3	2	12	50	10	50	8
10	Mozang	121,707	0	0	0	0	0	0	1	0	0	0	0	0	3	18	5	11	2	18	75	22	55	10
11	Anarkali	150,700	0	0	0	0	0	0	0	0	0	0	0	0	7	8	3	2	2	7	50	25	50	10
12	Gulberg	133,560	0	0	0	0	0	0	0	0	0	0	0	0	8	1	0	1	0	1	25	10	20	5
13	Shimla Hill	113,873	0	0	0	0	0	0	0	0	0	0	0	0	3	6	2	4	1	7	25	12	25	9
	Sub total	1,231,553	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	30	56	22	25	9	56	**280**	**96**	**255**	**52**
4	**AZIZ BHATTI TOWN**																							
14	Mustafabad	99,200	0	0	0	0	0	0	0	0	0	0	0	0	2	5	5	0	0	5	20	5	20	2
15	Tajpura	174,000	0	0	0	0	0	0	0	0	0	0	0	0	5	4	2	2	0	4	20	10	20	2
	Sub total	273,200	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	7	9	7	2	0	9	**40**	**15**	**40**	**4**
5	**ALLAMA IQBAL TOWN**																							
17	Iqbal Town	311576	0	1	1	0	0	1	0	0	0	0	0	0	3	4	4	0	0	4	85	30	80	10
18	Samanabad	425763	0	1	1	0	0	1	0	0	0	0	0	0	6	2	2	0	0	2	85	30	80	15
19	Sabazar	150000	0	1	1	0	0	1	0	0	0	0	0	0	4	1	1	0	0	1	85	25	80	9
20	Ichra	389,000	0	0	0	0	0	0	0	0	0	0	0	0	5	4	4	0	0	4	40	5	40	2
21	Johar Town	360,000	0	0	0	0	0	0	0	0	0	0	0	0	3	7	4	1	2	7	25	8	25	4
	Sub total	1,636,339	**0**	**3**	**3**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	21	18	15	1	2	18	**320**	**98**	**305**	**40**
6	**NISHTAR TOWN**																							
22	Industrial Area	315,500	0	0	0	0	0	0	0	0	0	0	0	0	6	9	6	3	0	9	100	35	80	10
23	Green Town	200,918	0	0	0	0	0	0	0	0	0	0	0	0	4	7	4	3	0	7	100	35	80	9
24	Garden Town	211,000	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	1	0	1	15	7	15	7
25	Town Ship	200,366	0	1	1	0	0	1	0	0	0	0	0	0	5	4	4	0	0	4	20	2	20	2
	Sub total	927,784	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	19	21	14	7	0	21	**235**	**79**	**195**	**28**
G.Total (WASA)		**6,782,925**	**0**	**5**	**5**	**0**	**0**	**5**	**4**	**2**	**2**	**0**	**0**	**2**	**111**	**153**	**87**	**55**	**11**	**153**	**1,184**	**375**	**1,099**	**165**

Source : Interview with all SDOs on September 9m2009

(1) Drainage Equipment

Drainage Directorate has been newly established centering on the drainage equipment, which JICA granted in 2005 and in September, 2009. From now on, in all the drainage desilting, dredge work will be carried out by Drainage Directorate. On the other hand, Drainage Directorate also continues to supports the cleaning up activities of sewerage as before. The order of precedence of the providing facilities will be considered on the following bases.

- In Phase-1, there is no drainage equipment in particular with urgency.
- In Phase-2 and long-term, all of the remaining equipment will be provided.

The overall plan of drainage equipment is shown in **Table 4.8.10.**

Table 4.8.10 Priority of the Drainage Equipment

Name	Capacity	Phase-1	Phase-2	Long-term	Total
Pumps	Max 3250 GPM、175 ft	0	5	0	5
Generators	output 55 KVA	0	2	0	2
Excavator	-	0	3	0	3
Big Float Amphibious Excavator	-	0	1	0	1
Wheel Loader	-	0	1	2	3
Dumped motor lorries	8 ton	0	6	0	6
Maintenance Vehicle	-	0	5	4	9
Spares, tiers, others	Set	0	2	2	4
Repair tools, others	Set	0	1	1	2
Total		0	26	9	35

Source: Drainage Department, September, 2009

(4) Maintenance Shop of Dredging Equipment

Repair task of the dredging equipment is based on existing repair facilities and outsourcing as before. Main maintenance status of the equipment is shown below.

- Maintenance equipment for special vehicle comprised a vacuum pump, a high-pressure water pump, and a hydraulic system.
- Repair of tire blowout, adjustment of alignment, and a periodic check to be outsourced.
- Simple maintenance work such as change of filters and oil, etc.
- Washing Vehicles, etc.

In addition, running cost will become high if the facilities are improved. Moreover,

employment of technicians and training are needed. The order of precedence of the providing facilities required will be considered the following bases.

- In Phase-1, there is no maintenance equipment in particular with urgency.
- In Phase-2 and long-term, all of the remaining equipment will be provided.

The priority of the maintenance equipment is shown in **Table 4.8.11.**

Table 4.8.11 Priority of the Maintenance Equipment

S.No.	Existing					Renewal (No. of Unit)			
	Name of Equipmet	No. of Unit	Size/ Model #	Necessary to replace (Urgent) or Repair	Requested	Phase-1	Phase-2	Long Team	Total (Set/No.)
1	Off road stringing puncture repair insert.	0	SIPK1 Heavy duty professional String puncture kit		5	0	0	5	5
2	Off road stringing puncture repair insert.	0	Box (60) Brown "String" Inserts 4" long x 6mm approx: 15-280		100	0	0	100	100
3	Off road stringing puncture repair insert.	0	Box (30) Brown "String" Inserts 7" long x 6mm approx: 15-281		100	0	0	100	100
4	Off road stringing puncture repair insert.	0	Pack (50) Black "String" Inserts 8" long x 3.5mm approx: 15-206BM		100	0	0	100	100
5	Off road stringing puncture repair insert.	0	Pack (40) Black "String" Inserts 12" long x 3.5mm approx: 15-283		100	0	0	100	100
6	Off road stringing puncture repair insert.	0	Pack (20) Black "String" Inserts 12" long x 6mm approx: 15-284		50	0	0	50	50
7	Commercial tyre changing tools	0	Gaither Bead saver system Truck & Bus tyre changing kit		5	0	0	5	5
8	Commercial tyre changing tool	0	Commercial Wheel Dolly		5	0	0	5	5
9	Tyre Inflators	0	Michelin type inflation gauge Eurodaira		5	0	0	5	5
10	Tyre valve connector/ chuck	0	PCL-C05B03 Twin Hold on Valve Connector - Short)		5	0	0	5	5
11	Tyre pressure checking gauge	0	Schrader Michelin Pressure gauge Eurodaira – LB		5	0	0	5	5
12	Tyre spreader	0	Tyre spreader for commercial vehicle tyres		5	0	0	5	5
13	Wheel nut braces and bars	0	1" drive L shaped wheel braces		5	0	0	5	5
14	Wheel nut braces and bars	0	Extension bar for 1" drive L shaped wheel braces		5	0	0	5	5
15	Wheel nut braces and bars	0	Support stand for L wheel braces		5	0	0	5	5
16	Wheel nut braces and bars	0	Commercial four way spin wrench		5	0	0	5	5
17	Axel stand	0	WTC axel stand(heavy)		5	0	0	5	5
18	Axel stand	0	Sealy Axel stand (light)		5	0	0	5	5
19	Air Hydraulic jack	0	CP9460 three stage air hydraulic service jack		5	0	0	5	5
20	Hydraulic Trolley jack	0	Omega 3 ton trolley jack fast lift with foot pedal OM21030		5	0	0	5	5
21	Air compressor	0	SIP Air mate PNB 3800 B4/200 pro tech		1	0	0	1	1
22	Air line Hose & Hose Assemblies /Tyre equipment company Ltd	0	(i) Air Hose Assembly		2	0	0	2	2
			(ii) Air Hose assembly		2	0	0	2	2
23	Truck tyre changer	0	Full automatic universal truck tyre changer SR- 558 (CE) Trade mark		2	0	0	2	2
24	Oil changer	0	SR-3097 Trade mark sunrise		2	0	0	2	2
25	Truck washer	0	KKE 503 automatic high pressure truck washer		1	0	0	1	1
26	Gas Cutting Machine	0	CM- 12 (Ningbo Kimpin)		2	0	0	2	2
27	Electric Welder	0	Arc Welding Inverter Thermal-Arc 155SE		2	0	0	2	2
28	Electrode Holder	0	KPH-04 Electrode German type		5	0	0	5	5
29	Welder Clamp set	0	Clamp set		5	0	0	5	5
30	Welders Leather Sleeves	0	High Quality, Heavy Duty, Leather sleeves		5	0	0	5	5
31	Welders Leather Jacket	0	High Quality, Heavy Duty, Leather Jacket.		5	0	0	5	5
32	Red Welders Gauntlets	0	Superior Quality, Heavy Duty Welders Leather Gauntlets		5	0	0	5	5
33	Hand Held Welding Mask	0	Conventional Glass Filter Hand Held Welding Mask		5	0	0	5	5
34	Passive Welding Helmet	0	Conventional Glass Filter Welding Helmet.		5	0	0	5	5
35	Mild Steel Electrode Starter Packs	0	Handy Starter Packs of Mild Steel Arc Welding Electrodes		100	0	0	100	100
36	Stainless Steel Electrodes	0	316L Stainless Steel Electrodes		10	0	0	10	10
37	Battery Chargers	0	War Horse Multi Circuit battery charger		2	0	0	2	2
38	Trucks Alignment	0	Bee line Advance Alignment runways		1	0	0	1	1
39	Truck Alignment	0	Bee line space saver Ramps		1	0	0	1	1
40	Truck Alignment	0	Bee line Truck Axle correction		1	0	0	1	1
41	Truck Alignment	0	Bee line Rear Axle Alignment		1	0	0	1	1
42	Truck Alignment	0	Bee Line LC7000 series Alignment		1	0	0	1	1
43	Truck's Wheel balancing	0	Bee line Wheel Balancing System		1	0	0	1	1
	Total				692	0	0	692	692

Source Dredging Dep. September, 2009

(5) Water Meter Repairing Work Shop Facilities

About 1,200 domestic water meters per year are repaired. However, flow calibration facilities are broken down, and a large-sized water meter (bulk flow meter) is not possible to calibrate due to lack of arrangement for the flow accuracy. On the other hand, according to the number

of installation of a water meter, it is necessary to strengthen the repair and calibration facilities for water meters. The order of precedence of providing the required facilities will be considered on the following base.

- In Phase-1, old and broken-down facilities will be improved.
- In Phase-2 and long-term, all of the remaining equipment will be provided.

The list of the equipment of water meter work shop is shown in **Table 4.8.12.**

Table 4.8.12 List of Water Meter Work Shop Equipment

METER REPIER SHOP		Existing							Renewal (No. of Unit)			
Sino.	Name of Tool	Capacity	No. of Unit (Nos.)	Name of Manufacturer	Year of Manufacturing	Size/ Model #	Condition	Problems	Necessary to replace (Urgent) or Repair	Phase-1	Phase-2	Long Team	Total
1	Test bed (For 0.5-1.5")	500 liters	1	Kimmon Japan	1974	½" to 1½" Ø	OK	-	-	0	0	0	0
2	Test bed (For 0.5-1.5")	500 liters	1	Kimmon Japan	1974	½" to 1½" Ø	Out of order	Calibration tube broken	Required to be replaced	1	0	0	1
3	Test bed (For 0.5-1.5")	24 gallons	1	Germany	1963	½" to 1" Ø	OK	-	-	0	0	0	0
4	Test bed (For 6-12")	15000 liters	1	Kimmon Japan	1974	6" to 12" Ø	Out of order	Calibration tube & Pump broken	Required to be replaced	1	0	0	1
5	Repair apparatus Water Meters		1	-	-	For 6-12"	-	-	Need more	2	0	0	2
6	Working tables (Wooden)		1	-	-	5m long *2m wide	-	Old	Need more	2	0	0	2
7	Tool cabinets (Steel w/rock)		1	-	-	2m wide* 3m high	-	Old	Need more	2	0	0	2
8	Storage Cabinet (Steel w/rock)		1	-	-	2m wide* 3m high	-	Old	Need more	2	0	0	2
9	Vices		0	-	-	30cm mouth	-	-	Need more	2	0	0	2
10			1	-	-	15cm mouth	-	-	Need more	2	0	0	2
11	Meter Repair tools (W/ Tool box)		0	-	-	Bigger meter	-	-	Need more	2	0	0	2
12			0	-	-	Smaller mater	-	-	Need more	2	0	0	2
	Total		-	-	-	-	-	-		18	0	0	18

Sourece : WASA O/M Dep. Work shop, Sept

(6) Water Quality Analyzer

Existing

The existing water analysis laboratory is carrying out only analysis of bare minimum parameters relation to the quality of drinking water. However, since the analysis equipment is too old, the data has not been collected for all the requisite water analysis premasters. Both of building and the analysis equipment need to be updated. The purpose of a water examination in the Laboratory will be shown below.

- Check the water quality value according to the water quality standard,
- Check the operation status of the facilities,
- Propose the optimal operating condition of the facilities,

Future

In the future, the type of water quality analysis and the analysis locus will be shown below.

- Central Water Analysis Center Building
  - For analysis of the drinking water, wastewater and industrial discharge.
- Simple wastewater analysis rooms

- Establishment of the laboratory facilities in the six sewage treatment plants

According to forward planning, the priority level of water analysis equipment is as follows.

1) Central Water Analysis Center Building

The water examination facility to be fixed in the Central Analysis Center is shown below.

- Drinking water examination facilities.
- Wastewater examination facilities.
- Industrial drainage examination facilities.
- Microbiological examination facilities.
- Glassware for drinking and wastewater laboratory.
- Glassware for microbiological laboratory.
- In addition to above the following facilities are also provided.

a) Drinking water examination facility and Vehicles

The existing water analysis equipment is inadequate / insufficient to check the quality of tap water as it was described above. Moreover, the complaints of contaminated water cannot be responded promptly due to lack of the required vehicles. The order of precedence of providing the required facilities will be considered on the following bases.

- In Phase-1, the old facility for drinking water test will be updated.
- In Phase-2 and long-term, all of the remaining equipment will be provided.

The list of the laboratory facilities of drinking water is shown in **Table 4.8.13.**

Table 4.8.13 List of Laboratory Facilities of Drinking Water

S.No.	Description	Existing Quantity	New Quantity	Phase-1	Phase-2	Long term
1	Composite liquid sampler	0	1	1	0	0
2	Jar tester	0	1	1	0	0
3	Electronic analytical balance	0	2	1	1	0
4	UV - VIS spectrophotometer	0	1	1	0	0
5	Electrical conductivity meter (for Laboratory)	0	2	1	1	0
6	Electrical Conductivity Meter (for Portable)	0	3	2	1	0
7	pH/mV meter with combined glass electrode (for Laboratory)	0	3	1	2	0
8	pH/mV meter with combined glass electrode (for Potable)	0	3	2	1	0
9	Nessleriser,Reagents: Iron, Range 2 - 18 ug, Method:- Thioglycolic acid, etc	0	1	1	0	0
10	Oven	1(old)	1	1	0	0
11	Turbidity Meter (Laboratory)	1	2	1	1	0
12	Digital Turbidity Meter (Portable)	0	3	2	1	0
13	Color meter	0	1	1	0	0
14	Residual chlorine meter	0	1	1	0	0
15	Water temperature meter	1(Old)	1	1	0	0
16	Centrifuge	0	1	1	0	0
17	Concentric ring steaming bath	0	2	1	1	0
18	Water still with deioniser, bench mountable	0	1	1	0	0
19	Magnetic stirrer	0	2	2	0	0
20	Refrigerator	0	1	1	0	0
21	Safety vented goggles	0	5	5	0	0
22	Kjeldahl Nitrogen distillation apparatus	0	1	1	0	0
23	Ultra sonic pipette washer	0	1	1	0	0
24	Ultra sonic washer with lid	0	1	1	0	0
25	Atomic Absorption spectrophotometer	0	1	1	0	0
26	Laboratory tables & reagent, etc	0	1	1	0	0
	Total	3	43	34	9	0
Source: WASA Water Laboratory, September, 2009						

b) Wastewater & Industrial Drainage Examination Facilities.

There is no wastewater and industrial drainage analysis facility in the existing WASA water analysis room. The Analysis facility required is needed to be provided according to the implementation schedule in Phase-2. The order of precedence of providing the facilities required will be considered on the following bases.

- In Phase-1, the facilities for wastewater & industrial drainage test will not be provided.
- In Phase-2 and long-term, all of the facility will be provided.

The list of the laboratory facilities and the instrumental laboratory facilities for wastewater & industrial drainage is shown in **Tables 4.8.14 and 4.8.15**.

Table 4.8.14 List of Laboratory Facilities

S.No.	Description	Existing Quantity	New Quantity	Phase-1	Phase-2	Long term
1	Electronic analytical balance	0	2	1	1	0
2	C.O.D. Distillation Apparatus (for opened reflux method)	0	1	1	0	0
3	COD meter(For Laboratory)	0	1	1	0	0
4	DO meter (for Laboratory)	0	1	1	0	0
5	DO meter (for Potable)	0	10	5	5	0
6	Water temperature meter (for Laboratory)	0	1	1	0	0
7	Water temperature meter (for Potable)	0	5	2	3	0
8	Transparency (for potable)	0	10	5	5	0
9	Turbidity meter	0	2	1	1	0
10	SS meter (For Laboratory)	0	1	1	0	0
11	UV - VIS spectrophotometer	0	1	1	0	0
12	Electrical conductivity meter (for Laboratory)	0	2	1	1	0
13	Electrical Conductivity Meter (for Portable)	0	10	5	5	0
14	pH/mV meter with combined glass electrode (for Laboratory)	0	3	1	2	0
15	pH meter (for otable)	0	10	5	5	0
16	Oven	0	1	1	0	0
17	Water still with deioniser, bench mountable	0	1	1	0	0
18	Refrigerator(small size)	0	1	1	0	0
19	Incubator for BOD	0	1	1	0	0
20	Atomic Absorption spectrophotometer	0	1	1	0	0
21	Water bath	0	1	1	0	0
22	Dispenser, acid	0	5	5	0	0
23	Safety vented goggles	0	5	5	0	0
24	Muffle furnace	0	1	1	0	0
25	Horizontal shaker	0	1	1	0	0
26	Laboratory tables & reagent, etc	0	1	1	0	0
	Total	0	79	51	28	0

Source: WASA Water Laboratory, September, 2009

Table 4.8.15 List of Instrumental Laboratory Facilities

S.No.	Description	Existing Quantity	New Quantity	Phase-1	Phase-2	Long term
1	GC-MS System:	0	1	0	1	0
2	Gas Chromatograph (GC System):	0	1	0	1	0
3	Gel Permeation Chromatograph :	0	1	0	1	0
4	Up- gradation HPLC MS(LC MS:	0	1	0	1	0
5	Total Organic Carbon Analzer(TOC):	0	1	0	1	0
6	Soxhlet Extraction System:	0	1	0	1	0
7	Nitrogen Distillation System:	0	1	0	1	0
8	Oil Analyzer:	0	1	0	1	0
9	Biological Safety Cabinet:	0	1	0	1	0
10	Laboratory Refrigerator:	0	1	0	1	0
11	Mechanical Shaker:	0	2	0	1	0
12	Deep Freezer:	0	1	0	1	0
13	Glassware Washer:	0	1	0	1	0
14	Temperature Recorder:	0	1	0	1	0
15	BOD Auto analyzer:	0	1	0	1	0
16	COD Auto analyzer:	0	1	0	1	0
17	Audio Visual Equipments:	0	1	0	1	0
18	Flame Photometer: (3+6=9)	0	9	0	1	0
19	BOD Measurement System;	0	1	0	1	0
	Total	0	28	0	19	0

Source: WASA Water Laboratory, September, 2009

c) Microbiological Examination Facilities

At this section, microbiological test for water supply, wastewater and industrial drainage will be implemented. The order of providing the requested facilities will be considered on the following bases.

- In Phase-1, the old facility for drinking water test will be provided.
- In Phase-2 & long-term, all of the facilities will be provided.

The list of the microbiological laboratory facilities is shown in **Tables 4.8.16**.

Table 4.8.16 List of Microbiological Laboratory Facility

S.No.	Description	Existing	New	Phase-1	Phase-2	Long term
		Quantity	Quantity			
1	Autoclave	1(old)	1	1	0	0
2	Filter funnel set		5	1	4	0
3	Vacuum pump		1	1	0	0
4	Incubator	1(old)	2	1	1	0
5	Oven	1(old)	1	1	0	0
6	Portable colony counter		1	1	0	0
7	Colony Counter		1	1	0	0
8	UV or gama sterilization box		1	1	0	0
9	Pipette canister		4	4	0	0
10	Electromantles		1	1	0	0
11	Electronic top loading balance		1	1	0	0
12	Hot plate	1(old)	1	1	0	0
13	Microscope with TV (Moniter)		1	1	0	0
14	Microscope lamp		1	1	0	0
15	Electromentals		5	1	4	0
16	Flask		1	1	0	0
17	Bunsen burner		2	1	1	0
18	LPG cylinder with gas, regulator, connecting tube		1	1	0	0
19	Forceps		2	2	0	0
20	Automatic water still		1	1	0	0
21	Pipette filler		5	1	4	0
22	Drying Sterilizer		1	1	0	0
23	Refrigerator		1	1	0	0
24	Laboratory tables & reagent, etc		1	1	0	0
	Total		42	28	14	0

Source: WASA Water Laboratory, September, 2009

d) Glassware for Drinking water, Wastewater, and Industrial Drainage Laboratory

The existing water analysis room has limited number of glassware needed. It is necessary to update the required analysis glassware according to the project progress. The order of precedence of providing the required facilities will be considered on the following bases.

- In Phase-1, the glassware for drinking water test will be provided.
- In Phase-2 and long-term, all of the facility will be provided.

The list of glassware for drinking water test, wastewater test r, and industrial drainage is shown in **Tables 4.8.17.**

Table 4.8.17 List of Glassware for Drinking, Wastewater and Industrial Drainage Analysis

S.No.	Description	Existing Quantity	New Quantity	Phase-1	Phase-2	Long term
1	Evaporating basing					
1.1	Borosilicate glass, round bottom, with spout, capacity 150ml.		10	5	5	0
1.2	Porcelain, round bottom, deep form with spout, 150 ml.		10	5	5	0
2	Beakers - Borocilicate glass, low form, with graduation and spout					
2.1	Capacity, 50 ml		20	10	10	0
2.2	Capacity, 100 ml.		20	10	10	0
2.3	Capacity, 200 ml.		20	10	10	0
2.4	Capacity, 500 ml		20	10	10	0
2.5	Capacity, 800 ml		20	10	10	0
2.6	Capacity, 1000 ml		20	10	10	0
2.7	Capacity, 2000 ml		20	10	10	0
3	Glass bottles - Amber, Winchester with plastic cap and PVC liner					
3.1	Capacity 1000 ml		10	5	5	0
3.2	Capacity 500 ml.		20	10	10	0
3.3	Sample bottles 500ml		1000	500	500	0
4	Reagent bottles					
4.1	Clear glass, glass stopper, with dust proof cap., Capacity 250 ml		10	5	5	0
4.2	do Capacity 500 ml		10	5	5	0
4.3	Amber glass, glass stopper, with dust proof cap., Capacity 250 ml		10	5	5	0
4.4	do Capacity 500 ml		10	5	5	0
4.5	Clear glass, Narrow mouth, interchangeable glass stopper, Capacity 250 ml		10	5	5	0
4.6	Clear glass, Narrow mouth, interchangeable glass stopper, Capacity 500 ml		10	5	5	0
4.7	Bottles, BOD. With glass stopper, Capacity 300 ml.		30	15	15	0
5	Bottles					
5.1	Bottles, polypropylene, translucent, narrow neck, screw cap, capacity 500 ml		10	5	5	0
5.2	Bottles, polypropylene, translucent, narrow neck, screw cap, capacity 1000 ml		10	5	5	0
6	Glass dropping bottles,Amber soda - lime glass. Hexagonal with plastic cap, rubber teat and glass pipette					
6.1	do Capacity 10 ml		10	5	5	0
6.2	do Capacity 10 ml		10	5	5	0
6.3	Clear glass with stopper, vinyl teat and glass stopper. Capacity 125 ml		10	5	5	0
6.4	Clear glass with plastic stopper, vinyl teat and graduated pipette, capacity 125 ml, pipette 1 x 0.5 ml		10	5	5	0
6.5	do Capacity 250 ml, pipette 8 x 0.2 ml.		10	5	5	0
6.6	do Capacity 500 ml, pipette 10 x 0.2 ml.		10	5	5	0
7	Brushes					
7.1	Brushes, beakers bristle head 70 mm dia x 150 mm long, on wood handle.		10	5	5	0
7.2	Brushes, bottle, bristle or nylon head on wire handle 50 x 60 mm 300 mm length		10	5	5	0
7.3	Brushes, burette, do dia 19 mm length 750 m.		10	5	5	0
7.4	Brushes, Cylinder, Nylon fan shaped end of wire handle,75 x 140 mm		10	5	5	0
7.5	Brushes, Tube , Nylon 70 mm long set in the centre of wire handle.		10	5	5	0
8	Buckets - plastic with spout and lid, capacity 5 l.		2	2	0	0
9	Bulbs					
9.1	PVC pear shape, Capacity 60 ml		10	5	5	0
9.2	do Capacity 100 ml		10	5	5	0
9.3	Pipettes , Chemically resistant rubber with valves for suction,		10	5	5	0
10	Burette with glass stopcock, soda lime, Class A, Capacity 50 x 0.10 ml		20	10	10	0
11	Burners					
11.1	with air regulator for LPG, 10 mm. dia.		2	1	1	0
11.2	maker pattern for LPG 20 mm. dia.		2	1	1	0
11.3	burner, Liquid fuel ,glass reservoir with wick and glass, capacity 50 ml.		2	1	1	0
12	Cylinders measuring, glass with spout and glass foot, with amber colour graduation, Class A					
12.1	Capacity 5 ml. subdivision 0.1		10	5	5	0
12.2	Capacity 10 ml. subdivision 0.2		10	5	5	0
12.3	Capacity 25 ml. subdivision 0.5		10	5	5	0
12.4	Capacity 50 ml. subdivision 1.0		10	5	5	0
12.5	Capacity 100 ml. subdivision 1.0		10	5	5	0
12.6	Capacity 250 ml. subdivision 2.0		10	5	5	0
12.7	Capacity 500 ml. subdivision 5.0		10	5	5	0
12.8	Capacity 1000 ml subdivision 10.0		5	5	0	0
12.9	Capacity 2000 ml. subdivision 20.0		5	5	0	0
13	Filter papers, quantitative grades					
13.1	Whatman No. 40 or equivalent		1000	500	500	0
13.2	Whatman No. 41 or equivalent		1000	500	500	0
13.3	Whatman No. 42 or equivalent		1000	500	500	0
13.4	Whatman No. 44 or equivalent		1000	500	500	0
13.5	Hardened ashless, Whatman No. 540 or equivalent (100/unit)		10	5	5	0

S.No.	Description	Existing Quantity	New Quantity	Phase-1	Phase-2	Long term
14	Flask, borosilicate glass, flat bottom, narrow neck, comply with ISO 1773					
14.1	Capacity 50 ml		10	5	5	0
14.2	Capacity 100 ml		10	5	5	0
14.3	Capacity 250 ml		10	5	5	0
14.4	Capacity 500 ml		10	5	5	0
14.5	Capacity 1000 ml		10	5	5	0
14.6	Capacity 2000 ml		10	5	5	0
15	Flask, borocilicate glass, round bottom, wide neck, comply with ISO 1773					
15.1	Capacity 50 ml		10	5	5	0
15.2	Capacity 100 ml		10	5	5	0
15.3	Capacity 250 ml		10	5	5	0
15.4	Capacity 500 ml		10	5	5	0
15.5	Capacity 1000 ml		10	5	5	0
15.6	Capacity 2000 ml		10	5	5	0
16	Supports for above flasks, cork rings, compressed, thickness 45 mm, approx.					
16.1	o.d. 75 x i.d. 45 mm. approximately		5	2	3	0
16.2	o.d. 115 x i.d. 85 mm. approximately		5	2	3	0
16.3	o.d. 150 x i.d. 120 mm. approximately		5	2	3	0
16.4	o.d. 195 x i.d. 160 mm. approximately		5	2	3	0
16.5	o.d. 240 x i.d. 200 mm. approximately		5	2	3	0
17	Flask, Erlenmeyer, narrow neck, graduated, comply with ISO 1773					
17.1	Capacity 5 ml.		10	5	5	0
17.2	Capacity 10 ml.		10	5	5	0
17.3	Capacity 25 ml.		10	5	5	0
17.4	Capacity 50 ml.		10	5	5	0
17.5	Capacity 100 ml.		10	5	5	0
17.6	Capacity 200 ml.		10	5	5	0
17.7	Capacity 250 ml.		10	5	5	0
17.8	Capacity 300 ml.		10	5	5	0
17.9	Capacity 500 ml.		10	5	5	0
17.1	Capacity 1000 ml.		10	5	5	0
17.11	Capacity 2000 ml.		5	5	0	0
18	Flask, erlenmeyer, wide neck, graduated, comply with ISO 1773					
18.1	Capacity 5 ml.		10	5	5	0
18.2	Capacity 10 ml.		10	5	5	0
18.3	Capacity 25 ml.		10	5	5	0
18.4	Capacity 50 ml.		10	5	5	0
18.5	Capacity 100 ml.		10	5	5	0
18.6	Capacity 200 ml.		10	5	5	0
18.7	Capacity 250 ml.		10	5	5	0
18.8	Capacity 300 ml.		10	5	5	0
18.9	Capacity 500 ml.		10	5	5	0
18.1	Capacity 1000 ml.		5	5	0	0
19	Flask, Buchner filter, heavy wall, integral side arm for 9 mm. bore, comply with ISO 6556					
19.1	Capacity 500 ml.		5	5	0	0
19.2	Capacity 1000 ml.		5	5	0	0
20	Flask, volumetric, clear glass, borosilicate, with polypropylene stopper, flat bottom, Class A					
20.1	Capacity 5 ml.		10	5	5	0
20.2	Capacity 10 ml.		10	5	5	0
20.3	Capacity 20 ml.		10	5	5	0
20.4	Capacity 25 ml.		10	5	5	0
20.5	Capacity 50 ml.		10	5	5	0
20.6	Capacity 100 ml.		10	5	5	0
20.7	Capacity 200 ml.		10	5	5	0
20.8	Capacity 250 ml.		10	5	5	0
20.9	Capacity 500 ml.		10	5	5	0
20.10	Capacity 1000 ml.		10	5	5	0
21	Flask, volumetric, flat bottom, clear glass, borocilicate, with glass stopper, Class A.					
21.1	Capacity 5ml		10	5	5	0
21.2	Capacity 10 ml.		10	5	5	0
21.3	Capacity 20 ml		10	5	5	0
21.4	Capacity 25 ml		10	5	5	0
21.5	Capacity 50 ml		10	5	5	0
21.6	Capacity 100 ml		10	5	5	0
21.7	Capacity 200 ml		10	5	5	0
21.8	Capacity 250 ml		10	5	5	0
21.9	Capacity 500 ml		10	5	5	0
21.1	Capacity 1000 ml		10	5	5	0

S.No.	Description	Existing Quantity	New Quantity	Phase-1	Phase-2	Long term
22	Glass funnels					
22.1	Top diameter 50 mm. approximately.		10	5	5	0
22.2	Top diameter 75 mm. approximately.		10	5	5	0
22.3	Top diameter 100 mm. approximately.		10	5	5	0
22.4	Top diameter 200 mm. approximately.		10	5	5	0
23	Funnels, separating, with glass stopper, conical shape.					
23.1	Capacity 50 ml.		10	5	5	0
23.2	Capacity 100 ml.		10	5	5	0
23.3	Capacity 250 ml.		10	5	5	0
23.4	Capacity 500 ml.		10	5	5	0
23.5	Capacity 1000 ml.		10	5	5	0
24	Gauzes. iron wire with ceramic centre 150 x 150 mm. approx		10	5	5	0
25	Safety gloves, provide protection at high temperature, washable terry clothe, size medium.		5	5	0	0
26	Safety goggles, light weight		2	2	0	0
27	Mortar and pestles, porcelain, unglazed, dia. 100 mm. approx.		5	2	0	0
28	Pipettes, bulb. borosilicate glass, ring mark amber stain., Class A					
28.1	1 ml.		10	5	5	0
28.2	2 ml.		10	5	5	0
28.3	3 ml.		10	5	5	0
28.4	5 ml.		10	5	5	0
28.5	10 ml.		10	5	5	0
28.6	20 ml.		10	5	5	0
28.7	25 ml.		10	5	5	0
28.8	50 ml.		10	5	5	0
29	Pipettes, graduated, borosilicate glass, calibrated for delivery from zero at top.					
29.1	Capacity 1 ml. grad. 0.10		10	5	5	0
29.2	Capacity 2 ml. grad. 0.02		10	5	5	0
29.3	Capacity 5 ml. grad. 0.10		10	5	5	0
29.4	Capacity 10 ml. grad. 0.10		10	5	5	0
30	Pipette stand, hard wood, for holding up to 10 min. horizontally.		5	5	0	0
31	Pipette rinser. for pipettes up to 460 mm long. with automatic fill/drain repeat siphoning cycle, made of		2	2	0	0
32	Water sampler, depth made with stainless steel or olypropylene, with inlet and outlet ports nylon cord 10 m,		1	1	0	0
33	Spatula					
33.1	Chattaway pattern, length 100 mm.		5	2	3	0
33.2	Chattaway pattern, length 150 mm.		5	2	3	0
33.3	Chattaway pattern, length 200 mm.		5	2	3	0
33.4	Stainless steel, spoon one end. length 150 mm.		5	2	3	0
33.5	Stainless steel, spoon one end. length 200 mm.		5	2	3	0
34	Funnel stand, hard wood or polyethylene, base 300 x 200 mm approx. for two conical funnels.		5	2	3	0
35	Clamp for burettes, hold two burettes, with rubber grips		5	2	3	0
36	Stand for separating funnels Stand, corrosion resistant, rod position edge, base 170 x 250 x 50 mm and rod		5	2	3	0
37	Retort rings					
37.1	Retort rings (section cut out and rubber coating) for above dia. 50 mm. approx. dia. 75 mm..		5	2	3	0
37.2	do dia. 100 mm. Approximately		5	2	3	0
38	Tripods, cast iron, rectangular top, side length 125 mm.		5	2	3	0
39	Tongs					
39.1	Tongs for crucible, stainless steel, with bow. Length 200mm. Approximately		2	1	1	0
39.2	Tongs for beaker, stainless steel, with bow. Length 350 mm. Approximately		2	1	1	0
39.3	Tongs for flask, stainless steel, extended handle, Length 350 mm. Approximately		2	1	1	0
40	Wash bottles, narrow neck, with swan neck jet and screw cap, made with polyethylene. capacity 250 ml.		10	5	5	0
41	Distillation unit, quick fit.					
41.1	Flask boiling, borosilicate glass, narrow long neck, capacity 500 ml. 24/29		5	2	3	0
41.2	Adapter, borosilicate, receiver for above, socket size 24/29 cone 24/29		5	2	3	0
41.3	Condenser, borosilicate, outer water jacket, one end plane,upper end socket 24 / 29		5	2	3	0
41.4	Flask boiling, borosilicate glass, narrow long neck, capacity 50 ml. 24/29		5	2	3	0
41.5	Flask boiling, borosilicate glass, narrow long neck, capacity 100 ml. 24/30		5	2	3	0
42	Flexible vacuum tubing, dia 9 mm.		10	5	5	0
43	Glass beads to prevent bumping while boiling liquids		1	1	0	0
44	Desiccators borosilicate Glass, Knob Lid, with disc					
44.1	Internal diameter - 100 mm		2	1	1	0
44.2	internal diameter - 200 mm		2	1	1	0
44.3	Internal diameter - 250 mm		2	1	1	0
45	Thermometer general purpose, Nominal length 300mm., White back, Mercury filled.					
45.1	Range -10 -100 C		5	2	3	0
45.2	Range -10 -250 C		5	2	3	0
46	Stirring rods borosilicate glass, dia. 0.6 mm. Length 200 mm. approximately		20	10	10	0

Source: WASA Water Laboratory, September, 2009

e) Glassware for Microbiological Laboratory

Facility status is the same as that of the above d). The order of precedence of providing the required facilities will be considered on the following bases.

- In Phase-1, the glassware for drinking water test will be provided.
- In Phase-2 and long-term, all of the facility will be provided.

The list of glassware for microbiological test is shown in **Tables 4.8.18**.

Table 4.8.18 List of Glassware for Microbiological Laboratory
（図変更済）

S.No.	Description	Existing Quantity	New Quantity	Phase-1	Phase-2	Long term
1	Bottles					
1.1	Borosilicate glass, wide mouth, glass stopper, autoclavable at 120o C, capacity 300 ml		50	25	25	0
1.2	Borosilicate glass, wide mouth, with aluminium screw cap, autoclavable at 120o C, capacity 14 ml min.		100	50	50	0
2	Beakers, borosilicate glass, low form, with graduation and spout, conform to ISO 3819					
2.1	Capacity 50 ml.		5	2	3	0
2.2	Capacity 100 ml.		5	2	3	0
2.3	Capacity 250 ml.		5	2	3	0
2.4	Capacity 500ml.		5	2	3	0
2.5	Capacity1000 ml.		5	2	3	0
2.6	Capacity 2000 ml.		5	2	3	0
2.7	Capacity3000 ml.		5	2	3	0
3	Brushes					
3.1	Brushes, beakers bristle or nylon head 70 mm. dia. x 150 mm long, on wood handle		5	2	3	0
3.2	Brushes, bottle, bristle or nylon head on wire handle 50 x 60 mm. 300 mm long.		5	2	3	0
3.3	Brushes, cylinder, bristle or nylon head on wire handle 75 x 140 mm. 300 mm long.		5	2	3	0
4	Bulbs					
4.1	Bulbs. PVC or rubber, pear shape, capacity 60 ml		5	2	3	0
4.2	Bulbs. PVC or rubber, pear shape, capacity 100 ml		5	2	3	0
5	Burner with air regulator for LPG, 11mm. Dia.		2	1	1	0
6	Cylinders measuring, glass with spout and glass foot, with amber colour graduation.					
6.1	capacity 5 ml. Sub division 0.1		5	2	3	0
6.2	capacity 10 ml. Sub division 0.2		5	2	3	0
6.3	capacity 25 ml. Sub division 0.5		5	2	3	0
6.4	capacity 50 ml. Sub division 1.0		5	2	3	0
6.5	capacity 100 ml. Sub division 1.0		5	2	3	0
6.6	capacity 250 ml. Sub division 2.0		5	2	3	0
6.7	capacity 500 ml. Sub division 5.0		5	2	3	0
6.8	capacity 1000 ml. Sub division 10.0		5	2	3	0
7	Flask, borosilicate glass, round bottom, wide neck, comply with ISO 1773					
7.1	capacity 250 ml.		5	2	3	0
7.2	capacity 500 ml.		5	2	3	0
7.3	capacity 1000 ml.		5	2	3	0
8	Flask, Erlenmeyer, wide neck, graduated, comply with ISO 1773					
8.1	capacity 250 ml.		5	2	3	0
8.2	capacity 500 ml.		5	2	3	0
8.3	capacity 1000 ml.		5	2	3	0
9	Gauzes, iron wire with ceramic centre 150*150 mm. (approx)		5	2	3	0
10	Pipettes, graduated, borosilicate glass, calibrated for delivery from zero.					
10.1	capacity 1 ml.		25	10	15	0
10.2	capacity 2 ml.		25	10	15	0
10.3	capacity 5 ml.		25	10	15	0
10.4	capacity 10 ml.		25	10	15	0
11	Pipettes rinser, for pipettes up to 460 mm long with automatic fill/drain repeat siphoning cycle, made of polyethylene.		1	1	0	0
12	Spatula					
12.1	stainless steel, spoon one end, length 150 mm.		5	2	3	0
12.2	stainless steel, spoon one end, length 200 mm.		5	2	3	0
13	Tripod, cast iron, rectangular top, side length 125 mm		5	2	3	0
14	Tongs for beaker, stainless steel, with bow length 350 mm. Approx.		2	1	1	0
15	LP Gas cylinder with regulator and rubber tubes, standard		1	1	0	0
	Total		406	179	227	0

Source: WASA Water Laboratory, September, 2009

f) In addition to above facts

The water analysis activities have the following factors which are not covered by usual analysis, Since related facilities have not been improved, consequentially the requests activities cannot be undertaken immediately. Furthermore, the pendency of sampling of water due to shortage of time and resource is a matter of concern because it is directly related to the civic health. It is, therefore, necessary to improve related

facilities immediately.

- Probing of abnormal quality of drinking water, sampling, and the water analysis,
- Sampling of water from resource and from distribution taps and water analysis,
- Visit area of frequent complaint and obtained information to analyze reasons,
- Data analysis and report writing, suggest measures of prevention of contamination and improvement of Water Quality,

The order of precedence of providing the required facilities required will be considered on the following bases.

- In Phase-1, the facility required for renewal of a vehicles and speeding up of activities will be provided.
- In Phase-2 and long-term, all of the remaining facilities will be provided.

The main list of the other related facility is shown in **Tables 4.8.19**.

Table 4.8.19 List of Other Related Facility

Others:

S.No.	Description	Existing Quantity	New Quantity	Phase-1	Phase-2	Long term
1	Vehicles					
1.1	Sampling Van (800cc)	2(old)	2	2	0	0
1.2	Small Vehicls (for field inspection/visit)	0	2	2	0	0
2	Photocopier Machine		1	1	0	0
3	Heavy duty printer (laser)		1	1	0	0
4	Sui gas connection		0	1	0	0
	Total		6	7	0	0

Communiction:

S.No.	Description	Existing Quantity	New Quantity	Phase-1	Phase-2	Long term
1	Laptop (Intel)		1	1	0	0
2	Internet connection (DSL)		0	0	0	0
3	Computer (P4)		4	1	3	0
4	Wireless Phone set (for field) (any with good signals)		2	1	1	0
	Total		7	3	4	0

Source: WASA Water Laboratory, September, 2009

2） Simple Wastewater Analysis Rooms (6No.s)

The wastewater examination facility to be provided in the six sewerage treatment plants is shown below.

- Wastewater testing laboratories
- Glassware for Wastewater Treatment Plants

a) Wastewater Testing Laboratories

Six simple new wastewater testing rooms will be provided at each plant according to the building plan of the sewerage treatment plant. The main analysis activities will be as follows.

- Routine wastewater examination,
- Patrol for wastewater quality inspection and for verification of operational conditions,
- Checking examining of wastewater treatment facility for troubleshooting the cause of poor performance,

The order of precedence of providing the required facilities will be considered on the following bases.

- In Phase-1, the facilities will not be provided.
- In Phase-2 and long-term, all of the facilities will be provided.

The main list of the laboratory facilities is shown in **Tables 4.8. 20**.

Table 4.8.20 List of Laboratory Facilities for Wastewater Treatment Plants (6 No's)

S.No.	Description	Existing	New	Phase-1	Phase-2	Long term
		Quantity	Quantity			
1	Digital Turbidity Meter:	0	6	0	3	3
2	Micro-biological Testing Kit:	0	6	0	3	3
3	Dissolved Oxygen/BOD Meter:	0	6	0	3	3
4	Conductivity/TDS Meter:	0	6	0	3	3
5	pH Meter:	0	6	0	3	3
6	Analytical Balance:	0	6	0	3	3
7	Distillation System:	0	6	0	3	3
8	Oven:	0	6	0	3	3
9	Chorine Meter:	0	6	0	3	3
10	COD Apparatus:	0	6	0	3	3
11	Incubator:	0	6	0	3	3
12	Autoclave:	0	6	0	3	3
15	Refrigerator:	0	6	0	3	3
16	Arsenic kit:	0	6	0	3	3
17	Computer with Printer:	0	6	0	3	3
	Total	0	90	0	45	45

Source: WASA Water Laboratory, September, 2009

b) Glassware for Wastewater Treatment Plants

Facility status is the same as that of the above a). The order of precedence of providing the required facilities will be considered on the following bases.

- In Phase-1, the facilities will not be provided.
- In Phase-2 and long-term, all of the facilities will be provided.

The main list of the laboratory facilities is shown in **Tables 4.8.21**.

Table 4.8.21 List of Glassware for Wastewater Treatment Plants

S.No.	Description	Existing Quantity	New Quantity	Phase-1	Phase-2	Long term
1	Beakers - Borocilicate glass, low form, with graduation and spout, Conform to ISO 3819					
1.1	Capacity, 50 ml		10	0	5	5
1.2	Capacity, 100 ml.		10	0	5	5
1.3	Capacity, 200 ml.		10	0	5	5
1.4	Capacity, 500 ml		10	0	5	5
1.5	Capacity, 800 ml		10	0	5	5
1.6	Capacity, 1000 ml		10	0	5	5
1.7	Capacity, 2000 ml		10	0	5	5
2	Glass bottles - Amber, Winchester with plastic cap and PVC liner			0		
2.1	Capacity 1000 ml		10	0	5	5
2.2	Capacity 500 ml.		20	0	10	10
2.3	Sample bottles 500ml		500	0	200	300
3	Reagent bottles			0		
3.1	Clear glass, glass stopper, with dust proof cap., Capacity 250 ml		10	0	5	5
3.2	do Capacity 500 ml		10	0	5	5
3.3	Amber glass, glass stopper, with dust proof cap., Capacity 250 ml		10	0	5	5
3.4	do Capacity 500 ml		10	0	5	5
3.5	Clear glass, Narrow mouth, interchangeable glass stopper, Capacity 250 ml		10	0	5	5
3.6	Clear glass, Narrow mouth, interchangeable glass stopper, Capacity 500 ml		10	0	5	5
3.7	Bottles, BOD. With glass stopper, Capacity 300 ml.		10	0	5	5
4	Brushes					
4.1	Brushes, beakers bristle head 70 mm dia x 150 mm long, on wood handle.		10	0	5	5
4.2	Brushes, bottle, bristle or nylon head on wire handle 50 x 60 mm 300 mm length		10	0	5	5
4.3	Brushes, burette, do dia 19 mm length 750 m.		10	0	5	5
4.4	Brushes, Cylinder, Nylon fan shaped end of wire handle, 75 x 140 mm		10	0	5	5
4.5	Brushes, Tube , Nylon 70 mm long set in the centre of wire handle.		10	0	5	5
5	Burette with glass stopcock, soda lime, Class A, Capacity 50 x 0.10 ml		20	0	10	10
6	Filter papers, quantitative grades					
6.1	Whatman No. 40 or equivalent		1000	0	500	500
6.2	Whatman No. 41 or equivalent		1000	0	500	500
6.3	Whatman No. 42 or equivalent		1000	0	500	500
6.4	Whatman No. 44 or equivalent		1000	0	500	500
6.5	Hardened ashless, Whatman No. 540 or equivalent		1000	0	500	500
7	Flask, borosilicate glass, flat bottom, narrow neck, comply with ISO 1773					
7.1	Capacity 50 ml		10	0	5	5
7.2	Capacity 100 ml		10	0	5	5
7.3	Capacity 250 ml		10	0	5	5
7.4	Capacity 500 ml		10	0	5	5
7.5	Capacity 1000 ml		10	0	5	5
7.6	Capacity 2000 ml		10	0	5	5
8	Flask, Erlenmeyer, narrow neck, graduated, comply with ISO 1773					
8.1	Capacity 5 ml.		10	0	5	5
8.2	Capacity 10 ml.		10	0	5	5
8.3	Capacity 25 ml.		10	0	5	5
8.4	Capacity 50 ml.		10	0	5	5
8.5	Capacity 100 ml.		10	0	5	5
8.6	Capacity 200 ml.		10	0	5	5
8.7	Capacity 250 ml.		10	0	5	5
8.8	Capacity 300 ml.		10	0	5	5
8.9	Capacity 500 ml.		10	0	5	5
8.1	Capacity 1000 ml.		10	0	5	5
8.11	Capacity 2000 ml.		5	0	2	3
9	Flask, volumetric, flat bottom, clear glass, borocilicate, with glass stopper, Class A.					
9.1	Capacity 5ml		10	0	5	5
9.2	Capacity 10 ml.		10	0	5	5
9.3	Capacity 20 ml		10	0	5	5
9.4	Capacity 25 ml		10	0	5	5
9.5	Capacity 50 ml		10	0	5	5
9.6	Capacity 100 ml		10	0	5	5
9.7	Capacity 200 ml		10	0	5	5
9.8	Capacity 250 ml		10	0	5	5
9.9	Capacity 500 ml		10	0	5	5
9.1	Capacity 1000 ml		10	0	5	5
10	Glass funnels					
10.1	Top diameter 50 mm. approximately.		10	0	5	5
10.2	Top diameter 75 mm. approximately.		10	0	5	5
10.3	Top diameter 100 mm. approximately.		10	0	5	5
10.4	Top diameter 200 mm. approximately.		10	0	5	5
11	Gauzes. iron wire with ceramic centre 150 x 150 mm. approx		10	0	5	5
12	Safety gloves, provide protection at high temperature, washable terry clothe, size medium.		5	0	2	3
13	Safety goggles, light weight		10	0	5	5
14	Mortar and pestles, porcelain, unglazed, dia. 100 mm. approx.		5	0	2	3

S.No.	Description	Existing Quantity	New Quantity	Phase-1	Phase-2	Long term
15	Pipettes, bulb. borosilicate glass, ring mark amber stain., Class A					
15.1	1 ml.		10	0	5	5
15.2	2 ml.		10	0	5	5
15.3	3 ml.		10	0	5	5
15.4	5 ml.		10	0	5	5
15.5	10 ml.		10	0	5	5
15.6	20 ml.		10	0	5	5
15.7	25 ml.		10	0	5	5
15.8	50 ml.		10	0	5	5
16	Spatula					
16.1	Chattaway pattern, length 100 mm.		5	0	2	3
16.2	Chattaway pattern, length 150 mm.		5	0	2	3
16.3	Chattaway pattern, length 200 mm.		5	0	2	3
16.4	Stainless steel, spoon one end. length 150 mm.		5	0	2	3
16.5	Stainless steel, spoon one end. length 200 mm.		5	0	2	3
17	Funnel stand, hard wood or polyethylene, base 300 x 200 mm approx. for two conical funnels.		5	0	2	3
18	Tongs					
18.1	Tongs for crucible, stainless steel, with bow. Length 200mm. Approximately		2	0	1	1
18.2	Tongs for beaker, stainless steel, with bow. Length 350 mm. Approximately		2	0	1	1
18.3	Tongs for flask, stainless steel, extended handle, Length 350 mm. Approximately		2	0	1	1
19	Distillation unit, quick fit.					
19.1	Flask boiling, borosilicate glass, narrow long neck, capacity 500 ml. 24/29		10	0	5	5
19.2	Adapter, borosilicate, receiver for above, socket size 24/29 cone 24/29		10	0	5	5
19.3	Condenser, borosilicate, outer water jacket, one end plane,		10	0	5	5
19.4	upper end socket 24 / 29		10	0	5	5
19.5	Flask boiling, borosilicate glass, narrow long neck, capacity 50 ml. 24/29		10	0	5	5
19.6	Flask boiling, borosilicate glass, narrow long neck, capacity 100 ml. 24/30		10	0	5	5
20	Desiccators borosilicate Glass, Knob Lid, with disc					
20.1	Internal diameter - 100 mm		2	0	1	1
20.2	internal diameter - 200 mm		2	0	1	1
20.3	Internal diameter - 250 mm		2	0	1	1
21	Thermometer general purpose, Nominal length 300mm., White back, Mercury filled.					
21.1	Range -10 -100 C		5	0	2	3
21.2	Range -10 -250 C		5	0	2	3
	Total		6,267	0	3,078	3,189

Source: WASA Water Laboratory, September, 2009

(7) Vehicles for Employees' Transportation

The conveyance vehicles of the employees for WASA field offices in an emergency and the vehicles for inspectors of water meter are required. The order of precedence of providing the required facilities will be considered on the following bases.

- In Phase-1, the minimum number of facilities will be provided.
- In Phase-2 and long-term, all of the facilities will be provided.

The main list of the laboratory facilities is shown in **Tables 4.8.22**.

Table 4.8.22 List of Vehicles

Description	Existing	Request	Phase-1	Phase-2	Long-term
For WASA Head Office, 800cc for field visit	0	8	3	5	3
For Water meter repair work shop, 800cc field inspection	0	1	1	0	0
Total	0	9	4	5	3

(8) Performance Inspection Apparatus

On-site inspection apparatus is a means for checking the potential break of performance of a facility in the field. Subsequent to the periodical inspection and sampling collection data has to be analyzed in order to make a maintenance schedule of the facilities. The main on-site checking bases are shown below.

- Tube wells (Residual chlorine Meters)
  - If the apparatus runs short, residual chlorine monitoring is not carried out. The apparatus which can measure the residual chlorine in the field periodically there is required.
- Wastewater Pumping Stations
  - If the apparatus runs short, pumping performance monitoring is not carried out. The apparatus which can measure flow, vibration and current periodically is required.

The order of precedence of providing the required facilities will be considered on the following bases.

- In Phase-1, the minimum number of facilities will be provided.
- In Phase-2 and long-term, all of the facilities will be provided.

The main list of the apparatus is shown in **Tables 4.8.23**.

Table 4.8.23 List of Measuring Apparatus

Name	Existing	Request	Phase-1	Phase-2	Long-term
1) For Tube wells:					
-Portable residual chlorine meters, Range: 1-5ppm	0	450	50	200	200
Sub Total	0	450	50	200	200
2) For Pumping Stations					
-Potable flow meters	0	100	10	40	50
-Vibration gauges	0	100	10	40	50
-Rotating meters	0	100	10	40	50
-Ampere meters	0	100	10	40	50
Sub Total	0	400	40	160	200

Appendix 10.9 Questionnaire on Customer Satisfaction (Proposed)

INTERVIERWER TO COMPLETE

DATE: _____
Time: _____
Interviewer Name: _____
Int. Type: Household □ Commercial □
Location: _____

Introduction: Hello. My name is from a company called XXXXX., a private research company based in Lahore. We are conducting a survey on water. We want to know how customers feel about various aspects of WASA's operations and services, and also about regulation of services.

Your household / business-place has been selected randomly, and we are inviting you to take part. The interview will last approximately 30 minutes and all information will be confidential. First, we need to identify whether you are the person we need to interview at this location.

A. SCREENER:	Yes	No	DK/NA	
Household				
1. Does your household use any water?				
2. [If "Yes"] Does any household member work for the WASA providing water services?				End if “Yes”
3. [If "No"] Are you the last household member to celebrate a birthday?				If “No”, ID correct person
4. [If "Yes"] Are you a full member of this household [eat & sleep together under same roof for 4 or more nights / week]?				End if “No”
5. Are you the head of the household?				Continue
6. [If "Yes"] Are you between the ages of 15 and 74 years?				End if “No” If “Yes”; Q.9
Commercial				
7. Does your business-place use any water?				End if “No”
8. [If "Yes"] Are you qualified to answer questions about these services on behalf of the business [e.g. General Manager / Managing Director / Operations Manager / Financial Manager]				If “No”, ID correct person
9. [All] [If "Yes"] May I interview you? / think you will find it interesting.				If “Yes”, Start interview

DK/NA: Don’t know/No answer

USING WASA's COMPLAINT CENTRES:

Tell me specifically, what has been your experience in using the WASA's complaint centre.

1. Tele-answer-time:

_____

_____

2. Resolving issues:

_____

_____

3. Improvement needed:

_____

_____

CUSTOMER SERVICE

How important is each of these types of service to you?

1. Here, use any number from "1" to "5". "1" is "not at all important" or "very poor" and "5" is "very important" or "very good"

Question	Evaluation "1" to "5"
b. How convenient service locations are	
c. How willing staff is to assist customers	
d. How professional staff is	
e. How adequate the tele-call centre system is	
f. How good wait-time for service is (all locations)	
g. How well staff know products & services	
h. How staff responds to queries & complaints	
i. How fast staff solves complaints	
j. How thorough staff conducts investigations	
k. How good the public education is	
I. Whether staff does much more than you expect	
m. How valued staff makes customers feel	

DK/NA: Don't know/No answer

2. For water service, tell me: (i) how important each aspect is, i.e. from "1" to "5", where "1" is "not at all important" and "5" is very important"; and (ii) how satisfied you are with WASA performance.

	(i)	(ii)					
	IMP	NA/DK	Very satisfied	Quite satisfied	Neither satisfied nor dissatisfied	Quite dissatisfied	Very dissatisfied
a. Consistency of service to the public							
b. Quality of water service to your premises							
c. Accuracy of billing for service provided							
d. Proper calculation of estimated bills							
e. Timely receipt of bills							
f. Adequacy of customer-communication							
g. Adequacy of customer query options,							
h. Professionalism of service reps.							
i. Management of queries and/or claims							
j. Proper investigations of complaints							

3. Tell me (i) whether you have ever heard about each of the following service standards for WASA; (ii) how important you think each one is, as a guaranteed standard to consumers. Use any number from "1" to "5"; "1" is "not at all important" and "5" is "very important" ["0" = DK]; and (iii) how satisfied you are with these as standards.

	(i)Aware?		(ii) How important?	(iii) Satisfaction		
	Yes	No		Not at all	Quite	Very
a. Meter reading: Max of 2 months between each meter reading and between bill issues.						
b. Reconnection: Max of 24 hours to restore supply in urban areas and 48 hours in rural areas.						
c. Payment of Compensation: Compensation amounting to 4 times the applicable service charge.						

DK/NA: Don’t know/No answer

4. Please indicate whether you "agree" or "disagree" with each of the following statements, and how strongly:

	(i)	(ii)					
	IMP	NA/DK	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree
a. They make information easily available to consumers.							
b. It is now easy to find information about them on the Internet.							
c. They offer better service.							
e. When they changed to bill payment centres, customer service got worse.							
f. I feel very confident in the WASA's interactions with customers							

DK/NA: Don't know/No answer

BACKGROUND INFORMATION

1. Utility Expenditures: About how much is regularly spent for the WASA?

Water bill: Rs._____

2. Readings: How well can an office/ household member read each of? ["5"=very well; "1" = not at all]:

Bills: Rs._____

Meters: Rs._____

3. Interest in reading: How interested are you in learning to read bills & meters?

□ Not at all

□ Only a little

□ Moderately interested

□ Very interested

□ DK / not sure

HOUSEHOLDS ONLY

1. Gender: □ Male □ Female

2. Age: _____

3. Composition: How many persons are in your household?

_____

4. Income:

□ Rs.5,000 or less
□ Rs.5,000 to Rs. 10,000
□ Rs.10,000 to Rs. 15,000
□ Rs.15,000 to Rs. 20,000
□ Rs.20,000 to Rs. 30,000
□ More than Rs.30,000

COMMERCIAL ONLY

1. Gender: □ Male □ Female
2. Position: What is your position or title?

_____

3. Composition: Approx, how many persons are employed here?

□ Less than 10
□ 10 - 25
□ 26 - 49
□ 50 - 99
□ Over 100

4. How would you describe this business?

□ Manufacturing only
□ Manufacturing & retail
□ On site consumption
□ Guest House / Hotel
□ Service (consultancy)
□ Service (retail)
□ Others_____

Appendix 10.10 History of Groundwater Regulation in Tokyo

Over-pumping of groundwater in Lahore causes the chronic drawdown of groundwater and dissolution of arsenic. Groundwater regulation in Tokyo, Japan is strongly promoted under the situation of groundwater drawdown and ground subsidence (extension of zero meter area below the mean sea water level by groundwater over-pumping. The history of groundwater regulation will be useful for Lahore in future.

Background

Tokyo low lying area with a ground elevation of lower than eight meter is situated above a few meters to 70 m thick alluvium in the northern coastal area of the Tokyo Bay. The natural gas is dissolved underground. The ground subsidence hit its peak during the rapid economic growth and recorded an annual subsidence of 23.89 m in 1968 in Edogawa Ward and a cumulative subsidence of 4.50 m at the biggest subsidence point in 1980 after the topographic survey had commenced in 1918. Thereafter, the acts and ordinances have been enforced to regulate groundwater use and ground subsidence has shown the tendency to settle down in the downtown of Tokyo in the beginning of 1970's.

The maximum daily pumping discharge was 302,000 m3/day in 1968 which was reduced to 15,000 m3/day in 2004. The use of groundwater is for public bath.

There is no area that has recorded an annual subsidence of more than 2 cm since 1995 and more than 1 cm since 2003.

Ground Subsidence Mechanism by Groundwater Over-pumping

Ground subsidence by groundwater over-pumping occurs in accordance with the following mechanism:

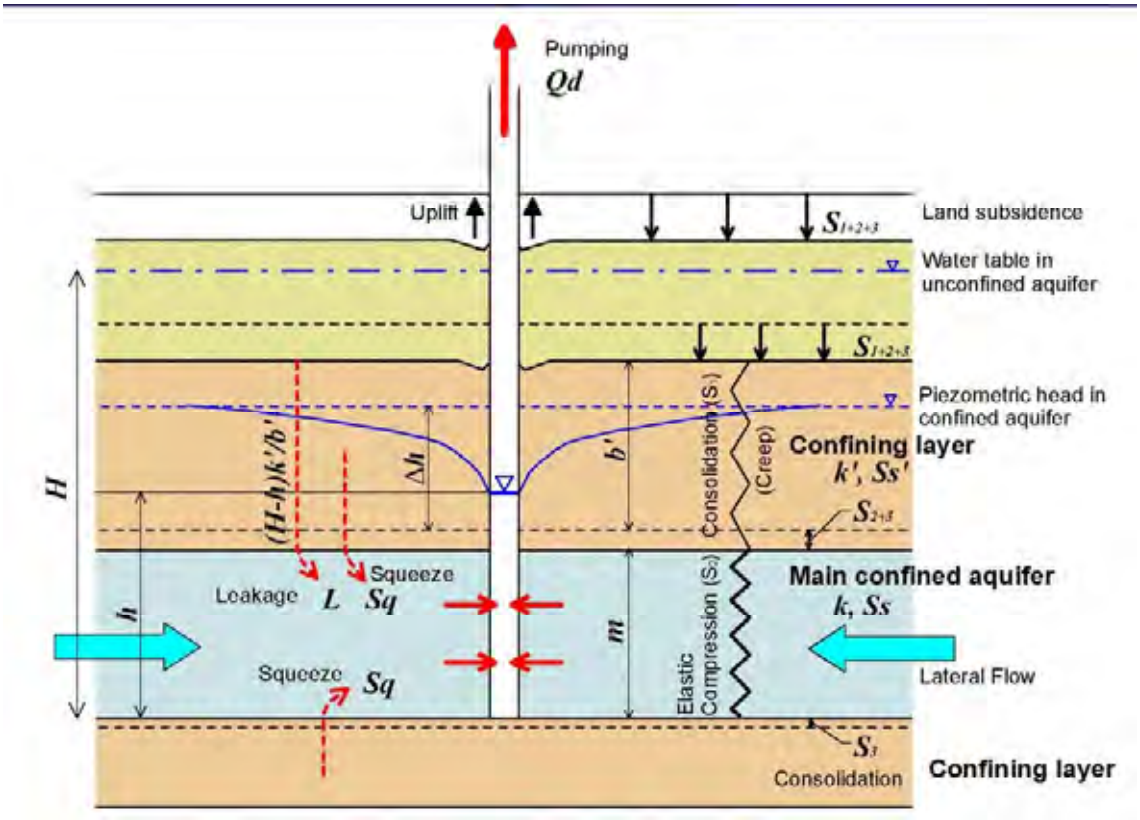


Figure Ground Subsidence Mechanism by Groundwater Over-pumping

Ground subsidence by groundwater over-pumping

↓

Drawdown of groundwater

↓

Squeezing of groundwater from a confining layer to an aquifer

↓

Consolidation of a confining layer

↓

Subsidence of the upper layer above a confining layer

(Occurrence of ground subsidence)

Flow of Groundwater Regulation

Groundwater regulation has advanced with steps of provision of alternative water source, compulsory conversion of water source, obligation installing a water meter and reporting an annual discharge, purchase of natural gas mining right and request for reasonable use of groundwater

1964 Industrial water supply as an alternative water source into operation

1965 Compulsory conversion of non-compliant wells to drinking water supply in ten areas based on the Building Water Act with no admittance of the vested right

1968 Record of an annual subsidence of 23.89 m

1973 Compulsory conversion of non-compliant wells to industrial water supply in Koto Area based on the Industrial Water Supply Act with no admittance of the vested right

1970 Enforcement of obligation installing a water meter and reporting an annual pumping discharge (once a year)

1972 Enforcement of designation of specified area and structural standards of wells through an ordinance for Public Nuisance Protection Act

1972 Purchase of natural gas mining right in the control area and suspension of pumping

1975 Request for reasonable use of groundwater to factories with a pumping discharge of more than 1,000 m^3/day

1978 Request for reasonable use of groundwater to factories with a pumping discharge of more than 500 m^3/day

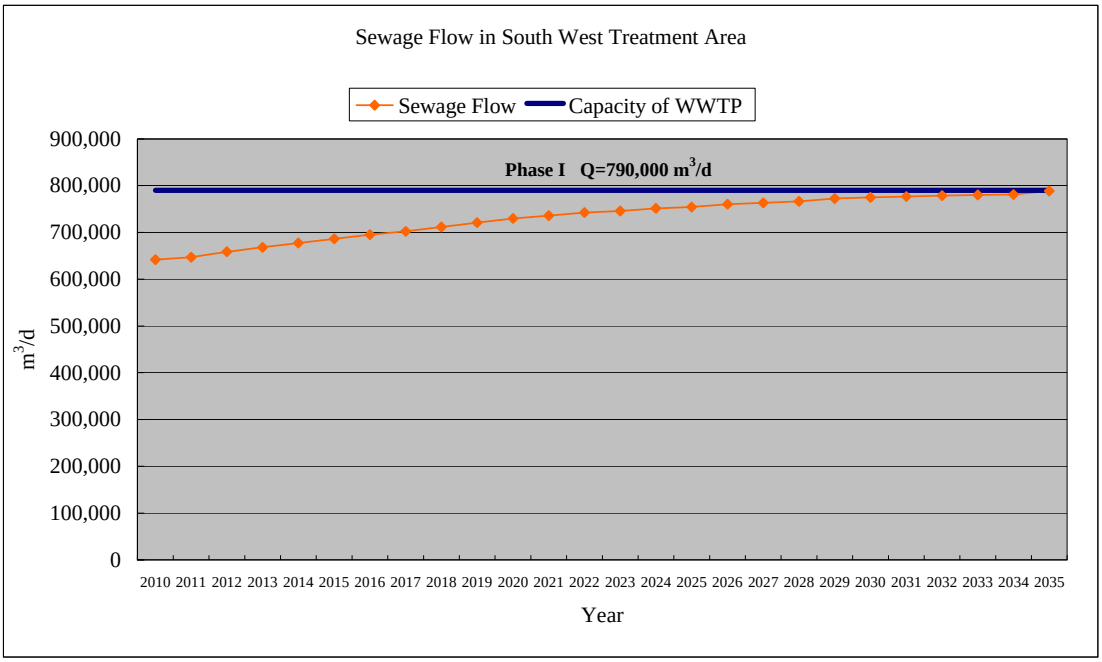
1981 Request for reasonable use of groundwater to factories with a pumping discharge of more than 250 m^3/day

Table of Structural Standards for Pumping Equipment (Wells)

Sectional area of delivery	Designated area	Position of strainer	Output of pump	Pumping discharge
Not more than 6 cm^2	23 wards 26 cities 2 towns	No limitation in depth	2.2 kw	Average Less than 10 m^3/day Maximum Less than 23 m^3/day
More than 6 cm^2 and Not more than 21 cm^2	Categorization into four areas responding the subsidence extent	Deeper than 650 m Deeper than 550 m Deeper than 500 m Deeper than 400 m		
More than 21 cm^2	23 wards 26 cities 2 towns	Prohibition of installation		

Appendix 13.1 Sewage flow in south west treatment area

	Year	2009	2012	2017	2022	2027	2032	2035
Population	Person	2,574,676	2,692,886	2,970,771	3,250,082	3,484,228	3,740,515	3,894,287
Sewered Ratio	%	84	86	89	92	95	98	100
Sewered Population	Person	2,162,728	2,312,112	2,642,798	2,992,025	3,315,592	3,675,430	3,894,287
Water Consumption per Capita	lpcd	225	220	209	198	185	171	164
Sewage Discharge per Capita	lpcd	225	220	209	198	185	171	164
Industrial sewage flow	(m^3/d)	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Sewage Flow	(m^3/d)	636,614	658,665	702,345	742,421	763,384	778,498	788,663
		81%	84%	89%	94%	97%	99%	100%



Appendix 13.2 Rough project cost estimation for wastewater treatment processes

Since rough cost comparison is the main purpose, it estimated with the ratio of the all method on the basis of the Activated sludge method.

1. Cost ratio of the each treatment method (It is based on the Activated Sludge method of 100%)

(1) Construction cost

Treatment Method	Construction Cost Ave. (US$/Person)	Construction Cost Ratio (%)
Stabilization Pond	70	***78***
Aerated Lagoon	45	***50***
Trickling Filter	60	***67***
UASB(+Secondary Process)	80	***89***
Oxidation Ditch	65	***72***
Activated Sludge	90	***100***

Source: Study report of waste water treatment processes in tropical and subtropical region
(Public Works Research Institute, Ministry of Land, Infrastructure and Transport, Japan 2001)

Note: (1) It is assumed that UASB process needs additionally treatment process because its removal ratio is inadequate.
Therefore, Cost of UASB method includes secondary process such as trickling filter.
(2)construction cost of Stabilization pond and Aerated Lagoon are based on the rough cost estimation.

(2) O&Mcost [Electricity]

Treatment Method	Required Power (W/Person)	O&M Cost Ratio (%) (Electricity)
Stabilization Pond	0	***0***
Aerated Lagoon	1.6	***75***
Trickling Filter	0.6	***28***
UASB(+Secondary Process)	0.5	***23***
Oxidation Ditch	2.75	***128***
Activated Sludge	2.15	***100***

Source: Study report of waste water treatment processes in tropical and subtropical region
(Public Works Research Institute, Ministry of Land, Infrastructure and Transport, Japan 2001)

Note : (1) Electricity of Inlet puping station is not included.
(2) O&M cost of Aerated lagoon is based on the assumed condition as follows.
[Hydraulic retention time is 3days and required energy is 5kw/1000m^3.]

(3) O&Mcost [Sludge Disposal]

Treatment Method	Sludge disposal volume (m^3/year)	O&M Cost Ratio (%) (Sludge Disposal)
Stabilization Pond (SP)	136,500	***88***
Aerated Lagoon (AL)	187,430	***121***
Trickling Filter (TF)	165,800	***107***
UASB(+Secondary Process)	82,900	***54***
Oxidation Ditch (OD)	116,000	***75***
Activated Sludge (AS)	154,700	***100***

Note : Estimation of Sludge volume is based on following assumptions.
SS concentration: Influent 350mg/l, Effluent 70mg/l
Sludge treatment process: Thickening + Digestion + Drying bed (Sludge Moisture Content=70%)
In case of SP and AL, Sludge is dewatered in the pond

(a)AS,TF: (350-70)×790,000×10^{-6}×0.575×100/(100-70)×365= 154,700 m^3/Year
(where: 0.575=Reduction rate by digestion, "Guidelines and Explanation for Planning and Design of Sewerage Facilities (2001 edition) P-341" [Japan Sewage Works Association])
(b) OD: (1)× 0.75 = 116,000 m^3/Ye (where: 0.75=Sludge generate rate , "Guidelines and Explanation for Planning and Design of Sewerage Facilities")
(c) UASB (+Secondary Process): (1)× 0.6= 92,800 m^3/Year
(d) AL: (350-70)×790,000×10^{-6}×0.65×100/(100-70)×365= 174,900 m^3/Year
(where: 0.65=Reduction rate of volatile solids, Metcalf and Eddy, "Wastewater Engineering-Fourth edition", pp. 851 Example 8-15, McGraw-Hill Inc. 2003)
(e) SP: AP; 0.04m^3/person/year×3,900,000person×0.5= 78,000 m^3/Yea (where: 0.5=Reduction rate by dewatering , Sludge moisture content from 85 to 70%)
FP; 0.03m^3/person/year×3,900,000person×0.5= 58,500 m^3/Yea SP total 78,000+58,500 = 136,500 m^3/Year
*Actual work of desludge for SP and AL will be done once in several years.

2. Unit cost of Activated Sludge Process

(1) Construction cost

Design Flow	250,000	(m3/d)
Construction Cost	5,379	(Million Rs)
Unit Construction Cost	21,516	(Rs/m3)

Source: PC-1 Form, Proforma for Development Projects For Drainage Project (Social Sector)
Construction of South West Wast WaterTreatment Plant Lahore, 2007 WASA
This PC-1 shows 5379 mil Rs of Activated Sludge process for 250,000m3/d.
Note : Inclusive sludge treatment faicilities

(2) O&M(Erectricity) cost

Design Flow	93,000 m^3/day				
Main Equipment	Nos.	Power (kW)	Ope.time (hr)	Power consumption (kWh/day)	
Primary Clarifier					
Sludge collector	8	0.75	1	6	
Sludge pump	2	5.5	12	132	
Aeration Tank					
Aerator	16	22	24	8448	
Mixer-I	8	3.7	24	710.4	
Mixer-II	16	3	24	1152	
Blower	4	200	24	19200	
Secondary Clarifier					
Sludge collector	8	2.2	24	422.4	
Return sludge pump	8	22	24	4224	
Waste sludge pump	2	3.7	16	118.4	
Others (25%of above)				8603.3	
Total				43,017	
Annual power requirement	43,017	× 31 day	× 12 month =	16,002,138	kWh/year
Annual unit power	16,002,138	÷ 93,000	=	172	kWh/m^3/year
Annual unit power cost	172	× 8	Rs/kWh =	1,377	Rs/m^3/year

Note: Specification of main equipment are based on the JBIC loan project, Pantai STP in Malaysia
Not include the electricity for inlet pumping station

(3) O&M(Sludge Disposal) cost

Sludge disposal volume	165,800	(m^3/year)
Unit cost for Sludge disposal	500	(Rs/m^3)
Sludge disposal Cost	82,900,000	(Rs/year)
Sludge disposal Cost per flow	105	(Rs/m^3/year)

(Design Flow = 790,000 m^3/day)

3. Unit cost of the each treatment method

Treatment Method	Construction Cost Ratio (%)	Construction Unit Cost (Rs/m^3)	O&M Cost Ratio			
			Electricity Cost Ratio (%)	Electricity Unit Cost (Rs/m^3/year)	Sludge Disposal Cost Ratio (%)	Sludge Disposal Unit Cost (Rs/m^3/year)
Stabilization Pond	78	***16,782***	0	***0***	88	***92***
Aerated Lagoon	50	***10,758***	75	***1,033***	121	***127***
Trickling Filter	67	***14,416***	28	***386***	107	***112***
UASB(+Secondary Process)	89	***19,149***	23	***317***	54	***57***
Oxidation Ditch	72	***15,492***	128	***1,763***	75	***79***
Activated Sludge	100	***21,516***	100	***1,377***	100	***105***

4. Rough cost estimate for the each treatment method

Design Flow : 790,000 m^3/day

Treatment Method	Construction Cost (Million Rs)	O&M Cost (30 years)		Land Acquisition (Million Rs)	Total (Million Rs)	Remarks
		Electricity (Million Rs)	Sludge Disposal (Million Rs)			
Stabilization Pond	14,397	0	2,180	1,139	17,716	
Aerated Lagoon	8,499	24,482	3,010	0	35,991	
Trickling Filter	11,389	9,148	2,654	0	23,191	
UASB(+Secondary Process)	15,128	7,513	1,351	0	23,992	
Oxidation Ditch	12,239	41,783	1,872	0	55,894	
Activated Sludge	16,998	32,635	2,487	0	52,120	

Note : (1) Electricity of Inlet puping station is not included.
(2) Cost for land purchase is estimated by information of "Lahore South-West WWTP, Review of Parameters (1994, Balfour Maunsell)"
This report shows that ultimate land requiremwnt is 684ha (16,411 Kanal). Therefore, additional land requirement is 9,111 Kanal .(16411-7300 [Existing
9,111 Kanal ×125,000 Rs/Kanal =Rs 1138.9 million

Appendix 13.3 Required area for waste stabilization pond

Treatment Volume (m^3/day)	Land Requirement (Hectar)			Total Area (incl. Common Area)	(Kanal)
	Anaerobic Ponds	Faculative Ponds	Net-total		
100,000	4.0	82.2	86.2	**107.8**	2,585
200,000	8.0	164.5	172.5	**215.6**	5,170
250,000	10.0	205.6	215.6	**269.5**	6,463
300,000	12.0	246.7	258.7	**323.4**	7,755
400,000	16.0	328.9	344.9	**431.2**	10,340
500,000	20.0	411.2	431.2	**539.0**	12,925
600,000	24.0	493.4	517.4	**646.8**	15,510
700,000	28.0	575.7	603.7	**754.6**	18,095
790,000	31.6	649.7	681.3	**851.6**	20,422

Note:
(1)Basic Conditions for Caluculation
Process: Anaerobic Ponds + Faculative Ponds
Criterion: Anaerobic Ponds; Retension time 2days, Depth 5m, Bank Slope 1:3
Faculative Ponds; Surface loading 152kg/ha/day
Influent Sewerage Quality (BOD_5): 250mg/l
Removal Rate: Anaerobic Ponds 50%, Faculative Ponds 85% (in Total)
Total Required Area: Ponds Area × 1.25 (Roads,Foot-path, Ancillary facilities, Buffer zone etc)
(2) 1 Kanal = 500 Square yards = 0.103 acre (= 417 m2)
Source: "Land Records Manual (Reviced by Malik Mushtaq Ahmad Nonari, Advocate High Court) "

[Reference]

BOD Surface loading (kg/ha day)

T (℃)	λ s (kg/ha･day)	T (℃)	λ s (kg/ha･day)
11	112	21	272
12	124	22	291
13	137	23	311
14	152	24	331
15	167	25	350
16	183	26	369
17	199	27	389
18	217	28	406
19	235	29	424
20	253	30	440

Source: Duncan Mara etc.

Appendix 13.4 Capacity Calculation for WWTP

1 BASIC CONDITIONS

1-1 Basic Items

(1) Name : **South-West Wastwater Treatment Plant**

(2) Land Area : Approximately 7,300 Kanal

(3) Elevation : + 198.00 m (Existing)

(4) Inlet Pipe Level : + m

(5) Pipe Diameter : mm

(6) Land Use : Agricultual Use

(7) Collection System : Combined System Separate System

Note: In spite of separating sewer and drain, existing sysytem is working as combined system practically.

(8) Treatment Process :

Sewage ; (Inlet PS) +Receiving well/Screen + Anaerobic Pond + Trickling Filter + Sedimentation Pond + Disinfection channel (Future)

Sludge ; Dewatering (In the Pond) → Carrying out to Dumping Site

(9) Effluent Point : River Ravi through existing channel

(10) Water Level at the Effluent Poir :

High water leve = 197.50 m

Low water leve = — m

(11) Target Year : **2035**

1-2 Design Population and Service Area

Item		Year 2035	—
Design Population	person	3,894,300	—
Service Area	km^2	100.26	—

1-3 Design Sewage Flow (Year 2035)

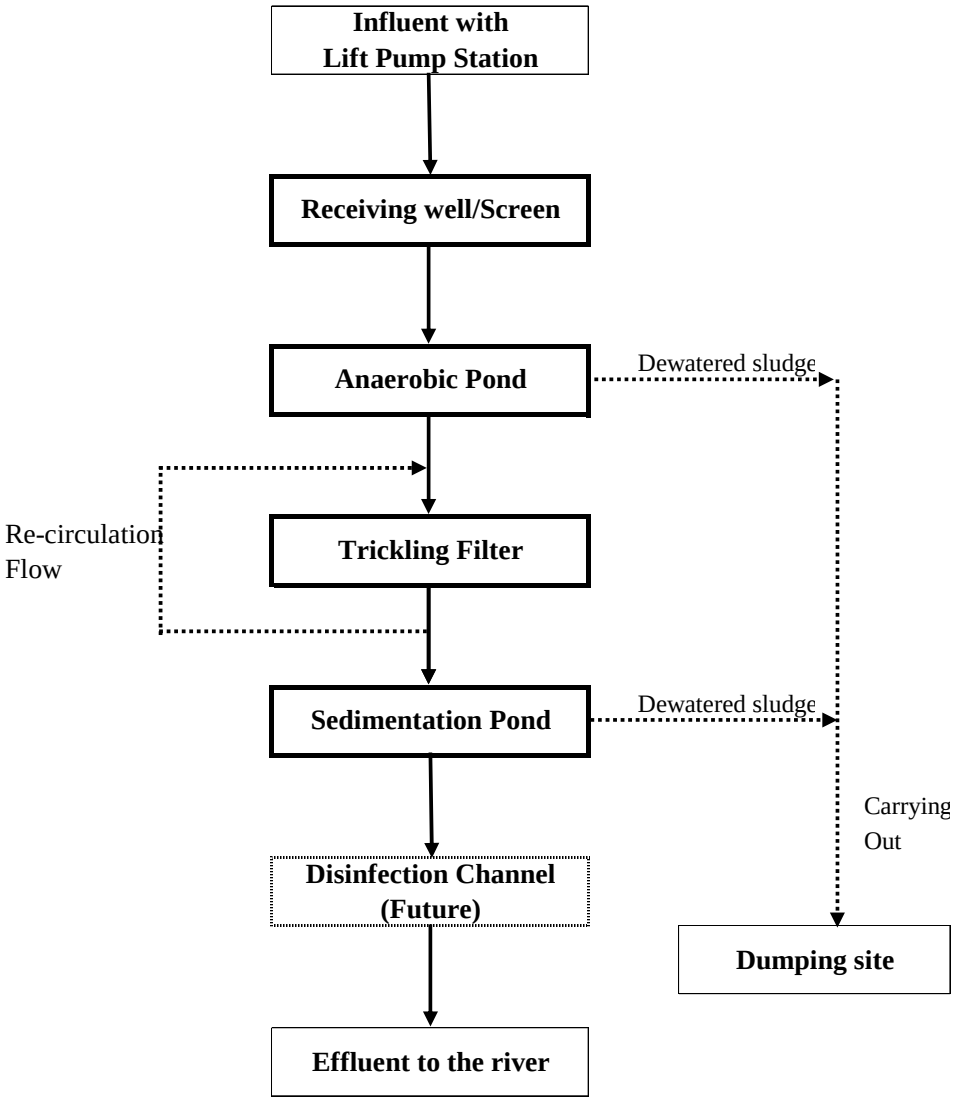
Item	m^3/day	m^3/hr	m^3/min	m^3/sec
Daily Average Flow Total	790,000	32916.7	548.61	9.144
from Collector channel	599,000	24958.3	415.97	6.933
from MultanRd PS	191,000	7958.3	132.64	2.211
Peak Flow Total	2,401,000	100,041.7	1667.36	27.789
from Collector channel	1,828,362	76181.8	1269.70	21.162
from MultanRd PS	572,638	23859.9	397.67	6.628

Note: Peak flow include storm water flow. Refer to plan of collector channel.

1-4 Design Sewage Quality

Item	Influent (mg/l)	Removal rate (%)	Effluent (mg/l)	Remarks
BOD	250	80.0	50	Less than NEQS 80 mg/l
SS	350	80.0	70	

1-5 Flow Chart (Trickling Filter Process)



1-6 Design Criteria

Items	Unit	Formula or Value	Adoption
1-6-1 Anaerobic Pond			
(1) BOD volumetric loading	kgBOD/m^3・day	-	180
			(Min T=14℃)
Reference :			
Temperature (℃) / BOD volumetric loading / BOD Removal Rate			
< 10 / 100 / 40%			
10～20 / 20T-100 / 20T+20 %			
> 20 / 300 / 60%			
Source: Mara & Pearson 1986			
(2) Water Depth	m	2.5 - 5	4
			* Pond depth 5m
1-6-2 Tricling Filter Basin (High rate)			
(1) Water Surface Load	m^3/m^2/day	10 - 40	25
(2) Re-circulation Rate	Percent	100 - 200	150
(3) Organic loading	kgBOD/m^3/day	0.5 - 1.0	0.5~1.0
(4) Depth of Filter	m	0.9 - 1.8	1.5
Metcalf and Eddy, "Wastewater Engineering-Fourth edition"			
Reference: Water Surface Load by Japanese standard (1984) shows 25 m^3/m^2/day			
1-6-3 Sedimentation Pond			
(1) Retention period	day	less than 2	2
(2) Water Depth	m	2	2
Metcalf and Eddy, "Wastewater Engineering-Fourth edition"			
pp. 851, McGraw-Hill Inc. 2003			

2 CAPACITY CALCULATION

2-1 Lifting Pump Station

Item	Sign	Unit	Calculation	Value
Type	-	-	Screw Pump	
Design Sewage Flow	Q1	m^3/sec	Peak Flow	21.162
Equipment				
Pump Unit Number(Total)	UN1	unit	Stand-by 2 units	12
Discharge per Unit	DU1	m^3/sec		2.12
Total Pump Head	PH	m		7.5
Pump Power	P1	kw		315
Specification		-	**Dia.2.6m×2.26m^3/sec (80 cusec)×7.5m×315kW**	
			×10(2)units	
			(Based on Manufacturer's Information)	

2-2 Receiving well / Screen

Item	Sign	Unit	Calculation	Value
Type	-	-	Automatic Bar Screen	
Design Sewage Flow	Q1	m^3/sec	Peak Flow	21.162
Equipment				
Set Number	SSN	set		8
Screen Opening	-	mm	15 to 25	20
Screen face Velocity	F*v*	m/sec	0.45 to 0.6 m/sec	0.6
Dimention Depth	H	m		1.8
Width	W	m	Q1/(F*v* ×H×SSN)	2.4
		m	*Therefore*	2.5
Specification		-	**W2.5m×H1.8m×SO20mm× 0.65kW×8sets**	
			(Based on Manufacturer's Information)	

2-3 Anaerobic Pond

Item	Sign	Unit	Calculation	Value
Type	-	-	Rectangular Type	
Design Sewage Flow	Q1	m^3/day	Average Flow	790,000
Inlet BOD Quality	INB	mg/L		250
Basin Number	BN	basin		8
BOD volumetric loading	BVL	kgBOD/m3･day		180.0
Required Volume	V1	m^3	Q1*INB/BVL	1,097,222
Retension Time	RT	day	V1/Q1	1.39
Required Volume per pond	V2	m^3	V1/BN	137,153
Required Volume per pond	V3	m^3	V2*1.33	182,413
* As sludge dewatering (6 ponds use of 8 ponds, 8/6=1.33)				
Water Depth	WD	m		4
Required Surface Area per Pon	A1	m^2	V3/WD	45,603
Pond Length (Average)	PL	m	$(A1)^{0.5}$	213.55
Therefore	PL2	m		215
Dimension (Length)	L	m	PL2	**215.0**
(Water Depth)	H	m	Pond Depth=5m	**4.0**
(Basin Number)	N	basin	BN	**8**
(Check)				
BOD volumetric loading	WSL	kgBOD/m3･day	Q1×INB/6 ponds×/(L^2×H)	178.02
				< 180 OK
Effective Water depth				
Accumulated Sludge per year	AS	m^3/year	PR×DP In the pond	156,000
Sludge production	PR	m^3/Person/year		0.04
Design population	DP	Person		3,900,000
Sludge layer per year	SL1	m/year	AS/(A1*N)	0.43
Accumulated period (Average)	AP	year	Cleaned once every four years	2
Sludge Layer (Average)	SL2	m	SL1×AP	0.86
Pond Depth	PD	m		5
Effective Water Depth	WD	m	PD-SL2	4.14
				> Water depth 4 m
				OK

2-4 Trickling Filter

Item	Sign	Unit	Calculation	Value
Type	-	-	Circular Type	
Design Sewage Flow	Q1	m^3/day	Average Flow	790,000
Re-circulation Rate	CR	Percent		150
Water Surface Load	WSL	m3/m2/day		25
Required Surface Area	A1	m^2	Q1*(1+CR/100)/WSL	79,000
Diameter	D1	m		46
Surface Area per basin	A2	m^2	D1^2*π/4	1,662
Basin Number	BN1	basin	A1/A2	47.5
Therefore	BN2	basin		48
Dimension (Diameter)	W	m		**46.0**
(Depth)	H	m	Depth of filter	**1.5**
(Basin Number)	N	basin		**48**
(Check)				
Inlet BOD Quality	INB	mg/L	Removal ratio in AP= 50%	125
Organic loading	BS	kgBOD/m^3/d	Q1*INB/(A2*H*N)	0.83
				< 1.0 OK
Equipment				
Lift/Re-circulation Pump				
Type	-		Submerged Type	
Design Sewage Flow	Q2	m^3/min		548.6
Pump Unit Number	UN1	unit		48
Discharge per Unit	DU1	m^3/min	Q2*(1+CR/100)/UN1	28.57
Pump Diameter(V=1.5~3.0m/s	$D1_{(V=3.0)}$	mm	$146\times(DU2/3.0)^{0.5}$	451
	$D1_{(V=1.5)}$	mm	$146\times(DU2/1.5)^{0.5}$	637
Therefore	D1	mm		500
Total Pump Head	PH	m		8.0
Pump Efficiency	PE	-		0.6
Axis Power	AP1	kw	0.163×DU1×PH/PE	62.1
Motor Allowance	MA	-		0.15
Pump Power	P1	kw	AP1×(1+MA)	71.41
Therefore				75
Specification		-	**Dia.500mm×34m^3/min (20 Cusec)×10m**	
			×75kW×48units	
			(Based on Manufacturer's Information)	

2-5 Sedimentation Pond

Item	Sign	Unit	Calculation	Value
Type	-	-	Rectangular Type	
Design Sewage Flow	Q1	m^3/day	Average Flow	790,000
Retension Time	RT	day	less than 2days	2
Water Depth	WD	m		2
Basin Number	BN	basin		8
Required Surface Area per Pon	A1	m^2	Q1×RT/WD/BN	98,750
Pond Length (Average)	PL	m	$(A1)^{0.5}$	314.25
Therefore	PL2	m		315
Dimension (Length)	L	m	PL2	**315.0**
(Water Depth)	H	m	WD, Pond Depth=2.5m	**2.0**
(Basin Number)	N	basin	BN	**8**
(Check)				
Effective Water depth				
Accumulated Sludge per year	AS	m^3/year	(SSi-SSo)×Q1×SR/SC×365	131,199
SS influent	SSi	mg/l	Removal ratio in AP= 50%	175
SS effluent	SSo	mg/l		70
*Volatile Solids Reduction r	SR	Percent		65
*Accumulated Sludge Conte	SC	Percent	In the Pond	15
*(Metcalf and Eddy, "Wastewater Engineering-Fourth edition", pp. 851 Exam. 8-15, McGraw-Hill Inc. 2003)				
Sludge layer per year	SL1	m/year	AS/(A1*N)	0.17
Accumulated period (Average)	AP	year	Cleaned once every four years	2
Sludge Layer (Average)	SL2	m	SL1×AP	0.33
Pond Depth	PD	m		2.5
Effective Water Depth	WD	m	PD-SL2	2.17
				> Water depth 2 m
				OK

Appendix 13.5 Hydraulic Calculation

Appendix 13.5.1 Hydraulic Calculation: Trunk Sewer from Larex Colony to New Gulshan-e-Ravi Disposal Station (1/8)

Line	Description	Manhole No.		Length (ft)		Population		Average	Peak	Peak	Infilter-	Design	Design Capacity			Slope	Ground Level (ft)		Invert Level (ft)		Depth (ft)		Remarks
		From	To	Segment	Commu-lative	on line	Commu-lative	Flow cfs	Factor	Flow cfs	ation cfs	Flow cfs	Dia inch	Vel. ft/s	Flow ft3/s		U/S	D/S	U/S	D/S	U/S	D/S	
A~B	Larex colony to Garhi Shahu Bazar	1	2	100	100	5,218	5,218	0.68	4.00	2.71	0.07	3.46	24	2.60	8.16	0.00130	697.87	696.29	688.00	687.87	9.87	8.42	Larex Colony lift station I.L 689.04
		2	3	100	200							3.46	24	2.60	8.16	0.00130	696.29	696.29	687.87	687.74	8.42	8.55	
		3	4	100	300							3.46	24	2.60	8.16	0.00130	696.29	697.69	687.74	687.61	8.55	10.08	
		4	5	100	400							3.46	24	2.60	8.16	0.00130	697.69	697.89	687.61	687.48	10.08	10.41	
		5	6	100	500							3.46	24	2.60	8.16	0.00130	697.89	697.86	687.48	687.35	10.41	10.51	
		6	7	100	600							3.46	24	2.60	8.16	0.00130	697.86	698.15	687.35	687.22	10.51	10.93	
		7	8	100	700							3.46	24	2.60	8.16	0.00130	698.15	698.24	687.22	687.09	10.93	11.15	
		8	9	100	800							3.46	24	2.60	8.16	0.00130	698.24	698.34	687.09	686.96	11.15	11.38	
		9	10	100	900							3.46	24	2.60	8.16	0.00130	698.34	698.72	686.96	686.83	11.38	11.89	
		10	11	100	1000							3.46	24	2.60	8.16	0.00130	698.72	699.22	686.83	686.70	11.89	12.52	
		11	12	100	1100							3.46	24	2.60	8.16	0.00130	699.22	699.54	686.70	686.57	12.52	12.97	
		12	13	100	1200							3.46	24	2.60	8.16	0.00130	699.54	699.64	686.57	686.44	12.97	13.20	
		13	14	100	1300							3.46	24	2.60	8.16	0.00130	699.64	699.66	686.44	686.31	13.20	13.35	
		14	15	100	1400							3.46	24	2.60	8.16	0.00130	699.66	699.46	686.31	686.18	13.35	13.28	
		15	16	100	1500							3.46	24	2.60	8.16	0.00130	699.46	699.32	686.18	686.05	13.28	13.27	
		16	17	100	1600							3.46	24	2.60	8.16	0.00130	699.32	699.26	686.05	685.92	13.27	13.34	
		17	18	63	1663							3.46	24	2.60	8.16	0.00130	699.26	699.48	685.92	685.84	13.34	13.64	
		18	19	88	1751							3.46	24	2.60	8.16	0.00130	699.48	699.74	685.84	685.72	13.64	14.02	
		19	20	100	1851							3.46	24	2.60	8.16	0.00130	699.74	699.78	685.72	685.59	14.02	14.19	
		20	21	100	1951							3.46	24	2.60	8.16	0.00130	699.78	700.15	685.59	685.46	14.19	14.69	
		21	22	100	2051							3.46	24	2.60	8.16	0.00130	700.15	700.63	685.46	685.33	14.69	15.30	
		22	23	100	2151							3.46	24	2.60	8.16	0.00130	700.63	700.64	685.33	685.20	15.30	15.44	
		23	24	100	2251							3.46	24	2.60	8.16	0.00130	700.64	700.52	685.20	685.07	15.44	15.45	
		24	25	100	2351							3.46	24	2.60	8.16	0.00130	700.52	700.48	685.07	684.94	15.45	15.54	
		25	26	100	2451							3.46	24	2.60	8.16	0.00130	700.48	700.59	684.94	684.81	15.54	15.78	
		26	27	100	2551							3.46	24	2.60	8.16	0.00130	700.59	700.59	684.81	684.68	15.78	15.91	
		27	28	88	2639							3.46	24	2.60	8.16	0.00130	700.59	699.67	684.68	684.57	15.91	15.10	
		28	29	70	2709							3.46	24	2.60	8.16	0.00130	699.67	699.22	684.57	684.48	15.10	14.74	Ghazi Mohalla lift station 15"sewer I.L MH29
B~C	Garhi Shahu Bazar to Allama Iqbal Road	29	30	150	2859	0	10,105	1.31	3.40	4.46	0.13	6.69	30	3.02	14.82	0.00131	699.22	698.74	683.98	683.78	15.24	14.96	686.91
		30	31	150	3009							6.69	30	3.02	14.82	0.00131	698.74	698.85	683.78	683.59	14.96	15.26	
		31	32	103	3112							6.69	30	3.02	14.82	0.00131	698.85	698.85	683.59	683.45	15.26	15.40	
		32	33	103	3215							6.69	30	3.02	14.82	0.00131	698.85	698.85	683.45	683.32	15.40	15.53	
	Allama Iqbal Road	33	34	150	3365	0	22,881	2.97	3.10	9.21	0.30	13.81	30	3.02	14.82	0.00131	698.85	698.82	683.32	683.12	15.53	15.70	
		34	35	150	3515							13.81	30	3.02	14.82	0.00131	698.82	698.22	683.12	682.93	15.70	15.29	
		35	36	150	3665							13.81	30	3.02	14.82	0.00131	698.22	698.80	682.93	682.73	15.29	16.07	

Appendix 13.5.1 Hydraulic Calculation: Trunk Sewer from Larex Colony to New Gulshan-e-Ravi Disposal Station (2/8)

Line	Description	Manhole No.		Length (ft)		Population		Average	Peak	Peak	Infilter-	Design	Design Capacity			Slope	Ground Level (ft)		Invert Level (ft)		Depth (ft)		Remarks
		From	To	Segment	Commu-lative	on line	Commu-lative	Flow cfs	Factor	Flow cfs	ation cfs	Flow cfs	Dia inch	Vel. ft/s	Flow ft3/s		U/S	D/S	U/S	D/S	U/S	D/S	
		36	37	150	3815							13.81	30	3.02	14.82	0.00131	698.80	699.74	682.73	682.53	16.07	17.21	
		37	38	150	3965							13.81	30	3.02	14.82	0.00131	699.74	699.86	682.53	682.34	17.21	17.52	
		38	39	100	4065							13.81	30	3.02	14.82	0.00131	699.86	698.76	682.34	682.21	17.52	16.55	Muhammad Nagar lift station 30" sewer I.L MH 39
C~D	Durand road	39	40	200	4265	8,651	59,177	7.68	2.70	20.75	0.77	31.12	48	2.50	31.47	0.00048	698.76	698.76	680.71	680.61	18.05	18.15	683.25
		40	41	200	4465							31.12	48	2.50	31.47	0.00048	698.76	700.86	680.61	680.52	18.15	20.34	
		41	42	200	4665							31.12	48	2.50	31.47	0.00048	700.86	700.66	680.52	680.42	20.34	20.24	
		42	43	121	4786							31.12	48	2.50	31.47	0.00048	700.66	700.64	680.42	680.36	20.24	20.28	
		43	44	200	4986							31.12	48	2.50	31.47	0.00048	700.64	700.54	680.36	680.27	20.28	20.27	
		44	45	200	5186							31.12	48	2.50	31.47	0.00048	700.54	700.21	680.27	680.17	20.27	20.04	
		45	46	200	5386							31.12	48	2.50	31.47	0.00048	700.21	700.14	680.17	680.07	20.04	20.07	
		46	47	200	5586							31.12	48	2.50	31.47	0.00048	700.14	700.12	680.07	679.98	20.07	20.14	
		47	48	200	5786							31.12	48	2.50	31.47	0.00048	700.12	700.23	679.98	679.88	20.14	20.35	
		48	49	200	5986							31.12	48	2.50	31.47	0.00048	700.23	700.21	679.88	679.79	20.35	20.42	
		49	50	200	6186							31.12	48	2.50	31.47	0.00048	700.21	700.01	679.79	679.69	20.42	20.32	
		50	51	200	6386							31.12	48	2.50	31.47	0.00048	700.01	700.14	679.69	679.59	20.32	20.55	
		51	52	200	6586							31.12	48	2.50	31.47	0.00048	700.14	699.96	679.59	679.50	20.55	20.46	
		52	53	200	6786							31.12	48	2.50	31.47	0.00048	699.96	699.52	679.50	679.40	20.46	20.12	Davis road 36" sewer I.L MH53
D~E	Around Shimla hill	53	54	200	6986	2,779	98,096	12.74	2.50	31.84	1.27	50.95	60	2.65	52.09	0.0004	699.52	699.60	678.40	678.32	21.12	21.28	685.90
		54	55	200	7186							50.95	60	2.65	52.09	0.0004	699.60	699.21	678.32	678.24	21.28	20.97	
		55	56	200	7386							50.95	60	2.65	52.09	0.0004	699.21	699.88	678.24	678.16	20.97	21.72	
		56	57	150	7536							50.95	60	2.65	52.09	0.0004	699.88	700.57	678.16	678.10	21.72	22.47	Empress road 24" sewer I.L MH57
E~F	Shimla Hill to Montgomary Road Chowk	57	58	200	7736	5,319	111,181	14.44	2.50	36.09	1.44	57.74	60	2.97	58.24	0.0005	700.57	701.54	678.10	678.00	22.47	23.54	683.15
		58	59	200	7936							57.74	60	2.97	58.24	0.0005	701.54	702.33	678.00	677.90	23.54	24.43	
		59	60	150	8086							57.74	60	2.97	58.24	0.0005	702.33	703.25	677.90	677.83	24.43	25.42	
		60	61	150	8236							57.74	60	2.97	58.24	0.0005	703.25	703.34	677.83	677.75	25.42	25.59	
		61	62	190	8426							57.74	60	2.97	58.24	0.0005	703.34	702.91	677.75	677.66	25.59	25.25	
		62	63	175	8601							57.74	60	2.97	58.24	0.0005	702.91	702.91	677.66	677.57	25.25	25.34	
		63	64	175	8776							57.74	60	2.97	58.24	0.0005	702.91	702.54	677.57	677.48	25.34	25.06	
		64	65	200	8976							57.74	60	2.97	58.24	0.0005	702.54	702.64	677.48	677.38	25.06	25.26	
		65	66	145	9121							57.74	60	2.97	58.24	0.0005	702.64	702.50	677.38	677.31	25.26	25.19	
		66	67	145	9266							57.74	60	2.97	58.24	0.0005	702.50	702.22	677.31	677.24	25.19	24.98	
		67	68	210	9476							57.74	60	2.97	58.24	0.0005	702.22	702.14	677.24	677.13	24.98	25.01	
		68	69	200	9676							57.74	60	2.97	58.24	0.0005	702.14	701.79	677.13	677.03	25.01	24.76	
		69	70	200	9876							57.74	60	2.97	58.24	0.0005	701.79	699.54	677.03	676.93	24.76	22.61	
		70	71	200	10076							57.74	60	2.97	58.24	0.0005	699.54	698.32	676.93	676.83	22.61	21.49	
		71	72	200	10276							57.74	60	2.97	58.24	0.0005	698.32	697.58	676.83	676.73	21.49	20.85	
		72	73	200	10476							57.74	60	2.97	58.24	0.0005	697.58	698.54	676.73	676.63	20.85	21.91	
		73	74	85	10561							57.74	60	2.97	58.24	0.0005	698.54	698.96	676.63	676.59	21.91	22.37	Montgomary road 42" sewer I.L MH 74
F~G	Montgomary Road Chowk to Imperial Cinema Chowk	74	75	225	10786	3,174	145,556	18.90	2.50	47.25	1.89	75.59	72	2.68	75.76	0.00032	698.96	699.12	675.59	675.52	23.37	23.60	677.71

Appendix 13.5.1 Hydraulic Calculation: Trunk Sewer from Larex Colony to New Gulshan-e-Ravi Disposal Station (3/8)

Line	Description	Manhole No.		Length (ft)		Population		Average	Peak	Peak	Infilter-	Design	Design Capacity			Slope	Ground Level (ft)		Invert Level (ft)		Depth (ft)		Remarks
		From	To	Segment	Commu-lative	on line	Commu-lative	Flow cfs	Factor	Flow cfs	ation cfs	Flow cfs	Dia inch	Vel. ft/s	Flow ft3/s		U/S	D/S	U/S	D/S	U/S	D/S	
		75	76	300	11086							75.59	72	2.68	75.76	0.00032	699.12	699.37	675.52	675.42	23.60	23.95	
		76	77	300	11386							75.59	72	2.68	75.76	0.00032	699.37	701.22	675.42	675.33	23.95	25.89	
		77	78	250	11636							75.59	72	2.68	75.76	0.00032	701.22	701.72	675.33	675.25	25.89	26.47	
		78	79	105	11741							75.59	72	2.68	75.76	0.00032	701.72	696.53	675.25	675.21	26.47	21.32	
		79	80	185	11926							75.59	72	2.68	75.76	0.00032	696.53	692.72	675.21	675.15	21.32	17.57	
		80	81	200	12126							75.59	72	2.68	75.76	0.00032	692.72	690.80	675.15	675.09	17.57	15.71	
		81	82	200	12326							75.59	72	2.68	75.76	0.00032	690.80	689.51	675.09	675.03	15.71	14.48	
		82	83	200	12526							75.59	72	2.68	75.76	0.00032	689.51	688.89	675.03	674.96	14.48	13.93	mecleod road sewer I.L 676.11
G~H	Imperial Cinema Chowk to Hall road Chowk	83	84	300	12826	51,119	196,675	25.54	2.30	58.73	2.55	102.14	84	2.68	103.01	0.00026	688.89	689.25	673.96	673.88	14.93	15.37	
		84	85	300	13126							102.14	84	2.68	103.01	0.00026	689.25	692.15	673.88	673.81	15.37	18.34	
		85	86	300	13426							102.14	84	2.68	103.01	0.00026	692.15	692.61	673.81	673.73	18.34	18.88	Food street 36"sewer
H~I	Hall road Chowk to Sanda road	86	87	236	13662	40,681	270,507	35.12	2.30	80.78	3.51	140.49	84	3.67	141.41	0.00049	692.61	693.60	673.73	673.61	18.88	19.99	678.37
		87	88	300	13962							140.49	84	3.67	141.41	0.00049	693.60	694.80	673.61	673.46	19.99	21.34	
		88	89	90	14052							140.49	84	3.67	141.41	0.00049	694.80	695.20	673.46	673.42	21.34	21.78	
		89	90	300	14352							140.49	84	3.67	141.41	0.00049	695.20	695.80	673.42	673.27	21.78	22.53	
		90	91	292	14644							140.49	84	3.67	141.41	0.00049	695.80	696.01	673.27	673.13	22.53	22.88	
		91	92	191	14835							140.49	84	3.67	141.41	0.00049	696.01	696.12	673.13	673.04	22.88	23.08	
		92	93	300	15135							140.49	84	3.67	141.41	0.00049	696.12	696.00	673.04	672.89	23.08	23.11	
		93	94	226	15361							140.49	84	3.67	141.41	0.00049	696.00	693.67	672.89	672.78	23.11	20.89	
		94	95	226	15587							140.49	84	3.67	141.41	0.00049	693.67	689.21	672.78	672.67	20.89	16.54	
		95	96	102	15689							140.49	84	3.67	141.41	0.00049	689.21	687.98	672.67	672.62	16.54	15.36	
		96	97	300	15989							140.49	84	3.67	141.41	0.00049	687.98	686.39	672.62	672.47	15.36	13.92	
		97	98	300	16289							140.49	84	3.67	141.41	0.00049	686.39	686.23	672.47	672.32	13.92	13.91	
		98	99	120	16409							140.49	84	3.67	141.41	0.00049	686.23	688.09	672.32	672.27	13.91	15.82	
		99	100	225	16634							140.49	84	3.67	141.41	0.00049	688.09	689.26	672.27	672.16	15.82	17.10	
		100	101	225	16859							140.49	84	3.67	141.41	0.00049	689.26	689.12	672.16	672.05	17.10	17.08	
		101	102	300	17159							140.49	84	3.67	141.41	0.00049	689.12	688.94	672.05	671.90	17.08	17.04	
		102	103	200	17359							140.49	84	3.67	141.41	0.00049	688.94	688.81	671.90	671.80	17.04	17.01	
		103	104	263	17622							140.49	84	3.67	141.41	0.00049	688.81	688.65	671.80	671.67	17.01	16.98	
		104	105	263	17885							140.49	84	3.67	141.41	0.00049	688.65	688.49	671.67	671.54	16.98	16.94	
		105	106	140	18025							140.49	84	3.67	141.41	0.00049	688.49	688.40	671.54	671.47	16.94	16.93	
		106	107	200	18225							140.49	84	3.67	141.41	0.00049	688.40	688.28	671.47	671.38	16.93	16.90	
		107	108	200	18425							140.49	84	3.67	141.41	0.00049	688.28	688.15	671.38	671.28	16.90	16.88	
		108	109	130	18555							140.49	84	3.67	141.41	0.00049	688.15	688.07	671.28	671.21	16.88	16.86	
	Lower Mall Sewer	109	110	280	18835							140.49	84	3.67	141.41	0.00049	688.07	687.90	671.21	671.08	16.86	16.82	Sanda road 54" sewer I.L MH110
I~J	Sanda road to Choburji chowk	110	111	68	18903	93,516	364,023	47.26	2.15	101.62	4.73	189.06	90	4.29	189.65	0.00061	687.90	688.02	667.49	667.45	20.41	20.57	671.08
		111	112	300	19203							189.06	90	4.29	189.65	0.00061	688.02	688.02	667.45	667.26	20.57	20.76	

Appendix 13.5.1 Hydraulic Calculation: Trunk Sewer from Larex Colony to New Gulshan-e-Ravi Disposal Station (4/8)

Line	Description	Manhole No.		Length (ft)		Population		Average	Peak	Peak	Infilter-	Design	Design Capacity			Slope	Ground Level (ft)		Invert Level (ft)		Depth (ft)		Remarks
		From	To	Segment	Commu-lative	on line	Commu-lative	Flow cfs	Factor	Flow cfs	ation cfs	Flow cfs	Dia inch	Vel. ft/s	Flow ft3/s		U/S	D/S	U/S	D/S	U/S	D/S	
		112	113	300	19503							189.06	90	4.29	189.65	0.00061	688.02	688.77	667.26	667.08	20.76	21.69	
		113	114	300	19803							189.06	90	4.29	189.65	0.00061	688.77	687.00	667.08	666.90	21.69	20.10	
		114	115	300	20103							189.06	90	4.29	189.65	0.00061	687.00	686.87	666.90	666.71	20.10	20.16	
		115	116	300	20403							189.06	90	4.29	189.65	0.00061	686.87	686.12	666.71	666.53	20.16	19.59	
		116	117	300	20703							189.06	90	4.29	189.65	0.00061	686.12	687.00	666.53	666.35	19.59	20.65	
		117	118	300	21003							189.06	90	4.29	189.65	0.00061	687.00	684.63	666.35	666.16	20.65	18.47	
		118	119	300	21303							189.06	90	4.29	189.65	0.00061	684.63	685.23	666.16	665.98	18.47	19.25	
		119	120	300	21603							189.06	90	4.29	189.65	0.00061	685.23	684.33	665.98	665.80	19.25	18.53	
		120	121	300	21903							189.06	90	4.29	189.65	0.00061	684.33	684.04	665.80	665.62	18.53	18.42	
		121	122	80	21983	45,000	409,023	53.11	2.15	114.18	5.31	212.43	90	4.82	213.08	0.00077	684.04	684.09	665.62	665.55	18.42	18.54	24" x 36"Sham Nagar Road Sewer (Depth 12'-2")
	Multan Road to Cantonment drain(Multan road)	122	123	300	22283							212.43	90	4.82	213.08	0.00077	684.09	684.51	665.55	665.32	18.54	19.19	
		123	124	300	22583							212.43	90	4.82	213.08	0.00077	684.51	684.59	665.32	665.09	19.19	19.50	
		124	125	300	22883							212.43	90	4.82	213.08	0.00077	684.59	684.51	665.09	664.86	19.50	19.65	
		125	126	300	23183							212.43	90	4.82	213.08	0.00077	684.51	683.75	664.86	664.63	19.65	19.12	
		126	127	300	23483							212.43	90	4.82	213.08	0.00077	683.75	683.71	664.63	664.40	19.12	19.31	
		127	128	300	23783							212.43	90	4.82	213.08	0.00077	683.71	685.98	664.40	664.17	19.31	21.81	
		128	129	300	24083							212.43	90	4.82	213.08	0.00077	685.98	685.83	664.17	663.94	21.81	21.89	
		129	130	300	24383							212.43	90	4.82	213.08	0.00077	685.83	685.65	663.94	663.71	21.89	21.94	
		130	131	250	24633							212.43	90	4.82	213.08	0.00077	685.65	685.35	663.71	663.51	21.94	21.84	
		131	132	250	24883							212.43	90	4.82	213.08	0.00077	685.35	685.95	663.51	663.32	21.84	22.63	
		132	133	250	25133							212.43	90	4.82	213.08	0.00077	685.95	686.46	663.32	663.13	22.63	23.33	
		133	134	250	25383							212.43	90	4.82	213.08	0.00077	686.46	686.09	663.13	662.94	23.33	23.15	
		134	135	250	25633							212.43	90	4.82	213.08	0.00077	686.09	686.60	662.94	662.74	23.15	23.86	
		135	136	250	25883							212.43	90	4.82	213.08	0.00077	686.60	685.72	662.74	662.55	23.86	23.17	
		136	137	300	26183							212.43	90	4.82	213.08	0.00077	685.72	685.54	662.55	662.32	23.17	23.22	Cantonment Drain Crossing (B.L 677.77)
	`	137	138	300	26483							212.43	90	4.82	213.08	0.00077	685.54	685.29	662.32	662.09	23.22	23.20	
		138	139	300	26783							212.43	90	4.82	213.08	0.00077	685.29	685.36	662.09	661.86	23.20	23.50	

Appendix 13.5.2 Hydraulic Calculation: Branch Sewers from Larex Colony to New Gulshan-e-Ravi Disposal Station (5/8)

Line	Description	Manhole No.		Length (ft)		Population		Average	Peak	Peak	Infilter-	Design	Allowance	Design Capacity			Slope	Ground Level (ft)		Invert Level (ft)		Depth (ft)		Remarks
		From	To	Segment	Commu-lative	on line	Commu-lative	Flow	Factor	Flow	ation	Flow	for Storm	Dia	Vel.	Discharge		U/S	D/S	U/S	D/S	U/S	D/S	
								ft^3/s		ft^3/s	ft^3/s	ft^3/s	ft^3/s	inch	ft/s	ft^3/s								
Branch Sewers																								
B1~B	Ghazi Mohalla lift station to Garhi Shahu Bazar	29.5	29.4	100	100	4,887	4,887	0.63	4.00	2.54	0.06	3.24	0.63	15	2.88	3.54	0.0030	698.63	698.21	690.00	689.70	8.63	8.51	Ghazi Mohalla lift Station I.L 690.79
		29.4	29.3	84	184									15	3.33	4.09	0.0040	698.21	698.01	689.70	689.36	8.51	8.65	
		29.3	29.2	84	268									15	3.33	4.09	0.0040	698.01	698.01	689.36	689.03	8.65	8.98	
		29.2	29.1	100	368									15	5.26	6.46	0.0100	698.01	699.32	689.03	688.03	8.98	11.29	
		29.1	29	112	480									15	5.26	6.46	0.0100	699.32	699.22	688.03	686.91	11.29	12.31	
C1~C	Muhammad Nagar lift station to Garhi Shahu chowk	39.9	39.8	150	150	27,645	27,645	3.59	3.10	11.13	0.36	16.69	5.20	30	3.45	16.91	0.0017	699.81	699.98	686.70	686.45	13.11	13.54	Muhammad Nagar lift station I.L 687.48
		39.8	39.7	150	300									30	3.45	16.91	0.0017	699.98	699.60	686.45	686.19	13.54	13.41	
		39.7	39.6	150	450									30	3.45	16.91	0.0017	699.60	699.24	686.19	685.94	13.41	13.30	
		39.6	39.5	150	600									30	3.45	16.91	0.0017	699.24	699.01	685.94	685.68	13.30	13.33	
		39.5	39.4	150	750									30	3.45	16.91	0.0017	699.01	698.76	685.68	685.43	13.33	13.33	
		39.4	39.3	150	900									30	3.45	16.91	0.0017	698.76	698.69	685.43	685.17	13.33	13.52	
		39.3	39.2	150	1050									30	3.55	17.40	0.0018	698.69	698.66	685.17	684.90	13.52	13.76	
		39.2	39.1	150	1200									30	5.91	29.00	0.0050	698.66	699.56	684.90	684.15	13.76	15.41	
		39.1	39	150	1350									30	6.47	31.77	0.0060	699.56	699.86	684.15	683.25	15.41	16.61	
D1~D	Davis Road Sewer	53.13	53.12	180	180	10,557	36,140	4.69	2.70	12.67	0.47	19.00	5.87	36	2.83	20.01	0.0009	700.33	700.40	688.10	687.94	12.23	12.46	Sunder Das road sewer I.L 688.87
		53.12	53.11	200	380									36	2.83	20.01	0.0009	700.40	699.90	687.94	687.76	12.46	12.14	
		53.11	53.10	200	580									36	2.83	20.01	0.0009	699.90	699.95	687.76	687.58	12.14	12.37	
		53.10	53.9	200	780									36	2.83	20.01	0.0009	699.95	700.05	687.58	687.40	12.37	12.65	
		53.9	53.8	200	980									36	2.83	20.01	0.0009	700.05	700.10	687.40	687.22	12.65	12.88	
		53.8	53.7	200	1180									36	2.83	20.01	0.0009	700.10	700.00	687.22	687.04	12.88	12.96	
		53.7	53.6	200	1380									36	2.83	20.01	0.0009	700.00	699.95	687.04	686.86	12.96	13.09	
		53.6	53.5	200	1580									36	2.83	20.01	0.0009	699.95	699.90	686.86	686.68	13.09	13.22	
		53.5	53.4	200	1780									36	2.83	20.01	0.0009	699.90	699.70	686.68	686.50	13.22	13.20	
		53.4	53.3	200	1980									36	2.83	20.01	0.0009	699.70	699.54	686.50	686.32	13.20	13.22	
		53.3	53.2	200	2180									36	2.83	20.01	0.0009	699.70	698.45	686.32	686.14	13.38	12.31	
		53.2	53.1	200	2380									36	2.83	20.01	0.0009	698.45	697.91	686.14	685.96	12.31	11.95	
		53.1	53	70	2450									36	2.83	20.01	0.0009	697.91	699.30	685.96	685.90	11.95	13.40	
E1~E	Empress road sewer	57.23	57.22	150	150	7,766	7,766	1.01	3.40	3.43	0.10	5.14	1.61	24	2.79	8.76	0.0015	701.91	701.80	688.10	687.88	13.81	13.93	
		57.22	57.21	150	300									24	2.79	8.76	0.0015	701.80	702.10	687.88	687.65	13.93	14.45	
		57.21	57.2	150	450									24	2.79	8.76	0.0015	702.10	702.31	687.65	687.43	14.45	14.89	
		57.2	57.19	150	600									24	2.79	8.76	0.0015	702.31	702.45	687.43	687.20	14.89	15.25	
		57.19	57.18	150	750									24	2.79	8.76	0.0015	702.45	702.67	687.20	686.98	15.25	15.70	
		57.18	57.17	150	900									24	2.79	8.76	0.0015	702.67	702.70	686.98	686.75	15.70	15.95	
		57.17	57.16	150	1050									24	2.79	8.76	0.0015	702.70	702.82	686.75	686.53	15.95	16.30	

Appendix 13.5.2 Hydraulic Calculation: Branch Sewers from Larex Colony to New Gulshan-e-Ravi Disposal Station (6/8)

Line	Description	Manhole No.		Length (ft)		Population		Average	Peak	Peak	Infilter-	Design	Allowance	Design Capacity			Slope	Ground Level (ft)		Invert Level (ft)		Depth (ft)		Remarks
		From	To	Segment	Commu-lative	on line	Commu-lative	Flow	Factor	Flow	ation	Flow	for Storm	Dia	Vel.	Discharge		U/S	D/S	U/S	D/S	U/S	D/S	
								ft^3/s		ft^3/s	ft^3/s	ft^3/s	ft^3/s	inch	ft/s	ft^3/s								
		57.16	57.15	150	1200									24	2.79	8.76	0.0015	702.82	702.88	686.53	686.30	16.30	16.58	
		57.15	57.14	150	1350									24	2.79	8.76	0.0015	702.88	702.61	686.30	686.08	16.58	16.54	
		57.14	57.13	150	1500									24	2.79	8.76	0.0015	702.61	702.95	686.08	685.85	16.54	17.10	
		57.13	57.12	150	1650									24	2.79	8.76	0.0015	702.95	702.94	685.85	685.63	17.10	17.32	
		57.12	57.11	150	1800									24	2.79	8.76	0.0015	702.94	702.96	685.63	685.40	17.32	17.56	
		57.11	57.10	150	1950									24	2.79	8.76	0.0015	702.96	702.98	685.40	685.18	17.56	17.81	
		57.10	57.09	150	2100									24	2.79	8.76	0.0015	702.98	702.99	685.18	684.95	17.81	18.04	
		57.09	57.08	150	2250									24	2.79	8.76	0.0015	702.99	702.99	684.95	684.73	18.04	18.27	
		57.08	57.07	150	2400									24	2.79	8.76	0.0015	702.99	703.01	684.73	684.50	18.27	18.51	
		57.07	57.06	150	2550									24	2.79	8.76	0.0015	703.01	703.32	684.50	684.28	18.51	19.05	
		57.06	57.05	150	2700									24	2.79	8.76	0.0015	703.32	703.39	684.28	684.05	19.05	19.34	
		57.05	57.04	150	2850									24	2.79	8.76	0.0015	703.39	703.41	684.05	683.83	19.34	19.59	
		57.04	57.03	150	3000									24	2.79	8.76	0.0015	703.41	702.85	683.83	683.60	19.59	19.25	
		57.03	57.02	150	3150									24	2.79	8.76	0.0015	702.85	702.15	683.60	683.38	19.25	18.78	
		57.02	57.01	150	3300									24	2.79	8.76	0.0015	702.15	702.33	683.38	683.15	18.78	19.18	
		57.01	57	91	3391									24	2.79	8.76	0.0015	702.33	702.33	683.15	683.01	19.18	19.32	
F1~F	Montgomary road sewer	74.12	74.11	200	200	31,201	31,201	4.05	2.70	10.94	0.41	18.84	7.49	42	2.50	24.02	0.0006	694.36	694.90	679.00	678.89	15.36	16.01	Lahore Hotel sewer I.L 679.57
		74.11	74.1	200	400									42	2.50	24.02	0.0006	694.90	695.72	678.89	678.77	16.01	16.95	
		74.10	74.9	200	600									42	2.50	24.02	0.0006	695.72	696.51	678.77	678.66	16.95	17.85	
		74.9	74.8	200	800									42	2.50	24.02	0.0006	696.51	696.59	678.66	678.54	17.85	18.05	
		74.8	74.7	200	1000									42	2.50	24.02	0.0006	696.59	696.17	678.54	678.43	18.05	17.74	
		74.7	74.6	200	1200									42	2.50	24.02	0.0006	696.17	696.78	678.43	678.32	17.74	18.46	
		74.6	74.5	200	1400									42	2.50	24.02	0.0006	696.78	698.02	678.32	678.20	18.46	19.82	I.L of Abbot road sewer 678.87
		74.5	74.4	200	1600									42	2.50	24.02	0.0006	698.02	698.91	678.20	678.09	19.82	20.82	
		74.4	74.3	200	1800									42	2.50	24.02	0.0006	698.91	700.22	678.09	677.97	20.82	22.25	
		74.3	74.2	210	2010									42	2.50	24.02	0.0006	700.22	701.48	677.97	677.85	22.25	23.63	
		74.2	74.1	130	2140									42	2.50	24.02	0.0006	701.48	700.15	677.85	677.78	23.63	22.37	
		74.1	74	130	2270									42	2.50	24.02	0.0006	700.15	699.37	677.78	677.71	22.37	21.66	
H1~H	Thronton road to Mcleod road	86.6	86.5	149	149	33,151	33,151	4.30	2.70	11.62	0.43	17.43	5.38	36	2.50	17.65	0.00070	706.15	704.81	679.00	678.90	27.15	25.91	Food street sewer I.L 679.79
		86.5	86.4	150	299									36	2.50	17.65	0.00070	704.81	701.30	678.90	678.79	25.91	22.51	
		86.4	86.3	150	449									36	2.50	17.65	0.00070	701.30	698.60	678.79	678.69	22.51	19.91	
		86.3	86.2	150	599									36	2.50	17.65	0.00070	698.60	696.50	678.69	678.58	19.91	17.92	
		86.2	86.1	150	749									36	2.50	17.65	0.00070	696.50	694.80	678.58	678.48	17.92	16.32	
		86.1	86	150	899									36	2.50	17.65	0.00070	694.80	692.61	678.48	678.37	16.32	14.24	
I 1~I	Sanda Road Sewer	110.33	110.32	150	150	93,516	93,516	12.14	2.50	30.35	1.21	48.57	17.00	54	3.05	48.57	0.00061	686.50	686.48	674.50	674.41	12.00	12.07	
		110.32	110.31	125	275									54	3.05	48.57	0.00061	686.48	686.29	674.41	674.33	12.07	11.96	
		110.31	110.30	180	455									54	3.05	48.57	0.00061	686.29	686.00	674.33	674.22	11.96	11.78	

Appendix 13.5.2 Hydraulic Calculation: Branch Sewers from Larex Colony to New Gulshan-e-Ravi Disposal Station (7/8)

Line	Description	Manhole No.		Length (ft)		Population		Average	Peak	Peak	Infilter-	Design	Allowance	Design Capacity			Slope	Ground Level (ft)		Invert Level (ft)		Depth (ft)		Remarks
		From	To	Segment	Commu-lative	on line	Commu-lative	Flow ft^3/s	Factor	Flow ft^3/s	ation ft^3/s	Flow ft^3/s	for Storm ft^3/s	Dia inch	Vel. ft/s	Discharge ft^3/s		U/S	D/S	U/S	D/S	U/S	D/S	
		110.30	110.29	100	555									54	3.05	48.57	0.00061	686.00	685.81	674.22	674.16	11.78	11.65	
		110.29	110.28	130	685									54	3.05	48.57	0.00061	685.81	685.76	674.16	674.08	11.65	11.68	
		110.28	110.27	190	875									54	3.05	48.57	0.00061	685.76	685.75	674.08	673.97	11.68	11.78	
		110.27	110.26	110	985									54	3.05	48.57	0.00061	685.75	685.72	673.97	673.90	11.78	11.82	
		110.26	110.25	200	1185									54	3.05	48.57	0.00061	685.72	685.71	673.90	673.78	11.82	11.93	
		110.25	110.24	198	1383									54	3.05	48.57	0.00061	685.71	685.69	673.78	673.66	11.93	12.03	
		110.24	110.23	96	1479									54	3.05	48.57	0.00061	685.69	685.68	673.66	673.60	12.03	12.08	
		110.23	110.22	104	1583									54	3.05	48.57	0.00061	685.68	685.00	673.60	673.53	12.08	11.47	
		110.22	110.21	200	1783									54	3.05	48.57	0.00061	685.00	684.63	673.53	673.41	11.47	11.22	
		110.21	110.20	128	1911									54	3.05	48.57	0.00061	684.63	684.00	673.41	673.33	11.22	10.67	
		110.20	110.19	107	2018									54	3.05	48.57	0.00061	684.00	683.64	673.33	673.27	10.67	10.37	
		110.19	110.18	106	2124									54	3.05	48.57	0.00061	683.64	683.81	673.27	673.20	10.37	10.61	24 x 36 sewer from main bazar islampura I.L 674.21
		110.18	110.17	143	2267									54	3.05	48.57	0.00061	683.81	683.11	672.70	672.62	11.11	10.49	674.21
		110.17	110.16	143	2410									54	3.05	48.57	0.00061	683.11	683.20	672.62	672.53	10.49	10.67	
		110.16	110.15	143	2553									54	3.05	48.57	0.00061	683.20	683.40	672.53	672.44	10.67	10.96	
		110.15	110.14	126	2679									54	3.05	48.57	0.00061	683.40	683.67	672.44	672.37	10.96	11.30	
		110.14	110.13	125	2804									54	3.05	48.57	0.00061	683.67	683.67	672.37	672.29	11.30	11.38	
		110.13	110.12	126	2930									54	3.05	48.57	0.00061	683.67	683.60	672.29	672.21	11.38	11.39	
		110.12	110.11	126	3056									54	3.05	48.57	0.00061	683.60	683.52	672.21	672.14	11.39	11.38	
		110.11	110.10	191	3247									54	3.05	48.57	0.00061	683.52	683.43	672.14	672.02	11.38	11.41	
		110.10	110.9	126	3373									54	3.05	48.57	0.00061	683.43	683.42	672.02	671.94	11.41	11.48	
		110.9	110.8	125	3498									54	3.05	48.57	0.00061	683.42	683.42	671.94	671.87	11.48	11.55	
		110.8	110.7	125	3623									54	3.05	48.57	0.00061	683.42	683.10	671.87	671.79	11.55	11.31	
		110.7	110.6	160	3783									54	3.05	48.57	0.00061	683.10	682.98	671.79	671.69	11.31	11.29	
		110.6	110.5	200	3983									54	3.05	48.57	0.00061	682.98	683.28	671.69	671.57	11.29	11.71	
		110.5	110.4	200	4183									54	3.05	48.57	0.00061	683.28	683.28	671.57	671.45	11.71	11.83	
		110.4	110.3	200	4383									54	3.05	48.57	0.00061	683.28	684.00	671.45	671.33	11.83	12.67	
		110.3	110.2	170	4553									54	3.05	48.57	0.00061	684.00	684.58	671.33	671.22	12.67	13.36	
		110.2	110.1	115	4668									54	3.05	48.57	0.00061	684.58	684.60	671.22	671.15	13.36	13.45	
		110.1	110	115	4783									54	3.05	48.57	0.00061	684.60	684.63	671.15	671.08	13.45	13.55	

Master Plan for Improvement of Sewerage and Drainage System of Central Zone Lahore
Hydraulic Statement

Trunk Sewer from Larex Colony to Gulshan-e-Ravi lift station

Line	Description	Manhole No.		Length (ft)		Population		Average Flow	Peak Factor	Peak Flow	Infilter-ation	Design Flow	Allowance for Storm	Design Capacity			Slope	Ground Level (ft)		Invert Level (ft)		Depth (ft)		Remarks	Drop
		From	To	Segment	Commu-lative	on line	Commu-lative	cfs		cfs	cfs	cfs	cfs	Dia inch	Vel. ft/s	Flow ft3/s		U/S	D/S	U/S	D/S	U/S	D/S		
H~I	Hall road Chowk to Sanda road	86	87	236	13662	40,681	270,507	35.12	2.30	80.78	3.51	140.49	56.20	84	3.67	141.41	0.00049	692.61	693.60	673.73	673.61	18.88	19.99	678.37	4.64
		87	88	300	13962							140.49		84	3.67	141.41	0.00049	693.60	694.80	673.61	673.46	19.99	21.34		
		88	89	90	14052							140.49		84	3.67	141.41	0.00049	694.80	695.20	673.46	673.42	21.34	21.78		
		89	90	300	14352							140.49		84	3.67	141.41	0.00049	695.20	695.80	673.42	673.27	21.78	22.53		
		90	91	292	14644							140.49		84	3.67	141.41	0.00049	695.80	696.01	673.27	673.13	22.53	22.88		
		91	92	191	14835							140.49		84	3.67	141.41	0.00049	696.01	696.12	673.13	673.04	22.88	23.08		
		92	93	300	15135							140.49		84	3.67	141.41	0.00049	696.12	696.00	673.04	672.89	23.08	23.11		
		93	94	226	15361							140.49		84	3.67	141.41	0.00049	696.00	693.67	672.89	672.78	23.11	20.89		
		94	95	226	15587							140.49		84	3.67	141.41	0.00049	693.67	689.21	672.78	672.67	20.89	16.54		
		95	96	102	15689							140.49		84	3.67	141.41	0.00049	689.21	687.98	672.67	672.62	16.54	15.36		
		96	97	300	15989							140.49		84	3.67	141.41	0.00049	687.98	686.39	672.62	672.47	15.36	13.92		
		97	98	300	16289							140.49		84	3.67	141.41	0.00049	686.39	686.23	672.47	672.32	13.92	13.91		
		98	99	120	16409							140.49		84	3.67	141.41	0.00049	686.23	688.09	672.32	672.27	13.91	15.82		
		99	100	225	16634							140.49		84	3.67	141.41	0.00049	688.09	689.26	672.27	672.16	15.82	17.10		
		100	101	225	16859							140.49		84	3.67	141.41	0.00049	689.26	689.12	672.16	672.05	17.10	17.08		
		101	102	300	17159							140.49		84	3.67	141.41	0.00049	689.12	688.94	672.05	671.90	17.08	17.04		
		102	103	200	17359							140.49		84	3.67	141.41	0.00049	688.94	688.81	671.90	671.80	17.04	17.01		
		103	104	263	17622							140.49		84	3.67	141.41	0.00049	688.81	688.65	671.80	671.67	17.01	16.98		
		104	105	263	17885							140.49		84	3.67	141.41	0.00049	688.65	688.49	671.67	671.54	16.98	16.94		
		105	106	140	18025							140.49		84	3.67	141.41	0.00049	688.49	688.40	671.54	671.47	16.94	16.93		
		106	107	200	18225							140.49		84	3.67	141.41	0.00049	688.40	688.28	671.47	671.38	16.93	16.90		
		107	108	200	18425							140.49		84	3.67	141.41	0.00049	688.28	688.15	671.38	671.28	16.90	16.88		
		108	109	130	18555							140.49		84	3.67	141.41	0.00049	688.15	688.07	671.28	671.21	16.88	16.86		
	Lower Mall Sewer	109	110	280	18835							140.49		84	3.67	141.41	0.00049	688.07	687.90	671.21	671.08	16.86	16.82	Sanda road 54" sewer I.L MH110	
I~J	Sanda road to Choburji chowk	110	111	68	18903	93,516	364,023	47.26	2.15	101.62	4.73	189.06	82.71	90	4.29	189.65	0.00061	687.90	688.02	667.49	667.45	20.41	20.57	671.08	3.60
		111	112	300	19203							189.06		90	4.29	189.65	0.00061	688.02	688.02	667.45	667.26	20.57	20.76		
		112	113	300	19503							189.06		90	4.29	189.65	0.00061	688.02	688.77	667.26	667.08	20.76	21.69		
		113	114	300	19803							189.06		90	4.29	189.65	0.00061	688.77	687.00	667.08	666.90	21.69	20.10		
		114	115	300	20103							189.06		90	4.29	189.65	0.00061	687.00	686.87	666.90	666.71	20.10	20.16		
		115	116	300	20403							189.06		90	4.29	189.65	0.00061	686.87	686.12	666.71	666.53	20.16	19.59		
		116	117	300	20703							189.06		90	4.29	189.65	0.00061	686.12	687.00	666.53	666.35	19.59	20.65		
		117	118	300	21003							189.06		90	4.29	189.65	0.00061	687.00	684.63	666.35	666.16	20.65	18.47		
		118	119	300	21303							189.06		90	4.29	189.65	0.00061	684.63	685.23	666.16	665.98	18.47	19.25		
		119	120	300	21603							189.06		90	4.29	189.65	0.00061	685.23	684.33	665.98	665.80	19.25	18.53		
		120	121	300	21903							189.06		90	4.29	189.65	0.00061	684.33	684.04	665.80	665.62	18.53	18.42		
		121	122	80	21983	45,000	409,023	53.11	2.15	114.18	5.31	212.43	92.94	90	4.82	213.08	0.00077	684.04	684.09	665.62	665.55	18.42	18.54	24" x 36"Sham Nagar Road Sewer (Depth 12'-2")	
	Multan Road to Cantonment drain(Multan road)	122	123	300	22283							212.43		90	4.82	213.08	0.00077	684.09	684.51	665.55	665.32	18.54	19.19		
		123	124	300	22583							212.43		90	4.82	213.08	0.00077	684.51	684.59	665.32	665.09	19.19	19.50		
		124	125	300	22883							212.43		90	4.82	213.08	0.00077	684.59	684.51	665.09	664.86	19.50	19.65		
		125	126	300	23183							212.43		90	4.82	213.08	0.00077	684.51	683.75	664.86	664.63	19.65	19.12		
		126	127	300	23483							212.43		90	4.82	213.08	0.00077	683.75	683.71	664.63	664.40	19.12	19.31		
		127	128	300	23783							212.43		90	4.82	213.08	0.00077	683.71	685.98	664.40	664.17	19.31	21.81		
		128	129	300	24083							212.43		90	4.82	213.08	0.00077	685.98	685.83	664.17	663.94	21.81	21.89		
		129	130	300	24383							212.43		90	4.82	213.08	0.00077	685.83	685.65	663.94	663.71	21.89	21.94		
		130	131	250	24633							212.43		90	4.82	213.08	0.00077	685.65	685.35	663.71	663.51	21.94	21.84		
		131	132	250	24883							212.43		90	4.82	213.08	0.00077	685.35	685.95	663.51	663.32	21.84	22.63		
		132	133	250	25133							212.43		90	4.82	213.08	0.00077	685.95	686.46	663.32	663.13	22.63	23.33		
		133	134	250	25383							212.43		90	4.82	213.08	0.00077	686.46	686.09	663.13	662.94	23.33	23.15		
		134	135	250	25633							212.43		90	4.82	213.08	0.00077	686.09	686.60	662.94	662.74	23.15	23.86		
		135	136	250	25883							212.43		90	4.82	213.08	0.00077	686.60	685.72	662.74	662.55	23.86	23.17		
		136	137	300	26183							212.43		90	4.82	213.08	0.00077	685.72	685.54	662.55	662.32	23.17	23.22	Cantonment Drain Crossing (B.L 677.77)	
		137	138	300	26483							212.43		90	4.82	213.08	0.00077	685.54	685.29	662.32	662.09	23.22	23.20		
		138	139	300	26783							212.43		90	4.82	213.08	0.00077	685.29	685.36	662.09	661.86	23.20	23.50		

Appendix 13.5.3 Proposed Sewer: Hydraulic Calculation
Trunk Sewer along Cantonment Drain (1/3)

Line	Description	Manhole No.		Length (ft)		Population		Average	Peak	Peak	Infilter-	Allowance	Design	Dia. of Pipe/ Box Size		Design Capacity		Slope	Ground Level (ft)		Invert Level (ft)		Depth (ft)		Remarks	Drop
		From	To	Segment	Commu-lative	on line	Commu-lative	Flow	Factor	Flow	ation	for Storm	Flow	Dia/Width	Depth	Vel.	Flow		U/S	D/S	U/S	D/S	U/S	D/S		
								cfs		cfs	cfs	cfs	cfs	inch / ft	ft	ft/s	ft3/s									
A	Sunny Flour Mill LS to Gulberg-II LS	76	75	215	33000	67,050	67,050	8.71	2.70	23.51	0.87	4.35	28.73	48		3.43	43.09	0.00090	704.40	704.57	683.00	682.81	21.40	21.76	42" dia sewr at Guru Mangat road	
		75	74	215	32785	0	67,050	8.71	2.70	23.51	0.87	4.35	28.73	48		3.43	43.09	0.00090	704.57	704.73	682.81	682.61	21.76	22.12		
		74	73	215	32570	0	67,050	8.71	2.70	23.51	0.87	4.35	28.73	48		3.43	43.09	0.00090	704.73	704.91	682.61	682.42	22.12	22.49		
		73	72	460	32355	0	67,050	8.71	2.70	23.51	0.87	4.35	28.73	48		3.43	43.09	0.00090	704.91	705.09	682.42	682.01	22.49	23.08		
		72	71	460	31895	0	67,050	8.71	2.70	23.51	0.87	4.35	28.73	48		3.43	43.09	0.00090	705.09	704.49	682.01	681.59	23.08	22.90		
		71	70	460	31435	0	67,050	8.71	2.70	23.51	0.87	4.35	28.73	48		3.43	43.09	0.00090	704.49	704.07	681.59	681.18	22.90	22.89		
	Gulberg-II LS to G-Block LS	70	69	250	30975	34,013	101,063	13.12	2.50	32.80	1.31	6.56	40.68	54		3.60	57.33	0.00085	704.07	703.60	680.68	680.47	23.39	23.13		
		69	68	500	30725	0	101,063	13.12	2.50	32.80	1.31	6.56	40.68	54		3.60	57.33	0.00085	703.60	702.14	680.47	680.04	23.13	22.10		
		68	67	500	30225	0	101,063	13.12	2.50	32.80	1.31	6.56	40.68	54		3.60	57.33	0.00085	702.14	701.31	680.04	679.62	22.10	21.69		
		67	66	500	29725	0	101,063	13.12	2.50	32.80	1.31	6.56	40.68	54		3.60	57.33	0.00085	701.31	701.31	679.62	679.19	21.69	22.12		
		66	65	500	29225	0	101,063	13.12	2.50	32.80	1.31	6.56	40.68	54		3.60	57.33	0.00085	701.31	701.74	679.19	678.77	22.12	22.97		
		65	64	160	28725	0	101,063	13.12	2.50	32.80	1.31	6.56	40.68	54		3.60	57.33	0.00085	701.74	702.00	678.77	678.63	22.97	23.37		
		64	63	310	28565	0	101,063	13.12	2.50	32.80	1.31	6.56	40.68	54		3.60	57.33	0.00085	702.00	700.77	678.63	678.37	23.37	22.40		
		63	62	310	28255	0	101,063	13.12	2.50	32.80	1.31	6.56	40.68	54		3.60	57.33	0.00085	700.77	700.12	678.37	678.10	22.40	22.02		
		62	61	370	27945	0	101,063	13.12	2.50	32.80	1.31	6.56	40.68	54		3.60	57.33	0.00085	700.12	700.15	678.10	677.79	22.02	22.36		
		61	60	370	27575	0	101,063	13.12	2.50	32.80	1.31	6.56	40.68	54		3.60	57.33	0.00085	700.15	700.05	677.79	677.48	22.36	22.57		
		60	59	360	27205	0	101,063	13.12	2.50	32.80	1.31	6.56	40.68	54		3.60	57.33	0.00085	700.05	700.00	677.48	677.17	22.57	22.83		
		59	58	360	26845	0	101,063	13.12	2.50	32.80	1.31	6.56	40.68	54		3.60	57.33	0.00085	700.00	699.90	677.17	676.86	22.83	23.04		
		58	57	360	26485	0	101,063	13.12	2.50	32.80	1.31	6.56	40.68	54		3.60	57.33	0.00085	699.90	699.56	676.86	676.56	23.04	23.00		
	G-Block LS to Canal Park LS	57	56	125	26125	48,224	149,287	19.38	2.50	48.46	1.94	9.69	60.09	66		3.74	88.85	0.00070	699.56	699.49	676.56	675.47	23.00	24.02	Egg Shaped sewer 36" x 54" G-block LS	
		56	55	370	26000	0	149,287	19.38	2.50	48.46	1.94	9.69	60.09	66		3.74	88.85	0.00070	699.49	699.38	675.47	675.21	24.02	24.17		
		55	54	500	25630	0	149,287	19.38	2.50	48.46	1.94	9.69	60.09	66		3.74	88.85	0.00070	699.38	700.52	675.21	674.86	24.17	25.66		
		54	53	320	25130	0	149,287	19.38	2.50	48.46	1.94	9.69	60.09	66		3.74	88.85	0.00070	700.52	701.08	674.86	674.64	25.66	26.44		
		53	52	320	24810	0	149,287	19.38	2.50	48.46	1.94	9.69	60.09	66		3.74	88.85	0.00070	701.08	704.00	674.64	674.41	26.44	29.59		
	Canal Park LS to Junction c	52	51	390	24490	11,900	161,187	20.93	2.30	48.13	2.09	10.46	60.69	66		3.74	88.85	0.00070	704.00	703.24	674.41	674.14	29.59	29.10	27" dia sewer Canal Park	
A1	Mustafabad LS to Saidan Shah-I	24	23	500	9580	58,200	58,200	7.56	2.70	20.40	0.76	3.78	24.94	42		3.62	34.85	0.00120	704.40	703.34	685.75	685.15	18.65	18.19	36" dia sewer with 16" depth at D/S	
		23	22	500	9080	0	58,200	7.56	2.70	20.40	0.76	3.78	24.94	42		3.62	34.85	0.00120	703.34	703.15	685.15	684.55	18.19	18.60		
		22	21	500	8580	0	58,200	7.56	2.70	20.40	0.76	3.78	24.94	42		3.62	34.85	0.00120	703.15	702.48	684.55	683.95	18.60	18.53		
		21	20	500	8080	0	58,200	7.56	2.70	20.40	0.76	3.78	24.94	42		3.62	34.85	0.00120	702.48	702.39	683.95	683.35	18.53	19.04		
		20	19	500	7580	0	58,200	7.56	2.70	20.40	0.76	3.78	24.94	42		3.62	34.85	0.00120	702.39	702.81	683.35	682.75	19.04	20.06		
	Saidan Shah-I to Saidan Shah-II	19	18	500	7080	8,388	66,588	8.65	2.70	23.34	0.86	4.32	28.53	48		3.43	43.09	0.00090	702.81	702.53	682.25	681.80	20.56	20.73		
		18	17	500	6580	0	66,588	8.65	2.70	23.34	0.86	4.32	28.53	48		3.43	43.09	0.00090	702.53	702.53	681.80	681.35	20.73	21.18		
		17	16	400	6080	0	66,588	8.65	2.70	23.34	0.86	4.32	28.53	48		3.43	43.09	0.00090	702.53	703.25	681.35	680.99	21.18	22.26		
	Saidan Shah-II to Zafar Ali Rd. LS	16	15	400	5680	14,875	81,463	10.58	2.50	26.44	1.06	5.29	32.79	48		3.43	43.09	0.00090	703.25	706.82	680.99	680.63	22.26	26.19		
		15	14	400	5280	0	81,463	10.58	2.50	26.44	1.06	5.29	32.79	48		3.43	43.09	0.00090	706.82	704.77	680.63	680.27	26.19	24.50		
		14	13	400	4880	0	81,463	10.58	2.50	26.44	1.06	5.29	32.79	48		3.43	43.09	0.00090	704.77	704.80	680.27	679.91	24.50	24.89		
		13	12	400	4480	0	81,463	10.58	2.50	26.44	1.06	5.29	32.79	48		3.43	43.09	0.00090	704.80	703.92	679.91	679.55	24.89	24.37		
		12	11	500	4080	0	81,463	10.58	2.50	26.44	1.06	5.29	32.79	48		3.43	43.09	0.00090	703.92	703.47	679.55	679.10	24.37	24.37		
		11	10	500	3580	0	81,463	10.58	2.50	26.44	1.06	5.29	32.79	48		3.43	43.09	0.00090	703.47	702.88	679.10	678.65	24.37	24.23		
		10	9	500	3080	0	81,463	10.58	2.50	26.44	1.06	5.29	32.79	48		3.43	43.09	0.00090	702.88	702.70	678.65	678.20	24.23	24.50		
	Zafar Ali Rd. LS to Junction Point	9	8	240	2580	14,496	95,959	12.46	2.50	31.15	1.25	6.23	38.62	54		3.60	57.33	0.00085	702.70	702.99	677.70	677.50	25.00	25.49	12" dia sewer at Zafar Ali Road	
		8	7	240	2340	0	95,959	12.46	2.50	31.15	1.25	6.23	38.62	54		3.60	57.33	0.00085	702.99	705.16	677.50	677.29	25.49	27.87		
		7	6	300	2100	0	95,959	12.46	2.50	31.15	1.25	6.23	38.62	54		3.60	57.33	0.00085	705.16	704.99	677.29	677.04	27.87	27.95		

Appendix 13.5.3 Proposed Sewer: Hydraulic Calculation
Trunk Sewer along Cantonment Drain (2/3)

Line	Description	Manhole No.		Length (ft)		Population		Average	Peak	Peak	Infilter-	Allowance	Design	Dia. of Pipe/ Box Size		Design Capacity		Slope	Ground Level (ft)		Invert Level (ft)		Depth (ft)		Remarks	Drop
		From	To	Segment	Commu-lative	on line	Commu-lative	Flow cfs	Factor	Flow cfs	ation cfs	for Storm cfs	Flow cfs	Dia/Width inch / ft	Depth ft	Vel. ft/s	Flow ft3/s		U/S	D/S	U/S	D/S	U/S	D/S		
		6	5	300	1800	0	95,959	12.46	2.50	31.15	1.25	6.23	38.62	54		3.60	57.33	0.00085	704.99	703.44	677.04	676.78	27.95	26.66		
		5	4	300	1500	0	95,959	12.46	2.50	31.15	1.25	6.23	38.62	54		3.60	57.33	0.00085	703.44	702.41	676.78	676.53	26.66	25.88		
		4	3	300	1200	0	95,959	12.46	2.50	31.15	1.25	6.23	38.62	54		3.60	57.33	0.00085	702.41	702.37	676.53	676.27	25.88	26.10		
		3	2	300	900	0	95,959	12.46	2.50	31.15	1.25	6.23	38.62	54		3.60	57.33	0.00085	702.37	702.53	676.27	676.02	26.10	26.51		
		2	1	300	600	0	95,959	12.46	2.50	31.15	1.25	6.23	38.62	54		3.60	57.33	0.00085	702.53	703.15	676.02	675.76	26.51	27.39		
		1	51	300	300	0	95,959	12.46	2.50	31.15	1.25	6.23	38.62	54		3.60	57.33	0.00085	703.15	703.24	675.76	675.51	27.39	27.73		
A	Junction Point to Shah Jamal LS	51	50	435	24100	257,145	257,145	33.39	2.30	76.79	3.34	16.69	96.82	78		4.18	138.71	0.00070	703.24	700.82	673.14	672.84	30.10	27.98	Canal crossing	
		50	49	435	23665	257,145	257,145	33.39	2.30	76.79	3.34	16.69	96.82	78		4.18	138.71	0.00070	700.82	700.33	672.84	672.53	27.98	27.80		
		49	48	435	23230	257,145	257,145	33.39	2.30	76.79	3.34	16.69	96.82	78		4.18	138.71	0.00070	700.33	700.96	672.53	672.23	27.80	28.73		
		48	47	435	22795	257,145	257,145	33.39	2.30	76.79	3.34	16.69	96.82	78		4.18	138.71	0.00070	700.96	701.05	672.23	671.92	28.73	29.13		
		47	46	230	22360	257,145	257,145	33.39	2.30	76.79	3.34	16.69	96.82	78		4.18	138.71	0.00070	701.05	700.05	671.92	671.76	29.13	28.29		
		46	45	440	22130	257,145	257,145	33.39	2.30	76.79	3.34	16.69	96.82	78		4.18	138.71	0.00070	700.05	699.50	671.76	671.45	28.29	28.05		
		45	44	145	21690	257,145	257,145	33.39	2.30	76.79	3.34	16.69	96.82	78		4.18	138.71	0.00070	699.50	698.62	671.45	671.35	28.05	27.27		
		44	43	270	21545	257,145	257,145	33.39	2.30	76.79	3.34	16.69	96.82	78		4.18	138.71	0.00070	698.62	698.76	671.35	671.16	27.27	27.60		
		43	42	500	21275	257,145	257,145	33.39	2.30	76.79	3.34	16.69	96.82	78		4.18	138.71	0.00070	698.76	698.08	671.16	670.81	27.60	27.27		
		42	41	500	20775	257,145	257,145	33.39	2.30	76.79	3.34	16.69	96.82	78		4.18	138.71	0.00070	698.08	699.10	670.81	670.46	27.27	28.64		
		41	40	500	20275	257,145	257,145	33.39	2.30	76.79	3.34	16.69	96.82	78		4.18	138.71	0.00070	699.10	701.64	670.46	670.11	28.64	31.53		
	Shah Jamal LS to Shama LS	40	39	500	19775	71,600	328,745	42.68	2.15	91.77	4.27	21.34	117.38	6.00	6.00	4.31	155.04	0.00075	701.64	692.65	670.11	669.74	31.53	22.91		
		39	38	500	19275	0	328,745	42.68	2.15	91.77	4.27	21.34	117.38	6.00	6.00	4.31	155.04	0.00075	692.65	692.05	669.74	669.36	22.91	22.69		
		38	37	500	18775	0	328,745	42.68	2.15	91.77	4.27	21.34	117.38	6.00	6.00	4.31	155.04	0.00075	692.05	691.70	669.36	668.99	22.69	22.71		
		37	36	500	18275	0	328,745	42.68	2.15	91.77	4.27	21.34	117.38	6.00	6.00	4.31	155.04	0.00075	691.70	691.58	668.99	668.61	22.71	22.97		
		36	35	500	17775	0	328,745	42.68	2.15	91.77	4.27	21.34	117.38	6.00	6.00	4.31	155.04	0.00075	691.58	692.05	668.61	668.24	22.97	23.81		
		35	34	500	17275	0	328,745	42.68	2.15	91.77	4.27	21.34	117.38	6.00	6.00	4.31	155.04	0.00075	692.05	699.78	668.24	667.86	23.81	31.92		
	Shama LS to Rasul Park LS	34	33	500	16775	53,840	382,585	49.67	2.15	106.80	4.97	24.84	136.60	7.00	6.00	4.29	180.01	0.00065	699.78	694.27	667.86	667.54	31.92	26.73	36" dia sewer at Shama LS	
		33	32	500	16275	0	382,585	49.67	2.15	106.80	4.97	24.84	136.60	7.00	6.00	4.29	180.01	0.00065	694.27	692.13	666.54	666.21	27.73	25.92		
		32	31	500	15775	0	382,585	49.67	2.15	106.80	4.97	24.84	136.60	7.00	6.00	4.29	180.01	0.00065	692.13	686.59	665.21	664.89	26.92	21.71		
	Rasul Park LS to Multan Road	31	30	500	15275	36,365	418,950	54.40	2.15	116.95	5.44	27.20	149.59	8.00	6.00	4.16	199.91	0.00055	686.59	685.20	663.89	663.61	22.70	21.59	36" dia sewer at Rasul Park LS	
		30	29	500	14775	0	418,950	54.40	2.15	116.95	5.44	27.20	149.59	8.00	6.00	4.16	199.91	0.00055	685.20	686.35	663.61	663.34	21.59	23.02		
		29	28	500	14275	0	418,950	54.40	2.15	116.95	5.44	27.20	149.59	8.00	6.00	4.16	199.91	0.00055	686.35	687.23	663.34	663.06	23.02	24.17		
		28	27	500	13775	0	418,950	54.40	2.15	116.95	5.44	27.20	149.59	8.00	6.00	4.16	199.91	0.00055	687.23	687.20	663.06	662.79	24.17	24.42		
		27	26	500	13275	0	418,950	54.40	2.15	116.95	5.44	27.20	149.59	8.00	6.00	4.16	199.91	0.00055	687.20	688.18	662.79	662.51	24.42	25.67		
		26	25	500	12775	0	418,950	54.40	2.15	116.95	5.44	27.20	149.59	8.00	6.00	4.16	199.91	0.00055	688.18	684.84	662.51	662.24	25.67	22.60		
		25	24	500	12275	0	418,950	54.40	2.15	116.95	5.44	27.20	149.59	8.00	6.00	4.16	199.91	0.00055	684.84	684.03	662.24	661.96	22.60	22.07		
		24	23	500	11775	0	418,950	54.40	2.15	116.95	5.44	27.20	149.59	8.00	6.00	4.16	199.91	0.00055	684.03	684.15	661.96	661.69	22.07	22.46		
		23	22	500	11275	0	418,950	54.40	2.15	116.95	5.44	27.20	149.59	8.00	6.00	4.16	199.91	0.00055	684.15	684.29	661.69	661.41	22.46	22.88		
		22	21	500	10775	0	418,950	54.40	2.15	116.95	5.44	27.20	149.59	8.00	6.00	4.16	199.91	0.00055	684.29	684.53	661.41	661.14	22.88	23.39		
		21	20	500	10275	0	418,950	54.40	2.15	116.95	5.44	27.20	149.59	8.00	6.00	4.16	199.91	0.00055	684.53	684.51	661.14	660.86	23.39	23.65		
		20	19	500	9775	0	418,950	54.40	2.15	116.95	5.44	27.20	149.59	8.00	6.00	4.16	199.91	0.00055	684.51	684.58	660.86	660.59	23.65	23.99		
		19	18	500	9275	0	418,950	54.40	2.15	116.95	5.44	27.20	149.59	8.00	6.00	4.16	199.91	0.00055	684.58	684.58	660.59	660.31	23.99	24.27		
		18	17	500	8775	0	418,950	54.40	2.15	116.95	5.44	27.20	149.59	8.00	6.00	4.16	199.91	0.00055	684.58	685.36	660.31	660.04	24.27	25.32		
	Multan Road to New Gulshan-e-Ravi DS	17	16	500	8275	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	685.36	684.37	658.04	657.84	27.32	26.53	90" dia sewer Central Zone	
		16	15	500	7775	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	684.37	685.32	657.84	657.64	26.53	27.68		
		15	14	500	7275	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	685.32	685.06	657.64	657.44	27.68	27.62		
		14	13	500	6775	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	685.06	684.53	657.44	657.24	27.62	27.29		
		13	12	500	6275	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	684.53	684.40	657.24	657.04	27.29	27.36		

Appendix 13.5.3 Proposed Sewer: Hydraulic Calculation
Trunk Sewer along Cantonment Drain (3/3)

Line	Description	Manhole No.		Length (ft)		Population		Average	Peak	Peak	Infilter-	Allowance	Design	Dia. of Pipe/ Box Size		Design Capacity		Slope	Ground Level (ft)		Invert Level (ft)		Depth (ft)		Remarks	Drop
		From	To	Segment	Commu-lative	on line	Commu-lative	Flow	Factor	Flow	ation	for Storm	Flow	Dia/Width	Depth	Vel.	Flow		U/S	D/S	U/S	D/S	U/S	D/S		
								cfs		cfs	cfs	cfs	cfs	inch / ft	ft	ft/s	ft3/s									
		12	11	500	5775	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	684.40	684.31	657.04	656.84	27.36	27.47		
		11	10	500	5275	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	684.31	684.18	656.84	656.64	27.47	27.54		
		10	9	500	4775	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	684.18	684.37	656.64	656.44	27.54	27.93		
		9	8	500	4275	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	684.37	684.27	656.44	656.24	27.93	28.03		
		8	7	500	3775	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	684.27	683.56	656.24	656.04	28.03	27.52		
		7	6	500	3275	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	683.56	683.23	656.04	655.84	27.52	27.39		
		6	5	500	2775	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	683.23	683.21	655.84	655.64	27.39	27.57		
		5	4	500	2275	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	683.21	683.49	655.64	655.44	27.57	28.05		
		4	3	500	1775	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	683.49	682.96	655.44	655.24	28.05	27.72		
		3	2	500	1275	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	682.96	682.86	655.24	655.04	27.72	27.82		
		2	1	425	775	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	682.86	684.37	655.04	654.87	27.82	29.50		
		1	DS	350	350	0	794,822	103.20	2.08	214.65	10.32	108.82	333.79	12.00	8.00	4.51	432.48	0.00040	684.37	683.05	654.87	654.73	29.50	28.32		

Appendix 13.5.4 Hydraulic Calculation: Central Drain and Meclod Road Drain (1/4)

Line	Chainage (ft)		Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	Segment	RD	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
Central Drain Out fall in Mian Mir drain at RD 36278													
A~B	600	19600	69.11	0.003	706.690	700.440	704.440	3	4	5.75	69.00	2.25	Railway Station
	500	19000	69.11	0.003	705.040	698.640	702.640	3	4	5.75	69.00	2.40	
	500	18500	69.11	0.003	702.840	697.140	701.140	3	4	5.75	69.00	1.70	
		18500			702.840	696.140	696.140						
	500	18000	69.11	0.003	699.520	694.640	698.640	3	4	5.75	69.00	0.88	
	500	17500	69.11	0.003	698.720	693.140	697.140	3	4	5.75	69.00	1.58	
	500	17000	69.11	0.003	696.760	691.640	695.640	3	4	5.75	69.00	1.12	
		17000			696.760	691.140	695.640						
	500	16500	69.11	0.003	694.930	689.640	693.640	3	4	5.75	69.00	1.29	
	500	16000	69.11	0.003	693.220	688.140	692.140	3	4	5.75	69.00	1.08	
	500	15500	69.11	0.003	691.870	686.640	690.640	3	4	5.75	69.00	1.23	
	500	15000	69.11	0.003	690.500	685.140	689.140	3	4	5.75	69.00	1.36	
		15000			690.500	684.140	689.140	6	5				
	115	14500	69.11	0.000700	690.130	682.640	687.640	6	5	3.99	119.56	2.49	
	385	14385	69.11	0.000700	690.130	682.560	687.560	6	5	3.99	119.56	2.57	
B~C	500	14000	119.98	0.000700	690.320	682.290	687.290	6	5	3.99	119.56	3.03	Mecleod road sewer
	500	13500	119.98	0.000700	690.750	681.940	686.940	6	5	3.99	119.56	3.81	Mecleod road sewer
	500	13000	119.98	0.000700	694.440	681.590	686.590	6	5	3.99	119.56	7.85	Mecleod road sewer
	250	12500	119.98	0.000700	698.370	681.240	686.240	6	5	3.99	119.56	12.13	Mecleod road sewer
	250	12250	119.98	0.000700	696.120	681.065	686.065	6	5	3.99	119.56	10.05	Mecleod road (Napier chowk) Lakshami Dr BL= 681.033, GL=693.60

Appendix 13.5.4 Hydraulic Calculation: Central Drain and Meclod Road Drain (2/4)

Line	Chainage (ft)		Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	Segment	RD	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
		12250			696.120	680.065	686.065						
C~D	500	12000	151.8	0.000170	693.230	679.890	685.890	10	6	2.52	151.28	7.34	Begum Salma Tasaddaq Husain road
	500	11500	151.8	0.000170	690.180	679.805	685.805	10	6	2.52	151.28	4.37	Mall road
	500	11000	151.8	0.000170	689.200	679.720	685.720	10	6	2.52	151.28	3.48	Mall road
	500	10500	151.8	0.000170	687.980	679.635	685.635	10	6	2.52	151.28	2.35	Ustad Maula Baksh road (GPO chowk)
	500	10000	151.8	0.000170	686.230	679.550	685.550	10	6	2.52	151.28	0.68	Ustad Maula Baksh road
	500	9500	151.8	0.000170	689.410	679.465	685.465	10	6	2.52	151.28	3.95	A.G office chowk
	500	9000	151.8	0.000170	685.670	679.380	685.380	10	6	2.52	151.28	0.29	Edward road
	500	8500	151.8	0.000170	685.680	679.295	685.295	10	6	2.52	151.28	0.39	"
	500	8000	151.8	0.000170	686.710	679.210	685.210	10	6	2.52	151.28	1.50	Lyton road
	500	7500	151.8	0.000170	687.980	679.125	685.125	10	6	2.52	151.28	2.86	"
	200	7000	151.8	0.000170	688.560	679.040	685.040	10	6	2.52	151.28	3.52	"
	300	6800	151.8	0.00017	688.560	679.006	685.006	10	6	2.52	151.28	3.55	Central Drain crossing (BL 679.61)
D~9	500	6500	151.8	0.000110	689.580	679.006	685.006	12	6	2.16	155.61	4.57	"
	500	6000	151.8	0.000110	696.970	678.951	684.951	12	6	2.16	155.61	12.02	"
	500	5500	151.8	0.000110	703.150	678.896	684.896	12	6	2.16	155.61	18.25	"
	500	5000	151.8	0.000110	702.640	678.841	684.841	12	6	2.16	155.61	17.80	"
	500	4500	151.8	0.000110	701.690	678.786	684.786	12	6	2.16	155.61	16.90	Miani Sahib Grave Yard
	500	4000	151.8	0.000110	701.550	678.731	684.731	12	6	2.16	155.61	16.82	"
	500	3500	151.8	0.000110	699.670	678.676	684.676	12	6	2.16	155.61	14.99	"
	500	3000	151.8	0.000110	695.142	678.621	684.621	12	6	2.16	155.61	10.52	"

Appendix 13.5.4 Hydraulic Calculation: Central Drain and Meclod Road Drain (3/4)

Line	Chainage (ft)		Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	Segment	RD	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
	500	2500	268.51	0.000110	689.480	678.566	684.566	12	6	2.16	155.61	4.91	"
	500	2000	268.51	0.000110	687.332	678.511	684.511	12	6	2.16	155.61	2.82	"
	500	1500	268.51	0.000110	686.712	678.456	684.456	12	6	2.16	155.61	2.26	Fasih road
	500	1000	268.51	0.000110	685.612	678.401	684.401	12	6	2.16	155.61	1.21	"
	500	500	268.51	0.000110	685.002	678.346	684.346	12	6	2.16	155.61	0.66	"
		0	268.51	0.000110	684.917	678.291	684.291	12	6	2.16	155.61	0.63	Out fall in Mian Mir Dr. at Fasih road (Existing BL 678.747, WL 681.747)

Appendix 13.5.5 Hydraulic Calculation: Dil Muhammad Road Drain

Line	Chainage (ft)		Discharge	Slope	Road Level (ft)	Bed Level (ft)	Water Level (ft)	Section		Velocity	Capacity	Free board (ft)	Remarks
	Segment	RD	Cusec					Breadth (ft)	Height (ft)	ft/sec	Cusec	D/S	
A1 ~ B	500	5500	66.88	0.0040	706.690	701.690	704.690	3.5	3	6.70	70.33	2.00	Railway Station
	500	5000	66.88	0.0040	704.850	699.690	702.690	3.5	3	6.70	70.33	2.16	Railway Road
	500	4500	66.88	0.0040	702.900	697.690	700.690	3.5	3	6.70	70.33	2.21	"
		4500			702.900	696.690	700.690						"
	500	4000	66.88	0.0036	699.250	694.690	697.690	3.5	3	6.35	66.72	1.56	"
	500	3500	66.88	0.0036	696.900	692.890	695.890	3.5	3	6.35	66.72	1.01	"
	500	3000	66.88	0.0036	695.100	691.090	694.090	3.5	3	6.35	66.72	1.01	Dill Muhammad Road
	500	2500	66.88	0.0036	693.900	689.290	692.290	3.5	3	6.35	66.72	1.61	"
		2500			693.900	688.040	692.290						"
	500	2000	66.88	0.0013	690.260	686.240	690.240	4	4	4.33	69.23	0.02	"
	500	1500	66.88	0.0013	689.930	685.590	689.590	4	4	4.33	69.23	0.34	"
	500	1000	66.88	0.0013	689.810	684.940	688.940	4	4	4.33	69.23	0.87	"
	500	500	66.88	0.0013	689.240	684.290	688.290	4	4	4.33	69.23	0.95	
	0	0	66.88	0.0013	690.130	683.640	687.640	4	4	4.33	69.23	2.49	Out Fall in Central Drain at Lakshami Chowk at RD 14385

Appendix 13.5.6 Hydraulic Calculation: Art Councel Drain and Allama Iqbal Road Drain (1/6)

Line	Chainage (ft)		Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	Segment	RD	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
A1~B	300	4300	53.43	0.002500	704.32	699.32	702.32	4	3	5.59	67.12	2.00	(A1)Near Nicholson Road
	500	4000	53.43	0.002500	703.30	698.57	701.57	4	3	5.59	67.12	1.73	Allama Iqbal Road
	500	3500	53.43	0.002000	701.34	697.32	700.32	4	3	5.00	60.04	1.02	Allama Iqbal Road
	500	3000	53.43	0.001800	701.01	696.32	699.32	4	3	4.75	56.96	1.69	Allama Iqbal Road
	500	2500	53.43	0.001800	700.68	695.42	698.42	4	3	4.75	56.96	2.26	Allama Iqbal Road
		2500			700.68	694.42	694.42						Allama Iqbal Road
	500	2000	53.43	0.000900	699.68	693.52	697.52	4	4	3.60	57.61	2.16	Muhammad Nagar Disposal
	500	1500	53.43	0.000800	699.24	693.07	697.07	4	4	3.39	54.31	2.17	Allama Iqbal Road
	500	1000	53.43	0.000800	698.66	692.67	696.67	4	4	3.39	54.31	1.99	Allama Iqbal Road
	500	500	53.43	0.000800	698.85	692.27	696.27	4	4	3.39	54.31	2.58	Allama Iqbal Road
	0	0	53.43	0.000800	698.82	691.87	695.87	4	4	3.39	54.31	2.95	(B) Garhi Shahu Chowk
A~B	500	3500	76.48	0.0022	704.20	699.70	703.70	3.5	4	5.30	74.17	0.50	(A) Near Dharam Pura Bridge
	500	3000	76.48	0.0022	704.00	698.60	702.60	3.5	4	5.30	74.17	1.40	Allama Iqbal Road
	500	2500	76.48	0.0022	703.92	697.50	701.50	3.5	4	5.30	74.17	2.42	Allama Iqbal Road
	500	2000	76.48	0.0022	703.15	696.40	700.40	3.5	4	5.30	74.17	2.75	Allama Iqbal Road
	500	1500	76.48	0.0022	701.84	695.30	699.30	3.5	4	5.30	74.17	2.54	Allama Iqbal Road
	500	1000	76.48	0.0022	701.04	694.20	698.20	3.5	4	5.30	74.17	2.84	Allama Iqbal Road
	500	500	76.48	0.0022	698.94	693.10	697.10	3.5	4	5.30	74.17	1.84	Allama Iqbal Road
	0	0	76.48	0.0022	698.82	692.00	696.00	3.5	4	5.30	74.17	2.82	(B) Garhi Shahu Chowk
													Change of depth
B~E2	538	3538	134.77	0.000450	698.82	690.87	695.87	7.5	5	3.49	130.99	2.95	(B) Garhi Shahu Chowk
	500	3000	134.77	0.000450	700.86	690.63	695.63	7.5	5	3.49	130.99	5.23	Durand Road

Appendix 13.5.6 Hydraulic Calculation: Art Councel Drain and Allama Iqbal Road Drain (2/6)

Line	Chainage (ft)		Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	Segment	RD	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
	500	2500	134.77	0.000450	700.66	690.40	695.40	7.5	5	3.49	130.99	5.26	Durand Road
	500	2000	134.77	0.000450	700.12	690.18	695.18	7.5	5	3.49	130.99	4.94	Durand Road
	500	1500	134.77	0.000450	700.21	689.95	694.95	7.5	5	3.49	130.99	5.26	Durand Road
	500	1000	134.77	0.000450	699.52	689.73	694.73	7.5	5	3.49	130.99	4.79	Durand Road
	500	500	134.77	0.000450	699.21	689.50	694.50	7.5	5	3.49	130.99	4.71	Durand Road
	0	0	134.77	0.000450	705.19	689.28	694.28	7.5	5	3.49	130.99	10.91	(E2) Shimla Hill
E1~E2	500	2500	24.44	0.000700	701.90	696.90	699.90	3	3	2.62	23.59	2.00	(E1) Bohar Wala Chowk
	500	2000	24.44	0.000700	701.91	696.55	699.55	3	3	2.62	23.59	2.36	Empress road
	500	1500	24.44	0.000700	702.69	696.20	699.20	3	3	2.62	23.59	3.49	Empress road
	500	1000	24.44	0.000700	702.88	695.85	698.85	3	3	2.62	23.59	4.03	Empress road
	500	500	24.44	0.000700	702.24	695.50	698.50	3	3	2.62	23.59	3.74	Empress road
	0	0	24.44	0.000700	705.19	695.15	698.15	3	3	2.62	23.59	7.04	(E2) Shimla Hill
E2~E	400	2900	152.93	0.000650	705.19	689.28	694.28	7.5	5	4.20	157.43	10.91	(E2) Egerton Road(Shimla Hill)
	500	2500	152.93	0.000650	701.61	689.02	694.02	7.5	5	4.20	157.43	7.59	Egerton Road
	500	2000	152.93	0.000650	699.22	688.69	693.69	7.5	5	4.20	157.43	5.53	Kashmir Road
	500	1500	152.93	0.000650	699.88	688.37	693.37	7.5	5	4.20	157.43	6.51	Kashmir Road
	500	1000	152.93	0.000650	699.05	688.04	693.04	7.5	5	4.20	157.43	6.01	Kashmir Road
	500	500	152.93	0.000650	697.60	687.72	692.72	7.5	5	4.20	157.43	4.88	Kashmir Road
	0	0	152.93	0.000650	697.28	687.39	692.39	7.5	5	4.20	157.43	4.89	(E) out Fall in Governer Drain(Mall Road near Governer House))

Appendix 13.5.7 Hydraulic Calculation: WAPDA House Drain

Line	Chainage (ft)		Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	Segment	RD	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
F1~F	110	3110	18.82	0.001500	703.400	698.400	701.400	3	3	3.84	34.53	2.00	(F1) Starts near Assembly Hall
	500	3000	18.82	0.001500	703.300	698.235	701.235	3	3	3.84	34.53	2.06	Mall road
	500	2500	18.82	0.001500	702.370	697.485	700.485	3	3	3.84	34.53	1.88	Mall road
	500	2000	18.82	0.001500	701.800	696.735	699.735	3	3	3.84	34.53	2.06	Mall road
	500	1500	18.82	0.001500	701.300	695.985	698.985	3	3	3.84	34.53	2.31	Mall road
	500	1000	18.82	0.001500	701.180	695.235	698.235	3	3	3.84	34.53	2.94	Mall road
		1000			701.180	693.735	698.235						Mall road
	500	500	18.82	0.001500	697.280	692.985	695.985	3	3	3.84	34.53	1.29	Mall road
	0	0	18.82	0.001500	698.390	692.235	695.235	3	3	3.84	34.53	3.15	(F) Out fall in Governer Drain Near Bagh-e-Jinnah

Appendix 13.5.8 Hydraulic Calculation: Lawrence Road Drain

Line	Chainage (ft)		Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	Segment	RD	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
G1~G	188	3688	27.13	0.0006	697.920	690.920	693.920	3.5	3	2.59	27.24	4.00	(G1) Lawrence Road Queens Road chowk
	500	3500	27.13	0.0006	694.150	690.807	693.807	3.5	3	2.59	27.24	0.34	Lawrence Road
	500	3000	27.13	0.0006	694.830	690.507	693.507	3.5	3	2.59	27.24	1.32	Lawrence Road
	500	2500	27.13	0.0006	694.420	690.207	693.207	3.5	3	2.59	27.24	1.21	Lawrence Road
	500	2000	27.13	0.0006	694.690	689.907	692.907	3.5	3	2.59	27.24	1.78	Lawrence Road
	500	1500	27.13	0.0006	694.480	689.607	692.607	3.5	3	2.59	27.24	1.87	Lawrence Road
	500	1000	27.13	0.0006	694.500	689.307	692.307	3.5	3	2.59	27.24	2.19	Lawrence Road
	500	500	27.13	0.0006	693.710	689.007	692.007	3.5	3	2.59	27.24	1.70	Lawrence Road
	0	0	27.13	0.0006	692.620	688.707	691.707	3.5	3	2.59	27.24	0.91	(G) Out fall in Governer Drain at (Bagh-e- Jinnah)

Master Plan for Improvement of Sewerage and Drainage System of Central Zone Lahore

Hydraulic Statement Governer House Drain

Line	Chainage (ft)		Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	Segment	RD	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
E~F	341	8435	164.6	0.00075	**697.28**	**687.28**	**692.28**	7.5	5	4.51	169.10	5.00	(E) Mall road Near Arts Council out fall of Arts council Drain
F~G	94	8094	170.6	0.00065	698.39	687.02	692.02	8	5	4.30	172.04	5.26	(F) out fall of Wapda House Drain
	500	8000	170.6	0.00065	698.39	686.96	691.96	8	5	4.30	172.04	6.43	
	500	7500	170.6	0.00065	693.06	686.64	691.64	8	5	4.30	172.04	6.75	
	500	7000	170.6	0.00065	691.92	686.31	691.31	8	5	4.30	172.04	1.75	
	500	6500	170.6	0.00065	691.36	685.99	690.99	8	5	4.30	172.04	0.93	
	288	6000	170.6	0.00065	691.62	685.66	690.66	8	5	4.30	172.04	0.70	
	212	5712	170.6	0.00065	**692.62**	**685.48**	**690.48**	8	5	4.30	172.04	1.14	(G) out fall of Lawrence Road Drain
		5712			692.62	**684.48**	690.48						
G~H	500	5500	214.3	0.00036	695.02	684.34	690.34	10	6	3.67	220.15	2.28	
	500	5000	214.3	0.00036	695.02	684.16	690.16	10	6	3.67	220.15	4.86	
	500	4500	214.3	0.00036	697.13	683.98	689.98	10	6	3.67	220.15	5.04	
	500	4000	214.3	0.00036	690.83	683.80	689.80	10	6	3.67	220.15	7.33	
	500	3500	214.3	0.00036	691.73	683.62	689.62	10	6	3.67	220.15	1.21	
	500	3000	214.3	0.00036	691.81	683.44	689.44	10	6	3.67	220.15	2.29	
	500	2500	214.3	0.00036	690.12	683.26	689.26	10	6	3.67	220.15	2.55	

Hydraulic Statement Governer House Drain

Line	Chainage (ft)		Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	Segment	RD	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
	500	2000	214.3	0.00036	692.59	683.08	689.08	10	6	3.67	220.15	1.04	
	359	1500	214.3	0.00036	692.59	682.90	688.90	10	6	3.67	220.15	3.69	
	141	1141	214.3	0.00036	**693.67**	**682.77**	**688.77**	10	6	3.67	220.15	3.82	(H) out fall of Queens road Drain
H~8	500	1000	218.47	0.00036	691.10	682.72	688.72	10	6	3.67	220.15	4.95	
	500	500	218.47	0.00036	691.10	682.54	688.54	10	6	3.67	220.15	2.56	
	0	0	218.47	0.00036	**688.60**	**682.36**	**688.36**	10	6	3.67	220.15	2.74	(8) Out fall in Cantonment Drain at RD 33177

Cantonment Dr. Data at RD 33177 40000 Proposed BL 677.578

VALID WL 685.578

DROP 2.780

Appendix 13.5.9 Hydraulic Calculation: Nicholson Road Drain

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
NR~A1	463	2463	17.85	0.000410	695.940	691.940	694.940	3	3	2.01	18.05	1.00	
	500	2000	17.85	0.000410	695.750	691.735	694.735	3	3	2.01	18.05	1.02	
	500	1500	17.85	0.000410	695.545	691.530	694.530	3	3	2.01	18.05	1.02	
	500	1000	17.85	0.000410	695.340	691.325	694.325	3	3	2.01	18.05	1.02	
	500	500	17.85	0.000410	695.135	691.120	694.120	3	3	2.01	18.05	1.02	
	0	0	17.85	0.000410	694.930	691.120	694.120	3	3	2.01	18.05	0.81	Outfall in Central Drain at RD 16510

Appendix 13.5.10 Hydraulic Calculation: Poonch Road Drain

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
PR~PR1	338	4838	43.96	0.000280	687.898	682.898	686.898	5	4	2.21	44.18	1.00	
	500	4500	43.96	0.000280	687.800	682.804	686.804	5	4	2.21	44.18	1.00	
	500	4000	43.96	0.000280	687.550	682.664	686.664	5	4	2.21	44.18	0.89	
	500	3500	43.96	0.000280	687.390	682.524	686.524	5	4	2.21	44.18	0.87	
	500	3000	43.96	0.000280	687.210	682.384	686.384	5	4	2.21	44.18	0.83	
	500	2500	43.96	0.000280	687.010	682.244	686.244	5	4	2.21	44.18	0.77	
	500	2000	43.96	0.000280	686.850	682.104	686.104	5	4	2.21	44.18	0.75	
	500	1500	43.96	0.000280	686.610	681.964	685.964	5	4	2.21	44.18	0.65	
	432	1000	43.96	0.000280	686.460	681.824	685.824	5	4	2.21	44.18	0.64	
PR1~9A	68	568	43.96	0.000280	686.300	681.703	685.703	5	4	2.21	44.18	0.60	
	500	500	43.96	0.000280	686.270	681.684	685.684	5	4	2.21	44.18	0.59	
	0	0	43.96	0.000280	686.060	681.544	685.544	5	4	2.21	44.18	0.52	Out fall in Cantonment Dr. 36500

Appendix 13.5.11 Hydraulic Calculation: Chauburji Drain

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
C~9A	48	3548	29.90	0.000360	687.337	682.337	686.337	3.5	4	2.14	30.00	1.00	
	500	3500	29.90	0.000360	687.350	682.320	686.320	3.5	4	2.14	30.00	1.03	
	500	3000	29.90	0.000360	687.110	682.140	686.140	3.5	4	2.14	30.00	0.97	
	500	2500	29.90	0.000360	686.980	681.960	685.960	3.5	4	2.14	30.00	1.02	
	500	2000	29.90	0.000360	686.820	681.780	685.780	3.5	4	2.14	30.00	1.04	
	500	1500	29.90	0.000360	686.620	681.600	685.600	3.5	4	2.14	30.00	1.02	
	432	1000	29.90	0.000360	686.450	681.420	685.420	3.5	4	2.14	30.00	1.03	
	68	568	29.90	0.000360	686.220	681.264	685.264	3.5	4	2.14	30.00	0.96	
	500	500	29.90	0.000360	686.170	681.240	685.240	3.5	4	2.14	30.00	0.93	
	0	0	29.90	0.000360	686.060	681.060	685.060	3.5	4	2.14	30.00	1.00	Out fall in Cantonment Dr. 36919

Appendix 13.5.12 Hydraulic Calculation: New Samanabad Drain

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
IC ~ IC1	40	4540	32.73	0.000300	690.627	684.627	688.627	4	4	2.08	33.26	2.00	
	500	4500	32.73	0.000300	690.615	684.615	688.615	4	4	2.08	33.26	2.00	
	500	4000	32.73	0.000300	690.460	684.465	688.465	4	4	2.08	33.26	1.99	
	500	3500	32.73	0.000300	690.305	684.315	688.315	4	4	2.08	33.26	1.99	
	500	3000	32.73	0.000300	690.150	684.165	688.165	4	4	2.08	33.26	1.98	
	500	2500	32.73	0.000300	689.875	684.015	688.015	4	4	2.08	33.26	1.86	
	418	2000	32.73	0.000300	689.600	683.865	687.865	4	4	2.08	33.26	1.73	
	82	1582	32.73	0.000300	689.340	683.740	687.740	4	4	2.08	33.26	1.60	
	66	1500	32.73	0.000300	689.260	683.715	687.715	4	4	2.08	33.26	1.54	
IC1~ 8A	434	1434	40.7	0.000320	689.110	683.696	687.696	4.5	4	2.26	40.7	1.41	
	500	1000	40.7	0.000320	689.050	683.557	687.557	4.5	4	2.26	40.7	1.49	
	500	500	40.7	0.000320	688.775	683.397	687.397	4.5	4	2.26	40.7	1.38	
	0	0	40.7	0.000320	688.500	683.237	687.237	4.5	4	2.26	40.7	1.26	Out fall in Cantonment Dr. RD 35000

Appendix 13.5.13 Hydraulic Calculation: Morrhe Samanabad Drain

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
C'~10A	48	3683	29.90	0.000360	683.350	675.350	679.350	3.5	4	2.14	30.00	4.00	
	500	3500	29.90	0.000360	683.150	675.333	679.333	3.5	4	2.14	30.00	3.82	
	500	3000	29.90	0.000360	682.980	675.153	679.153	3.5	4	2.14	30.00	3.83	
	500	2500	29.90	0.000360	682.740	674.973	678.973	3.5	4	2.14	30.00	3.77	
	469	2000	29.90	0.000360	682.560	674.793	678.793	3.5	4	2.14	30.00	3.77	
	31	1531	29.90	0.000360	682.410	674.624	678.624	3.5	4	2.14	30.00	3.79	
	500	1500	29.90	0.000360	682.250	674.613	678.613	3.5	4	2.14	30.00	3.64	
	500	1000	29.90	0.000360	682.120	674.433	678.433	3.5	4	2.14	30.00	3.69	
	500	500	29.90	0.000360	681.950	674.253	678.253	3.5	4	2.14	30.00	3.70	
	0	0	29.90	0.000360	682.000	674.073	678.073	3.5	4	2.14	30.00	3.93	Out fall in Cantonment Dr. 41057

Appendix 13.5.14 Hydraulic Calculation: Almumtaz Road Drain

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
MR~ MT3	188	3188	16.11	0.000400	685.100	681.100	684.100	3.5	3	2.12	22.24	1.00	
	500	3000	16.11	0.000400	684.890	681.025	684.025	3.5	3	2.12	22.24	0.87	
	500	2500	16.11	0.000400	684.690	680.825	683.825	3.5	3	2.12	22.24	0.87	
	500	2000	16.11	0.000400	684.510	680.625	683.625	3.5	3	2.12	22.24	0.89	
	500	1500	16.11	0.000400	684.320	680.425	683.425	3.5	3	2.12	22.24	0.90	
	500	1000	16.11	0.000400	684.120	680.225	683.225	3.5	3	2.12	22.24	0.90	
	500	500	16.11	0.000400	683.540	680.025	683.025	3.5	3	2.12	22.24	0.52	
	0	0	16.11	0.000400	683.310	679.825	682.825	3.5	3	2.12	22.24	0.49	Out fall in Bund Road Dr. at RD 6715

Appendix 13.5.15 Hydraulic Calculation: Multan Road Drain and Old Bund Road Drain (6/9)

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
MT1~MT2	457	10957	21.59	0.000400	684.875	680.875	683.875	3.5	3	2.12	22.24	1.00	Multan Road Drain
	500	10500	21.59	0.000400	684.670	680.69	683.692	3.5	3	2.12	22.24	0.98	
	246	10000	21.59	0.000400	684.520	680.49	683.492	3.5	3	2.12	22.24	1.03	
		10000				679.492							
MT2~ MT3	254	9754	37.33	0.000390	684.410	679.394	683.394	4	4	2.37	37.92	1.02	
	500	9500	37.33	0.000390	684.260	679.29	683.295	4	4	2.37	37.92	0.97	
	500	9000	37.33	0.000390	684.200	679.10	683.100	4	4	2.37	37.92	1.10	
	500	8500	37.33	0.000390	683.800	678.90	682.905	4	4	2.37	37.92	0.90	
	500	8000	37.33	0.000390	683.750	678.71	682.710	4	4	2.37	37.92	1.04	
	500	7500	37.33	0.000390	683.450	678.51	682.515	4	4	2.37	37.92	0.94	
	285	7000	37.33	0.000390	683.316	678.32	682.320	4	4	2.37	37.92	1.00	
MT3~BR1	215	6715	43.57	0.000370	683.310	678.435	682.435	4.5	4	2.43	43.74	0.87	
	500	6500	43.57	0.000370	683.000	678.135	682.135	4.5	4	2.43	43.74	0.87	
	268	6000	43.57	0.000370	682.840	678.221	682.221	4.5	4	2.43	43.74	0.62	
BR1~BR2	232	5732	45.47	0.000400	683.090	678.128	682.128	4.5	4	2.53	45.48	0.96	Old Bund Road Drain
	500	5500	45.47	0.000400	682.748	678.021	682.021	4.5	4	2.53	45.48	0.73	

Appendix 13.5.15 Hydraulic Calculation: Multan Road Drain and Old Bund Road Drain (7/9)

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
	500	5000	45.47	0.000400	682.548	677.821	681.821	4.5	4	2.53	45.48	0.73	
	500	4500	45.47	0.000400	682.348	677.821	681.821	4.5	4	2.53	45.48	0.53	
	42	4000	45.47	0.000400	682.148	677.804	681.804	4.5	4	2.53	45.48	0.34	
BR2~BR3	458	3958	55.86	0.000450	682.131	677.614	681.614	5	4	2.80	56.01	0.52	
	500	3500	55.86	0.000450	681.925	677.579	681.579	5	4	2.80	56.01	0.35	
	500	3000	55.86	0.000450	681.700	677.354	681.354	5	4	2.80	56.01	0.35	
	500	2500	55.86	0.000450	681.490	677.129	681.129	5	4	2.80	56.01	0.36	
	500	2000	55.86	0.000450	681.310	676.904	680.904	5	4	2.80	56.01	0.41	
	500	1500	55.86	0.000450	681.013	676.679	680.679	5	4	2.80	56.01	0.33	
	500	1000	55.86	0.000450	680.900	676.454	680.454	5	4	2.80	56.01	0.45	
	500	500	55.86	0.000450	680.675	676.229	680.229	5	4	2.80	56.01	0.45	
	0	0	55.86	0.000450	680.350	676.229	680.229	5	4	2.80	56.01	0.12	Out fall in Cantonment Dr. 51187

Appendix 13.5.16 Hydraulic Calculation: Sodewal Drain

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
S~ BR1	38	4038	25.38	0.000360	685.400	681.400	684.400	4	3	2.12	25.47	1.00	
	500	4000	25.38	0.000360	685.100	681.386	684.386	4	3	2.12	25.47	0.71	
	500	3500	25.38	0.000360	684.800	681.206	684.206	4	3	2.12	25.47	0.59	
	500	4000	25.38	0.000360	684.600	681.026	684.026	4	3	2.12	25.47	0.57	
	500	3500	25.38	0.000360	684.450	680.846	683.846	4	3	2.12	25.47	0.60	
	500	3000	25.38	0.000360	684.320	680.666	683.666	4	3	2.12	25.47	0.65	
	500	2500	25.38	0.000360	683.990	680.486	683.486	4	3	2.12	25.47	0.50	
	500	2000	25.38	0.000360	683.820	680.306	683.306	4	3	2.12	25.47	0.51	
	500	1500	25.38	0.000360	683.750	680.126	683.126	4	3	2.12	25.47	0.62	
	500	1000	25.38	0.000360	683.650	679.946	682.946	4	3	2.12	25.47	0.70	
	500	500	25.38	0.000360	683.410	679.766	682.766	4	3	2.12	25.47	0.64	
	0	0	25.38	0.000360	683.090	679.586	682.586	4	3	2.12	25.47	0.50	Out fall in Bund Road Dr. at RD 5732

Appendix 13.5.17 Hydraulic Calculation: Gulgasht Drain

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
GG~ BR2	435	2435	21.52	0.000420	683.500	680.000	683.000	3.5	3	2.17	22.79	0.50	
	500	2000	21.52	0.000420	683.120	679.817	682.817	3.5	3	2.17	22.79	0.30	
	500	1500	21.52	0.000420	682.880	679.607	682.607	3.5	3	2.17	22.79	0.27	
	500	1000	21.52	0.000420	682.550	679.397	682.397	3.5	3	2.17	22.79	0.15	
	500	500	21.52	0.000420	682.450	679.187	682.187	3.5	3	2.17	22.79	0.26	
	0	0	21.52	0.000420	682.131	678.977	681.977	3.5	3	2.17	22.79	0.15	Out fall in Bund Road Dr. at RD 3958

Appendix 13.5.18 Hydraulic Calculation: Nasir Bagh Drain

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
E4~E3	100	1100	20	0.000510	688.671	683.671	686.671	3	3	2.24	20.14	2.00	
	500	1000	20	0.000510	688.620	683.620	686.620	3	3	2.24	20.14	2.00	
	500	500	20	0.000510	688.365	683.365	686.365	3	3	2.24	20.14	2.00	
	0	0	20	0.000510	688.110	683.110	686.110	3	3	2.24	20.14	2.00	Outfalls into Lower Mall Drain at starting point.

Appendix 13.5.19 Hydraulic Calculation: Mall Road Drain

Line	Chainage (ft)	RD	Discharge	Slope	Road Level (ft)	Bed Level (ft)	Water Level (ft)	Section		Velocity	Capacity	Free board (ft)	Remarks
			Cusec					Breadth (ft)	Height (ft)	ft/sec	Cusec	D/S	
E5~E3	225	1725	15	0.000800	689.590	685.590	687.590	3	2	2.53	15.17	2.00	
	500	1500	15	0.000800	689.410	685.410	687.410	3	2	2.53	15.17	2.00	
	500	1000	15	0.000800	689.010	685.010	687.010	3	2	2.53	15.17	2.00	
	500	500	15	0.000800	688.610	684.610	686.610	3	2	2.53	15.17	2.00	
		0	15	0.000800	688.210	684.210	686.210	3	2	2.53	15.17	2.00	
													Outfalls into Nasir Bagh Drain at RD 0+080

Appendix 13.5.20 Hydraulic Calculation: Queens Road Drain

Line	Chainage (ft)		Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	Segment	RD	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
I1~I	382	5382	61.33	0.00059	693.67	687.67	692.67	4	5	3.05	61.05	1.00	(I1) Queens Road near FJMC
	500	5000	61.33	0.00059	693.48	687.44	692.44	4	5	3.05	61.05	1.04	Queens Road
	500	4500	61.33	0.00059	693.34	687.15	692.15	4	5	3.05	61.05	1.19	Queens Road
	500	4000	61.33	0.00059	693.20	686.85	691.85	4	5	3.05	61.05	1.35	Queens Road
	500	3500	61.33	0.00059	693.00	686.56	691.56	4	5	3.05	61.05	1.44	Queens Road
	500	3000	61.33	0.00059	692.90	686.26	691.26	4	5	3.05	61.05	1.64	Queens Road
	500	2500	61.33	0.00059	692.80	685.97	690.97	4	5	3.05	61.05	1.83	Queens Road (Qartba Chowk)
	500	2000	61.33	0.00059	692.60	685.67	690.67	4	5	3.05	61.05	1.93	Ferozpur road
	500	1500	61.33	0.00059	692.40	685.38	690.38	4	5	3.05	61.05	2.02	Ferozpur road
	500	1000	61.33	0.00059	692.20	685.08	690.08	4	5	3.05	61.05	2.12	Ferozpur road
	500	500	61.33	0.00059	692.10	684.79	689.79	4	5	3.05	61.05	2.31	Ferozpur road
	0	0	61.33	0.00059	693.67	684.49	689.49	4	5	3.05	61.05	4.18	(I) Out Fall in Governer House Drain near Shamma Chowk

Appendix 13.5.21 Hydraulic Calculation: Shahra Awane Tijarat Road Drain (2/3)

Line	Chainage (ft)		Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	Segment	RD	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
D1~D	315	12815	47.04	0.001500	706.28	702.28	705.28	4	3	4.33	51.99	1.00	(D1) Start of Sunder Das Road near Canal
	500	12500	47.04	0.001500	705.90	701.81	704.81	4	3	4.33	51.99	1.09	Sunder Das Road
	500	12000	47.04	0.001300	705.25	701.06	704.06	4	3	4.03	48.40	1.19	Sunder Das Road
	500	11500	47.04	0.001300	704.63	700.41	703.41	4	3	4.03	48.40	1.22	Sunder Das Road
	500	11000	47.04	0.001300	704.62	699.76	702.76	4	3	4.03	48.40	1.86	Sunder Das Road
	500	10500	47.04	0.001300	703.77	699.11	702.11	4	3	4.03	48.40	1.66	Sunder Das Road
	500	10000	47.04	0.001300	704.75	698.46	701.46	4	3	4.03	48.40	3.29	Sunder Das Road
	500	9500	47.04	0.001300	702.83	697.81	700.81	4	3	4.03	48.40	2.02	Sunder Das Road
	500	9000	47.04	0.001300	701.27	697.16	700.16	4	3	4.03	48.40	1.11	Sunder Das Road
	500	8500	47.04	0.001300	700.96	696.51	699.51	4	3	4.03	48.40	1.45	Sunder Das Road
D~H2	500	8000	47.04	0.001300	700.65	695.86	698.86	4	3	4.03	48.40	1.79	Muslam League House Chowk
	500	7500	47.04	0.001300	699.50	695.21	698.21	4	3	4.03	48.40	1.29	Punjab squash complex road
	292	7000	47.04	0.001300	699.00	694.56	697.56	4	3	4.03	48.40	1.44	
	208	6708	47.04	0.001300	699.28	694.18	697.18	4	3	4.03	48.40	2.10	
		6708			699.28	693.18	697.18						
H2~H3	500	6500	172.51	0.001200	698.560	692.908	696.908	8	4	5.45	174.32	1.65	(H2) Mall road near Governer House
	500	6000	172.51	0.001200	697.190	692.308	696.308	8	4	5.45	174.32	0.88	Shahrah-e- Awane Tijarat Road
	500	5500	172.51	0.001200	698.730	691.708	695.708	8	4	5.45	174.32	3.02	Shahrah-e- Awane Tijarat Road
	254	5000	172.51	0.001200	697.480	691.108	695.108	8	4	5.45	174.32	2.37	Shahrah-e- Awane Tijarat Road
H3~H4	246	4746	172.51	0.001200	697.480	690.803	694.803	8	4	5.45	174.32	2.68	Shahrah-e- Awane Tijarat Road
	500	4500	172.51	0.001200	696.810	690.508	694.508	8	4	5.45	174.32	2.30	Shahrah-e- Awane Tijarat Road

Appendix 13.5.21 Hydraulic Calculation: Shahra Awane Tijarat Road Drain (3/3)

Line	Chainage (ft)		Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	Segment	RD	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
	500	4000	172.51	0.001200	696.780	689.908	693.908	8	4	5.45	174.32	2.87	Shahrah-e- Awane Tijarat Road
	500	3500	172.51	0.001200	696.780	689.308	693.308	8	4	5.45	174.32	3.47	Shahrah-e- Awane Tijarat Road
	500	3000	172.51	0.001200	696.760	688.708	692.708	8	4	5.45	174.32	4.05	Shahrah-e- Awane Tijarat Road
	500	2500	172.51	0.001200	696.070	688.108	692.108	8	4	5.45	174.32	3.96	Shahrah-e- Awane Tijarat Road
	289	2000	172.51	0.001200	696.070	687.508	691.508	8	4	5.45	174.32	4.56	Shahrah-e- Awane Tijarat Road
H4~7	211	1711	172.51	0.001200	696.070	687.161	691.161	8	4	5.45	174.32	4.91	Shahrah-e- Awane Tijarat Road
	500	1500	172.51	0.001200	697.170	686.908	690.908	8	4	5.45	174.32	6.26	Lahore college chowk
	500	1000	172.51	0.001200	699.870	686.308	690.308	8	4	5.45	174.32	9.56	Shadman Road
	500	500	172.51	0.001200	700.940	685.708	689.708	8	4	5.45	174.32	11.23	Shadman Road
	0	0	172.51	0.001200	702.440	685.108	689.108	8	4	5.45	174.32	13.33	(7) Shadman Chowk (Outfall into Cantonment Drain at RD 28350)
H1~H2	675	4675	42.55	0.000600	704.24	697.24	701.24	4	4	2.94	47.03	3.00	(H1) Mall Road Near GOR
	500	4000	42.55	0.000600	704.73	696.84	700.84	4	4	2.94	47.03	3.89	Mall Road
	500	3500	42.55	0.000600	704.16	696.54	700.54	4	4	2.94	47.03	3.62	Mall Road
	500	3000	42.55	0.000600	703.80	696.24	700.24	4	4	2.94	47.03	3.56	Mall Road
	500	2500	42.55	0.000600	702.16	695.94	699.94	4	4	2.94	47.03	2.22	Mall Road
	500	2000	42.55	0.000600	701.90	695.64	699.64	4	4	2.94	47.03	2.26	Mall Road
	500	1500	42.55	0.000600	701.57	695.34	699.34	4	4	2.94	47.03	2.23	Mall Road
	500	1000	42.55	0.000600	699.81	695.04	699.04	4	4	2.94	47.03	0.77	Mall Road
	500	500	42.55	0.000600	699.18	694.74	698.74	4	4	2.94	47.03	0.44	Mall Road
	0	0	42.55	0.000600	699.28	694.44	698.44	4	4	2.94	47.03	0.84	(H2) Mall Road near Governer House

Appendix 13.5.22 Golf Road Drain

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
GR~H3	148	5648	6.57	0.000450	697.050	693.550	696.550	3	3	2.10	18.91	0.50	
	500	5500	6.57	0.000450	696.990	693.483	696.483	3	3	2.10	18.91	0.51	
	500	5000	6.57	0.000450	696.920	693.258	696.258	3	3	2.10	18.91	0.66	
	500	4500	6.57	0.000450	696.930	693.033	696.033	3	3	2.10	18.91	0.90	
	500	4000	6.57	0.000450	696.840	692.808	695.808	3	3	2.10	18.91	1.03	
		4000			696.840	691.808	695.808						
	500	3500	25.66	0.000300	696.780	691.583	695.583	4	4	2.08	33.26	1.20	
	500	3000	25.66	0.000300	696.710	691.433	695.433	4	4	2.08	33.26	1.28	
	500	2500	25.66	0.000300	696.780	691.283	695.283	4	4	2.08	33.26	1.50	
	500	2000	25.66	0.000300	696.650	691.133	695.133	4	4	2.08	33.26	1.52	
	500	1500	25.66	0.000300	696.720	690.983	694.983	4	4	2.08	33.26	1.74	
	500	1000	25.66	0.000300	696.650	690.833	694.833	4	4	2.08	33.26	1.82	
	500	500	25.66	0.000300	696.610	690.683	694.683	4	4	2.08	33.26	1.93	
	0	0	25.66	0.000300	696.500	690.533	694.533	4	4	2.08	33.26	1.97	Outfall in Shahra-e-Awan Tijarat Drain at RD 4746

Appendix 13.5.23 Hydraulic Calculation: Kinnaird Drain

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
KC~H4	190	6690	41.81	0.000360	698.100	692.600	697.100	4	5	2.34	42.03	1.00	
	500	6500	41.81	0.000360	698.038	692.532	697.032	4	5	2.34	42.03	1.01	
	500	6000	41.81	0.000360	697.960	692.352	696.852	4	5	2.34	42.03	1.11	
	500	5500	41.81	0.000360	697.914	692.172	696.672	4	5	2.34	42.03	1.24	
	500	5000	41.81	0.000360	697.880	691.992	696.492	4	5	2.34	42.03	1.39	
	500	4500	41.81	0.000360	697.820	691.812	696.312	4	5	2.34	42.03	1.51	
	500	4000	41.81	0.000360	697.750	691.632	696.132	4	5	2.34	42.03	1.62	
	500	3500	41.81	0.000360	697.666	691.452	695.952	4	5	2.34	42.03	1.71	
	500	3000	41.81	0.000360	697.620	691.272	695.772	4	5	2.34	42.03	1.85	
	500	2500	41.81	0.000360	697.542	691.092	695.592	4	5	2.34	42.03	1.95	
	500	2000	41.81	0.000360	697.510	690.912	695.412	4	5	2.34	42.03	2.10	
	500	1500	41.81	0.000360	697.418	690.732	695.232	4	5	2.34	42.03	2.19	
	500	1000	41.81	0.000360	697.370	690.552	695.052	4	5	2.34	42.03	2.32	
	500	500	41.81	0.000360	697.294	690.372	694.872	4	5	2.34	42.03	2.42	
	0	0	41.81	0.000360	697.170	690.192	694.692	4	5	2.34	42.03	2.48	Outfall in Shahra-e-Awan Tijarat Drain at RD 1711

Appendix 13.5.24 Hydraulic Calculation: Shah Jamal Drain

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
S~S1	456	5956	17.65	0.000450	702.350	696.350	699.350	3	3	2.10	18.91	3.00	Starts near Railway line area
	500	5500	17.65	0.000450	702.180	696.145	699.145	3	3	2.10	18.91	3.04	
	500	5000	17.65	0.000450	702.110	695.920	698.920	3	3	2.10	18.91	3.19	
	338	4500	17.65	0.000450	701.820	695.695	698.695	3	3	2.10	18.91	3.13	
S1~S2	162	4162	31.58	0.000580	701.700	695.543	698.543	4	3	2.69	32.33	3.16	
	500	4000	31.58	0.000580	701.480	695.449	698.449	4	3	2.69	32.33	3.03	
	500	3500	31.58	0.000580	701.210	695.159	698.159	4	3	2.69	32.33	3.05	
	478	3000	31.58	0.000580	700.970	694.869	697.869	4	3	2.69	32.33	3.10	
		3000			700.970	693.869	697.86874						
S2~7	22	2522	58.06	0.000300	700.750	693.592	697.592	6	4	2.46	58.99	3.16	
	500	2500	58.06	0.000300	700.810	693.585	697.585	6	4	2.46	58.99	3.23	
	288	2000	58.06	0.000300	700.520	693.435	697.435	6	4	2.46	58.99	3.09	
	212	1712	58.06	0.000300	700.370	693.349	697.349	6	4	2.46	58.99	3.02	
	500	1500	58.06	0.000300	700.310	693.285	697.285	6	4	2.46	58.99	3.03	
	500	1000	58.06	0.000300	700.160	693.135	697.135	6	4	2.46	58.99	3.03	
	500	500	58.06	0.000300	700.150	692.985	696.985	6	4	2.46	58.99	3.17	
	0	0	58.06	0.000300	699.930	692.835	696.835	6	4	2.46	58.99	3.10	Out fall in Cantonment Dr. 28350

Appendix 13.5.25 Hydraulic Calculation: Gulshan-e-Ravi Drain (1/3)

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
B2 ~ B2A	120	6620	29.28	0.000350	689.920	681.920	685.920	3.5	4	2.11	29.58	4.00	
	500	6500	29.28	0.000350	689.420	681.878	685.878	3.5	4	2.11	29.58	3.54	
	500	6000	29.28	0.000350	689.250	681.703	685.703	3.5	4	2.11	29.58	3.55	
	500	5500	29.28	0.000350	689.170	681.528	685.528	3.5	4	2.11	29.58	3.64	
	500	5000	29.28	0.000350	689.000	681.353	685.353	3.5	4	2.11	29.58	3.65	
	264	4500	29.28	0.000350	688.850	681.178	685.178	3.5	4	2.11	29.58	3.67	
B2A ~ B1	236	4236	45.11	0.000400	688.650	681.086	685.086	4.5	4	2.53	45.48	3.56	
	500	4000	45.11	0.000400	688.570	680.991	684.991	4.5	4	2.53	45.48	3.58	
	400	3500	45.11	0.000400	688.410	680.791	684.791	4.5	4	2.53	45.48	3.62	
B1 ~ B	100	3100	45.11	0.000400	688.350	680.631	684.631	4.5	4	2.53	45.48	3.72	
	500	3000	45.11	0.000400	688.220	680.591	684.591	4.5	4	2.53	45.48	3.63	
	146	2500	45.11	0.000400	688.150	680.391	684.391	4.5	4	2.53	45.48	3.76	
		2500			688.150	679.391							
B ~ 11	354	2354	173.06	0.000360	688.100	679.333	684.333	10	5	3.46	173.12	3.77	
	500	2000	173.06	0.000360	687.850	679.205	684.205	10	5	3.46	173.12	3.64	
	500	1500	173.06	0.000360	687.720	679.025	684.025	10	5	3.46	173.12	3.69	
	500	1000	173.06	0.000360	687.640	678.845	683.845	10	5	3.46	173.12	3.79	
	500	500	173.06	0.000360	687.370	678.665	683.665	10	5	3.46	173.12	3.70	
	0	0	173.06	0.000360	687.250	678.485	683.485	10	5	3.46	173.12	3.76	out fall in cantonment drain at RD 45806

Appendix 13.5.25 Hydraulic Calculation: Gulshan-e-Ravi Drain (2/3)

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
GR~ B2A	176	2176	17.58	0.000400	689.582	685.582	688.582	3.5	3	2.12	22.24	1.00	
	500	2000	17.58	0.000400	689.511	685.511	688.511	3.5	3	2.12	22.24	1.00	
	500	1500	17.58	0.000400	689.311	685.311	688.311	3.5	3	2.12	22.24	1.00	
	500	1000	17.58	0.000400	689.111	685.111	688.111	3.5	3	2.12	22.24	1.00	
	500	500	17.58	0.000400	688.911	684.911	687.911	3.5	3	2.12	22.24	1.00	
	0	0	17.58	0.000400	688.711	684.711	687.711	3.5	3	2.12	22.24	1.00	Outfall in Main Gulshaneravi drain

Appendix 13.5.25 Hydraulic Calculation: Gulshan-e-Ravi Drain (3/3)

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
A~B	117	2617	122.81	0.000340	688.990	681.99	686.99	8	5	3.11	124.43	2.00	
	500	2500	122.81	0.000340	688.880	681.95	686.95	8	5	3.11	124.43	1.93	
	500	2000	122.81	0.000340	688.700	681.78	686.78	8	5	3.11	124.43	1.92	
	500	1500	122.81	0.000340	688.520	681.61	686.61	8	5	3.11	124.43	1.91	
	500	1000	122.81	0.000340	688.360	681.44	686.44	8	5	3.11	124.43	1.92	
	500	500	122.81	0.000340	688.250	681.27	686.27	8	5	3.11	124.43	1.98	
	0	0	122.81	0.000340	688.062	681.10	686.10	8	5	3.11	124.43	1.96	Outfall in Main Gulshaneravi drain

Appendix 13.5.26 Hydraulic Calculation: Sanda Road Drain

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
S~ B	79	3079	16.2	0.000400	687.552	683.552	686.552	3.5	3	2.12	22.24	1.00	
	500	3000	16.2	0.000400	687.520	683.520	686.520	3.5	3	2.12	22.24	1.00	
	500	2500	16.2	0.000400	687.320	683.320	686.320	3.5	3	2.12	22.24	1.00	
	500	2000	16.2	0.000400	687.120	683.120	686.120	3.5	3	2.12	22.24	1.00	
	500	1500	16.2	0.000400	686.920	682.920	685.920	3.5	3	2.12	22.24	1.00	
	500	1000	16.2	0.000400	686.720	682.720	685.720	3.5	3	2.12	22.24	1.00	
	500	500	16.2	0.000400	686.520	682.520	685.520	3.5	3	2.12	22.24	1.00	
	0	0	16.2	0.000400	686.320	682.320	685.320	3.5	3	2.12	22.24	1.00	Out fall in Krishan Nagar Dr. 5500

Appendix 13.5.27 Hydraulic Calculation: Krishan Nagar Drain (8/10)

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
A1 ~ A	342	3842	22.96	0.000350	701.025	696.025	699.025	4	3	2.09	25.11	2.00	
	500	3500	22.96	0.000350	700.750	695.91	698.905	4	3	2.09	25.11	1.84	
	500	3000	22.96	0.000350	699.650	695.73	698.730	4	3	2.09	25.11	0.92	
	200	2500	22.96	0.000350	699.387	695.56	698.555	4	3	2.09	25.11	0.83	
A ~ B	300	2300	22.96	0.000350	699.100	695.49	698.485	4	3	2.09	25.11	0.61	
	500	2000	22.96	0.000350	699.100	695.38	698.380	4	3	2.09	25.11	0.72	
	500	1500	22.96	0.000350	698.825	695.21	698.205	4	3	2.09	25.11	0.62	
	500	1000	22.96	0.000350	698.550	695.03	698.030	4	3	2.09	25.11	0.52	
	500	500	22.96	0.000350	698.275	694.86	697.855	4	3	2.09	25.11	0.42	
	0	0	22.96	0.000350	698.000	694.68	697.680	4	3	2.09	25.11	0.32	
B3~B2	179	13179	20	0.000600	688.889	684.889	687.889	3	3	2.43	21.84	1.00	
	500	13000	20	0.000600	688.837	684.782	687.782	3	3	2.43	21.84	1.06	
	500	12500	20	0.000600	688.687	684.482	687.482	3	3	2.43	21.84	1.21	
	500	12000	20	0.000600	688.537	684.182	687.182	3	3	2.43	21.84	1.36	
	500	11500	20	0.000600	688.387	683.882	686.882	3	3	2.43	21.84	1.51	
	328	11000	20	0.000600	688.237	683.582	686.582	3	3	2.43	21.84	1.66	
	172	10672	20	0.000600	688.138	683.385	686.385	3	3	2.43	21.84	1.75	
		10672				682.385							
	500	10500	39	0.000400	688.087	682.282	686.282	4	4	2.40	38.40	1.81	
	500	10000	39	0.000400	687.937	682.082	686.082	4	4	2.40	38.40	1.86	
	500	9500	39	0.000400	687.787	681.882	685.882	4	4	2.40	38.40	1.91	
	500	9000	39	0.000400	687.637	681.682	685.682	4	4	2.40	38.40	1.96	

Appendix 13.5.27 Hydraulic Calculation: Krishan Nagar Drain (9/10)

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
	500	8500	39	0.000400	687.487	681.482	685.482	4	4	2.40	38.40	2.01	
	355	8000	39	0.000400	687.337	681.282	685.282	4	4	2.40	38.40	2.06	
B2~B	145	7645	115.59	0.000400	687.230	681.140	685.140	4	4	2.40	38.40	2.09	
		7645			687.230	680.140							
	500	7500	115.59	0.000420	687.170	680.082	685.082	7	5	3.29	115.00	2.09	
	500	7000	115.59	0.000420	686.900	679.872	684.872	7	5	3.29	115.00	2.03	
	500	6500	115.59	0.000420	686.740	679.66	684.662	7	5	3.29	115.00	2.08	
	500	6000	115.59	0.000420	686.520	679.45	684.452	7	5	3.29	115.00	2.07	
		6000			686.520	678.452							
B~C	500	5500	194.26	0.000300	686.320	678.24	684.242	10.0	6	3.35	200.97	2.08	
	500	5000	194.26	0.000300	685.900	678.092	684.092	10.0	6	3.35	200.97	1.81	
	500	4500	194.26	0.000300	685.700	677.942	683.942	10.0	6	3.35	200.97	1.76	
	500	4000	194.26	0.000300	684.910	677.792	683.792	10.0	6	3.35	200.97	1.12	
	500	3500	194.26	0.000300	685.750	677.642	683.642	10.0	6	3.35	200.97	2.11	
C~10	500	3000	194.26	0.000300	685.350	677.492	683.492	10.0	6	3.35	200.97	1.86	
	500	2500	202.81	0.000187	685.110	677.342	683.342	12.0	6	2.82	202.89	1.77	
	500	2000	202.81	0.000187	684.910	677.248	683.248	12.0	6	2.82	202.89	1.66	
	500	1500	202.81	0.000187	684.810	677.155	683.155	12.0	6	2.82	202.89	1.66	
	500	1000	202.81	0.000187	684.610	677.061	683.061	12.0	6	2.82	202.89	1.55	
	500	500	202.81	0.000187	684.510	676.968	682.968	12.0	6	2.82	202.89	1.54	
	0	0	202.81	0.000187	683.300	676.874	682.874	12.0	6	2.82	202.89	0.43	out fall in cantonment drain at RD 40111

Appendix 13.5.28 Hydraulic calculation: Rewaz Garden Drain

Line	Chainage	RD	Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	(ft)	(ft)	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
R~R1	31	5031	3.37	0.000720	688.482	683.982	686.982	2	3	2.19	13.17	1.50	
	500	5000	3.37	0.000720	688.252	683.960	686.960	2	3	2.19	13.17	1.29	
	466	4500	3.37	0.000720	688.252	683.600	686.600	2	3	2.19	13.17	1.65	
	34	4034	3.37	0.000720	688.022	683.264	686.264	2	3	2.19	13.17	1.76	
		4034			688.022	682.264	686.264						
R1 ~ R2	500	4000	26.35	0.000350	687.792	682.240	686.240	3.5	4	2.11	29.58	1.55	
	500	3500	26.35	0.000350	687.562	682.065	686.065	3.5	4	2.11	29.58	1.50	
	500	3000	26.35	0.000350	687.332	681.890	685.890	3.5	4	2.11	29.58	1.44	
	500	2500	26.35	0.000350	687.102	681.715	685.715	3.5	4	2.11	29.58	1.39	
	441	2000	26.35	0.000350	686.872	681.540	685.540	3.5	4	2.11	29.58	1.33	
R2 ~ C	59	1559	26.35	0.000350	686.656	681.385	685.385	3.5	4	2.11	29.58	1.27	
	500	1500	26.35	0.000350	686.642	681.365	685.365	3.5	4	2.11	29.58	1.28	
	500	1000	26.35	0.000350	686.412	681.190	685.190	3.5	4	2.11	29.58	1.22	
	500	500	26.35	0.000350	686.182	681.015	684.852	3.5	4	2.11	29.58	1.33	
	0	0	26.35	0.000350	685.160	680.840	684.840	3.5	4	2.11	29.58	0.32	out fall in krishan nagar

Appendix 13.5.29 Hydraulic Calculation: Governor House Drain (1/2)

Line	Chainage (ft)		Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	Segment	RD	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
E~F	341	8435	164.6	0.00075	697.28	687.28	692.28	7.5	5	4.51	169.10	5.00	(E) Mall road Near Arts Council out fall of Arts council Drain
F~G	94	8094	170.6	0.00065	698.39	687.02	692.02	8	5	4.30	172.04	5.26	(F) out fall of Wapda House Drain
	500	8000	170.6	0.00065	698.39	686.96	691.96	8	5	4.30	172.04	6.43	
	500	7500	170.6	0.00065	693.06	686.64	691.64	8	5	4.30	172.04	6.75	
	500	7000	170.6	0.00065	691.92	686.31	691.31	8	5	4.30	172.04	1.75	
	500	6500	170.6	0.00065	691.36	685.99	690.99	8	5	4.30	172.04	0.93	
	288	6000	170.6	0.00065	691.62	685.66	690.66	8	5	4.30	172.04	0.70	
	212	5712	170.6	0.00065	692.62	685.48	690.48	8	5	4.30	172.04	1.14	(G) out fall of Lawrence Road Drain
		5712			692.62	684.48	690.48						
G~H	500	5500	214.3	0.00036	695.02	684.34	690.34	10	6	3.67	220.15	2.28	
	500	5000	214.3	0.00036	695.02	684.16	690.16	10	6	3.67	220.15	4.86	
	500	4500	214.3	0.00036	697.13	683.98	689.98	10	6	3.67	220.15	5.04	
	500	4000	214.3	0.00036	690.83	683.80	689.80	10	6	3.67	220.15	7.33	
	500	3500	214.3	0.00036	691.73	683.62	689.62	10	6	3.67	220.15	1.21	
	500	3000	214.3	0.00036	691.81	683.44	689.44	10	6	3.67	220.15	2.29	
	500	2500	214.3	0.00036	690.12	683.26	689.26	10	6	3.67	220.15	2.55	

Appendix 13.5.29 Hydraulic Calculation: Governor House Drain (2/2)

Line	Chainage (ft)		Discharge	Slope	Road Level	Bed Level	Water Level	Section (ft)		Velocity	Capacity	Free board	Remarks
	Segment	RD	Cusec		(ft)	(ft)	(ft)	Breadth	Height	ft/sec	Cusec	(ft)	
	500	2000	214.3	0.00036	692.59	683.08	689.08	10	6	3.67	220.15	1.04	
	359	1500	214.3	0.00036	692.59	682.90	688.90	10	6	3.67	220.15	3.69	
	141	1141	214.3	0.00036	693.67	682.77	688.77	10	6	3.67	220.15	3.82	(H) out fall of Queens road Drain
H~8	500	1000	218.47	0.00036	691.10	682.72	688.72	10	6	3.67	220.15	4.95	
	500	500	218.47	0.00036	691.10	682.54	688.54	10	6	3.67	220.15	2.56	
	0	0	218.47	0.00036	688.60	682.36	688.36	10	6	3.67	220.15	2.74	(8) Out fall in Cantonment Drain at RD 33177