APPENDIX E

WATER DEMAND DISTRIBUTION AND NETWORK ANALYSIS

APPENDIX E WATER DEMAND DISTRIBUTION AND NETWORK ANALYSIS

E.1 Water Demand Distribution

（1） Target Area

The target area of network analysis for the proposed transmission is Basrah city area and Al Hartha that for the distribution system is Basrah city area only.

（2） Water Demand Distribution

The estimated total water demand in Basrah District was distributed to sub-districts by following procedures:

1) The road density of each sub-district is estimated using GIS.
2) It is assumed that the road density is proportional to the population density of each sub-district.
3) The total population is distributed according to the road density of the sub-district and thus the population of sub-district is calculated.
4) The water demand of sub-district is calculated multiplying by per capita consumption.
5) Distribution zone demand of 13 zones is calculated by aggregating sub-district demand in the zone.
6) Node demand for network analysis is calculated by subdividing and aggregating sub-district demand.

The population density and water demand of sub-zones in 2006, 2015 and 2025 are shown in Figure E.1 and in Figure E.2.

E.2 Network Model

（1） Distribution Network Model

The distribution and transmission network model including existing and proposed pipelines are shown in Figure E.3 and Figure E.4.

（2） Network Analysis

The route and diameter of required distribution mains are calculated to convey hourly peak water demand in 2015 using network analysis software. Those of required transmission mains are calculated to convey the maximum day water demand in 2015. EPANET 2 (US EPA) is used for network analysis software, where, Hazen Williams Formula was used for the hydraulic formula.

In distribution network analysis, the water demand is assigned to nodes (junctions) and the feeding point of water in each zone is only one, the elevated tank, from which water is fed to the network at 35 m water pressure. The diameter of required pipelines is calculated to retaining the water pressure of more than 25 m at the end of distribution mains. In analysis, the maximum water velocity is set at about 3.0 m/s for snaller diameter pipeline and the maximum head-loss of pipe is set at about 5 m/km.

In transmission network analysis, the water demand is assigned to a distribution reservoir located in each distribution zone and the pipelines located on the proposed zone boundaries are closed by valves by which water cannot move to neighbor zones.

The feeding point is at the proposed transmission pumping station, which is located nearby R-Zero. The low water level of elevated reservoirs is set as 35 m and the minimum service pressure at the end of zone is set at 15 m. The diameter of required pipelines is calculated to retaining the water pressure of more than 5 m at distribution reservoirs. Simultaneously, required pump pressure at the transmission pumping station is calculated. In analysis, the maximum water velocity is set at about 2.0 m/s for large diameter pipeline and the maximum head-loss of pipe is set at about 2 m/km.

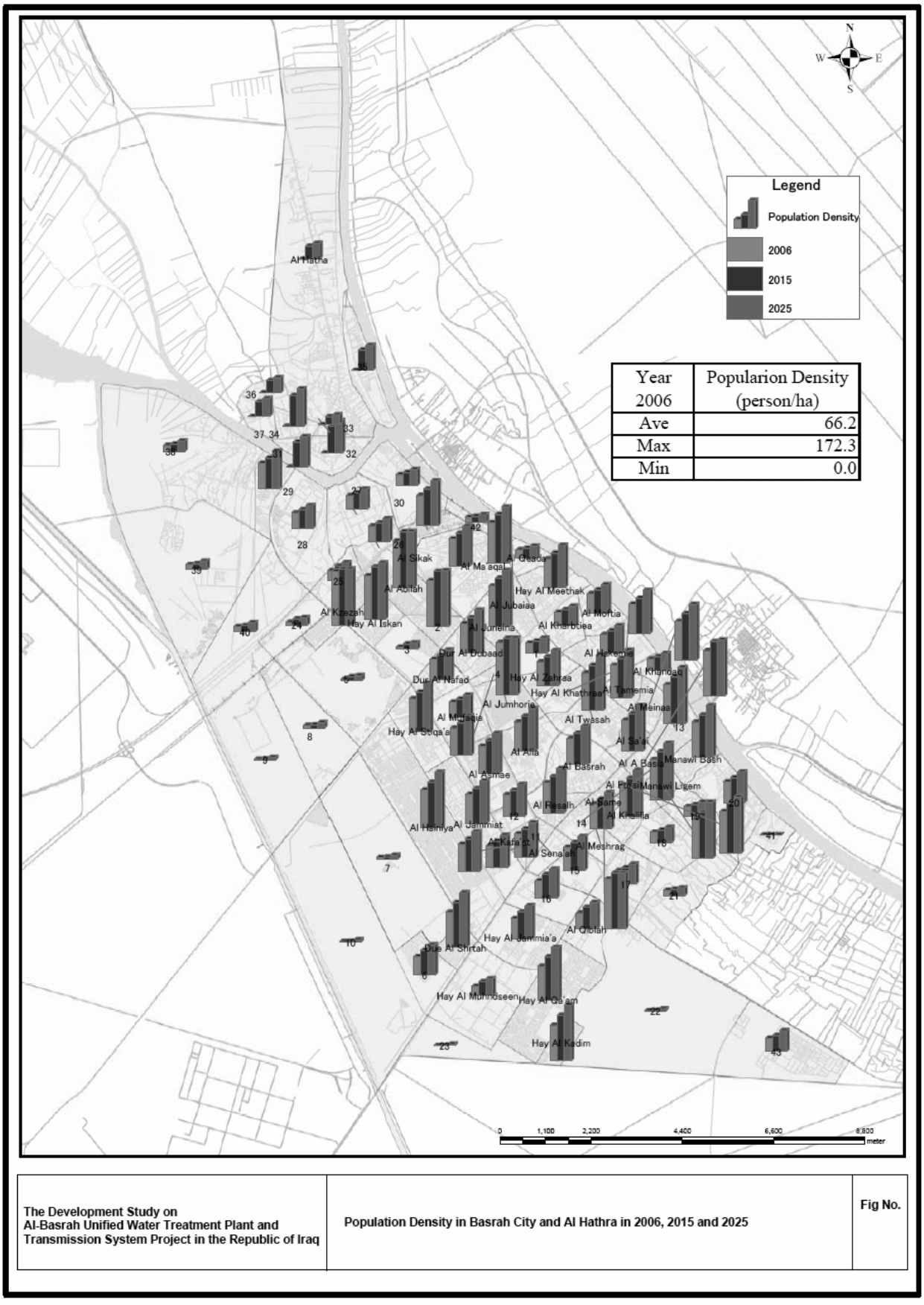
E.3 Results of Network Analysis

The results of distribution network analysis are shown as follows:

Figure E.5 Result of Distribution Network Analysis
Table E.1 Result of Distribution Network Analysis

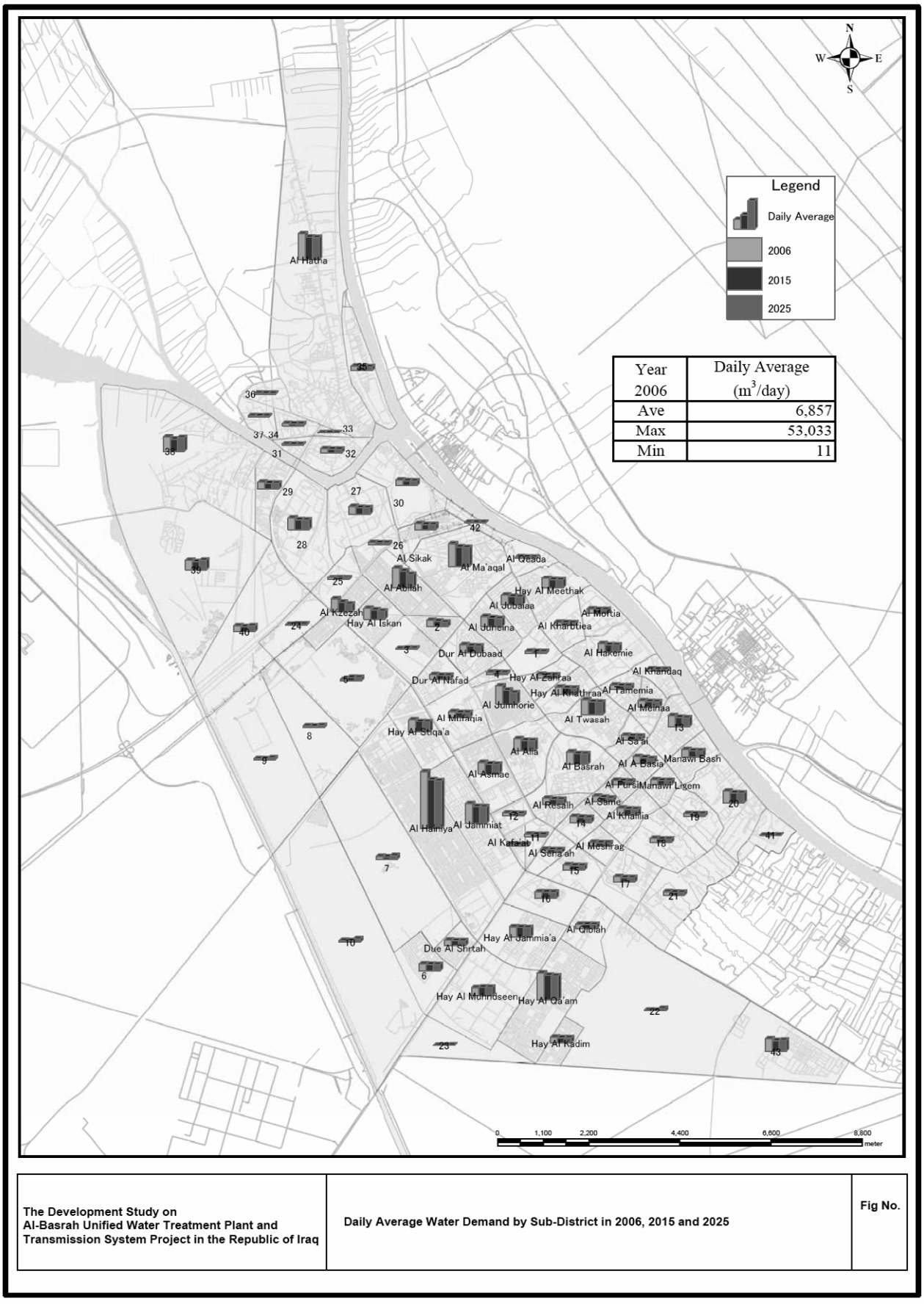
The results of transmission network analysis are shown as follows:

Figure E.6 Results of Transmission Network Analysis
Table E.2 Results of Transmission Network Analysis



The Development Study on Al-Basrah Unified Water Treatment Plant and Transmission System Project in the Republic of Iraq	Population Density in Basrah City and Al Hathra in 2006, 2015 and 2025	Fig No.

Figure E.1 Estimated Population Density of Sub-District



The Development Study on Al-Basrah Unified Water Treatment Plant and Transmission System Project in the Republic of Iraq	Daily Average Water Demand by Sub-District in 2006, 2015 and 2025	Fig No.

Figure E.2 Estimated Water Demand Distribution to Sub-Divisions

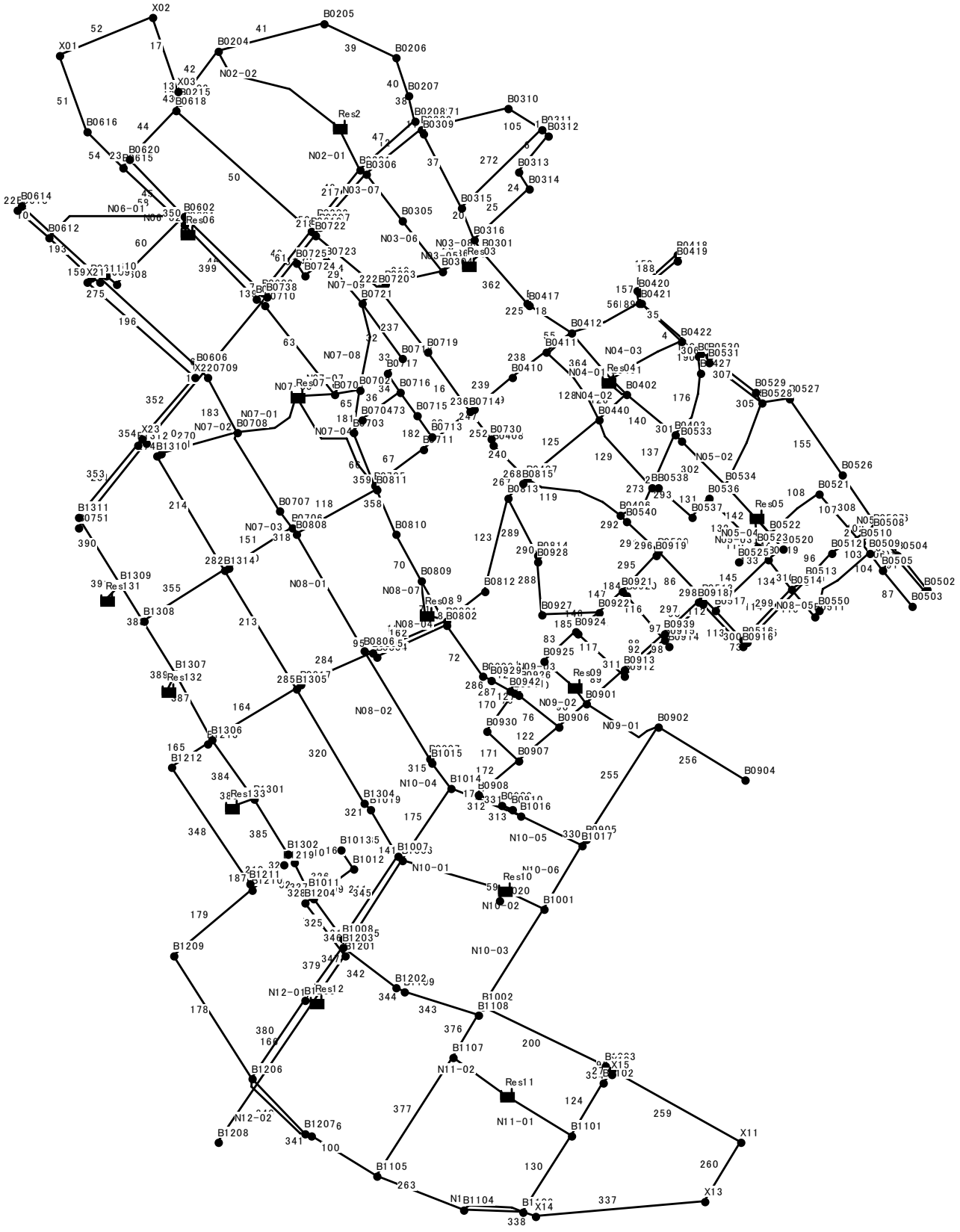


Figure E.3 Distribution Main Network Model

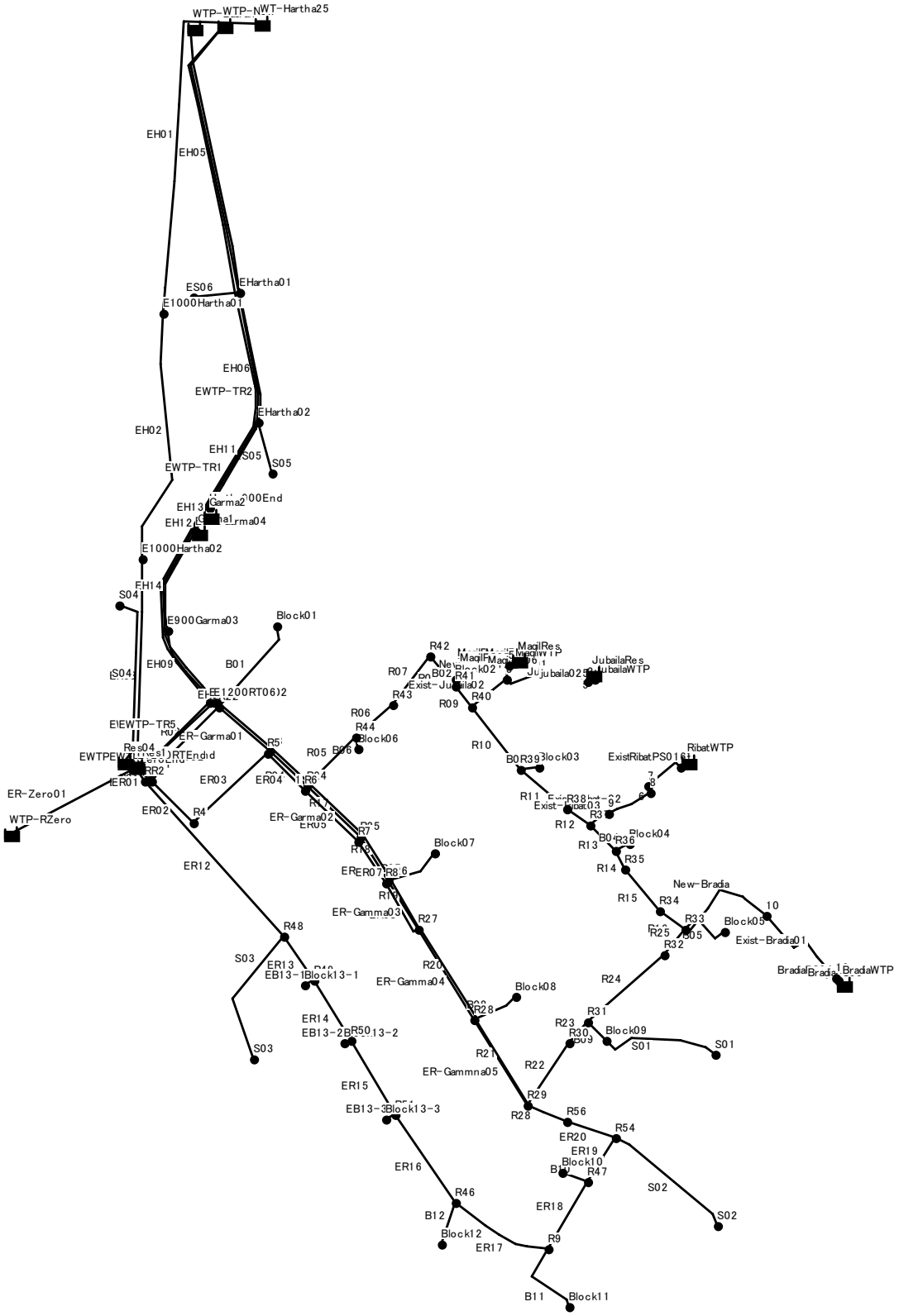


Figure E.4 Transmission Main Netowrk Model

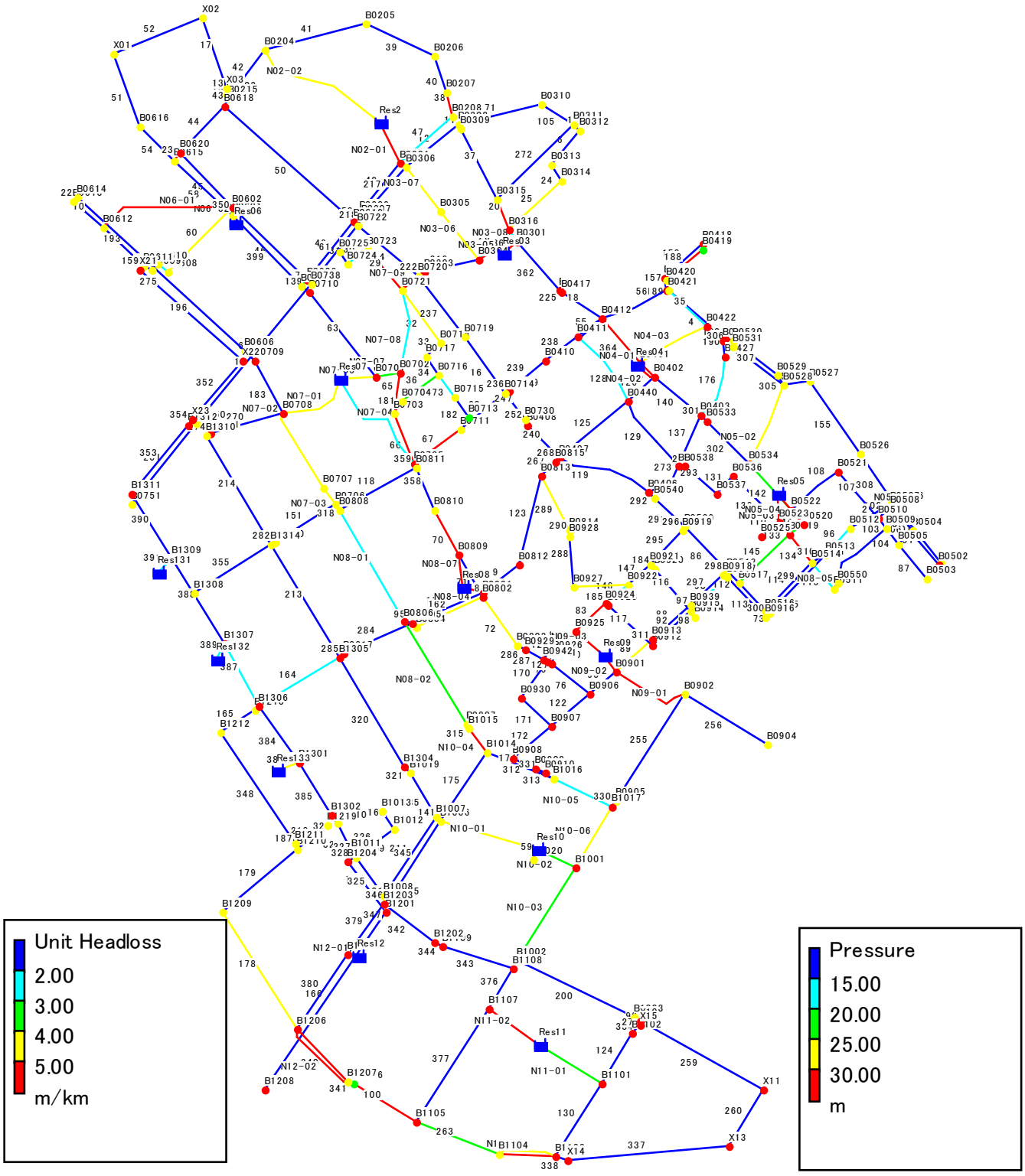


Figure E.5 Result of Distribution Network Analysis

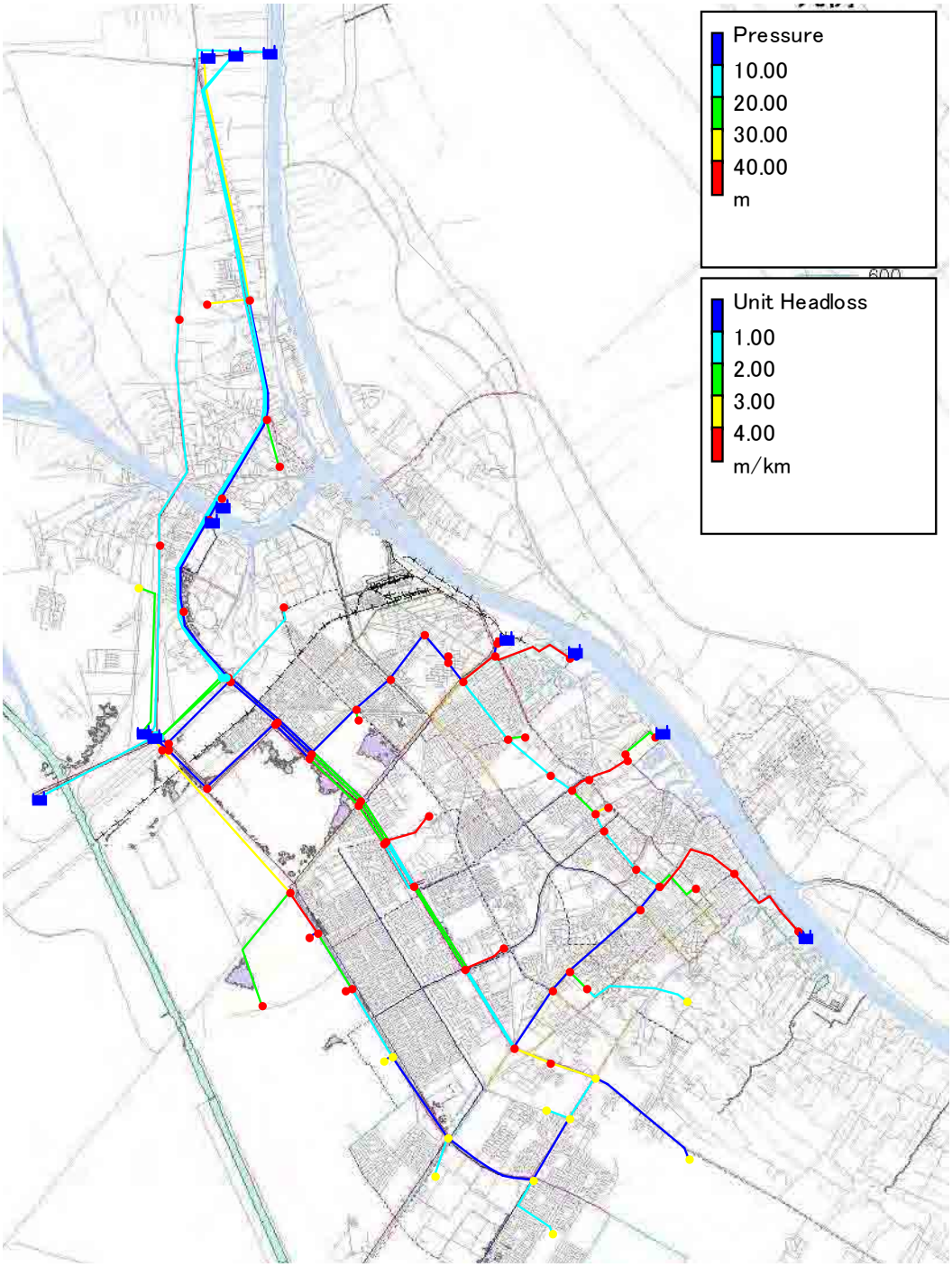


Figure E.6 Results of Transmission Network Analysis

Table E.1 Result of Distribution Network Analysis

Network Table - Nodes		
Node ID	Base Demand	Pressure
	CMD	m
Junc B0201	7375	30.52
Junc B0202	7375	30.46
JuncB0203	0	26.97
JuncB0204	7375	27.48
JuncB0205	7375	25.88
JuncB0206	7375	25.56
JuncB0207	7375	26.04
JuncB0208	7375	28.24
JuncB0215	7375	26.97
JuncB0301	4757.1	31.14
JuncB0302	4757.1	30.72
JuncB0303	4757.1	31.97
JuncB0304	4757.1	32.69
JuncB0305	4757.1	29.24
JuncB0306	4757.1	26.51
JuncB0307	4757.1	26.38
JuncB0308	0	27.35
JuncB0309	4757.1	27.68
JuncB0310	0	27.85
JuncB0311	4757.1	27.85
JuncB0312	4757.1	27.85
JuncB0313	4757.1	27.84
JuncB0314	4757.1	28.06
JuncB0315	4757.1	28.21
JuncB0316	4757.1	31.52
JuncB0401	4717.6	34.83
JuncB0402	4717.6	33.28
JuncB0403	4717.6	32.21
JuncB0406	4717.6	32.22
JuncB0407	4717.6	32.3
JuncB0408	4717.6	32.29
JuncB0409	4717.6	30.57
JuncB0410	4717.6	30.59
JuncB0411	4717.6	30.64
JuncB0412	4717.6	30.67
JuncB0413	0	30.67
JuncB0414	0	30.67
JuncB0415	4717.6	32.22
JuncB0417	4717.6	30.37
JuncB0418	0	30.67
JuncB0419	4717.6	21.61
JuncB0420	0	27.63
JuncB0421	4717.6	28.85
JuncB0422	0	30.66
JuncB0423	0	30.16
JuncB0424	4717.6	30.17
JuncB0427	4717.6	30.17
JuncB0440	4717.6	32.69
JuncB0501	0	27.3
JuncB0502	0	30.19
JuncB0503	3665.4	27.48
JuncB0504	0	27.44
JuncB0505	3665.4	27.51
JuncB0506	0	27.3
JuncB0507	0	27.35
JuncB0508	0	30.19
JuncB0509	0	27.57
JuncB0510	0	30.19
JuncB0511	3665.4	27.91
JuncB0512	3665.4	27.58
JuncB0513	3665.4	28.47
JuncB0514	3665.4	28.76
JuncB0515	0	28.75
JuncB0516	3665.4	28.75

Network Table - Links						
Link ID	Length	Diameter	Flow	Velocity	Unit Headloss	Status
	m	mm	CMD	m/s	m/km	
Pipe 11	58.22	600	0	0	0	Closed
Pipe12	785.7	600	0	0	0	Closed
Pipe14	920.44	500	-10299.9	0.61	0.82	Open
Pipe16	791.53	400	3132.13	0.29	0.26	Open
Pipe18	524.48	400	4717.6	0.43	0.57	Open
Pipe20	361.2	400	19364.72	1.78	9.15	Open
Pipe6	525.15	350	336.32	0.04	0.01	Open
Pipe24	216.62	350	-4420.78	0.53	0.99	Open
Pipe25	825.65	350	-9177.88	1.1	4.19	Open
Pipe26	490.04	350	-6921.91	0.83	2.4	Open
Pipe28	248.84	350	-13146.68	1.58	8.53	Open
Pipe29	597.8	350	10299.9	1.24	5.26	Open
Pipe30	290.27	350	6866.6	0.83	2.36	Open
Pipe31	153.65	350	3433.3	0.41	0.61	Open
Pipe32	750.86	350	9213.7	1.11	4.22	Open
Pipe33	219.03	350	5780.4	0.7	1.68	Open
Pipe34	261.41	350	2347.1	0.28	0.29	Open
Pipe36	506.82	350	-7952.8	0.96	3.16	Open
Pipe37	926.73	400	4757.1	0.44	0.58	Open
Pipe38	302.3	350	12124.82	1.46	7.27	Open
Pipe41	1192.67	450	-10000.18	0.73	1.34	Open
Pipe42	682.36	450	7375	0.54	0.74	Open
Pipe44	733.61	800	-6979.91	0.16	0.03	Open
Pipe45	875.19	800	-28294.39	0.65	0.53	Open
Pipe46	1172.48	800	18061.68	0.42	0.22	Open
Pipe47	787.91	500	-19499.82	1.15	2.9	Open
Pipe49	848.77	500	-6020.09	0.35	0.29	Open
Pipe50	1973.97	400	479.91	0.04	0.01	Open
Pipe52	1084.22	300	0	0	0	Open
Pipe54	543.2	400	-6500	0.6	1.06	Open
Pipe57	150.52	500	17899.33	1.06	2.44	Open
Pipe58	923.38	300	1814.47	0.3	0.39	Open
Pipe399	1129.94	300	958.41	0.16	0.11	Open
Pipe60	1052.68	500	24399.33	1.44	4.51	Open
Pipe61	846.82	700	6866.6	0.21	0.07	Open
Pipe62	2082.74	700	3433.3	0.1	0.02	Open
Pipe64	263.4	300	5941.78	0.97	3.97	Open
Pipe65	463.35	300	8012.41	1.31	7.16	Open
Pipe66	624.73	300	-6806.99	1.11	5.19	Open
Pipe67	670.41	300	7167.77	1.17	5.75	Open
Pipe68	643.67	300	3734.47	0.61	1.59	Open
Pipe70	574.57	300	-9255.52	1.52	9.53	Open
Pipe71	566.94	300	-3425.1	0.56	1.34	Open
Pipe72	676.96	300	6437.5	1.05	4.65	Open
Pipe74	41.13	300	1401.29	0.23	0.24	Open
Pipe75	58.17	500	-7301.68	0.43	0.42	Open
Pipe76	570.02	500	-2046.54	0.12	0.04	Open
Pipe82	374.44	500	-13097.83	0.77	1.32	Open
Pipe83	473.41	500	25972.65	1.53	5.11	Open
Pipe86	701.54	500	-3665.4	0.22	0.11	Open
Pipe88	595.43	500	-14442.77	0.85	1.6	Open
Pipe89	551.68	500	-25558.55	1.51	4.95	Open
Pipe90	394.75	500	15888.46	0.94	1.93	Open
Pipe92	583.32	350	5703.61	0.69	1.64	Open
Pipe93	577.41	350	6441.4	0.77	2.08	Open
Pipe94	624.29	350	3220.7	0.39	0.54	Open
Pipe96	408.53	350	6563.88	0.79	2.16	Open
Pipe101	857.33	600	0	0	0	Closed
Pipe102	188.77	600	0	0	0	Closed
Pipe103	148.38	600	0	0	0	Closed
Pipe104	230.96	600	9521.88	0.39	0.28	Open
Pipe106	242.95	350	2191.08	0.26	0.25	Open
Pipe107	694.15	600	0	0	0	Closed
Pipe108	703.22	350	-3665.4	0.44	0.69	Open

Network Table - Nodes		
Node ID	Base Demand	Pressure
	CMD	m
JuncB0517	3665.4	28.83
JuncB0518	3665.4	28.75
JuncB0519	3665.4	31.46
JuncB0520	3665.4	32.15
JuncB0521	3665.4	32.81
JuncB0522	3665.4	33.29
JuncB0523	3665.4	33.02
JuncB0525	3665.4	32.84
JuncB0526	3665.4	26.4
JuncB0527	3665.4	26.29
JuncB0528	3665.4	26.37
JuncB0529	0	26.37
JuncB0530	0	26.37
JuncB0531	3665.4	25.86
JuncB0533	3665.4	30.36
JuncB0534	3665.4	30.59
JuncB0536	3665.4	31.81
JuncB0537	3665.4	31.6
JuncB0538	3665.4	31.51
JuncB0539	3665.4	28.67
JuncB0540	0	28.67
JuncB0550	3665.4	27.81
JuncB0601	6500	29.22
JuncB0602	6500	32.81
JuncB0603	6500	32.55
JuncB0604	6500	29.1
JuncB0606	0	27.57
JuncB0608	6500	28.06
JuncB0609	6500	27.58
JuncB0610	6500	27.69
JuncB0611	6500	27.58
JuncB0612	6500	27.58
JuncB0613	6500	27.57
JuncB0614	0	27.57
JuncB0615	6500	29.58
JuncB0616	6500	29.01
JuncB0618	6500	32.32
JuncB0619	6500	32.31
JuncB0620	6500	32.35
JuncB0701	3433.3	32.88
JuncB0702	3433.3	31.83
JuncB0703	3433.3	28.51
JuncB0704	3433.3	27.49
JuncB0705	3433.3	31.75
JuncB0706	3433.3	26.15
JuncB0707	0	27.14
JuncB0708	3433.3	31.12
JuncB0709	0	31.12
JuncB0710	3433.3	31.21
JuncB0711	3433.3	27.9
JuncB0713	3433.3	24.94
JuncB0714	3433.3	26.88
JuncB0715	3433.3	25.17
JuncB0716	3433.3	25.89
JuncB0717	3433.3	25.96
JuncB0718	3433.3	26.33
JuncB0719	3433.3	27.08
JuncB0720	3433.3	27.38
JuncB0721	3433.3	29.5
JuncB0722	3433.3	26.62
JuncB0723	3433.3	26.35
JuncB0724	3433.3	25.67
JuncB0725	3433.3	25.58
JuncB0730	3433.3	26.87
JuncB0738	3433.3	26.56
JuncB0740	3433.3	25.04
JuncB0741	3433.3	31.1
JuncB0750	3433.3	26.53

Network Table - Links						
Link ID	Length	Diameter	Flow	Velocity	Unit Headloss	Status
	m	mm	CMD	m/s	m/km	
Pipe109	201.14	350	5174.49	0.62	1.35	Open
Pipe110	252.27	350	3665.4	0.44	0.69	Open
Pipe111	867.14	600	-9521.88	0.39	0.28	Open
Pipe112	185.52	500	-7330.8	0.43	0.42	Open
Pipe113	455.56	500	4678.43	0.28	0.18	Open
Pipe114	751.52	500	-1391.49	0.08	0.02	Open
Pipe115	393.68	500	16852.68	0.99	2.17	Open
Pipe116	653.42	350	822.18	0.1	0.04	Open
Pipe117	680.73	350	-1029.23	0.12	0.06	Open
Pipe119	1112.13	700	7379.65	0.22	0.08	Open
Pipe121	875.94	700	-35806.98	1.08	1.67	Open
Pipe123	1042.97	700	19312.5	0.58	0.5	Open
Pipe125	1013.94	700	-16814.85	0.51	0.38	Open
Pipe126	411.42	700	-33129.32	1	1.43	Open
Pipe128	955.01	375	-7831.95	0.82	2.14	Open
Pipe129	925.69	375	3764.92	0.39	0.51	Open
Pipe131	286.93	450	-7330.8	0.53	0.73	Open
Pipe132	745.77	450	-10996.2	0.8	1.62	Open
Pipe133	192.29	500	32760.14	1.93	8.09	Open
Pipe134	404.12	500	29734.32	1.75	6.68	Open
Pipe137	619.7	800	1709.37	0.04	0	Open
Pipe140	684.02	400	7897.66	0.73	1.55	Open
Pipe142	713.6	450	-16902.84	1.23	3.78	Open
Pipe143	215.95	450	19979.61	1.45	5.26	Open
Pipe144	196.65	450	16314.21	1.19	3.52	Open
Pipe145	808.43	450	15674.63	1.14	3.25	Open
Pipe146	321.92	500	18502.02	1.09	2.61	Open
Pipe147	348.49	500	8839.92	0.52	0.61	Open
Pipe148	606.91	300	6441.4	1.05	4.65	Open
Pipe154	303.52	350	2241.25	0.27	0.27	Open
Pipe155	997.77	350	-1424.15	0.17	0.11	Open
Pipe157	123.74	450	0	0	0	Closed
Pipe158	601.33	450	0	0	0	Closed
Pipe162	823.83	300	6437.5	1.05	4.65	Open
Pipe164	1071.81	700	-41250	1.24	2.21	Open
Pipe165	486.42	400	0	0	0	Open
Pipe166	2449.47	350	0	0	0	Open
Pipe167	718.84	350	4660	0.56	1.1	Open
Pipe169	263.22	350	5686.7	0.68	1.63	Open
Pipe170	525.06	500	5482.27	0.32	0.24	Open
Pipe171	468.72	500	2261.57	0.13	0.04	Open
Pipe172	582.69	500	9662.1	0.57	0.73	Open
Pipe174	829.3	500	-2003.5	0.12	0.03	Open
Pipe175	924.81	500	-13376.9	0.79	1.38	Open
Pipe178	1591.66	400	13980	1.29	4.8	Open
Pipe179	1111.94	600	9320	0.38	0.26	Open
PipeN08-01	1469.88	400	10056.98	0.93	2.5	Open
Pipe193	624.9	900	-1600.67	0.03	0	Open
Pipe196	1559.14	600	0	0	0	Open
Pipe199	103.01	900	4899.33	0.09	0.01	Open
Pipe201	1168.71	500	0	0	0	Closed
Pipe210	438.02	600	-4660	0.19	0.07	Open
Pipe211	1077.38	700	-16087.14	0.48	0.35	Open
Pipe213	1500.75	700	24750	0.74	0.81	Open
Pipe214	1453.08	700	8250	0.25	0.09	Open
Pipe255	1444.27	500	-3220.7	0.19	0.09	Open
Pipe256	1107.58	300	0	0	0	Open
Pipe259	1622.83	600	0	0	0	Open
Pipe260	741.47	500	0	0	0	Open
Pipe262	644.82	200	2608.41	0.96	6.5	Open
Pipe263	1032.35	200	-1894.97	0.7	3.46	Open
Pipe271	985.93	600	0	0	0	Closed
Pipe272	1213.5	600	-9850.52	0.4	0.29	Open
Pipe273	507.88	800	-2662.05	0.06	0.01	Open
Pipe275	2587.4	700	0	0	0	Open
Pipe2	542.14	350	2898.48	0.35	0.44	Open
Pipe3	382.54	350	-2191.08	0.26	0.25	Open
Pipe4	853.55	225	-1711.59	0.5	1.53	Open

Network Table - Nodes		
Node ID	Base Demand	Pressure
	CMD	m
JuncB0751	0	26.53
JuncB0801	6437.5	32.61
JuncB0802	6437.5	32.52
JuncB0803	6437.5	29.37
JuncB0804	6437.5	28.69
JuncB0805	6437.5	31.14
JuncB0806	6437.5	30.97
JuncB0807	6437.5	25.97
JuncB0808	6437.5	27.29
JuncB0809	6437.5	31.76
JuncB0810	6437.5	26.28
JuncB0811	6437.5	25.8
JuncB0812	6437.5	32.15
JuncB0813	6437.5	31.63
JuncB0814	6437.5	28.38
JuncB0815	6437.5	31.62
JuncB0817	6437.5	31.09
JuncB0901	3220.7	33.09
JuncB0902	3220.7	27.14
JuncB0904	0	27.14
JuncB0905	3220.7	27.01
JuncB0906	3220.7	32.33
JuncB0907	3220.7	32.13
JuncB0908	3220.7	31.71
JuncB0909	3220.7	31.62
JuncB0910	3220.7	31.59
JuncB0912	3220.7	30.32
JuncB0913	3220.7	30.36
JuncB0914	3220.7	29.32
JuncB0915	3220.7	29.37
JuncB0916	3220.7	27.83
JuncB0917	3220.7	28.16
JuncB0918	3220.7	29.36
JuncB0919	3220.7	29.32
JuncB0920	3220.7	29.34
JuncB0921	3220.7	29.36
JuncB0922	3220.7	29.57
JuncB0923	3220.7	30.37
JuncB0924	3220.7	30.41
JuncB0925	3220.7	32.83
JuncB0926	3220.7	32.34
JuncB0927	3220.7	26.75
JuncB0928	3220.7	26.07
JuncB0929	3220.7	31.99
JuncB0930	3220.7	32.15
JuncB0939	3220.7	29.41
JuncB0940	0	32.3
JuncB0941	3220.7	32.28
JuncB0942	0	32.29
JuncB1001	0	33.44
JuncB1002	5686.7	29.45
JuncB1003	5686.7	29.43
JuncB1005	5686.7	29.38
JuncB1006	5686.7	29.88
JuncB1007	5686.7	29.74
JuncB1008	5686.7	29.37
JuncB1009	0	28.76
JuncB1010	5686.7	28.79
JuncB1011	5686.7	28.83
JuncB1012	0	27.9
JuncB1013	5686.7	27.47
JuncB1014	5686.7	28.6
JuncB1015	5686.7	26.8
JuncB1016	5686.7	28.57
JuncB1017	5686.7	30.21
JuncB1019	5686.7	29.71
JuncB1101	0	31.68
JuncB1102	8275	31.54

Network Table - Links						
Link ID	Length	Diameter	Flow	Velocity	Unit Headloss	Status
	m	mm	CMD	m/s	m/km	
Pipe5	248.68	350	6257.37	0.75	1.97	Open
Pipe9	530.26	700	-25750	0.77	0.87	Open
Pipe10	460.77	900	6500	0.12	0.02	Open
Pipe188	532.2	225	-4717.6	1.37	11.31	Open
Pipe189	107.98	225	-4717.6	1.37	11.31	Open
Pipe39	875.07	350	2625.18	0.32	0.36	Open
Pipe40	420.96	350	-4749.82	0.57	1.15	Open
Pipe105	421.65	600	0	0	0	Open
Pipe48	754.48	700	7375	0.22	0.08	Open
Pipe63	1232.69	300	3433.3	0.56	1.35	Open
Pipe150	108.75	500	11399.33	0.67	1	Open
Pipe217	744.95	500	4757.1	0.28	0.18	Open
Pipe219	624.58	350	4757.1	0.57	1.15	Open
Pipe237	867.58	500	6565.43	0.39	0.34	Open
Pipe238	458.61	700	9435.2	0.28	0.12	Open
Pipe239	536.62	700	4717.6	0.14	0.03	Open
Pipe240	522.9	700	4717.6	0.14	0.03	Open
Pipe247	381.45	700	-3433.3	0.1	0.02	Open
Pipe267	225.38	700	6437.5	0.19	0.06	Open
Pipe270	866.69	700	3433.3	0.1	0.02	Open
Pipe284	863.44	700	6437.5	0.19	0.06	Open
Pipe287	252.03	300	-3220.7	0.53	1.19	Open
Pipe288	567.74	300	3220.7	0.53	1.19	Open
Pipe289	699.83	300	6437.5	1.05	4.65	Open
Pipe291	479.11	700	0	0	0	Open
Pipe293	470.42	450	3665.4	0.27	0.19	Open
Pipe295	529.47	500	3220.7	0.19	0.09	Open
Pipe297	507.93	500	3220.7	0.19	0.09	Open
Pipe299	930.31	350	-2404.52	0.29	0.3	Open
Pipe302	688.08	400	-3665.4	0.34	0.35	Open
Pipe303	642.84	225	0	0	0	Open
Pipe305	124.56	225	0	0	0	Open
Pipe307	728.37	350	3665.4	0.44	0.69	Open
Pipe308	689.95	350	-5089.56	0.61	1.31	Open
Pipe310	194.08	400	-7824.76	0.72	1.53	Open
Pipe311	71.11	500	7895.08	0.47	0.49	Open
Pipe312	268.81	500	6441.4	0.38	0.33	Open
PipeN08-02	1386.99	315	6437.5	0.96	3.6	Open
PipeN10-04	345.51	280	-5686.7	1.07	5.21	Open
PipeN07-03	242.42	315	6866.6	1.02	4.09	Open
Pipe320	1447.16	700	8250	0.25	0.09	Open
Pipe324	363.87	600	-5686.7	0.23	0.1	Open
Pipe325	625.32	600	-17060.1	0.7	0.86	Open
Pipe326	532.11	350	-5686.7	0.68	1.63	Open
Pipe327	77.46	400	-5686.7	0.52	0.82	Open
Pipe331	131.69	400	-3220.7	0.3	0.27	Open
Pipe200	1487.6	900	5686.7	0.1	0.01	Open
Pipe337	1853.79	200	0	0	0	Open
Pipe340	822.47	200	2354.37	0.87	5.31	Open
Pipe342	719.03	700	4660	0.14	0.03	Open
Pipe343	843.18	700	-8275	0.25	0.1	Open
Pipe345	1089.35	600	12346.36	0.51	0.46	Open
Pipe347	87.4	350	9320	1.12	4.32	Open
Pipe348	1545.75	400	0	0	0	Open
Pipe352	876.15	600	0	0	0	Open
Pipe353	1014.86	600	-8250	0.34	0.21	Open
Pipe355	1032.46	400	8250	0.76	1.69	Open
Pipe358	523.97	300	2818.02	0.46	0.92	Open
PipeN02-01	506.56	500	34249.81	2.02	8.84	Open
Pipe361	167.85	400	9514.2	0.88	2.24	Open
Pipe362	733.24	400	4757.1	0.44	0.58	Open
Pipe364	684.45	400	-15756.05	1.45	6.08	Open
Pipe365	230.96	400	16556.08	1.52	6.71	Open
PipeN04-01	51.69	700	-51010.71	1.53	3.37	Open
PipeN05-03	324.35	600	45912.66	1.88	6.11	Open
PipeN06-02	179.55	700	97500.01	2.93	12.21	Open
PipeN07-05	433.85	700	61557.84	1.85	4.89	Open
PipeN08-04	226.04	700	90732.08	2.73	10.58	Open

Network Table - Nodes		
Node ID	Base Demand	Pressure
	CMD	m
JuncB1103	8275	31.04
JuncB1104	8275	26.85
JuncB1105	8275	30.42
JuncB1106	8275	24.15
JuncB1107	8275	31.11
JuncB1108	8275	30.91
JuncB1109	8275	30.83
JuncB1201	4660	33.54
JuncB1202	4660	33.89
JuncB1203	4660	33.91
JuncB1204	4660	32.74
JuncB1205	4660	34.64
JuncB1206	4660	33
JuncB1207	4660	28.63
JuncB1208	0	33.54
JuncB1209	4660	25.36
JuncB1210	4660	25.07
JuncB1211	0	25.07
JuncB1212	0	25.07
JuncB1213	0	25.07
JuncB1219	4660	25.04
JuncB1301	8250	33.85
JuncB1302	8250	33.7
JuncB1304	8250	30.17
JuncB1305	8250	30.31
JuncB1306	8250	32.68
JuncB1307	8250	34.4
JuncB1308	8250	27.35
JuncB1309	8250	34.45
JuncB1310	8250	28.96
JuncB1311	8250	33.76
JuncB1312	8250	33.55
JuncB1314	8250	29.09
JuncX01	0	27.99
JuncX02	0	27.99
JuncX03	0	27.99
JuncX10	0	30.87
JuncX11	0	30.87
JuncX13	0	30.87
JuncX14	0	30.87
JuncX15	0	30.87
JuncX21	0	30.62
JuncX22	0	30.62
JuncX23	0	30.62
JuncB1020	5686.7	25.57
ResvrRes2	#N/A	0
ResvrRes03	#N/A	0
ResvrRes04	#N/A	0
ResvrRes05	#N/A	0
ResvrRes06	#N/A	0
ResvrRes07	#N/A	0
ResvrRes08	#N/A	0
ResvrRes09	#N/A	0
ResvrRes10	#N/A	0
ResvrRes11	#N/A	0
ResvrRes12	#N/A	0
ResvrRes131	#N/A	0
ResvrRes132	#N/A	0
ResvrRes133	#N/A	0

Network Table - Links						
Link ID	Length	Diameter	Flow	Velocity	Unit Headloss	Status
	m	mm	CMD	m/s	m/km	
PipeN10-06	797.4	355	-9369.9	1.1	4.05	Open
PipeN10-03	1250.05	400	11373.4	1.05	3.19	Open
PipeN10-02	476.37	500	20743.3	1.22	3.27	Open
Pipe376	547.96	700	-16550	0.5	0.37	Open
Pipe377	1517.07	700	18444.97	0.55	0.45	Open
PipeN11-02	716.31	600	43269.97	1.77	5.43	Open
Pipe379	712.02	600	-18640	0.76	1.03	Open
Pipe380	1031.71	600	23300	0.95	1.59	Open
PipeN12-01	126.33	700	46600	1.4	2.82	Open
Pipe384	784.34	600	-22587.45	0.92	1.5	Open
Pipe385	718.97	600	8250	0.34	0.21	Open
Pipe386	258.06	600	-39087.45	1.6	4.44	Open
Pipe387	811.02	600	-26912.55	1.1	2.12	Open
Pipe388	1141.97	600	-3930.37	0.16	0.05	Open
Pipe389	211.72	600	31232.18	1.28	2.85	Open
Pipe390	860.79	600	16500	0.68	0.81	Open
Pipe391	226.87	600	28680.38	1.17	2.4	Open
Pipe15	63.39	300	0	0	0	Open
Pipe17	854.66	300	0	0	0	Open
Pipe8	59.43	600	22737.59	0.93	1.52	Open
PipeN10-05	738.28	280	-3683.2	0.69	2.22	Open
Pipe85	593.92	700	-5686.7	0.17	0.05	Open
PipeN02-02	1620.96	500	24750.18	1.46	4.64	Open
Pipe122	563.11	600	10621.23	0.43	0.34	Open
PipeN03-08	359.1	500	35891.99	2.12	9.7	Open
PipeN05-02	1000.49	355	9572.04	1.12	4.23	Open
PipeN05-04	242.02	600	49387.74	2.02	7.06	Open
PipeN07-01	837.86	400	13733.2	1.26	4.63	Open
PipeN07-04	1402.73	500	17408.06	1.03	2.31	Open
Pipe181	160.14	350	11386.1	1.37	6.42	Open
Pipe95	112.82	600	22931.98	0.94	1.55	Open
Pipe118	996.08	300	3619.48	0.59	1.5	Open
Pipe176	757.85	300	4889.42	0.8	2.7	Open
PipeN09-01	892.24	280	6441.4	1.21	6.67	Open
PipeN10-01	1143.86	700	58870.5	1.77	4.48	Open
Pipe21	83.82	600	6659.66	0.27	0.14	Open
Pipe22	54.71	600	0	0	0	Open
Pipe23	113.98	300	14814.47	2.43	24.24	Open
PipeN04-02	267.64	500	29188.5	1.72	6.44	Open
Pipe56	818.43	375	0	0	0	Closed
Pipe84	344.57	375	0	0	0	Closed
Pipe97	76.33	500	8001.37	0.47	0.5	Open
Pipe98	84.26	500	3220.7	0.19	0.57	Open
PipeN09-02	252.93	600	51109.11	2.09	7.56	Open
Pipe100	822.3	300	8275	1.35	7.63	Open
Pipe124	661.27	600	-8275	0.34	0.21	Open
Pipe130	1002.46	600	14655.03	0.6	0.64	Open
PipeN11-01	832.38	500	22930.03	1.35	3.99	Open
Pipe141	61.82	600	27460.54	1.12	2.21	Open
Pipe151	822.21	300	3433.3	0.56	1.35	Open
PipeN07-02	972.98	315	6866.6	1.02	4.09	Open
Pipe173	304.61	350	6866.6	0.83	2.36	Open
Pipe182	366.35	350	3433.3	0.41	0.61	Open
Pipe183	690.19	700	0	0	0	Open
PipeN12-02	857.08	200	2305.63	0.85	5.1	Open
Pipe184	61.38	350	-2398.52	0.29	0.3	Open
Pipe185	52.34	350	-4249.93	0.51	0.92	Open
PipeN07-07	339.06	700	48749.46	1.47	3.08	Open
PipeN07-08	959.47	700	43245.53	1.3	2.43	Open
PipeN07-09	258.73	280	7151.95	1.34	8.2	Open
PipeN08-07	390.61	500	12267.92	0.72	8.3	Open
Pipe187	62.08	400	0	0	0	Open
Pipe190	176.59	350	171.82	0.02	0	Open
Pipe191	38.47	350	1711.59	0.21	0.16	Open
PipeN09-03	417.92	600	42291.18	1.73	5.19	Open
Pipe1	94.44	600	-5093.42	0.21	0.08	Open
PipeN03-05	324.31	500	30707.41	1.81	7.12	Open
PipeN03-06	691.19	400	14271.3	1.31	5	Open

Network Table - Nodes		
Node ID	Base Demand	Pressure
	CMD	m

Network Table - Links						
Link ID	Length	Diameter	Flow	Velocity	Unit Headloss	Status
	m	mm	CMD	m/s	m/km	
PipeN03-07	652.32	355	9514.2	1.11	4.18	Open
PipeN04-03	869.14	400	13980.98	1.29	4.8	Open
Pipe35	605.57	350	7723.61	0.93	2.98	Open
Pipe55	360.99	700	-6320.85	0.19	0.06	Open
Pipe73	47.16	500	2404.52	0.14	0.05	Open
Pipe87	507.29	600	3665.4	0.15	0.04	Open
PipeN08-05	74.83	500	-13187.28	0.78	1.34	Open
PipeN05-06	35.23	350	5089.56	0.61	1.31	Open
Pipe91	861.91	350	0	0	0	Open
Pipe99	38.1	600	0	0	0	Open
Pipe120	157.08	450	4621.99	0.34	0.3	Open
Pipe127	144.03	500	5255.15	0.31	0.22	Open
PipeN06-01	1000	400	14600.67	1.34	5.23	Open
Pipe350	1000	300	-5643.93	0.92	3.58	Open
Pipe7	1000	300	5541.59	0.91	3.46	Open
PipeN11-04	1000	250	3771.62	0.89	4.19	Open
Pipe59	1000	250	5686.7	1.34	9.43	Open
Valve43	#N/A	450	0	0	0	Closed
Valve51	#N/A	400	0	0	0	Closed
Valve53	#N/A	500	0	0	0	Closed
Valve139	#N/A	300	0	0	0	Closed
Valve159	#N/A	600	0	0	0	Closed
Valve218	#N/A	500	0	0	0	Closed
Valve222	#N/A	350	0	0	0	Closed
Valve225	#N/A	400	0	0	0	Closed
Valve236	#N/A	700	0	0	0	Closed
Valve252	#N/A	700	0	0	0	Closed
Valve268	#N/A	700	0	0	0	Closed
Valve274	#N/A	700	0	0	0	Closed
Valve282	#N/A	300	0	0	0	Closed
Valve285	#N/A	700	0	0	0	Closed
Valve286	#N/A	300	0	0	0	Closed
Valve290	#N/A	300	0	0	0	Closed
Valve292	#N/A	700	0	0	0	Closed
Valve294	#N/A	450	0	0	0	Closed
Valve296	#N/A	500	0	0	0	Closed
Valve298	#N/A	500	0	0	0	Closed
Valve300	#N/A	350	0	0	0	Closed
Valve301	#N/A	400	0	0	0	Closed
Valve304	#N/A	225	0	0	0	Closed
Valve306	#N/A	350	0	0	0	Closed
Valve313	#N/A	500	0	0	0	Closed
Valve315	#N/A	900	0	0	0	Closed
Valve318	#N/A	900	0	0	0	Closed
Valve321	#N/A	700	0	0	0	Closed
Valve323	#N/A	600	0	0	0	Closed
Valve328	#N/A	350	0	0	0	Closed
Valve330	#N/A	900	0	0	0	Closed
Valve334	#N/A	900	0	0	0	Closed
Valve338	#N/A	200	0	0	0	Closed
Valve341	#N/A	200	0	0	0	Closed
Valve344	#N/A	700	0	0	0	Closed
Valve346	#N/A	600	0	0	0	Closed
Valve354	#N/A	600	0	0	0	Closed
Valve359	#N/A	300	0	0	0	Closed
Valve13	#N/A	300	0	0	0	Closed
Valve27	#N/A	600	0	0	0	Closed
Valve19	#N/A	700	0	0	0	Closed

Table E.2 Results of Transmission Network Analysis

NetworkTable-Nodesat0:00Hrs		
NodeID	BaseDemand	Pressure
	CMD	m
JuncBlock01	37700	55.08
JuncBlock02	36900	53.56
JuncBlock03	41,600	50.65
JuncBlock04	50200	46.28
JuncBlock05	59600	42.05
JuncBlock06	60900	55.03
JuncBlock07	57,900	47.99
JuncBlock08	64400	41.85
JuncBlock09	58400	41.04
JuncBlock10	53300	35.93
JuncBlock11	41400	35.07
JuncBlock12	29200	36.08
JuncBlock13-2	20600	41.08
JuncS01	22400	38.11
JuncS02	22600	36.88
JuncS03	10400	42.24
JuncS05	43600	62.48
JuncS06	50400	63.51
JuncR21	0	59.74
JuncR22	0	58.33
JuncR3	0	57.27
JuncR24	0	56.45
JuncR25	0	53.93
JuncR26	0	52.06
JuncR27	0	50.53
JuncR28	0	46.21
JuncR29	0	43.43
JuncR30	0	42.44
JuncR31	0	42.05
JuncR32	0	43.73
JuncR33	0	44.26
JuncR34	0	45.13
JuncR35	0	46.59
JuncR36	0	47.13
JuncR37	0	48.69
JuncR38	0	49.55
JuncR39	0	51.39
JuncR40	0	53.55
JuncR41	0	53.73
JuncR42	0	54.19
JuncR43	0	54.9
JuncR44	0	55.47
JuncR46	0	36.92
JuncR48	0	48.57
JuncR49	0	44.69
JuncR50	0	41.16
JuncR51	0	38.56
JuncE1200RT02	0	12.97
JuncE1000Hartha02	0	69.01
JuncEHartha02	0	64.66
JuncE1000Hartha01	0	73.52
JuncR58	0	59.08
JuncRZeroEnd	96000	15.67
JuncR2	0	59.67
JuncR4	0	58.77
JuncR5	0	57.23
JuncR6	0	56.42
JuncR7	0	53.86
JuncR8	0	52.06
JuncR9	0	36.62
JuncE900Garma03	0	49.1
JuncEHartha01	0	66.15
JuncE1000HarthEnd	72000	65.36
JuncE1200RT03	0	12.91
JuncE900Garma02	0	48.35

NetworkTable-Linksat0:00Hrs					
LinkID	Length	Diameter	Flow	Velocity	UnitHeadloss
	m	mm	CMD	m/s	m/km
PipeR01	289.51	2000	407095.6	1.5	0.89
PipeR02	1586.87	2000	407095.6	1.5	0.89
PipeR03	1134.38	1800	318279.4	1.45	0.94
PipeR06	815.98	1200	94801.27	0.97	0.7
PipeR07	1023.1	1200	94801.27	0.97	0.7
PipeR08	644.73	1200	94801.27	0.97	0.7
PipeR10	1370.73	1100	113870.2	1.39	1.58
PipeR11	1007.2	900	72270.23	1.31	1.82
PipeR12	477.14	900	72270.23	1.31	1.82
PipeR13	614.88	900	85395.1	1.55	2.53
PipeR14	334.64	700	35195.11	1.06	1.62
PipeR15	903.45	700	35195.11	1.06	1.62
PipeR16	533.74	700	35195.11	1.06	1.62
PipeR25	549.96	600	18177.95	0.74	0.98
PipeR24	1709.98	600	18177.95	0.74	0.98
PipeR23	482.08	1000	-62622.06	0.92	0.79
PipeR22	1250.32	1000	-62622.06	0.92	0.79
PipeR21	1698.79	1000	-90304.18	1.33	1.64
PipeR20	1804.17	1100	-140495.5	1.71	2.39
PipeR19	937.45	900	-68372.78	1.24	1.63
PipeR18	902.34	1000	-101753.9	1.5	2.07
PipeR17	1215.2	1000	-101753.9	1.5	2.07
PipeB12	759.08	700	29200	0.88	1.12
PipeB02	99.57	700	36900	1.11	1.78
PipeB03	324.98	700	41600	1.25	2.25
PipeB04	261.07	700	50200	1.51	3.27
PipeB05	967.58	800	59600	1.37	2.29
PipeB09	445.76	900	80800.01	1.47	2.27
PipeS01	1986.96	600	22400	0.92	1.48
PipeEH03	3493.75	1000	-72000	1.06	1.05
PipeES05	883.14	700	43600	1.31	2.47
PipeER11	304.63	1000	122999.6	1.81	3.02
PipeER12	3479.57	1000	122999.6	1.81	3.02
PipeER14	1203.12	900	91999.63	1.67	2.94
PipeER15	1463.08	900	71399.63	1.3	1.78
PipeEB13-2	139.7	700	20600	0.62	0.56
PipeS03	2369.35	400	10400	0.96	2.67
PipeB06	184.92	800	60900	1.4	2.39
PipeR09	445.23	1100	57901.28	0.71	0.42
PipeB07	937.63	700	57900	1.74	4.33
PipeER16	1800.54	900	50799.63	0.92	0.91
PipeR04	870.39	1800	318279.4	1.45	0.94
PipeR05	1158.03	1400	155701.3	1.17	0.84
PipeB08	814.19	700	64400	1.94	5.35
PipeER-Zero01	2342.08	1000	96000	1.41	1.85
PipeB01	1753.66	700	37700	1.13	1.85
PipeER02	992.05	1000	66928.1	0.99	0.9
PipeER03	1709.13	1000	66928.1	0.99	0.9
PipeER04	890.06	1000	66928.1	0.99	0.9
PipeER05	1218.59	1000	102509.2	1.51	2.1
PipeER06	855.11	1000	102509.2	1.51	2.1
PipeER07	73.65	1000	15666.52	0.23	0.05
PipeER01	363.27	1000	66928.1	0.99	0.9
PipeER17	1786.4	900	21599.63	0.39	0.17
PipeB11	1392.08	800	41400	0.95	1.11
PipeEH01	6201.95	1000	72000	1.06	1.05
PipeEH02	4314.37	1000	72000	1.06	1.05
PipeEH05	4521.73	900	93999.99	1.71	3.06
PipeEH06	2218.14	900	43600	0.79	0.67
PipeES06	800.81	700	50400	1.52	3.29
PipeEWTP-TR1	12404.49	1200	156092.8	1.6	1.88
PipeEWTP-TR2	12437.4	1200	155907.2	1.6	1.87
PipeEH09	1504.26	900	37400	0.68	0.5
PipeEH11	1671.03	900	0	0	0
PipeEH12	56.24	900	27632.35	0.5	0.27

NetworkTable-Nodesat0:00Hrs		
NodeID	BaseDemand	Pressure
	CMD	m
JuncHartha900End	0	64.66
JuncE900Garma04	0	49.98
JuncE1200RTEnd	349,400	12.75
JuncR47	0	36.81
JuncR54	0	38.42
JuncR56	0	41.16
JuncBlock13-1	20600	44.6
JuncBlock13-3	20600	38.47
JuncS04	47900	31.38
JuncJubailaWTP	0	-0.22
Junc2	0	66.98
Junc3	0	60.19
JuncMaqilWTP	0	-0.05
Junc5	0	60.42
Junc4	0	-0.13
Junc6	0	57.67
Junc7	0	55.9
Junc8	0	55.62
Junc9	0	50.79
Junc10	0	54.49
Junc11	0	-0.42
Junc12	0	63.84
JuncE1200RT05	0	16.7
JuncE1200RT06	0	16.71
ResvrTRes1	#N/A	0
ResvrWTP-RZero	#N/A	0
ResvrWTP-Basrah	#N/A	0
ResvrWTP-New	#N/A	0
ResvrWT-Hartha25	#N/A	0
ResvrGarma1	#N/A	0
ResvrGarma2	#N/A	0
ResvrRes04	#N/A	0
ResvrMaqilRes	#N/A	0
ResvrJubailaRes	#N/A	0
ResvrRibatWTP	#N/A	0
ResvrBradiaWTP	#N/A	0

NetworkTable-Linksat0:00Hrs					
LinkID	Length	Diameter	Flow	Velocity	UnitHeadloss
	m	mm	CMD	m/s	m/km
PipeEH13	421.88	900	9767.65	0.18	0.04
PipeEH14	1789.24	900	37400	0.68	0.5
PipeEWTP-TR3	96.02	1200	173428.3	1.77	2.31
PipeEWTP-TR4	68.05	1200	175971.7	1.8	2.38
PipeER08	1011.73	1000	86842.71	1.28	1.51
PipeER-Garma01	2057.28	900	51116.2	0.93	0.92
PipeER-Garma02	2163.44	900	76359.29	1.39	2.03
PipeR28	714.44	900	95700.38	1.74	3.17
PipeER20	862.75	900	95700.38	1.74	3.17
PipeER19	868.06	900	73100.38	1.33	1.86
PipeER18	1288.96	900	19800.38	0.36	0.14
PipeB10	478.16	800	53300	1.23	1.84
PipeS02	2282.19	700	22600	0.68	0.68
PipeER13	886.98	900	112599.6	2.05	4.38
PipeEB13-1	151.64	700	20600	0.62	0.56
PipeEB13-3	149.58	700	20600	0.62	0.56
PipeS04	2897.55	700	47900	1.44	2.98
Pipe1	89.99	1000	-35581.13	0.52	0.26
PipeER-Gamma03	961.39	900	67506.95	1.23	1.59
PipeER-Gamma04	1839.24	900	82226.91	1.5	2.35
PipeER-Gammna05	1722.69	900	68018.25	1.24	1.61
PipeExist-Jubaila01	1583.81	600	38407.02	1.57	4.29
PipeExist-Jubaila02	733.58	600	55968.95	2.29	9.05
PipeNew-Maqil01	251.5	600	17561.92	0.72	0.91
Pipe4	53.43	600	17561.92	0.72	0.91
Pipe5	50.16	600	38407.02	1.57	4.29
Pipe2	58	450	13124.88	0.96	2.29
PipeExist-Ribat01	773.01	450	13124.88	0.96	2.29
Pipe6	123.76	450	13124.88	0.96	2.29
PipeExist-Ribat-02	813.94	375	13124.88	1.38	5.93
PipeExist-Ribat03	355.18	375	13124.88	1.38	5.93
Pipe10	79.43	600	42582.84	1.74	5.26
PipeExist-Bradia01	1778.32	600	42582.84	1.74	5.26
PipeNew-Bradia	1943.36	600	42582.84	1.74	5.26
PipeEH20	46.05	900	20064.49	0.37	0.15
PipeEWTP-TR11	1591.56	1200	175971.7	1.8	2.38
PipeEWTP-TR5	1615.16	1200	173428.3	1.77	2.31
PumpJubailaPS01	#N/A	#N/A	19203.51	0	-67.2
PumpMaqilPS01	#N/A	#N/A	2926.99	0	-60.47
PumpMaqilPS02	#N/A	#N/A	2926.99	0	-60.47
PumpMaqilPS03	#N/A	#N/A	2926.99	0	-60.47
PumpMaqilPS04	#N/A	#N/A	2926.99	0	-60.47
PumpMaqilPS05	#N/A	#N/A	2926.99	0	-60.47
PumpMaqil022	#N/A	#N/A	3840.7	0	-67.2
PumpMAqil023	#N/A	#N/A	3840.7	0	-67.2
PumpMaqil024	#N/A	#N/A	3840.7	0	-67.2
PumpMaqul021	#N/A	#N/A	3840.7	0	-67.2
Pump MaqilPS06	#N/A	#N/A	2926.99	0	-60.47
Pump jubaila025	#N/A	#N/A	3840.7	0	-67.2
Pump RibatPS01	#N/A	#N/A	13124.88	0	-57.81
Pump BradiaPS01	#N/A	#N/A	8516.57	0	-64.26
Pump BradiaPS02	#N/A	#N/A	8516.57	0	-64.26
Pump BradiaPS03	#N/A	#N/A	8516.57	0	-64.26
Pump BradiaPS04	#N/A	#N/A	8516.57	0	-64.26
Pump BradiaPS05	#N/A	#N/A	8516.57	0	-64.26
Valve 3	#N/A	12	37400	3827.38	31.65

APPENDIX F

ESTIMATION OF FACILITY CAPACITY AND BENEFITS

BY STAGE

APPENDIX F ESTIMATION OF FACILITY CAPACITY AND BENEFITS BY STAGE

The capacity of proposed facilities and its benefits are estimated in following five stages as attached.

Stage 5 : Full RO plant with existing Al Hartha 25 G, Basrah Unified and R-Zero WTPs

Stage 4 : RO plant with all existing WTPs

Stage 4-2 : Half RO capacity of Stage 4 with all existing WTPs

Stage 3 : Transmission facilities, distribution main facilities and new water treatment plant with all existing WTPs

Stage 2 : Transmission facilities and new water treatment plant with all existing WTPs

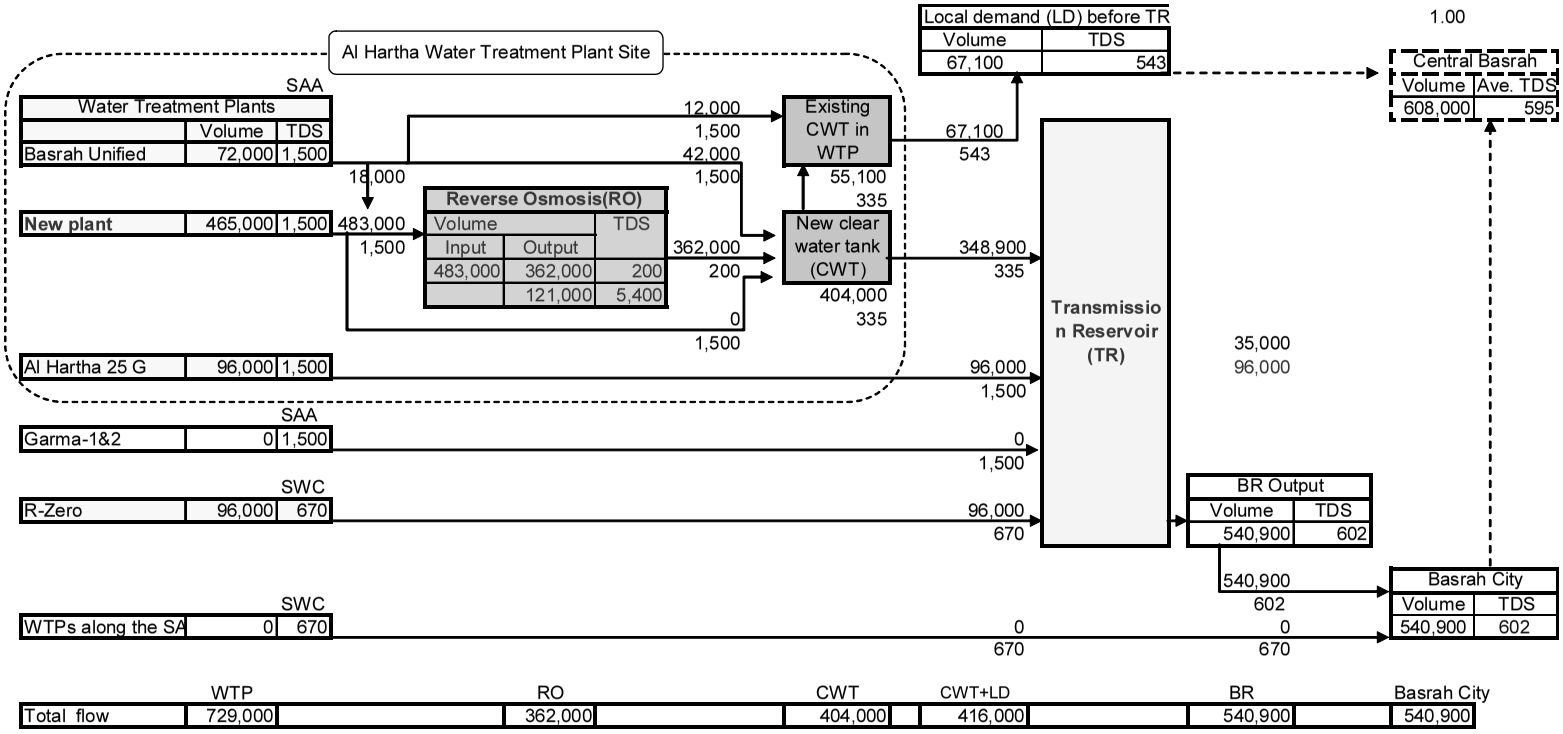
Stage 1 : Transmission facilities and no new water treatment plant with all existing WTPs

The following table presents the summary of facilities and benefits by stage.

		Final Goal					
Works	unit	Stage 5	Stage 4	Stage 3	Stage 2-4	Stage 2	Stage 1
New water treatment plant	m3/day	465,000	280,000	184,000	231,500	184,000	0
RO plant	m3/day	362,000	287,000	0	143,500	0	0
Treated water PS	m3/day	348,900	273,900	188,900	188,900	188,900	0
Transmission reservoir (TR) Blending res.	m3	64,000	48,000	48,000	48,000	48,000	30,000
Transmission PS (TPS)	m3/day	710,000	538,000	538,000	538,000	538,000	328,000
Ring main		Yes	Yes	Yes	Yes	Yes	Yes
Main distribution facilities (13 zones)		Yes	Yes	Yes	No	No	No
Rehabilitation of existing WTP		Yes	Yes	Yes	Yes	Yes	No
Rehabilitation of network		Yes	Yes	Yes	Yes	Yes	Yes
Existing WTP		Not Used	Used	Used	Used	Used	Used

Benefits								
Water quality	Average TDS in Central Basrah	mg/l	595	588	1,289	894	1,289	1,087
	TDS in blending reservoir	mg/l	602	567	1,437	964	1,437	1,172
	Oil, turbidity, color &bacteria	-	OK	Improved	Improved	Improved	Improved	Present
Water quantity	360 l/d(urban), 200 l/d (rural)		100%	100%	100%	100%	100%	70%
Water pressure			OK	OK	OK	OK	Improved	Not enough
Leakage			Improved	Improved	Improved	Improved	Improved	Improved

Stage 5 : Full RO plant with existing Al Hartha 25 G, Basrah Unified and R-Zero WTPs



Summary of facility capacity						
New WTP	465,000	m3/day				
RO plant	362,000	m3/day				
Treated water transmission PS	348,900	m3/day				
Transmission reservoir (TR)	64,000	m3	Local demand	34200	3	1
Transmission pumping station (TPS)	710,000	m3/day	Local demand	34200	1.4	
Existing WTPs	264,000	m3/day				

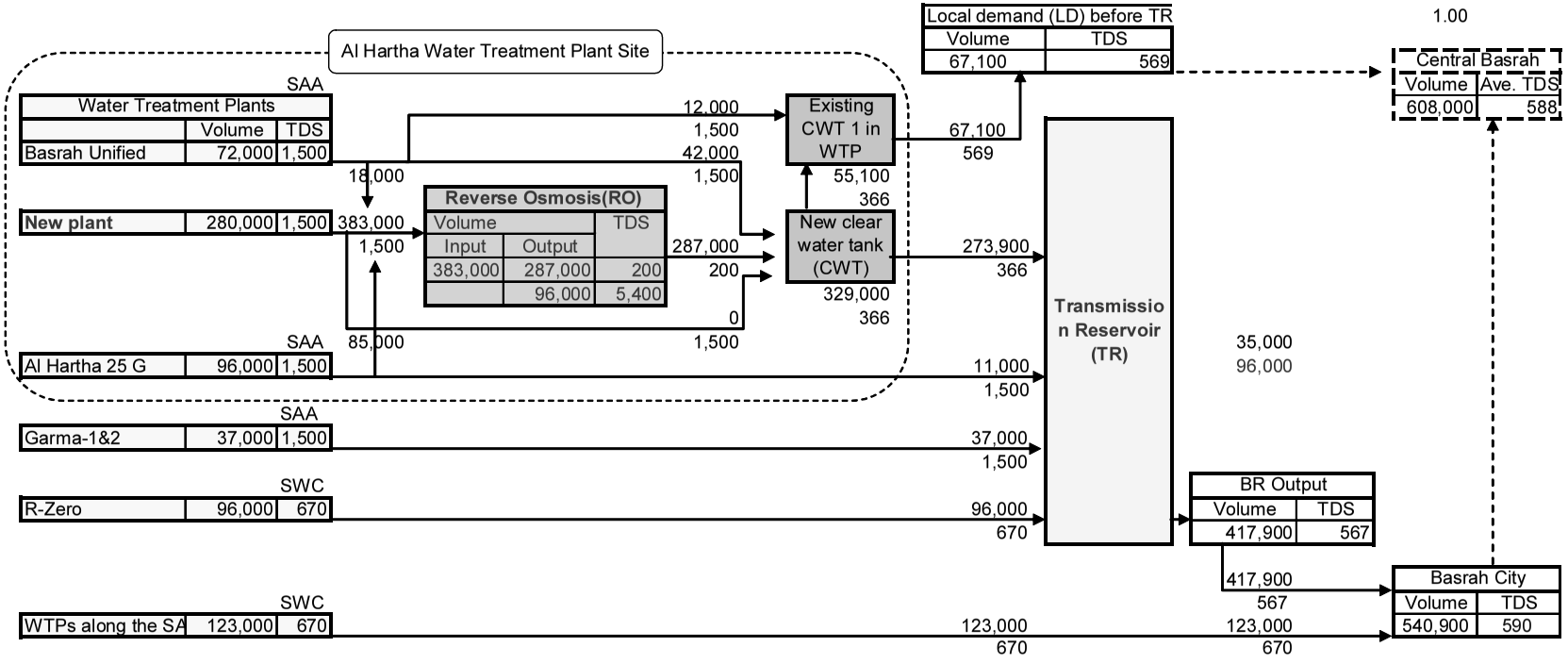
Input	Total ave demand	608,000
	Local demand	67,100
	TDS of SWC	670
	TDS of SAA	1,500
	TDS of RO treated water	200
	RO recovery rate	0.75
	RO plant capacity	362,000
Output	Total supply	608,000
	Ratio of supply to demand	1.00

1500

362,000

Effects			
1 Water quality	Average TDS in Basrah City	595 mg/l	
	TDS in blending reservoir	602 mg/l	
	Oil, turbidity, color & bacteria	no problem	
2 Water quantity	Supply quantity of average water demand	100%	
	Per capita consumption	360 l/ca/d for urban	200 l/ca/day for rural of Al Hartha
3 Water pressure		Improved	

Stage 4 : RO plant with all existing WTPs



	WTP		RO		CWT	CWT+LD		BR		Basrah City
Total flow	704,000		287,000		329,000	341,000		417,900		540,900

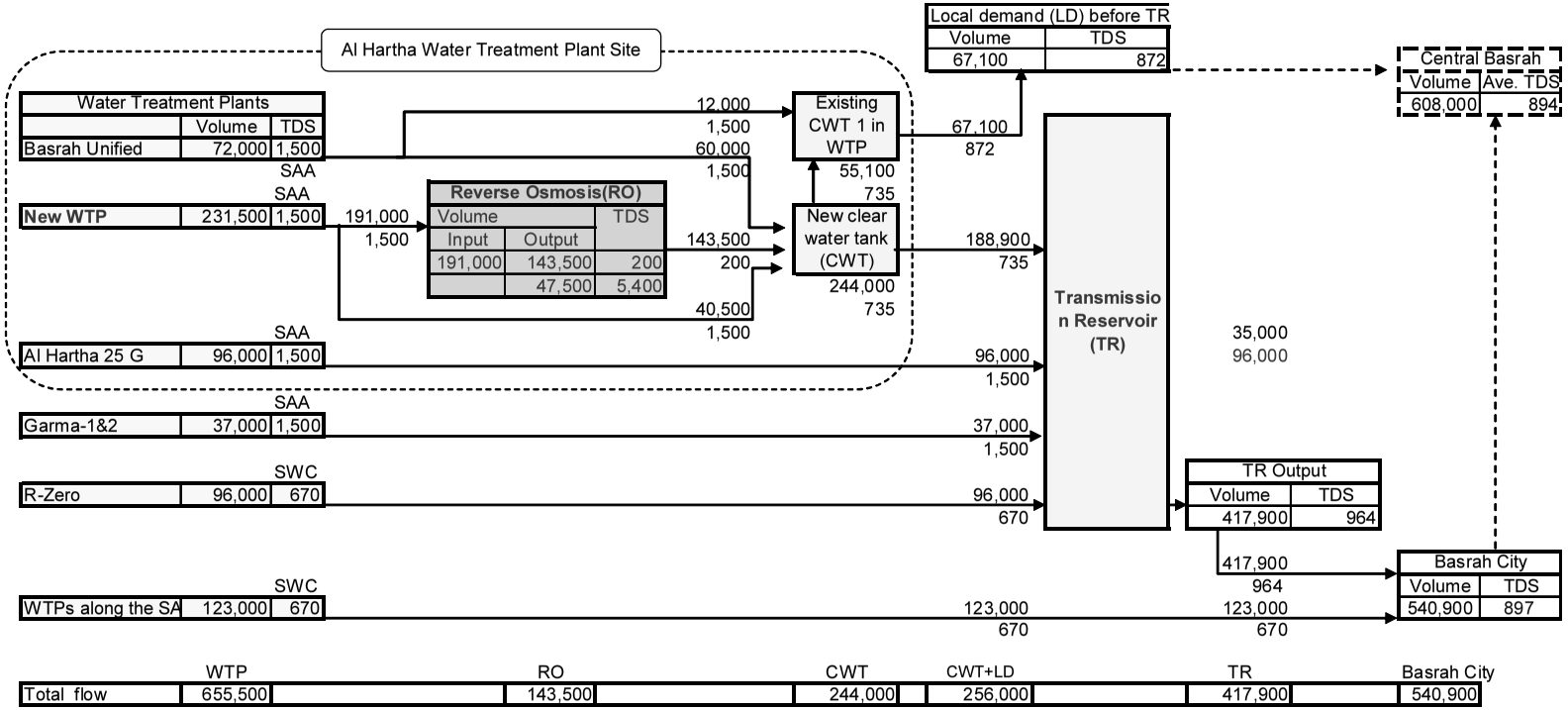
Summary of facility capacity						
New WTP	280,000	m3/day				
RO plant	287,000	m3/day				
Treated water transmission PS	273,900	m3/day				
Transmission reservoir (TR)	48,000	m3	Local demand	34200	3	1
Transmission pumping station (TPS)	538,000	m3/day	Local demand	34200	1.4	
Existing WTPs	424,000	m3/day				

Input	Total ave demand	608,000
	Local demand	67,100
	TDS of SWC	670
	TDS of SAA	1,500
	TDS of RO treated water	200
	RO recovery rate	0.75
	RO plant capacity	287,000
Output	Total supply	608,000
	Ratio of supply to demand	1.00

1500

Effects			
1 Water quality	Average TDS in Basrah City	588 mg/l	
	TDS in blending reservoir	567 mg/l	
	Oil, turbidity, color & bacteria	no problem	
2 Water quantity	Supply quantity of average water demand	100%	
	Per capita consumption	360 l/ca/d for urban	200 l/ca/day for rural of Al Hartha
3 Water pressure		Improved	

Stage 4-2 : Half RO capacity of Stage 4 with all existing WTPs



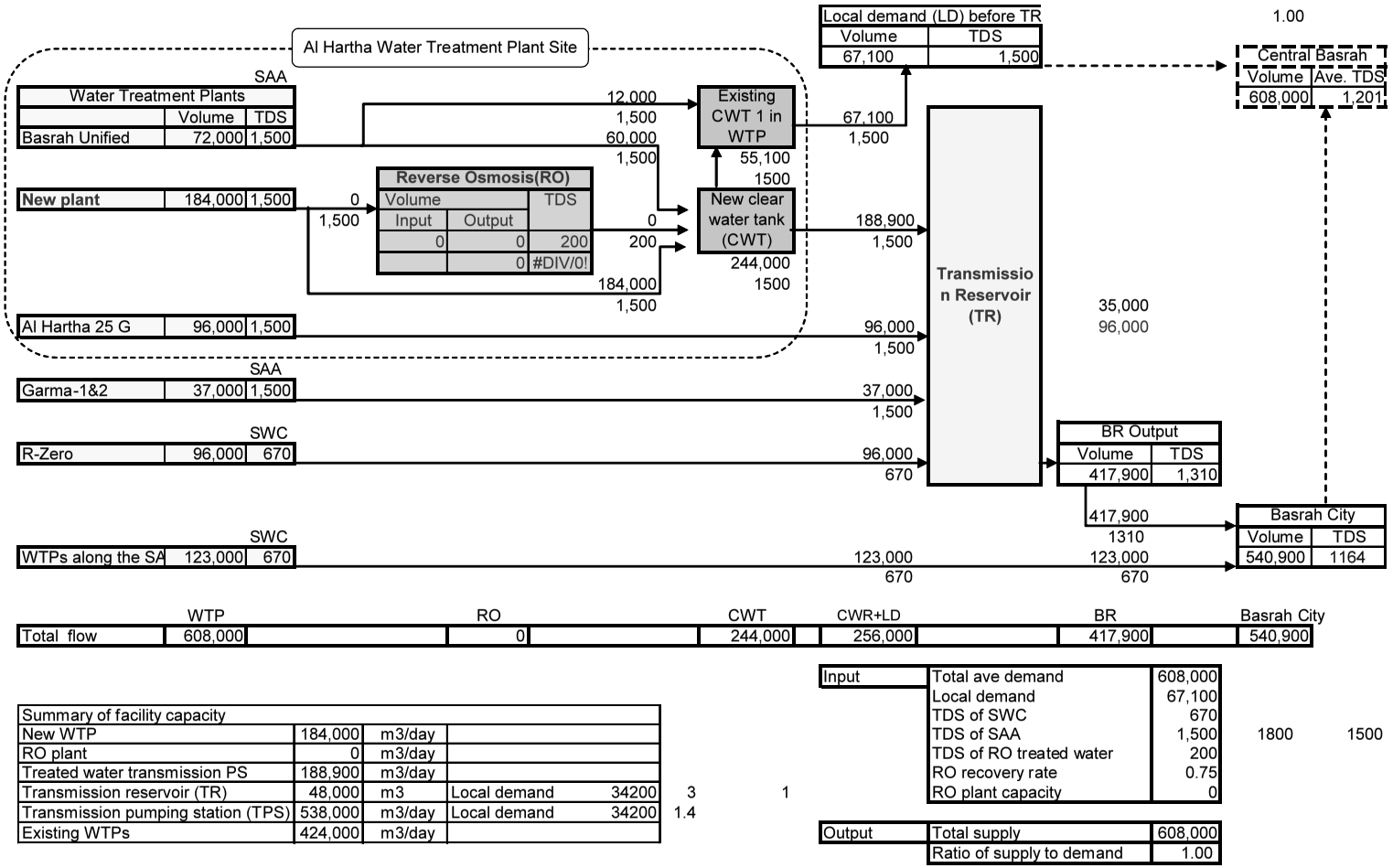
Summary of facility capacity						
New WTP	231,500	m3/day				
RO plant	143,500	m3/day				
Treated water transmission PS	188,900	m3/day				
Transmission reservoir (TR)	48,000	m3	Local demand	34200	3	1
Transmission pumping station (TPS)	538,000	m3/day	Local demand	34200	1.4	
Existing WTPs	424,000	m3/day				

Input parameters			
	Total ave demand	608,000	
	Local demand in Hartha	67,100	
	TDS of SWC	670	
	TDS of SAA	1,500	1500
	TDS of RO treated water	200	
	RO recovery rate	0.75	
	RO plant capacity	143,500	143,500
Output	Total supply	608,000	
	Ratio of supply to demand	1.00	

Effects			
1 Water quality	Average TDS in Basrah City	894 mg/l	
	TDS in Transmission Reservoir	964 mg/l	
	Oil, turbidity, color & bacteria	no problem	
2 Water quantity	Supply quantity of average water demand	100%	
	Per capita consumption	360 l/ca/d for urban	200 l/ca/day for rural of Al Hartha
3 Water pressure		Improved	

Stage 3 : Transmission facilities, distribution main facilities and new water treatment plant with all existing WTPs

Stage 2 : Transmission facilities and new water treatment plant with all existing WTPs



	WTP		RO		CWT	CWR+LD		BR		Basrah City
Total flow	608,000		0		244,000	256,000		417,900		540,900

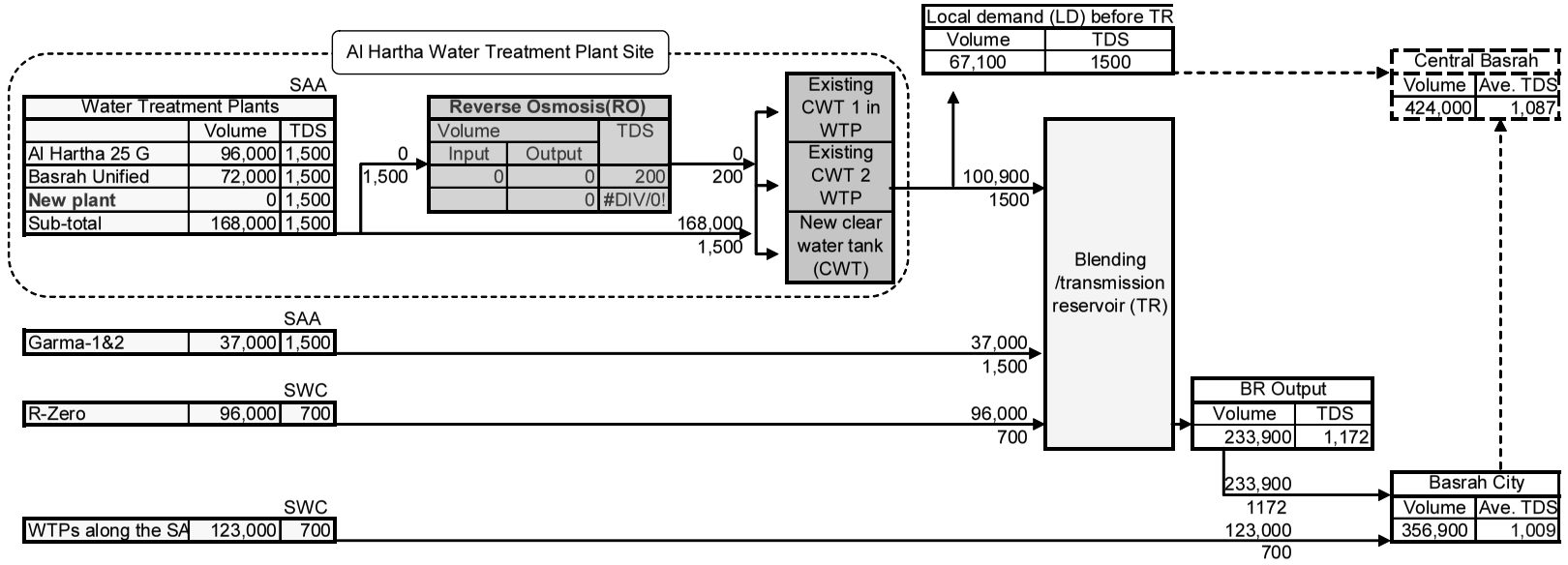
Summary of facility capacity							
New WTP	184,000	m3/day					
RO plant	0	m3/day					
Treated water transmission PS	188,900	m3/day					
Transmission reservoir (TR)	48,000	m3	Local demand	34200	3	1	
Transmission pumping station (TPS)	538,000	m3/day	Local demand	34200	1.4		
Existing WTPs	424,000	m3/day					

Input	Total ave demand	608,000
	Local demand	67,100
	TDS of SWC	670
	TDS of SAA	1,500
	TDS of RO treated water	200
	RO recovery rate	0.75
	RO plant capacity	0
Output	Total supply	608,000
	Ratio of supply to demand	1.00

1800 1500

Effects			
1 Water quality	Average TDS in Basrah City	1201 mg/l	
	TDS in blending reservoir	1310 mg/l	
	Oil, turbidity, color & bacteria	no problem	
2 Water quantity	Supply quantity of average water demand	100%	
	Per capita consumption	360 l/ca/d for urban	200 l/ca/day for rural of Al Hartha
3 Water pressure		Improved	

Stage 1 : Transmission facilities and no new water treatment plant with all existing WTPs



	WTP		RO		CWT	CWR+LD		BR		Basrah City
Total flow	424,000		0		168,000	205,000		233,900		356,900

Input	Total ave demand	608,000
	Local demand	67,100
	TDS of SWC	700
	TDS of SAA	1,500
	TDS of RO treated water	200
	RO recovery rate	0.75
	RO plant capacity	0
Output	Total supply	424,000
	Ration of supply to demand	0.70

1800 1500

Summary of facility capacity			
New WTP	0	m3/day	
RO plant	0	m3/day	
Treated water transmission PS	0	m3/day	
Transmission reservoir (TR)	30,000	m3	
Transmission pumping station (TPS)	328,000	m3/day	
Existing WTPs	424,000	m3/day	

3 1

1.4

Effects			
1 Water quality	Average TDS in Basrah City	1090 mg/l	
	TDS in blending reservoir	1170 mg/l	
	Oil, turbidity, color & bacteria	no problem	
2 Water quantity	Supply quantity of average water demand	70%	
	Per capita consumption	252 l/ca/d for urban	140 l/ca/day for rural of Al Hartha
3 Water pressure		Improved	

APPENDIX G

FACILITY DESIGN OF FOR WSPCB (WTP)

APPENDIX G FACILITY DESIGN FOR WSPCB (WTP)

1. Capacity of WTP

465,000 m3/day= 19,375 m3/hr= 322.9 m3/min= 5.382 m3/sec

2. Receiving Well

1) Detention Time

Detention Time:		1.5	min	(1.5-min)
Required Capacity:	355.6*1.5=	533.4	m3	
Actual Capacity:	6.50*(5.00+1.50)*6.4*2=	540.8	m3	
	533.4 < 541 O.K.			

2) Dimension

W6.50m*L6.70m*D6.40m*2unit

3. Mixing Basin

1) Detention Time

Detention Time:		1.0	min	(1-5min)
Required Capacity:	355.6*1.0=	355.6	m3	
Actual Capacity:	4.00*4.00*4.00*6=	384.0	m3	
	355.6 < 384.0 O.K.			

2) Dimension

W4.00m*L4.00m*D4.00m*6unit

4. Flocculation Basin

1) Mean Flow Rate

Mean Flow Rate:		25	cm/sec	(15-30cm/sec)
Required Section Area:	5.926/(25/100)=	23.70	m2	
Actual Section Area:	1.50*1.50*12=	27.00	m2	
	23.7 < 27.0 O.K.			

2) Detention Time

Detention Time:		30.0	min	(20-40min)
Required Capacity:	355.6*30=	10,668.0	m3	
Actual Capacity:	1.50*18.00*4.00*9*12=	11,664.0	m3	
	10,668.0 < 11,664 O.K.			

3) Dimension

W1.50m*L(18.00m*9)*D4.00m*12unit

5. Chemical Sedimentation Basin

1) Mean Flow Rate

Mean Flow Rate:		0.4	m/min	(~0.4m/min)
Required Section Area:	355.6/0.4=	889.00	m2	
Actual Section Area:	19.00*4.00*12=	912.00	m2	
	889.0 < 912.0 O.K.			

2) Surface Loading Rate

Surface Loading Rate:			25.0	mm/min	(15-30min)
Required Capacity:	355.6/(25/1000)=		14,224.0	m2	
Actual Capacity:	18.00*68*12=		14,688.0	m2	
	14,224.0	< 14,688	O.K.		

3) Dimension

W18.00m*L68.00m*D4.00m*12unit

6. Rapid Sand Filter

1) Filtration Rate

Fintration Rate:		150	m/day	(120-150m/day)
Required Filtration Area:	512000/150=	3,413.3	m2	
Required Filtaration Area of Each Filter:				
	3413.3/((8-1)*6)=	81.3	m2	
Actual Area of Each Filte	(4*2)*11=	88.0	m2	
	81.3 < 88.0	O.K.		

2) Dimension

W(4.00*2)m*L11.00*8set*6unit

7. Receiving & Distribution Well

1) Capacity of Receiving & Dsitribution Well

512000+72000+96000 = 680,000 m2

680,000 m3/day= 28,333 m3/hr= 472.2 m3/min= 7.870 m3/sec

2) Detention Time

Detention Time:		1.5	min	(1.5-min)
Required Capacity:	472.2*1.5=	708.3	m3	
Actual Capacity:	15.00*15.00*4.00 =	900.0	m3	
	708.3 < 900	O.K.		

2) Dimension

W15.00m*L15.00m*D4.00m*1unit

8. Clear Water Reservoir

1) Capacity of Clear Water Reservoir

416,000 m3/day= 17,333 m3/hr

2) Detention Time

Detention Time:		1.0	hr	(~1hr)
Required Capacity:	14125*1=	14,125.0	m3	
Actual Capacity:	20.00*60.00*4.00*3=	14,400.0	m3	
	14,125.0 < 14,400	O.K.		

3) Dimension

W20.00m*L60.00*3unit

APPENDIX H

INSTITUTIONAL CAPACITY BUILDING

APPENDIX H INSTITUTIONAL CAPACITY BUILDING

H.1 Existing Structure of Organizations

(1) Numbers of Staff of BWD

Table H.1 Number of Staff of BWD

Name of Department	Name of Section	Numbers of Staff
Director General		1
1. Technical Dept.	(1) Head Quarter	17
	(2) O&M Section for Basra City	82
	(a) Al Basrah	<38>
	(b) Al Ashar	
	(c) Al Rabat	<11>
	(d) Al Maqel	<13>
	(e) Al Qiblah	<7>
	(f) Al Khalij	<13>
	(3) O&M Section for Outside Basra City	577
	(a) Shat Al Arab	<80>
	(b) Abu Al Khasib	<72>
	(c) Khor Al Zubeir	<40>
	(d) Al Faw	<16>
	(e) Al Nashwa	<94>
	(f) Al Zubeir	<24>
	(g) Al Quma +Al Kaim	<70>
	(h) Al Madina+ Al Hewar + Al Sadik	<69>
	(i) Al Deir	<112>
	(4) Projects Section	362
	(a) Basrah Unified Project	<74>
	(b) Hartha 25M Project	<62>
	(c) R Zero Station	<78>
	(d) Bradhya Project	<26>
	(e) Jubeilah Project	<54>
	(f) Garma Project	<50>
	(g) Ribat Project	<18>
2. Financial Dept.	(include auditing dept and billing and collection dept)	238
3. Vehicle Dept.		58
4. Administration Dept.		56
5. Computers and IT Dept.		5
6. Laboratories Dept.		14
7. Legal Dept.		5
8. Warehouses Dept.		8
Total		**1,423**

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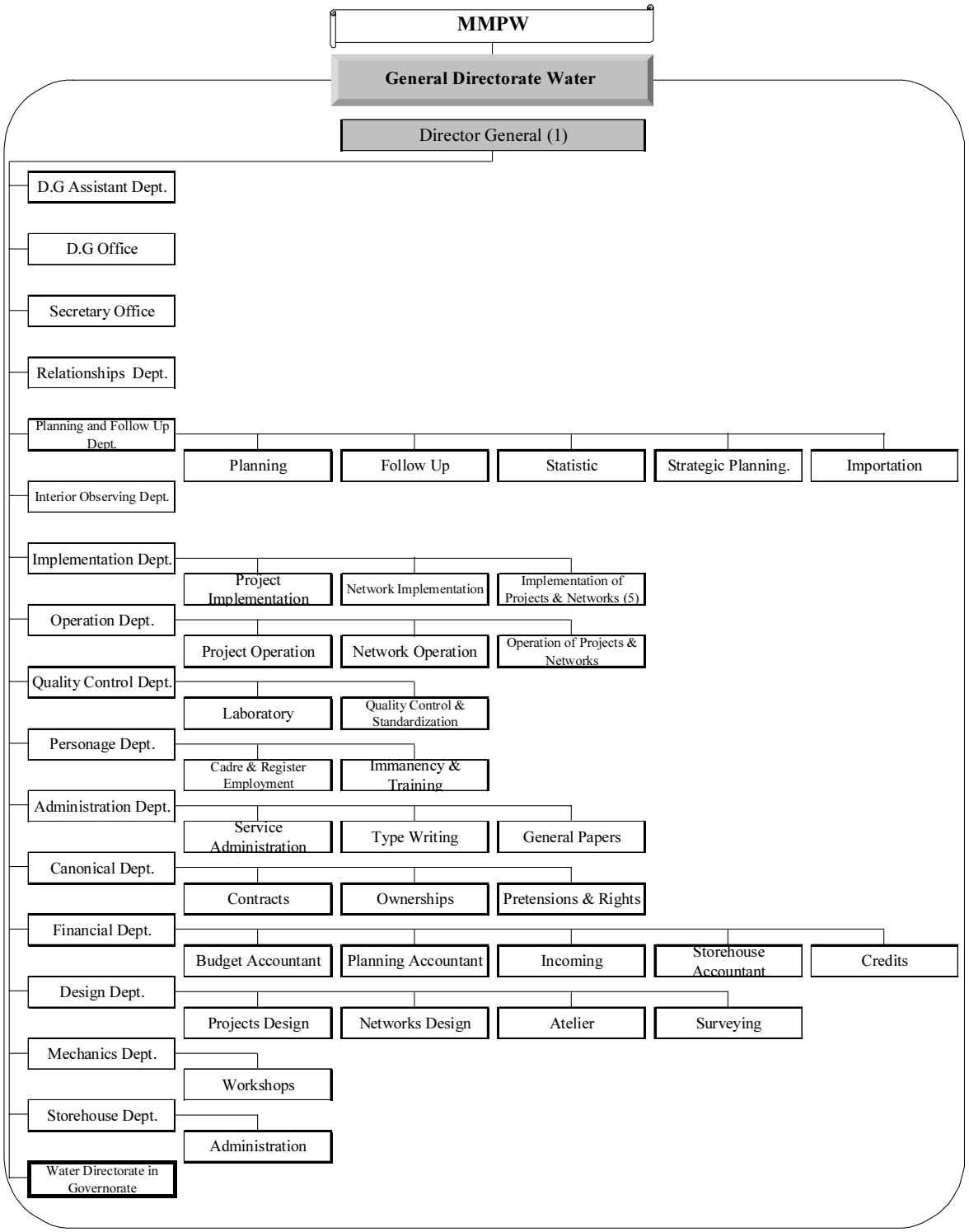
Source: BWD

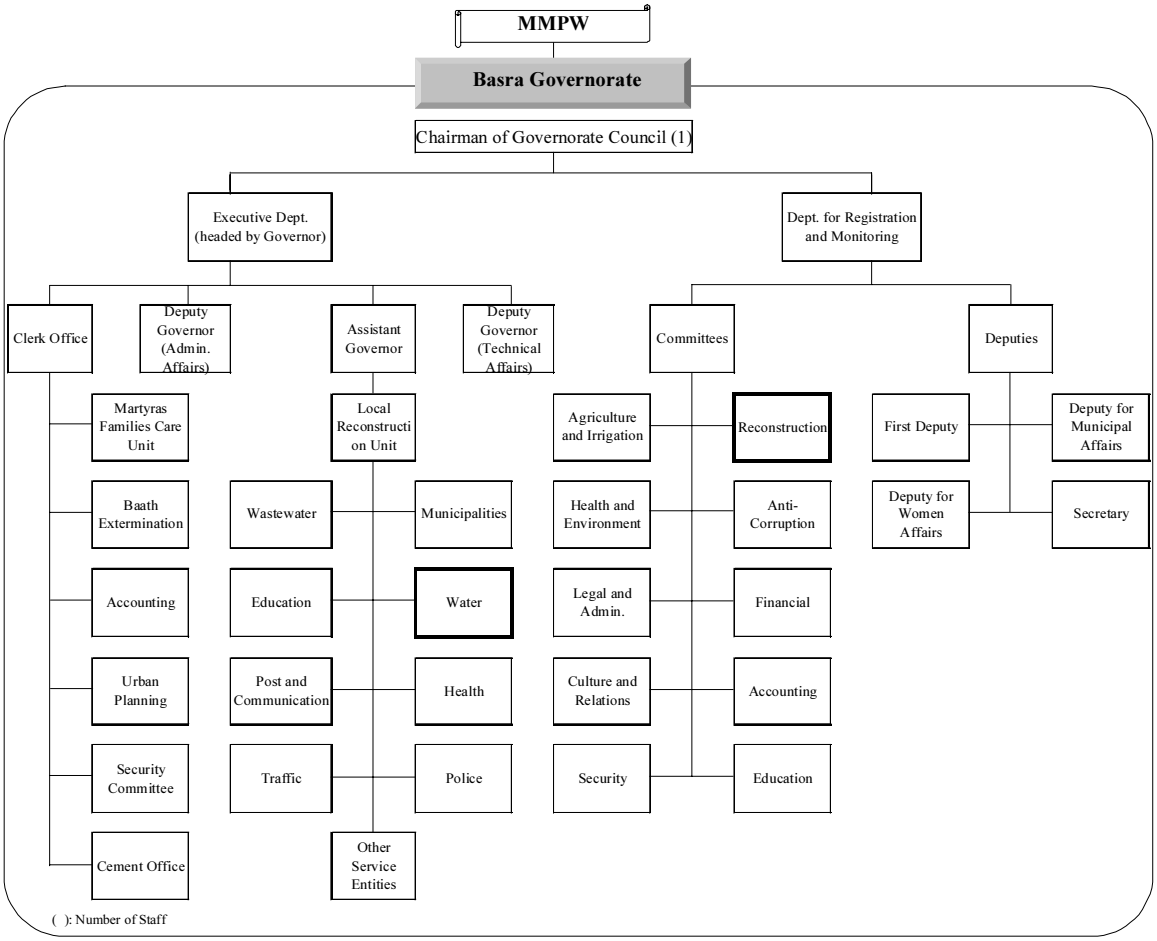
(2) Current Organization of GDW of MMPW



Source: MMPW

Figure H.1 Current Organization of GDW of MMPW

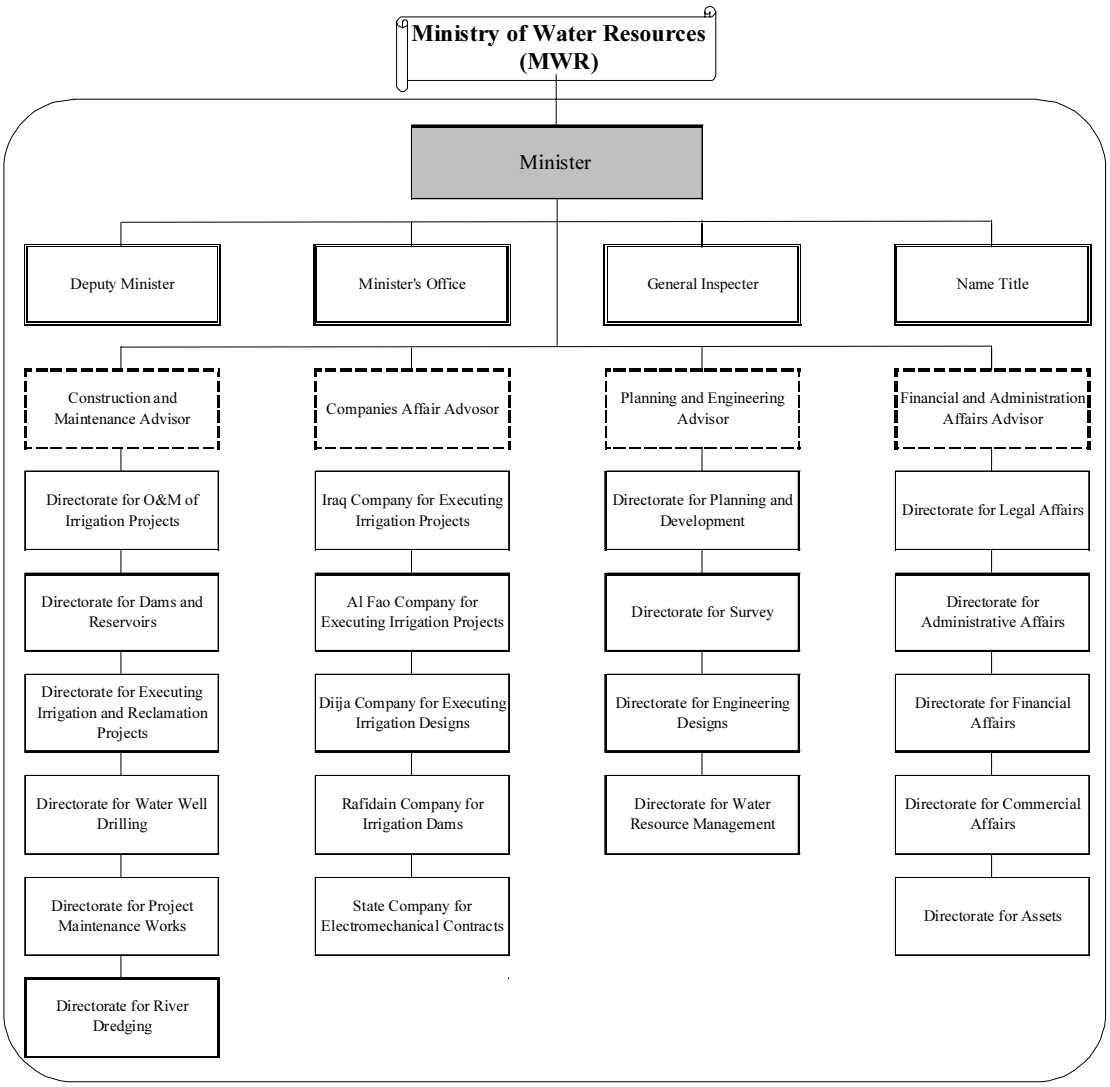
(3) Existing Organization of Basra Governorate (BG)



Source: BG

Figure H.2 Existing Organization of Basra Governorate (BG)

(4) Existing Organization of Ministry of Water Resources (MWR)



Source: MWR

Figure H.3 Existing Organization of Ministry of Water Resources (MWR)

H.2 Results of Project Cycle Management Workshop

(1) Organization and Institution Aspect

The problem trees and the objective trees with the alternative analysis on organization and institution aspect are shown as below.

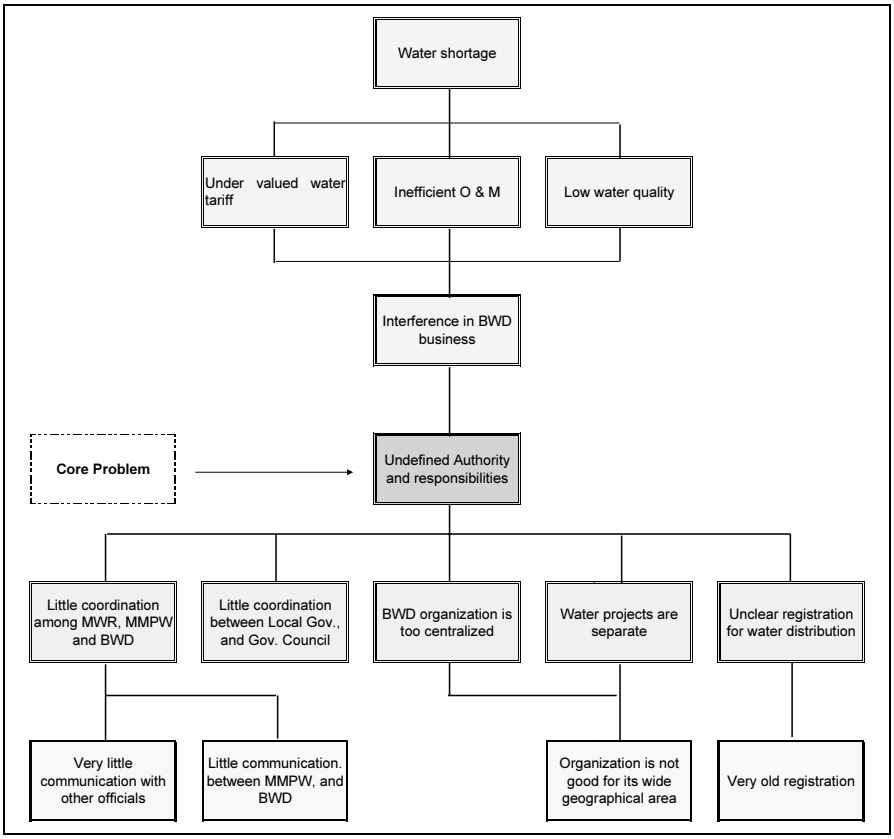


Figure H.4 Problem Trees on Organization and Institution Aspect

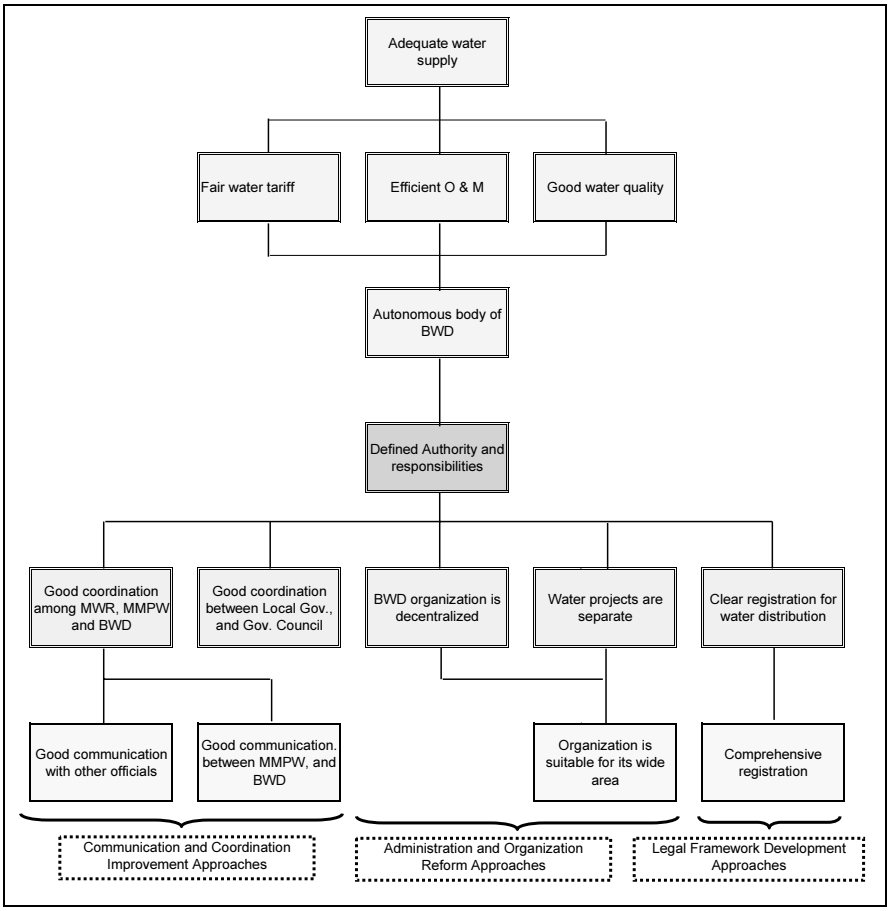


Figure H.5 Objective Trees with Alternative Analysis on Organization and Institution Aspect

(2) Facility Management and Technical Aspect

The problem trees and the objective trees with the alternative analysis on facility management and technical aspect are shown as below.

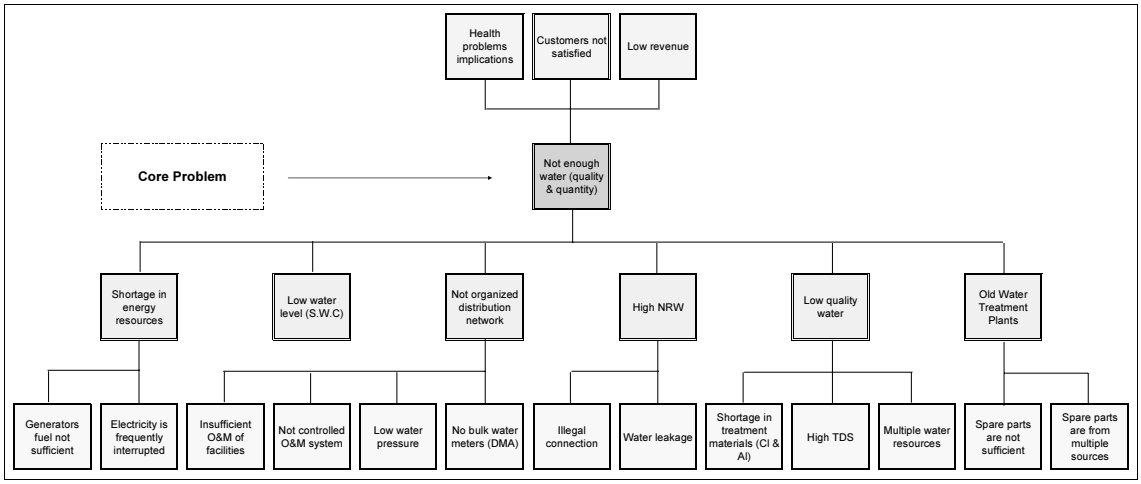


Figure H.6 Problem Trees on Facility Management and Technical Aspect

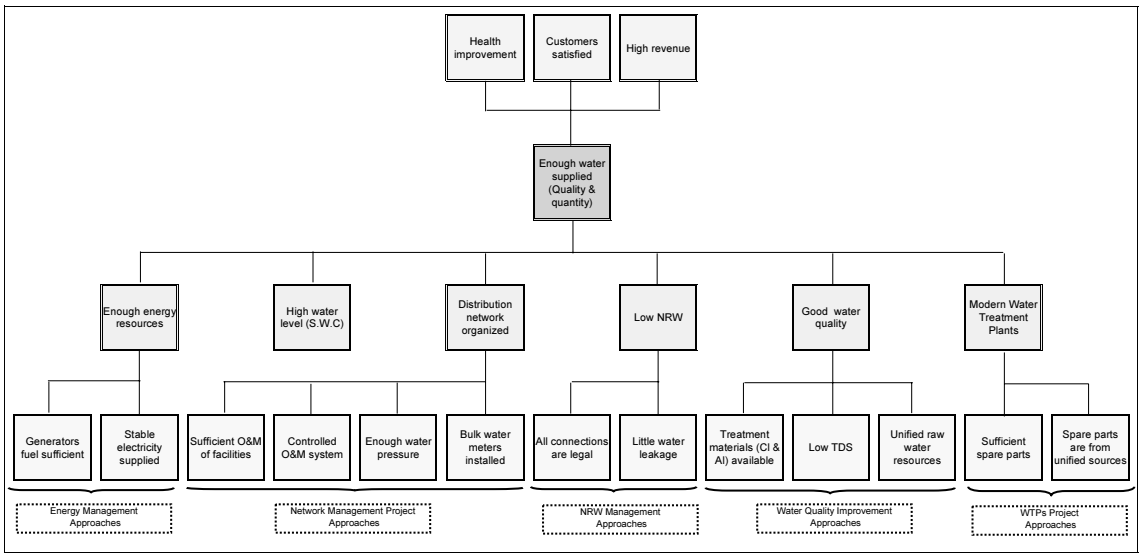


Figure H.7 Objective Trees with Alternative Analysis on Facility Management and Technical Aspect

(3) Human Resources Development (HRD) Aspect

The problem trees and the objective trees with the alternative analysis on human resources development (HRD) aspect are shown as below.

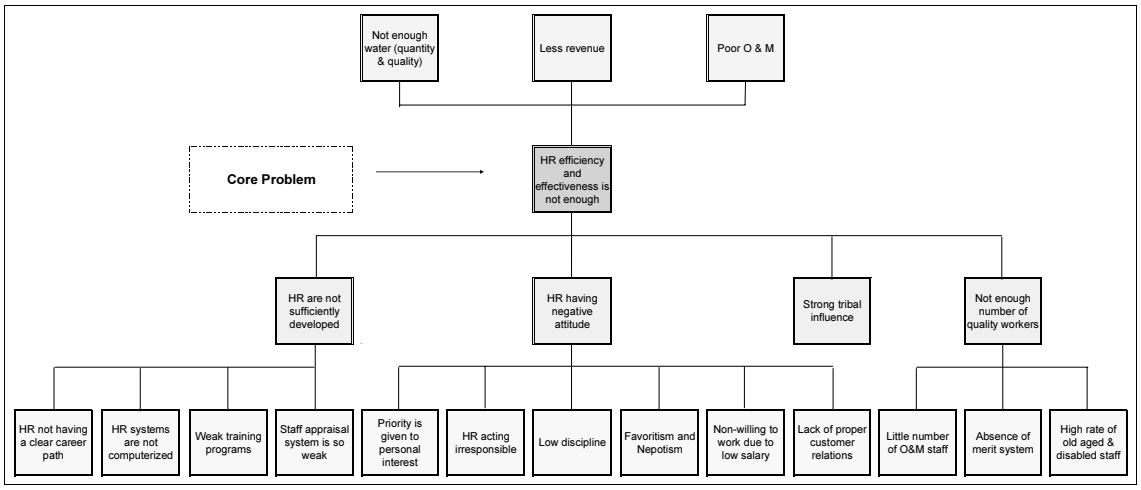


Figure H.8 Problem Trees on Human Resources Development (HRD) Aspect

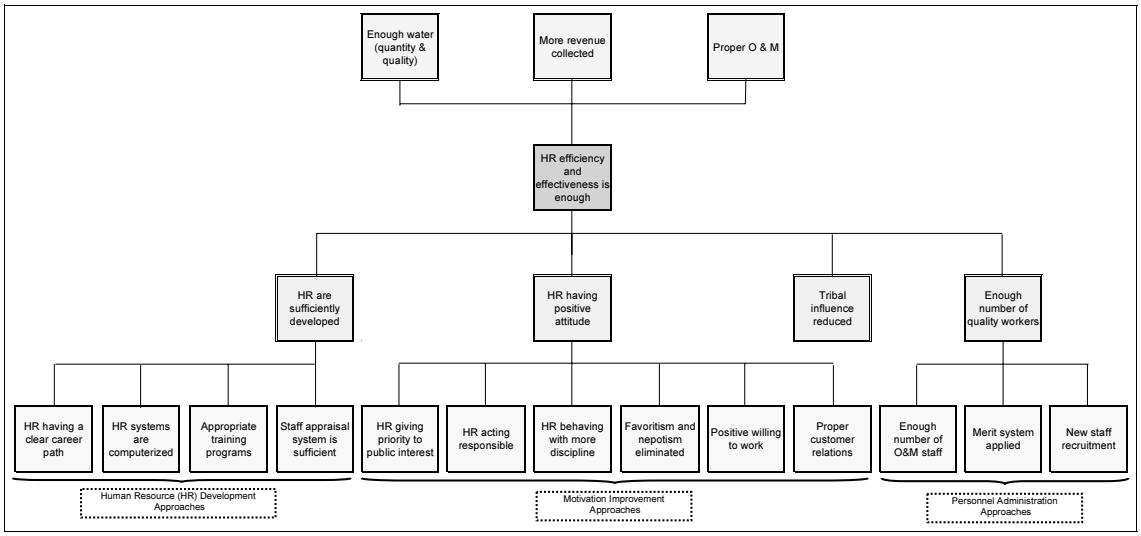


Figure H.9 Objective Trees with Alternative Analysis on Human Resources Development (HRD) Aspect

(4) Financial Management Aspect

The problem trees and the objective trees with the alternative analysis on financial management aspect are shown as below.

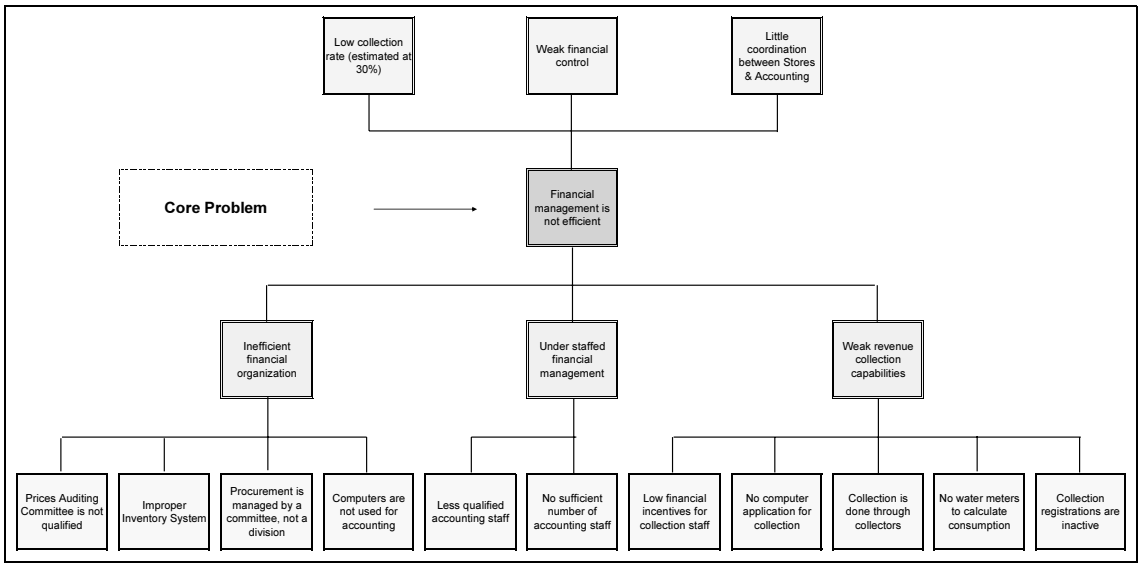


Figure H.10 Problem Trees on Financial Management Aspect

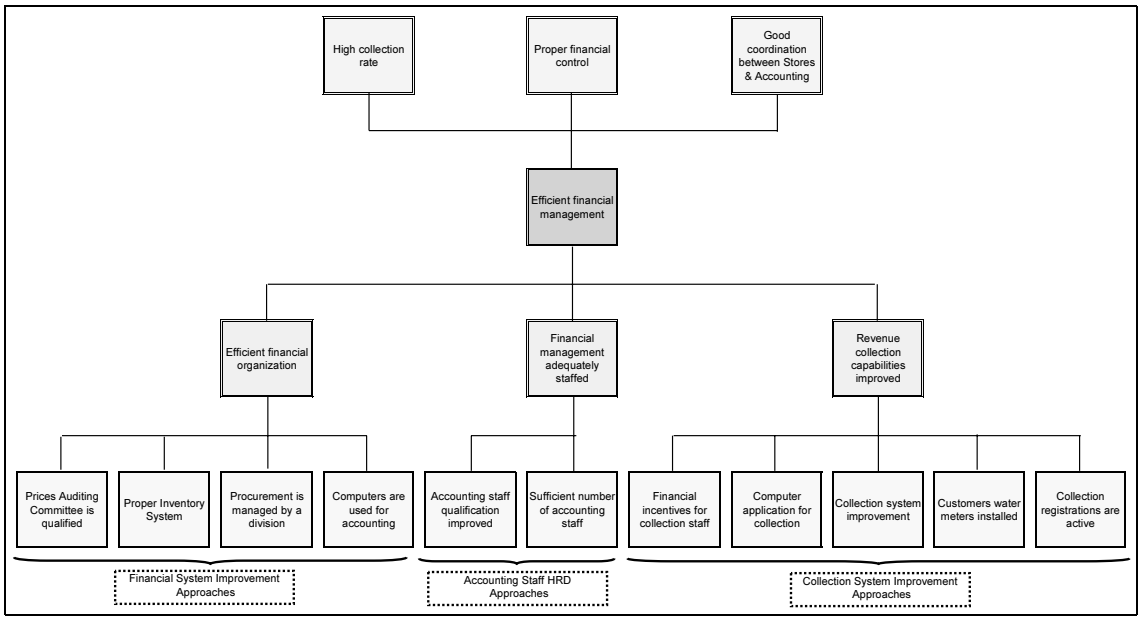


Figure H.11 Objective Trees with Alternative Analysis on Financial Management Aspect

H.3 Example of Staff Appraisal Criteria

Introduction of the staff appraisal system is one of the essentials for BWD. The method of the staff appraisal system is described as below.

The staff appraisal systems should be based on following basic principles:

- Managers should clearly understand the performance of the staff and inform the staff if the output or skill does not meet the requirements
- Managers shall provide OJT and give advice to make sure the staff performance is appropriate
- Managers shall analyze the potential of the staff and promote further skill development.
- Managers shall evaluate job performance and willingness to work, which will lead to fair decision-making regarding promotion and salary.

The staff appraisals can be made based on evaluation criteria. The following table shows the standard five rankings and points of evaluation. Once the scale of evaluation criteria is set, subjective evaluation will be minimized.

Table H.2 Criteria for Evaluation (Example)

Rank	Points for Evaluation	
S	Excellent (Total score: more than 90)	1. Completing all target items and contributing to improving BWD performance. 2. Good model to the staff. 3. Not a single failure.
A	Good (Total score: 80-89)	1. Performing above average and showing good output. 2. Other staff should follow the way this one performs the task. 3. Few mistakes.
B	Moderate (Total score: 50-79)	1. Simply performing the task he is responsible for and meeting the task requirements. 2. Considered average.
C	Poor (Total score: 30-49)	1. Can perform the task with some minor mistakes (careless mistakes) and with some assistance. 2. Unstable job performance. 3. Without support, the task may not be completed
D	Very poor (Total score: less than 30)	1. Can not perform the tasks. 2. Output cannot meet the expected target. 3. Cannot be trusted. 4. Always requires assistance. 5. No improvement

Note: For scoring, refer to Table H.3.

The weight of criteria for evaluation should be different depending on the position of the staff. Evaluation of senior staff and management staff should have more weight on leadership. Besides, evaluation of junior staff focuses more on discipline and understanding. The following table shows

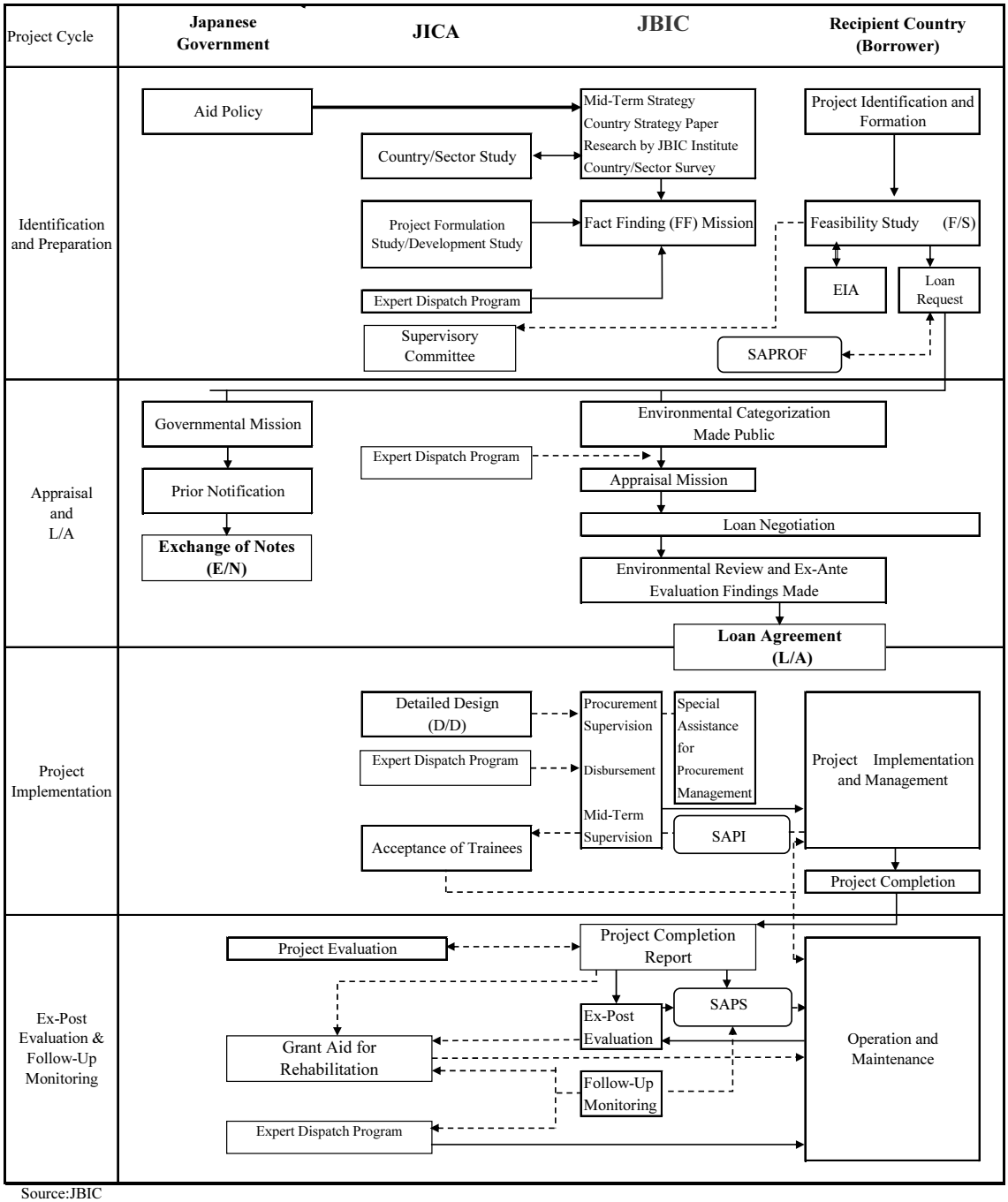
an example of weight of evaluation for evaluation indicators. In the table, the score for each item of evaluation indicator shows the maximum value.

Table H.3 Weight of Evaluation for Scoring (Example)

		Management	Technical Staff (Senior)	Technical Staff (Junior)	Technical Staff (Freshman)	Administrative Staff (Senior)	Administrative Staff (Junior)	Administrative Staff (Freshman)
Operational Skills	Knowledge, Skill	5	10	15	10	15	10	5
	Understanding	10	5	10	15	5	10	15
	Planning, Development	10	10	5	-	10	5	-
	Leadership	20	15	5	-	15	5	-
	Negotiation	10	10	10	5	10	10	5
Attitude	Responsibility	20	20	15	10	15	15	10
	Initiative	10	15	10	10	15	10	5
	Cooperation	5	5	5	10	5	10	20
	Morale	5	5	15	20	5	15	20
	Diligence	5	5	10	20	5	10	20
Total		100	100	100	100	100	100	100

H.4 JBIC Loan Procedures

(1) JICB Loan Procedure



Source:JBIC

Figure H.12 JBIC Loan Procedures

(2) Procedures for Employment of Consultant

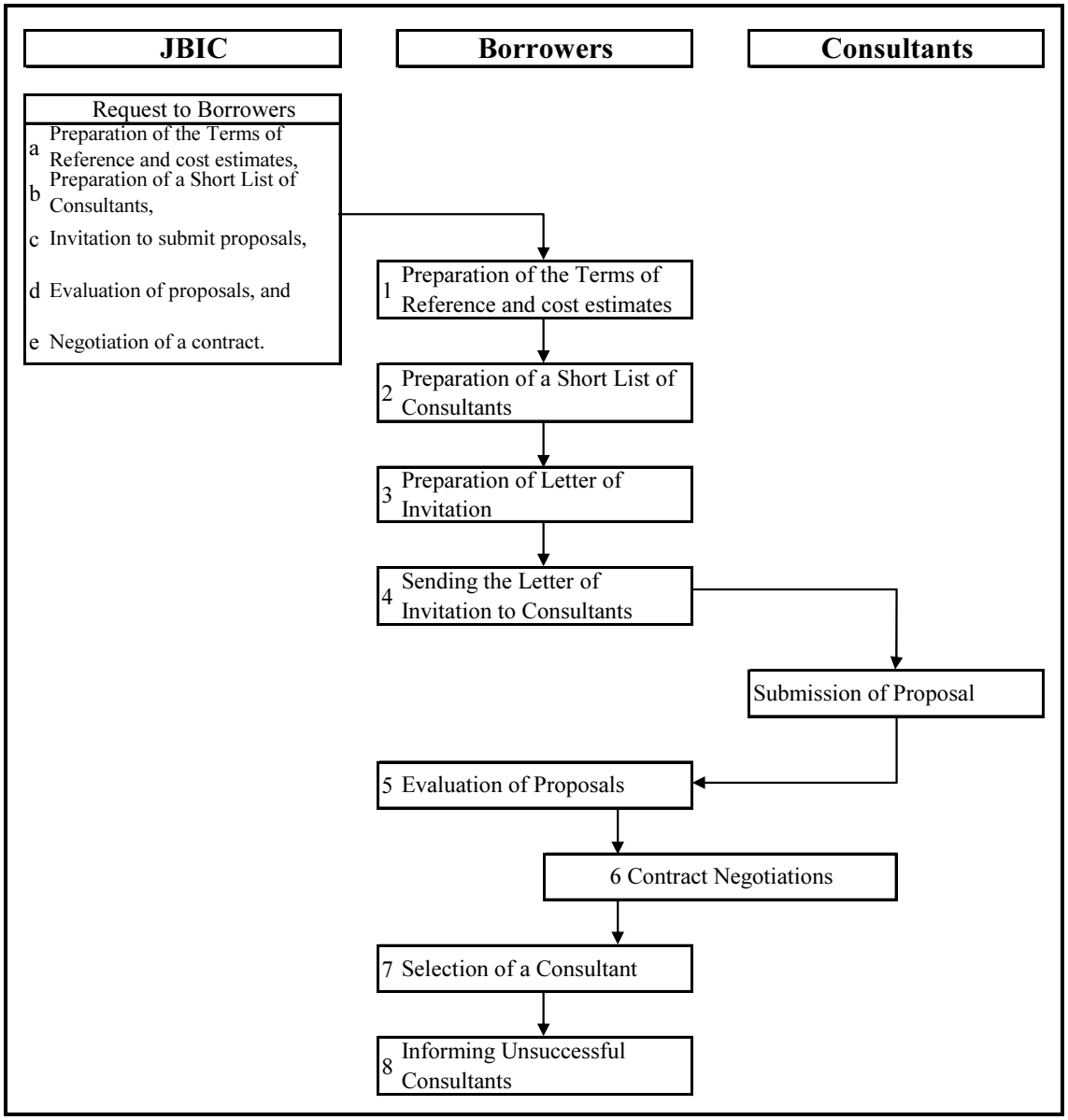


Figure H.13 Procedures for Employment of Consultant

(3) Procedures for Procurement of Contractor

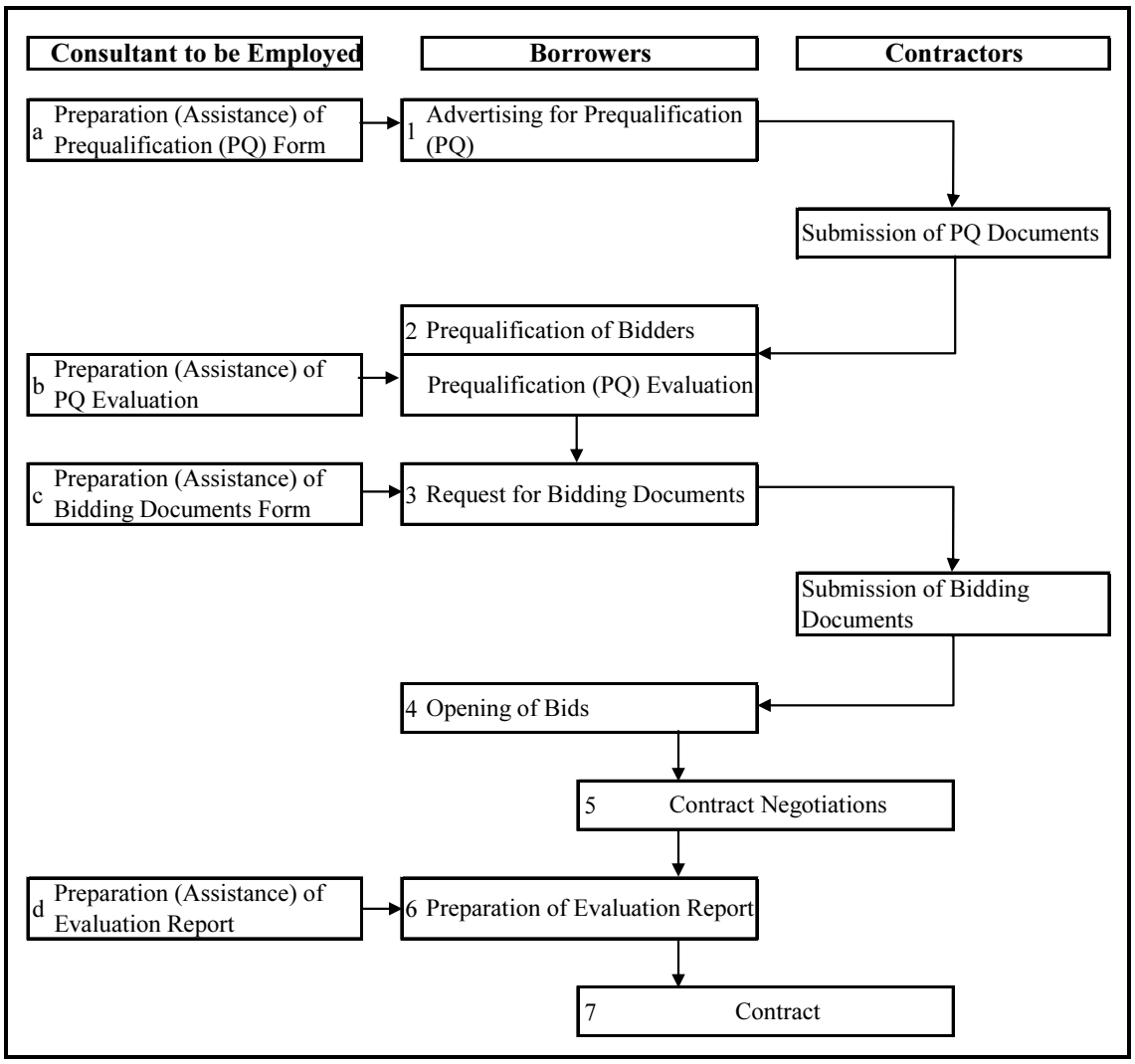


Figure H.14 Procedures for Procurement of Contractor

APPENDIX I

COST ESTIMATION FOR WSPCB

APPENDIX I COST ESTIMATION FOR WSPCB

I.1 Estimated Unit Direct Construction Cost

	Unit	Unit Cost (L/C)	Unit Cost (F/C)	Unit Cost (Total)
1. Pipeline				
Diameter 110mm	US$/m	26 US$	16 US$	42 US$
Diameter 125mm	US$/m	27 US$	20 US$	47 US$
Diameter 140mm	US$/m	28 US$	25 US$	53 US$
Diameter 160mm	US$/m	30 US$	32 US$	62 US$
Diameter 180mm	US$/m	31 US$	41 US$	72 US$
Diameter 200mm	US$/m	35 US$	50 US$	85 US$
Diameter 225mm	US$/m	36 US$	64 US$	99 US$
Diameter 250mm	US$/m	37 US$	78 US$	115 US$
Diameter 280mm	US$/m	38 US$	98 US$	137 US$
Diameter 315mm	US$/m	41 US$	124 US$	165 US$
Diameter 355mm	US$/m	44 US$	157 US$	201 US$
Diameter 400mm	US$/m	156 US$	186 US$	343 US$
Diameter 450mm	US$/m	159 US$	225 US$	384 US$
Diameter 500mm	US$/m	163 US$	267 US$	430 US$
Diameter 600mm	US$/m	169 US$	368 US$	537 US$
Diameter 700mm	US$/m	176 US$	483 US$	659 US$
Diameter 800mm	US$/m	208 US$	618 US$	825 US$
Diameter 900mm	US$/m	215 US$	760 US$	975 US$
Diameter 1000mm	US$/m	226 US$	932 US$	1,158 US$
Diameter 1100mm	US$/m	235 US$	1,112 US$	1,347 US$
Diameter 1200mm	US$/m	245 US$	1,302 US$	1,547 US$
Diameter 1400mm	US$/m	278 US$	1,747 US$	2,040 US$
Diameter 1500mm	US$/m	293 US$	1,991 US$	2,284 US$
Diameter 1600mm	US$/m	317 US$	2,464 US$	2,781 US$
Diameter 1800mm	US$/m	363 US$	3,027 US$	3,390 US$
Diameter 2000mm	US$/m	375 US$	3,870 US$	4,245 US$
2. Water Treatment Plant	US$/$m^3$/day		refer to Figure 1	
3. Distribution Pump Station	US$/$m^3$/day		refer to Figure 2	
4. Grand Reservoir	US$/$m^3$		refer to Figure 3	
5. Elevated Tank	US$/$m^3$		refer to Figure 4	
6. RO Plant	US$/$m^3$/day	40 US$	570 US$	610 US$

Figure 1. Direct Constrution Cost of Water Treatment Plant

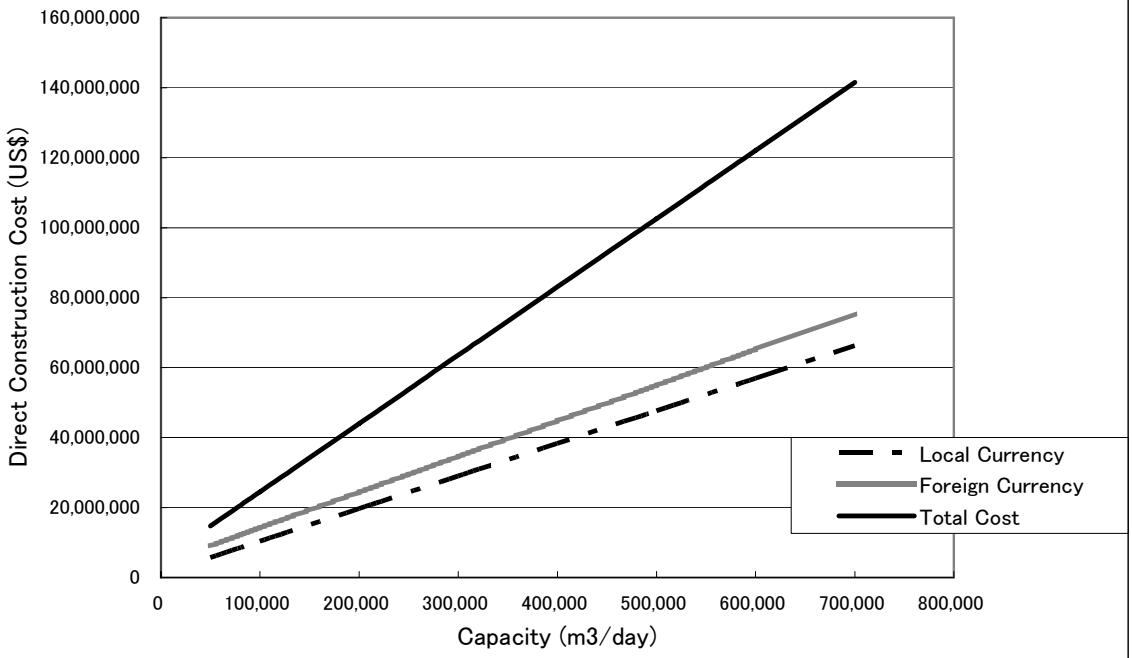


Figure 2. Direct Construction Cost of Distribution Pump Station

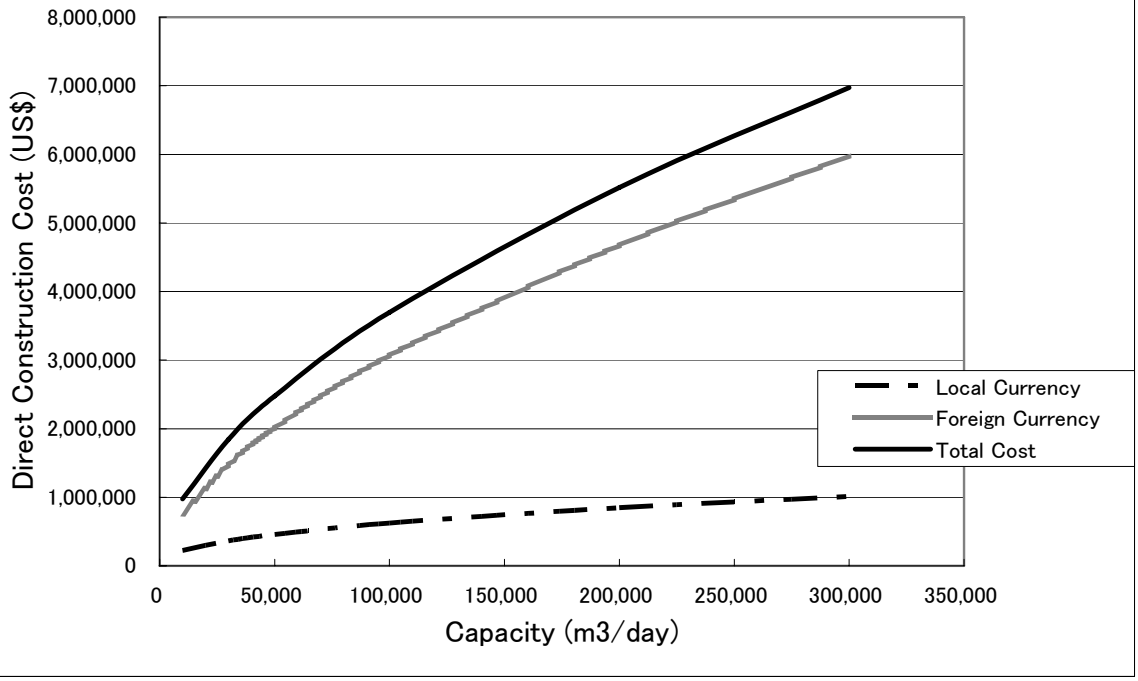


Figure 3. Direct Constrution Cost of Ground Reservoir

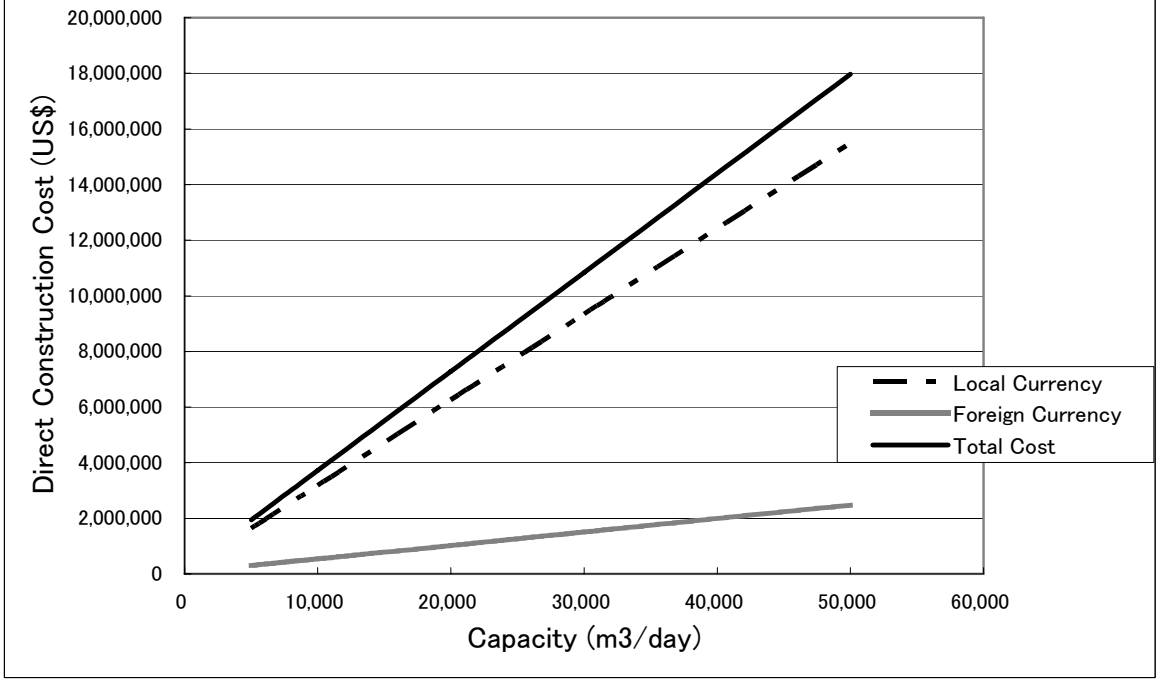
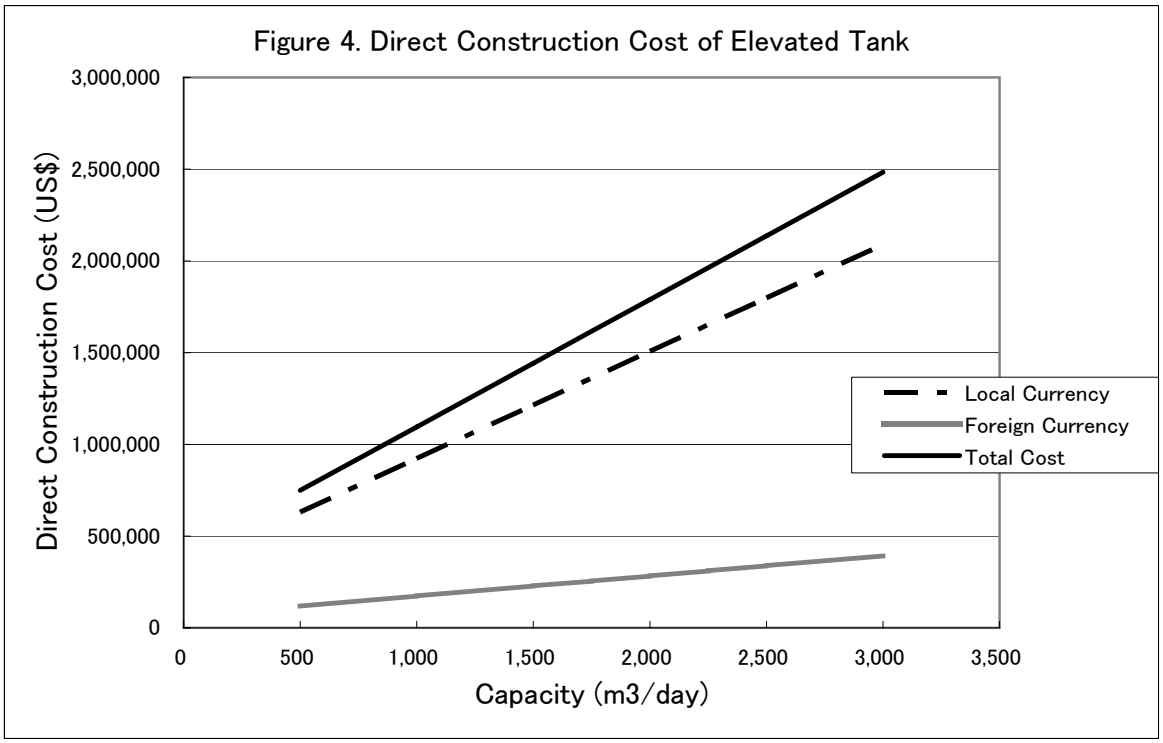


Figure 4. Direct Construction Cost of Elevated Tank



I.2 Cost Estimation for WSPCB (Stage 5)

Item Description		Unit	Quantity	Unit Rate (US$)		Amount (US$)		Total Amount (US$)
				L.C	F.C	L.C	F.C	
1	**Direct Construction Cost**							
-1	Rehabilitation of Distribution Network							
	DCIP dia.700mm	m	7,000	176	483	1,232,000	3,381,000	4,613,000
	DCIP dia.500mm	m	6,500	163	267	1,059,500	1,735,500	2,795,000
	DCIP dia.400mm	m	1,000	156	186	156,000	186,000	342,000
	HDPE dia.225mm	m	18,500	36	64	666,000	1,184,000	1,850,000
	HDPE dia.160mm	m	54,000	30	32	1,620,000	1,728,000	3,348,000
	HDPE dia.110mm	m	198,500	26	15	5,161,000	2,977,500	8,138,500
	Sub Total of -1					**9,894,500**	**11,192,000**	**21,086,500**
-2	Rehabilitation of WTP							
1)	R-Zero 25 compact units							
	Sub Total of 1)					175,000	1,003,000	1,178,000
2)	R-Zero Raw Water Pumps							
	Sub Total of 2)					250,000	298,000	548,000
3)	Al Hartha 25 C.U.							
	Sub Total of 3)					175,000	881,500	1,056,500
4)	Basra Unified							
	Sub Total of 4)					90,000	1,188,500	1,278,500
5)	Garma1							
	Sub Total of 5)					35,000	329,000	364,000
6)	Garma 2							
	Sub Total of 6)					25,000	206,000	231,000
7)	Ribat							
	Sub Total of 7)					35,000	159,000	194,000
8)	Al Maqil 1							
	Sub Total of 8)					0	96,000	96,000
9)	Jubaila 1							
	Sub Total of 9)					40,000	591,500	631,500
10)	Jubaila 2							
	Sub Total of 10)					25,000	186,000	211,000
11)	Bradiah 1							
	Sub Total of 11)					60,000	647,000	707,000
12)	Bradiah 2							
	Sub Total of 12)					60,000	707,000	767,000
13)	Bradiah C.U.							
	Sub Total of 13)					25,000	66,000	91,000
	Sub Total of -2					**995,000**	**6,358,500**	**7,353,500**
-3	Construction of Transmission System							
1)	Ring Transmission Mains and Branch							
	DCIP dia.2000mm	m	1,900	375	3,870	712,500	7,353,000	8,065,500
	DCIP dia.1800mm	m	2,000	363	3,027	726,000	6,054,000	6,780,000
	DCIP dia.1600mm	m	0	317	2,464	0	0	0
	DCIP dia.1500mm	m	0	293	1,991	0	0	0
	DCIP dia.1400mm	m	1,200	278	1,747	333,600	2,096,400	2,430,000
	DCIP dia.1200mm	m	2,500	245	1,302	612,500	3,255,000	3,867,500
	DCIP dia.1100mm	m	3,600	235	1,112	846,000	4,003,200	4,849,200
	DCIP dia.1000mm	m	5,500	226	932	1,243,000	5,126,000	6,369,000
	DCIP dia.900mm	m	4,200	215	760	903,000	3,192,000	4,095,000
	DCIP dia.800mm	m	3,000	208	618	624,000	1,854,000	2,478,000
	DCIP dia.700mm	m	6,800	176	483	1,196,800	3,284,400	4,481,200
	DCIP dia.600mm	m	2,300	169	368	388,700	846,400	1,235,100
	Sub Total of 1)					7,586,100	37,064,400	44,650,500
2)	Transmission Reservoir							
	Transmission Reservoir	m3	64,000	-	-	19,806,000	3,144,000	22,950,000
	Sub Total of 2)					19,806,000	3,144,000	22,950,000
3)	Transmission Pump Station							
	Transmission Pump Station	m3/day	710,000	-	-	1,589,000	9,411,000	11,000,000
	Sub Total of 3)					1,589,000	9,411,000	11,000,000
	Sub Total of -3					**28,981,100**	**49,619,400**	**78,600,500**
-4	Construction of Water Treatment Plant							
1)	Water Treatment Plant							

Item Description	Unit	Quantity	Unit Rate (US$)		Amount (US$)		Total Amount (US$)
			L.C	F.C	L.C	F.C	
Water Treatment Plant	m3/day	465,000	-	-	44,312,000	51,411,000	95,723,000
Sub Total of 1)					44,312,000	51,411,000	95,723,000
2) Transmission Pump Station							
Transmission Pump Station	m3/day	348,900	-	-	1,084,000	5,364,000	6,448,000
Sub Total of 2)					1,084,000	5,364,000	6,448,000
3) Pipeline to Transmission Reservoir							
DCIP dia.1600mm	m	0	317	2,464	0	0	0
DCIP dia.1200mm	m	0	245	1,302	0	0	0
Sub Total of 3)					0	0	0
Sub Total of -4					**45,396,000**	**56,775,000**	**102,171,000**
-5 Construction of Distribution System							
1) Distribution Pipe							
1 DCIP dia.700mm	m	3,500.0	176	483	616,000	1,690,500	2,306,500
2 DCIP dia.600mm	m	2,000.0	169	368	338,000	736,000	1,074,000
3 DCIP dia.500mm	m	6,300.0	163	267	1,026,900	1,682,100	2,709,000
4 DCIP dia.450mm	m	0.0	159	225	0	0	0
5 DCIP dia.400mm	m	6,100.0	156	186	951,600	1,134,600	2,086,200
6 DCIP dia. 355mm	m	2,500.0	44	157	110,000	392,500	502,500
7 HDPE dia.315 mm	m	2,600.0	41	124	106,600	322,400	429,000
8 HDPE dia.280 mm	m	2,200.0	39	98	85,800	215,600	301,400
9 HDPE dia.250 mm	m	1,000.0	37	78	37,000	78,000	115,000
10 HDPE dia.225 mm	m	0.0	36	64	0	0	0
11 HDPE dia.200 mm	m	900.0	35	50	31,500	45,000	76,500
Sub Total of 1)					3,303,400	6,296,700	9,600,100
2) Distribution Reservoir							
Distribution Reservoir (Zone1)	m3	12,000	-	-	3,798,000	640,000	4,438,000
Distribution Reservoir (Zone2)	m3	12,000	-	-	3,798,000	640,000	4,438,000
Distribution Reservoir (Zone3)	m3	13,000	-	-	4,106,000	688,000	4,794,000
Distribution Reservoir (Zone4)	m3	16,000	-	-	5,029,000	833,000	5,862,000
Distribution Reservoir (Zone5)	m3	19,000	-	-	5,953,000	977,000	6,930,000
Distribution Reservoir (Zone6)	m3	19,000	-	-	5,953,000	977,000	6,930,000
Distribution Reservoir (Zone7)	m3	18,000	-	-	5,645,000	929,000	6,574,000
Distribution Reservoir (Zone8)	m3	20,000	-	-	6,261,000	1,025,000	7,286,000
Distribution Reservoir (Zone9)	m3	18,000	-	-	5,645,000	929,000	6,574,000
Distribution Reservoir (Zone10)	m3	17,000	-	-	5,337,000	881,000	6,218,000
Distribution Reservoir (Zone11)	m3	13,000	-	-	4,106,000	688,000	4,794,000
Distribution Reservoir (Zone12)	m3	9,000	-	-	2,874,000	496,000	3,370,000
Sub Total of 2)					58,505,000	9,703,000	68,208,000
3) Distribution Pump Station							
Distribution Pump Station (Zone1)	m3/day	60,000	-	-	497,000	2,248,000	2,745,000
Distribution Pump Station (Zone2)	m3/day	59,000	-	-	493,000	2,225,000	2,718,000
Distribution Pump Station (Zone3)	m3/day	67,000	-	-	522,000	2,404,000	2,926,000
Distribution Pump Station (Zone4)	m3/day	80,000	-	-	565,000	2,678,000	3,243,000
Distribution Pump Station (Zone5)	m3/day	95,000	-	-	609,000	2,973,000	3,582,000
Distribution Pump Station (Zone6)	m3/day	97,000	-	-	615,000	3,011,000	3,626,000
Distribution Pump Station (Zone7)	m3/day	93,000	-	-	604,000	2,935,000	3,539,000
Distribution Pump Station (Zone8)	m3/day	103,000	-	-	632,000	3,123,000	3,755,000
Distribution Pump Station (Zone9)	m3/day	93,000	-	-	604,000	2,935,000	3,539,000
Distribution Pump Station (Zone10)	m3/day	85,000	-	-	580,000	2,779,000	3,359,000
Distribution Pump Station (Zone11)	m3/day	66,000	-	-	519,000	2,382,000	2,901,000
Distribution Pump Station (Zone12)	m3/day	47,000	-	-	446,000	1,938,000	2,384,000
Sub Total of 3)					6,686,000	31,631,000	38,317,000
4) Elevated Tank							
Elevated Tank (Zone1)	m3	800	-	-	806,000	152,000	958,000
Elevated Tank (Zone2)	m3	800	-	-	806,000	152,000	958,000
Elevated Tank (Zone3)	m3	900	-	-	864,000	163,000	1,027,000
Elevated Tank (Zone4)	m3	1,000	-	-	922,000	174,000	1,096,000
Elevated Tank (Zone5)	m3	1,200	-	-	1,039,000	196,000	1,235,000
Elevated Tank (Zone6)	m3	1,300	-	-	1,098,000	207,000	1,305,000
Elevated Tank (Zone7)	m3	1,200	-	-	1,039,000	196,000	1,235,000
Elevated Tank (Zone8)	m3	1,300	-	-	1,098,000	207,000	1,305,000
Elevated Tank (Zone9)	m3	1,200	-	-	1,039,000	196,000	1,235,000
Elevated Tank (Zone10)	m3	1,100	-	-	981,000	185,000	1,166,000
Elevated Tank (Zone11)	m3	900	-	-	864,000	163,000	1,027,000
Elevated Tank (Zone12)	m3	600	-	-	689,000	130,000	819,000
Sub Total of 4)					11,245,000	2,121,000	13,366,000
Sub Total of -5					**79,739,400**	**49,751,700**	**129,491,100**

Item Description	Unit	Quantity	Unit Rate (US$)		Amount (US$)		Total Amount (US$)
			L.C	F.C	L.C	F.C	
-6 Construction of RO Plant							
RO Plant	m3/day	362,000	40	570	14,480,000	206,340,000	220,820,000
Sub Total of -6					**14,480,000**	**206,340,000**	**220,820,000**
Sub Total of -1+-2+-3+-4+-5+-6					**179,486,000**	**380,036,600**	**559,522,600**
2 Administration Cost							
-1 Security							
Security Issue of Transportation	L.S				0	6,527,000	6,527,000
Security Issue of Construction Site	L.S				12,035,000	0	12,035,000
Sub-Total of -1					**12,035,000**	**6,527,000**	**18,562,000**
-2 Insurance							
Insurance for Transportation	%	3.5			0	13,301,000	13,301,000
Insurance for Construction	%	3.5			6,282,000	0	6,282,000
Sub-Total of -2					**6,282,000**	**13,301,000**	**19,583,000**
-3 Administration Cost							
Administration Cost 10% of Direct Cost	%	10.0			17,949,000	38,004,000	55,953,000
Sub-Total of -3					**17,949,000**	**38,004,000**	**55,953,000**
Sub-Total of -1+-2+-3					**36,266,000**	**57,832,000**	**94,098,000**
3 Tax and Duty							
-1 Import Duty of Material Procurement	%	5.0			19,002,000	0	19,002,000
and Supply							
-2 Contract of Civil Works	%	10.0			65,362,000	0	65,362,000
Sub-Total of -1+-2+-3					**84,364,000**	**0**	**84,364,000**
4 Engineering Cost							
-1 Engineering Cost							
Engineering Cost (11.0% of Direct Cost)	%	11.0			19,743,000	41,804,000	61,547,000
Sub-Total of -1					**19,743,000**	**41,804,000**	**61,547,000**
-2 Contingency							
Price Contingency (9.0%of LC&1.7%of FC)	L.S.	1.0			14,815,000	5,069,000	19,884,000
Physical Contingency (20% of LC & FC)	L.S.	1.0			6,912,000	9,375,000	16,287,000
Sub-Total of -2					**21,727,000**	**14,444,000**	**36,171,000**
Sub-Total of -1+-2					**41,470,000**	**56,248,000**	**97,718,000**
5 Price Contingency (Escalation Cost)							
-1 For Local Portion of Item 1and 2	%	9.0			189,828,000	0	189,828,000
-2 For Foreign Portion of Item 1and 2	%	1.7			0	60,147,000	60,147,000
Sub-Total of -1+-2					**189,828,000**	**60,147,000**	**249,975,000**
Sub-Total (Item 1, 2 and 5)					**405,580,000**	**498,015,600**	**903,595,600**
6 Physical Contingency							
-1 For Local Portion of Item 1, 2 and 5	%	20.0			81,116,000	0	81,116,000
for Construction Cost							
-2 For Foreign Portion of Item 1, 2 and 5	%	20.0			0	99,603,000	99,603,000
for Construction Cost							
Sub-Total of -1+-2					**81,116,000**	**99,603,000**	**180,719,000**
Total							
With Tax (1+2+3+4+5+6)					**612,530,000**	**653,866,600**	**1,266,396,600**
Without Tax (1+2+4+5+6)					**528,166,000**	**653,866,600**	**1,182,032,600**

I.3 Breakdown of Rehabilitation Cost of Water Treatment Plants

Item Description	Unit	Quantity	Unit Rate (US$)		Amount (US$)		Total Amount (US$)
			L.C	F.C	L.C	F.C	
1) R-Zero 25 compact units							
Rehabilitation of C.U.	nr	25		30,000		750,000	750,000
Rehabilitation of storage tank	-			-	75,000		75,000
Rehabilitation of high lift p.s.	nr	8		3,000		24,000	24,000
Rehabilitation of low lift p.s.	nr	9		3,000		27,000	27,000
Rehabilitation of chlorine system	-			-		10,000	10,000
Rehabilitation of electrical equipments(33kv/11kv) substation & low tension equipments	-			-		150,000	150,000
Rehabilitation of diesel generators	-			-		30,000	30,000
Rehabilitation of the plant buildings	-		-		100,000		100,000
Rehabilitation of waste water pumps	nr	4		3,000		12,000	12,000
Sub Total of 1)					175,000	1,003,000	1,178,000
2) R-Zero Raw Water Pumps							
Rehabilitation of Al Hartha pumps	nr	6		4,000		24,000	24,000
Rehabilitation of Basra Unified. pumps	nr	6		4,000		24,000	24,000
Rehabilitation of Al Jubaila pumps	nr	4		4,000		16,000	16,000
Rehabilitation of Bradiah pumps	nr	3		4,000		12,000	12,000
Rehabilitation of Shuaiba pumps	nr	4		4,000		16,000	16,000
Rehabilitation of Abu Al khaseeb pumps	nr	6		4,000		24,000	24,000
Rehabilitation of Kor Al Zubair pumps	nr	3		4,000		12,000	12,000
Rehabilitation of the plant buildings	-		-		250,000		250,000
Rehabilitation of electrical equipments	-			-		80,000	80,000
Rehabilitation of mechanical equipments	-			-		90,000	90,000
Sub Total of 2)					250,000	298,000	548,000
3) Al Hartha 25 C.U.							
Rehabilitation of C.U.	nr	25		30,000		750,000	750,000
Rehabilitation of storage tank	-		-		75,000		75,000
Rehabilitation of high lift p.s.	nr	8		3,000		24,000	24,000
Rehabilitation of low lift p.s.	nr	7		2,500		17,500	17,500
Rehabilitation of chlorine system	-			-		10,000	10,000
Rehabilitation of electrical equipments	-			-		50,000	50,000
Rehabilitation of diesel generators	-			-		30,000	30,000
Rehabilitation of the plant buildings	-		-		100,000		100,000
Sub Total of 3)					175,000	881,500	1,056,500
4) Basra Unified							
Rehabilitation of gravity sand filters	nr	20		30,000		600,000	600,000
Rehabilitation of storage tank	-		-		30,000		30,000
Rehabilitation of high lift p.s.	nr	7		3,000		21,000	21,000
Rehabilitation of low lift p.s.	nr	5		2,500		12,500	12,500
Rehabilitation of chlorine system	-			-		10,000	10,000
Rehabilitation of electrical equipments	-			-		25,000	25,000
Rehabilitation of diesel generators	-			-		30,000	30,000
Rehabilitation of the plant buildings	-		-		60,000		60,000
Rehabilitation of the sedimentation tanks	nr	4		50,000		200,000	200,000
Rehabilitation of the alum dosing system	-			-		15,000	15,000
Rehabilitation of the pack washing system	-			-		25,000	25,000
Rehabilitation of the pneumatic system & measuring equipments	-			-		250,000	250,000
Sub Total of 4)					90,000	1,188,500	1,278,500
5) Garma1							
Rehabilitation of C.U.	nr	8		30,000		240,000	240,000
Rehabilitation of low lift p.s.	nr	3		3,000		9,000	9,000
Rehabilitation of chlorine system	-			-		10,000	10,000
Rehabilitation of electrical equipments	-			-		40,000	40,000
Rehabilitation of diesel generators	-			-		30,000	30,000
Rehabilitation of the plant buildings	-		-		35,000		35,000
Sub Total of 5)					35,000	329,000	364,000
6) Garma 2							
Rehabilitation of C.U.	nr	7		20,000		140,000	140,000

Item Description	Unit	Quantity	Unit Rate (US$)		Amount (US$)		Total Amount (US$)
			L.C	F.C	L.C	F.C	
Rehabilitation of low lift p.s.	nr	2		3,000		6,000	6,000
Rehabilitation of chlorine system	-			-		10,000	10,000
Rehabilitation of electrical equipments	-			-		20,000	20,000
Rehabilitation of diesel generators	-			-		30,000	30,000
Rehabilitation of the plant buildings	-		-		25,000		25,000
Sub Total of 6)					25,000	206,000	231,000
7) Ribat							
Rehabilitation of C.U.	nr	3		30,000		90,000	90,000
Rehabilitation of low lift p.s.	nr	3		3,000		9,000	9,000
Rehabilitation of chlorine system	-			-		10,000	10,000
Rehabilitation of electrical equipments	-			-		20,000	20,000
Rehabilitation of diesel generators	-			-		30,000	30,000
Rehabilitation of the plant buildings	-		-		35,000		35,000
Sub Total of 7)					35,000	159,000	194,000
8) Al Maqil 1							
Rehabilitation of C.U.	nr	3		20,000		60,000	60,000
Rehabilitation of low lift p.s.	nr	2		3,000		6,000	6,000
Rehabilitation of chlorine system	-			-		10,000	10,000
Rehabilitation of electrical equipments	-			-		20,000	20,000
Sub Total of 8)					0	96,000	96,000
9) Jubaila 1							
Rehabilitation of pressure sand filters	nr	12		30,000		360,000	360,000
Rehabilitation of high lift p.s.	nr	3		3,000		9,000	9,000
Rehabilitation of low lift p.s.	nr	3		2,500		7,500	7,500
Rehabilitation of chlorine system	-			-		10,000	10,000
Rehabilitation of electrical equipments	-			-		25,000	25,000
Rehabilitation of diesel generators	-			-		30,000	30,000
Rehabilitation of the plant buildings	-		-		40,000		40,000
Rehabilitation of the sedimentation tanks	nr	2		40,000		80,000	80,000
Rehabilitation of the alum dosing system	-			-		15,000	15,000
Rehabilitation of the pack washing system	-			-		25,000	25,000
Rehabilitation of the inlet piping system	-			-		30,000	30,000
Sub Total of 9)					40,000	591,500	631,500
10) Jubaila 2							
Rehabilitation of C.U.	nr	4		30,000		120,000	120,000
Rehabilitation of low lift p.s.	nr	2		3,000		6,000	6,000
Rehabilitation of chlorine system	-			-		10,000	10,000
Rehabilitation of electrical equipments	-			-		20,000	20,000
Rehabilitation of diesel generators	-			-		30,000	30,000
Rehabilitation of the plant buildings	-		-		25,000		25,000
Sub Total of 10)					25,000	186,000	211,000
11) Bradiah 1							
Rehabilitation of pressure sand filters	nr	14		30,000		420,000	420,000
Rehabilitation of high lift p.s.	nr	4		3,000		12,000	12,000
Rehabilitation of low lift p.s.	nr	4		2,500		10,000	10,000
Rehabilitation of chlorine system	-			-		10,000	10,000
Rehabilitation of electrical equipments	-			-		25,000	25,000
Rehabilitation of diesel generators	-			-		30,000	30,000
Rehabilitation of the plant buildings	-		-		60,000		60,000
Rehabilitation of the sedimentation tanks	nr	2		50,000		100,000	100,000
Rehabilitation of the alum dosing system	-			-		15,000	15,000
Rehabilitation of the pack washing system	-			-		25,000	25,000
Sub Total of 11)					60,000	647,000	707,000
12) Bradiah 2							
Rehabilitation of pressure sand filters	nr	14		30,000		420,000	420,000
Rehabilitation of high lift p.s.	nr	4		3,000		12,000	12,000
Rehabilitation of low lift p.s.	nr	4		2,500		10,000	10,000
Rehabilitation of chlorine system	-			-		10,000	10,000
Rehabilitation of electrical equipments	-			-		25,000	25,000
Rehabilitation of diesel generators	-			-		30,000	30,000
Rehabilitation of the plant buildings	-		-		60,000		60,000
Rehabilitation of the sedimentation tanks	nr	2		80,000		160,000	160,000
Rehabilitation of the alum dosing system	-			-		15,000	15,000
Rehabilitation of the pack washing system	-			-		25,000	25,000

Item Description	Unit	Quantity	Unit Rate (US$)		Amount (US$)		Total Amount (US$)
			L.C	F.C	L.C	F.C	
Sub Total of 12)					60,000	707,000	767,000
13) Bradiah C.U.							
Rehabilitation of C.U.	nr	1		30,000		30,000	30,000
Rehabilitation of low lift p.s.	nr	2		3,000		6,000	6,000
Rehabilitation of chlorine system	-			-		10,000	10,000
Rehabilitation of electrical equipments	-			-		20,000	20,000
Rehabilitation of the plant buildings	-		-		25,000		25,000
Sub Total of 13)					25,000	66,000	91,000
Total of 1) - 13)					**995,000**	**6,358,500**	**7,353,500**

I.4 Cost Estimation by Stage

Item	Stage 5	Stage 4	Stage 3	Stage 2-4	Stage 2	Stage 1
1. Rehabilitation of network	21	21	21	21	21	21
2. Rehabilitation of existing WTP	7	7	7	7	7	0
3. Transmission system	79	71	71	74	74	62
(1) Transmission reservoir (TR)	23	17	17	17	17	9
(2) Transmission PS (TPS)	11	9	9	12	12	8
(3) Ring mains	45	45	45	45	45	45
4. New water treatment plant	102	66	46	58	46	0
(1) Treatment plant	96	60	41	53	41	0
(2) Treated water PS	6	6	5	5	5	0
5. Main distribution facilities (13 zones)	129	129	129	0	0	0
6. RO plant	221	175	0	88	0	0
Total of Direct Construction Cost	**559**	**469**	**274**	**248**	**148**	**83**
Construction administration expenses	94	82	55	46	32	21
Tax and Duty	84	71	40	38	23	13
Engineering Cost	98	86	52	40	24	13
Price Contingency	250	250	167	82	55	28
Physical Contingency	181	160	99	75	47	26
Total of indirect Cost	**707**	**649**	**413**	**281**	**181**	**101**
Total	**1,266**	**1,118**	**687**	**529**	**329**	**184**

APPENDIX J

FINANCIAL AND ECONOMIC EVALUATION

APPENDIX J FINANCIAL AND ECONOMIC EVALUATION

J.1 Standard Conversion Factor

Table J.1 Calculation of Standard Conversion Factor

Year	(A) Import Amount (billion USD FOB)	(B) Export Amount (billion USD FOB)	Import Duties 1)	Export Duties	Export Subsidies	Total	Standard Conversion Factor ((A+B)/Total)
2003	6.5	7.5	0.359	0	0	14.4	0.975
2004	9.9	10.1	0.545	0	0	20.5	0.973
Standard Conversion Factor (Average)				0.974			

1) 5 % as reconstruction surcharge on the all imported goods except for humanitarian products.

An import tax of 0.5 % for capital and consumer goods. (Certain consumer goods are taxed at 0.75%)

Foods, Books, medicines and humanitarian goods are excepted from this import taxation.

J.2 Results of Financial Analysis (Full Cost Recovery)

Table J.2 Summary of Financial Indicators (Full Cost Recovery)

Case		Water price (USD/m^3)	Net Present value 1) Million US$	FIRR	B/C ratio 1)	Remarks The existing price level (EPL)	
						Times of EPL,	% of house income 2)
Stage 5	(1)	0.0074	-576	#DIV/0!	0.010	1	0.11%
	(2)	0.372	-283	#NUM!	0.514	50	5.5%
	(3)	0.743	16	10.4%	1.027	100	11.0%
Stage 3	(1)	0.0074	-298	#DIV/0!	0.020	1	0.11%
	(2)	0.372	-5	9.8%	0.983	50	5.5%
	(3)	0.743	294	20.7%	1.967	100	11.0%
Stage 2	(1)	0.0074	-199	#DIV/0!	0.029	1	0.11%
	(2)	0.372	94	15.1%	1.460	50	5.5%
	(3)	0.743	393	27.1%	2.919	100	11.0%
Stage 2-4	(1)	0.0074	-304	#DIV/0!	0.019	1	0.11%
	(2)	0.372	-11	9.5%	0.966	50	5.5%
	(3)	0.743	288	21.0%	1.932	100	11.0%

1) in the condition of discount rate at 10 %

2) This value is percentage of expenditure for water in the monthly household income

Average of monthly household income is 836,000 ID/household/month (around 557 USD/household/month)
Average size of family is 7.9 persons. Planned water consumption is 338 litter/person/day.

According to the above condition,

Water consumption of household = 7.9 person/hh x 338 lcd x 30 days = 80.1 m^3/month

Expenditure for water = 80.1 m^3/household/month x 0.0074 USD/m^3 = 0.59 USD/household/month

This amount is equivalent to 0.11% of the average monthly household income.

Table J.3 Calculation of Financial Indicator (Stage 5 (3))

Year in Order	Fiscal Year	Financial Cost (Million USD)					Revenue							Cash Balance
		Construction Cost		O & M Cost	Re-place -ment Cost	Total	Served population	unit water consumption (l/person /day)	Ratio of Leakage (%)	Water supply amount ($x10^6$ m^3/year)	unit water rate (USD /1000 m^3)	Collection rate (%)	Revenue	
		F/C portion	L/C portion											
	2006						807,000					-		
1	2007	0.0	0.0				876,500	338				-		
2	2008	0.5	0.3			0.8	946,000	338				-		-1
3	2009	5.9	4.3			10.2	1,015,500	338				-		-10
4	2010	15.4	13.4			28.8	1,085,000	338				-		-29
5	2011	55.8	52.0			107.8	1,119,400	338				-		-108
6	2012	53.9	48.2			102.1	1,153,800	338				-		-102
7	2013	54.2	49.1			103.3	1,188,200	338				-		-103
8	2014	159.1	90.9	6.3		256.3	1,222,600	338	30%	215.5		60%	96.1	-160
9	2015	159.3	91.6	6.3		257.2	1,257,000	338	30%	221.5		60%	98.8	-158
10	2016			17.2		17.2	1,296,800	332	29%	221.6		62%	101.3	84
11	2017			17.2		17.2	1,336,600	327	28%	221.4		63%	103.7	86
12	2018			17.2		17.2	1,376,400	321	27%	221.0		65%	105.9	89
13	2019			17.2		17.2	1,416,200	316	26%	220.5		66%	108.1	91
14	2020			17.2		17.2	1,456,000	310	25%	219.7		68%	110.2	93
15	2021			17.2		17.2	1,502,400	304	24%	219.6		69%	112.6	95
16	2022			17.2		17.2	1,548,800	299	23%	219.4		71%	114.9	98
17	2023			17.2		17.2	1,595,200	293	22%	218.9		72%	117.1	100
18	2024			17.2		17.2	1,641,600	288	21%	218.1		74%	119.1	102
19	2025			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
20	2026			17.2		17.2	1,688,000	282	20%	217.2	743	75%	121.0	104
21	2027			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
22	2028			17.2	170.2	187.4	1,688,000	282	20%	217.2		75%	121.0	-66
23	2029			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
24	2030			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
25	2031			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
26	2032			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
27	2033			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
28	2034			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
29	2035			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
30	2036			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
31	2037			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
32	2038			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
33	2039			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
34	2040			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
35	2041			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
36	2042			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
37	2043			17.2	170.2	187.4	1,688,000	282	20%	217.2		75%	121.0	-66
38	2044			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
39	2045			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
40	2046			17.2		17.2	1,688,000	282	20%	217.2		75%	121.0	104
Total		504	350	546	340.4	1,740							3,850.2	2,110
in the condition of discount rate at 10 %														
Net Present Value						582							598	16
Internal rate of return (FIRR)														10.4%
B/C														1.027

Condition of calculation

Assumed water rate: 100 times of the existing water rate (11 ID/m3, or 0.0074 USD/m3)

Table J.4 Calculation of Financial Indicator (Stage 3 (3))

Year in Order	Fiscal Year	Financial Cost (Million USD)					Revenue							Cash Balance
		Construction Cost		O & M Cost	Re-place -ment Cost	Total	Served population	unit water consumption (l/person /day)	Ratio of Leakage (%)	Water supply amount ($x10^6$ m^3/year)	unit water rate (USD /1000 m^3)	Collection rate (%)	Revenue	
		F/C portion	L/C portion											
	2006						807,000					-		
1	2007	0.0	0.0				876,500	338				-		
2	2008	0.5	0.3			0.8	946,000	338				-		-1
3	2009	5.0	3.2			8.2	1,015,500	338				-		-8
4	2010	14.7	12.4			27.1	1,085,000	338				-		-27
5	2011	43.5	35.7			79.2	1,119,400	338				-		-79
6	2012	35.2	31.0			66.2	1,153,800	338				-		-66
7	2013	35.0	31.2			66.2	1,188,200	338				-		-66
8	2014	31.6	64.1	7.1		102.8	1,222,600	338	30%	215.5		60%	96.1	-7
9	2015	31.7	64.6	7.1		103.4	1,257,000	338	30%	221.5		60%	98.8	-5
10	2016			7.1		7.1	1,296,800	332	29%	221.6		62%	101.3	94
11	2017			7.1		7.1	1,336,600	327	28%	221.4		63%	103.7	97
12	2018			7.1		7.1	1,376,400	321	27%	221.0		65%	105.9	99
13	2019			7.1		7.1	1,416,200	316	26%	220.5		66%	108.1	101
14	2020			7.1		7.1	1,456,000	310	25%	219.7		68%	110.2	103
15	2021			7.1		7.1	1,502,400	304	24%	219.6		69%	112.6	106
16	2022			7.1		7.1	1,548,800	299	23%	219.4		71%	114.9	108
17	2023			7.1		7.1	1,595,200	293	22%	218.9		72%	117.1	110
18	2024			7.1		7.1	1,641,600	288	21%	218.1		74%	119.1	112
19	2025			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
20	2026			7.1		7.1	1,688,000	282	20%	217.2	743	75%	121.0	114
21	2027			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
22	2028			7.1	67	74.1	1,688,000	282	20%	217.2		75%	121.0	47
23	2029			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
24	2030			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
25	2031			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
26	2032			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
27	2033			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
28	2034			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
29	2035			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
30	2036			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
31	2037			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
32	2038			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
33	2039			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
34	2040			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
35	2041			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
36	2042			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
37	2043			7.1	67	74.1	1,688,000	282	20%	217.2		75%	121.0	47
38	2044			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
39	2045			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
40	2046			7.1		7.1	1,688,000	282	20%	217.2		75%	121.0	114
Total		197	243	234	134	808							3,850.2	3042
in the condition of discount rate at 10 %														
Net Present Value						304							598	294
Internal rate of return (FIRR)														20.7%
B/C														1.967

Condition of calculation

Assumed water rate: 100 times of the existing water rate (11 ID/m3, or 0.0074 USD/m3)

Table J.5 Calculation of Financial Indicator (Stage 2 (3))

Year in Order	Fiscal Year	Financial Cost (Million USD)					Revenue							Cash Balance
		Construction Cost		O & M Cost	Re-place -ment Cost	Total	Served population	unit water consumption (l/person /day)	Ratio of Leakage (%)	Water supply amount ($x10^6$ m^3/year)	unit water rate (USD /1000 m^3)	Collection rate (%)	Revenue	
		F/C portion	L/C portion											
	2006						807,000					-		
1	2007	0.0	0.0				876,500	338				-		
2	2008	0.5	0.3			0.8	946,000	338				-		-1
3	2009	5.1	3.2			8.3	1,015,500	338				-		-8
4	2010	14.9	12.6			27.5	1,085,000	338				-		-28
5	2011	45.2	36.6			81.8	1,119,400	338				-		-82
6	2012	35.4	28.1			63.5	1,153,800	338				-		-64
7	2013	35.2	28.1			63.3	1,188,200	338				-		-63
8	2014	0.0	0.0	7.0		7.0	1,222,600	338	30%	215.5		60%	96.1	89
9	2015	0.0	0.0	7.0		7.0	1,257,000	338	30%	221.5		60%	98.8	92
10	2016			7.0		7.0	1,296,800	332	29%	221.6		62%	101.3	94
11	2017			7.0		7.0	1,336,600	327	28%	221.4		63%	103.7	97
12	2018			7.0		7.0	1,376,400	321	27%	221.0		65%	105.9	99
13	2019			7.0		7.0	1,416,200	316	26%	220.5		66%	108.1	101
14	2020			7.0		7.0	1,456,000	310	25%	219.7		68%	110.2	103
15	2021			7.0		7.0	1,502,400	304	24%	219.6		69%	112.6	106
16	2022			7.0		7.0	1,548,800	299	23%	219.4		71%	114.9	108
17	2023			7.0		7.0	1,595,200	293	22%	218.9		72%	117.1	110
18	2024			7.0		7.0	1,641,600	288	21%	218.1		74%	119.1	112
19	2025			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
20	2026			7.0		7.0	1,688,000	282	20%	217.2	743	75%	121.0	114
21	2027			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
22	2028			7.0	46.3	53.3	1,688,000	282	20%	217.2		75%	121.0	68
23	2029			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
24	2030			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
25	2031			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
26	2032			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
27	2033			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
28	2034			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
29	2035			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
30	2036			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
31	2037			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
32	2038			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
33	2039			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
34	2040			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
35	2041			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
36	2042			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
37	2043			7.0	46.3	53.3	1,688,000	282	20%	217.2		75%	121.0	68
38	2044			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
39	2045			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
40	2046			7.0		7.0	1,688,000	282	20%	217.2		75%	121.0	114
Total		136	109	231	92.6	569							3,850.2	3281
in the condition of discount rate at 10 %														
Net Present Value						205							598	393
Internal rate of return (FIRR)														27.1%
B/C														2.919

Condition of calculation

Assumed water rate: 100 times of the existing water rate (11 ID/m3, or 0.0074 USD/m3)

Table J.6 Calculation of Financial Indicator (Stage 4-2 (3))

Year in Order	Fiscal Year	Financial Cost (Million USD)					Revenue							Cash Balance
		Construction Cost		O & M Cost	Re-place -ment Cost	Total	Served population	unit water consumption (l/person /day)	Ratio of Leakage (%)	Water supply amount ($x10^6$ m^3/year)	unit water rate (USD /1000 m^3)	Collection rate (%)	Revenue	
		F/C portion	L/C portion											
	2006						807,000					-		
1	2007	0.0	0.0				876,500	338				-		
2	2008	0.5	0.3			0.8	946,000	338				-		-1
3	2009	5.3	3.4			8.7	1,015,500	338				-		-9
4	2010	14.8	12.7			27.5	1,085,000	338				-		-28
5	2011	46.8	39.3			86.1	1,119,400	338				-		-86
6	2012	39.6	31.3			70.9	1,153,800	338				-		-71
7	2013	39.5	31.4			70.9	1,188,200	338				-		-71
8	2014	51.4	11.2	7.0		69.6	1,222,600	338	30%	215.5		60%	96.1	26
9	2015	51.5	11.2	7.0		69.7	1,257,000	338	30%	221.5		60%	98.8	29
10	2016			12.6		12.6	1,296,800	332	29%	221.6		62%	101.3	89
11	2017			12.6		12.6	1,336,600	327	28%	221.4		63%	103.7	91
12	2018			12.6		12.6	1,376,400	321	27%	221.0		65%	105.9	93
13	2019			12.6		12.6	1,416,200	316	26%	220.5		66%	108.1	96
14	2020			12.6		12.6	1,456,000	310	25%	219.7		68%	110.2	98
15	2021			12.6		12.6	1,502,400	304	24%	219.6		69%	112.6	100
16	2022			12.6		12.6	1,548,800	299	23%	219.4		71%	114.9	102
17	2023			12.6		12.6	1,595,200	293	22%	218.9		72%	117.1	104
18	2024			12.6		12.6	1,641,600	288	21%	218.1		74%	119.1	107
19	2025			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
20	2026			12.6		12.6	1,688,000	282	20%	217.2	743	75%	121.0	108
21	2027			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
22	2028			12.6	84.8	97.4	1,688,000	282	20%	217.2		75%	121.0	24
23	2029			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
24	2030			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
25	2031			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
26	2032			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
27	2033			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
28	2034			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
29	2035			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
30	2036			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
31	2037			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
32	2038			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
33	2039			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
34	2040			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
35	2041			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
36	2042			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
37	2043			12.6	84.8	97.4	1,688,000	282	20%	217.2		75%	121.0	24
38	2044			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
39	2045			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
40	2046			12.6		12.6	1,688,000	282	20%	217.2		75%	121.0	108
Total		249	141	405	169.6	964							3,850.2	2886
in the condition of discount rate at 10 %														
Net Present Value						310							598	288
Internal rate of return (FIRR)														21.0%
B/C														1.932

Condition of calculation

Assumed water rate: 100 times of the existing water rate (11 ID/m3, or 0.0074 USD/m3)

Table J.7 Calculation of Financial Costs for Financial Evaluation

unit: Million USD

Year	Stage -5					Stage -3					Stage -2					Stage 4-2				
	Construction Cost		O & M Cost	Re-place -ment Cost	Total	Construction Cost		O & M Cost	Re-place -ment Cost	Total	Construction Cost		O & M Cost	Re-place -ment Cost	Total	Construction Cost		O & M Cost	Re-place -ment Cost	Total
	F/C portion	L/C portion				F/C portion	L/C portion				F/C portion	L/C portion				F/C portion	L/C portion			
2006					0															
2007	0.0	0.0			0	0.0	0.0				0.0	0.0				0.0	0.0			
2008	0.5	0.3			0.8	0.5	0.3			0.8	0.5	0.3			0.8	0.5	0.3			0.8
2009	5.9	4.3			10.2	5.0	3.2			8.2	5.1	3.2			8.3	5.3	3.4			8.7
2010	15.4	13.4			28.8	14.7	12.4			27.1	14.9	12.6			27.5	14.8	12.7			27.5
2011	55.8	52.0			107.8	43.5	35.7			79.2	45.2	36.6			81.8	46.8	39.3			86.1
2012	53.9	48.2			102.1	35.2	31.0			66.2	35.4	28.1			63.5	39.6	31.3			70.9
2013	54.2	49.1			103.3	35.0	31.2			66.2	35.2	28.1			63.3	39.5	31.4			70.9
2014	159.1	90.9	6.3		256.3	31.6	64.1	7.1		102.8	0.0	0.0	7.0		7.0	51.4	11.2	7.0		69.6
2015	159.3	91.6	6.3		257.2	31.7	64.6	7.1		103.4	0.0	0.0	7.0		7.0	51.5	11.2	7.0		69.7
2016			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2017			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2018			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2019			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2020			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2021			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2022			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2023			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2024			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2025			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2026			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2027			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2028			17.2	170.2	187.4			7.1	67	74.1			7.0	46.3	53.3			12.6	84.8	97.4
2029			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2030			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2031			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2032			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2033			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2034			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2035			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2036			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2037			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2038			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2039			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2040			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2041			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2042			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2043			17.2	170.2	187.4			7.1	67	74.1			7.0	46.3	53.3			12.6	84.8	97.4
2044			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2045			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
2046			17.2		17.2			7.1		7.1			7.0		7.0			12.6		12.6
Total	504.1	349.8	545.8	340.4	1740.1	197.2	242.5	234.3	134	808.0	136.3	108.9	231	92.6	568.8	249.4	140.8	404.6	169.6	964.4

J.3 Results of Financial Analysis (O&M Cost Recovery with Generator Option)

Table J.8 Results of Financial Analysis (O&M cost recovery with generator option)

Case		Water price (USD/ m3)	Times of EPL	Percentage of house income 2)	Net Present value 1)	FIRR	B/C ratio
O&M cost recovery with generator option	Stage-5	0.223	30	3.3%	16	-	1.10
	Stage-3	0.104	14	1.5%	9	-	1.12
	Stage-2	0.082	11	1.2%	6	-	1.11
	Stage 2-4	0.126	17	1.9%	6	-	1.06
O&M cost recovery without generator option	Stage-5	0.149	20	2.2%	8	-	1.10
	Stage-3	0.052	7	0.8%	4	-	1.09
	Stage-2	0.052	7	0.8%	4	-	1.11
	Stage 2-4	0.104	14	1.5%	1	-	1.01

1) in the condition of discount rate at 10 %

2) This value is percentage of expenditure for water in the monthly household income
Average of monthly household income is 836,000 ID/household/month (around 557 USD/hh/month)
Average size of family is 7.9 persons. Planned water consumption is 338 litter/person/day.
According to the above condition,
Water consumption of household = 7.9 person/hh x 338 lcd x 30 days = 80.1 m^3/month
Expenditure for water = 80.1 m3/hh/month x 0.0074 USD/m^3 = 0.59 USD/hh/month
This amount is equivalent equivalent to 0.11% of the average monthly household income.

Table J.9 Operation and Maintenance Cost

Million US$/year

Year	Recovery of the O/M cost (with Generator)				Recovery of the O/M cost (without Generator)			
	Stage-5	Stage-3	Stage-2	Stage 2-4	Stage-5	Stage-3	Stage-2	Stage 2-4
2014	15.6	13.8	11	10.9	6.3	7.1	7	7
2015	15.6	13.8	11	10.9	6.3	7.1	7	7
2016	33.4	13.8	11	19.3	17.2	7.1	7	12.6
2017 - 2046	33.4	13.8	11	19.3	17.2	7.1	7	12.6

Table J.10 Calculation of Financial Indicator (Stage 2)
(O&M cost recovery with generator option)

Year in Order	Fiscal Year	Financial Cost (Million USD)					Revenue							Cash Balance
		Construction Cost												
		F/C portion	L/C portion	O & M Cost	Re-place -ment Cost	Total	Served population	unit water consumption (l/person /day)	Ratio of Leakage (%)	Water supply amount ($x10^6$ m^3/year)	unit water rate (USD /1000 m^3)	Collection rate (%)	Revenue	
	2006						807,000					-		
1	2007						876,500	338				-		
2	2008					0.0	946,000	338				-		0
3	2009					0.0	1,015,500	338				-		0
4	2010					0.0	1,085,000	338				-		0
5	2011					0.0	1,119,400	338				-		0
6	2012					0.0	1,153,800	338				-		0
7	2013					0.0	1,188,200	338				-		0
8	2014			11.0		11.0	1,222,600	338	30%	215.5		60%	10.6	0
9	2015			11.0		11.0	1,257,000	338	30%	221.5		60%	10.9	0
10	2016			11.0		11.0	1,296,800	332	29%	221.6		62%	11.1	0
11	2017			11.0		11.0	1,336,600	327	28%	221.4		63%	11.4	0
12	2018			11.0		11.0	1,376,400	321	27%	221.0		65%	11.7	1
13	2019			11.0		11.0	1,416,200	316	26%	220.5		66%	11.9	1
14	2020			11.0		11.0	1,456,000	310	25%	219.7		68%	12.1	1
15	2021			11.0		11.0	1,502,400	304	24%	219.6		69%	12.4	1
16	2022			11.0		11.0	1,548,800	299	23%	219.4		71%	12.6	2
17	2023			11.0		11.0	1,595,200	293	22%	218.9		72%	12.9	2
18	2024			11.0		11.0	1,641,600	288	21%	218.1		74%	13.1	2
19	2025			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
20	2026			11.0		11.0	1,688,000	282	20%	217.2	82	75%	13.3	2
21	2027			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
22	2028			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
23	2029			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
24	2030			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
25	2031			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
26	2032			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
27	2033			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
28	2034			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
29	2035			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
30	2036			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
31	2037			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
32	2038			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
33	2039			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
34	2040			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
35	2041			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
36	2042			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
37	2043			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
38	2044			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
39	2045			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
40	2046			11.0		11.0	1,688,000	282	20%	217.2		75%	13.3	2
Total		0	0	363	0	363							423.5	61
in the condition of discount rate at 10 %														
Net Present Value						59							66	6
Internal rate of return (FIRR)														-
B/C														1.107

Condition of calculation

Assumed water rate: 11 times of the existing water rate (11 ID/m3, or 0.0074 USD/m3)

Table J.11 Calculation of Financial Indicator (Stage 2)
(O&M cost recovery without generator option)

Year in Order	Fiscal Year	Financial Cost (Million USD)					Revenue							Cash Balance
		Construction Cost		O & M Cost	Re-place -ment Cost	Total	Served population	unit water consumption (l/person /day)	Ratio of Leakage (%)	Water supply amount ($x10^6$ m^3/year)	unit water rate (USD /1000 m^3)	Collection rate (%)	Revenue	
		F/C portion	L/C portion											
	2006						807,000					-		
1	2007						876,500	338				-		
2	2008					0.0	946,000	338				-		0
3	2009					0.0	1,015,500	338				-		0
4	2010					0.0	1,085,000	338				-		0
5	2011					0.0	1,119,400	338				-		0
6	2012					0.0	1,153,800	338				-		0
7	2013					0.0	1,188,200	338				-		0
8	2014			7.0		7.0	1,222,600	338	30%	215.5		60%	6.7	0
9	2015			7.0		7.0	1,257,000	338	30%	221.5		60%	6.9	0
10	2016			7.0		7.0	1,296,800	332	29%	221.6		62%	7.1	0
11	2017			7.0		7.0	1,336,600	327	28%	221.4		63%	7.3	0
12	2018			7.0		7.0	1,376,400	321	27%	221.0		65%	7.4	0
13	2019			7.0		7.0	1,416,200	316	26%	220.5		66%	7.6	1
14	2020			7.0		7.0	1,456,000	310	25%	219.7		68%	7.7	1
15	2021			7.0		7.0	1,502,400	304	24%	219.6		69%	7.9	1
16	2022			7.0		7.0	1,548,800	299	23%	219.4		71%	8.0	1
17	2023			7.0		7.0	1,595,200	293	22%	218.9		72%	8.2	1
18	2024			7.0		7.0	1,641,600	288	21%	218.1		74%	8.3	1
19	2025			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
20	2026			7.0		7.0	1,688,000	282	20%	217.2	52	75%	8.5	1
21	2027			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
22	2028			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
23	2029			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
24	2030			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
25	2031			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
26	2032			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
27	2033			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
28	2034			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
29	2035			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
30	2036			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
31	2037			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
32	2038			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
33	2039			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
34	2040			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
35	2041			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
36	2042			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
37	2043			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
38	2044			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
39	2045			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
40	2046			7.0		7.0	1,688,000	282	20%	217.2		75%	8.5	1
Total		0	0	231	0	231							269.5	39
in the condition of discount rate at 10 %														
Net Present Value						38							42	4
Internal rate of return (FIRR)														-
B/C														1.107

Condition of calculation

Assumed water rate: 7 times of the existing water rate (11 ID/m3, or 0.0074 USD/m3)

J.4 Results of Economic Analysis

Table J.12 Results of Economic Analysis

Stage	Economic Cost		Economic Benefit		EIRR
	without project	with project	without project	with project	
Stage-5	Existing water supply system	Construction and O&M of total project components	Willingness to pay for the existing situation 0.21 USD/ person/month	Willingness to pay for the satisfied condition (0.73 USD/person/month)	-
				2% of the average household income (1.41 USD/person/month)	-
				3% of the average household income (2.11 USD/person/month)	-
Stage-3		Construction and O&M of total project components without RO plant		Willingness to pay for the satisfied condition (0.73 USD/person/month)	-
				2% of the average household income (1.41 USD/person/month)	-
				3% of the average household income (2.11 USD/person/month)	6.3%
Stage-2		Construction and O&M of total project components without RO plant and distribution main facilities		Willingness to pay for the satisfied condition (0.73 USD/person/month)	-
				2% of the average household income (1.41 USD/person/month)	5.8%
				3% of the average household income (2.11 USD/person/month)	11.2%
Stage 2-4		Stage 2 components and half a capacity of RO plant		Willingness to pay for the satisfied condition (0.73 USD/person/month)	-
				2% of the average household income (1.41 USD/person/month)	-
				3% of the average household income (2.11 USD/person/month)	5.9%

Table J.13 Calculation of Economic Indicator (Stage 5 (3))

Year in Order	Fiscal Year	Economic Cost (Million US$)										Economic Benefit (US$)						Cash Balance
		Without Project					With Project						Without Project		With Project			
		Construction Cost					Construction Cost											
		F/C portion	L/C portion	O & M Cost	Re-place -ment Cost	Total	F/C portion	L/C portion	O & M Cost	Re-place -ment Cost	Total	Additional Cost	Served Population	Unit water price 1)	Benefit	Unit water price 2)	Benefit	Additional Benefit	
	2006																	
1	2007					0.0	0.0	0.0			0	0.0	876,500						0
2	2008					0.0	0.3	0.3			0.6	0.6	946,000						-1
3	2009					0.0	4.2	4.3			8.5	8.5	1,015,500						-9
4	2010				8.27	8.3	11.0	11.3			22.3	14.0	1,085,000						-14
5	2011					0.0	39.9	41.1			81	81.0	1,119,400						-81
6	2012					0.0	38.2	39.4			77.6	77.6	1,153,800						-78
7	2013					0.0	38.9	40.1			79	79.0	1,188,200						-79
8	2014			3.1		3.1	62.2	64.1	18.8		145.1	142.0	1,222,600		2.2		31.0	28.7	-113
9	2015			3.1		3.1	62.8	64.7	18.8		146.3	143.2	1,257,000		2.2		31.8	29.6	-114
10	2016			3.1		3.1			18.8		18.8	15.7	1,296,800		2.2		32.8	30.6	15
11	2017			3.1		3.1			18.8		18.8	15.7	1,336,600		2.2		33.8	31.6	16
12	2018			3.1	8.27	11.4			18.8		18.8	7.4	1,376,400		2.2		34.9	32.6	25
13	2019			3.1		3.1			18.8		18.8	15.7	1,416,200		2.2		35.9	33.6	18
14	2020			3.1		3.1			18.8		18.8	15.7	1,456,000		2.2		36.9	34.7	19
15	2021			3.1		3.1			18.8		18.8	15.7	1,502,400		2.2		38.0	35.8	20
16	2022			3.1		3.1			18.8		18.8	15.7	1,548,800		2.2		39.2	37.0	21
17	2023			3.1		3.1			18.8		18.8	15.7	1,595,200	0.21	2.2	2.11	40.4	38.2	22
18	2024			3.1		3.1			18.8		18.8	15.7	1,641,600	USD/	2.2	USD/	41.6	39.4	24
19	2025			3.1		3.1			18.8		18.8	15.7	1,688,000	person/	2.2	person/	42.7	40.5	25
20	2026			3.1	8.27	11.4			18.8		18.8	7.4	1,688,000	month	2.2	month	42.7	40.5	33
21	2027			3.1		3.1			18.8		18.8	15.7	1,688,000		2.2		42.7	40.5	25
22	2028			3.1		3.1			18.8		18.8	15.7	1,688,000		2.2		42.7	40.5	25
23	2029			3.1		3.1			18.8		18.8	15.7	1,688,000		2.2		42.7	40.5	25
24	2030			3.1		3.1			18.8	175.4	194.18	191.1	1,688,000		2.2		42.7	40.5	-151
25	2031			3.1		3.1			18.8		18.8	15.7	1,688,000		2.2		42.7	40.5	25
26	2032			3.1		3.1			18.8		18.8	15.7	1,688,000		2.2		42.7	40.5	25
27	2033			3.1		3.1			18.8		18.8	15.7	1,688,000		2.2		42.7	40.5	25
28	2034			3.1	8.27	11.4			18.8		18.8	7.4	1,688,000		2.2		42.7	40.5	33
29	2035			3.1		3.1			18.8		18.8	15.7	1,688,000		2.2		42.7	40.5	25
30	2036			3.1		3.1			18.8		18.8	15.7	1,688,000		2.2		42.7	40.5	25
31	2037			3.1		3.1			18.8		18.8	15.7	1,688,000		2.2		42.7	40.5	25
32	2038			3.1		3.1			18.8		18.8	15.7	1,688,000		2.2		42.7	40.5	25
33	2039			3.1		3.1			18.8		18.8	15.7	1,688,000		2.2		42.7	40.5	25
34	2040			3.1		3.1			18.8		18.8	15.7	1,688,000		2.2		42.7	40.5	25
35	2041			3.1		3.1			18.8		18.8	15.7	1,688,000		2.2		42.7	40.5	25
36	2042			3.1	8.27	11.4			18.8		18.8	7.4	1,688,000		2.2		42.7	40.5	33
37	2043			3.1		3.1			18.8		18.8	15.7	1,688,000		2.2		42.7	40.5	25
38	2044			3.1		3.1			18.8		18.8	15.7	1,688,000		2.2		42.7	40.5	25
39	2045			3.1		3.1			18.8	175.4	194.18	191.1	1,688,000		2.2		42.7	40.5	-151
40	2046			3.1		3.1			18.8		18.8	15.7	1,688,000		2.2		42.7	40.5	25
Total		0	0	102	41.35	144	258	265	620	351	1,494	1,350			73		1,337	1,264	-87

Unit water price 1) willingness to pay

2) 3 % of average household income (average income=836,000 ID/household/month, 3% of income= 2.11 USD/person/month)

Internal rate of return (EIRR)	#DIV/0!

Table J.14 Calculation of Economic Indicator (Stage 3 (3))

Year in Order	Fiscal Year	Economic Cost (Million US$)											Economic Benefit (US$)						Cash Balance
		Without Project					With Project							Without Project		With Project			
		Construction Cost		O & M Cost	Re-place -ment Cost	Total	Construction Cost		O & M Cost	Re-place -ment Cost	Total	Additional Cost	Served Population	Unit water price 1)	Benefit	Unit water price 2)	Benefit	Additional Benefit	
		F/C portion	L/C portion				F/C portion	L/C portion											
	2006																		
1	2007					0.0	0.0	0.0			0	0.0	876,500						0
2	2008					0.0	0.5	0.3			0.8	0.8	946,000						-1
3	2009					0.0	5.0	3.1			8.1	8.1	1,015,500						-8
4	2010				8.27	8.3	14.7	10.0			24.7	16.4	1,085,000						-16
5	2011					0.0	43.5	26.9			70.4	70.4	1,119,400						-70
6	2012					0.0	35.2	24.4			59.6	59.6	1,153,800						-60
7	2013					0.0	35.0	24.4			59.4	59.4	1,188,200						-59
8	2014			3.1		3.1	31.6	53.4	8.3		93.3	90.2	1,222,600		2.2		31.0	28.7	-61
9	2015			3.1		3.1	31.7	53.9	8.3		93.9	90.8	1,257,000		2.2		31.8	29.6	-61
10	2016			3.1		3.1			8.3		8.3	5.2	1,296,800		2.2		32.8	30.6	25
11	2017			3.1		3.1			8.3		8.3	5.2	1,336,600		2.2		33.8	31.6	26
12	2018			3.1	8.27	11.4			8.3		8.3	-3.1	1,376,400		2.2		34.9	32.6	36
13	2019			3.1		3.1			8.3		8.3	5.2	1,416,200		2.2		35.9	33.6	28
14	2020			3.1		3.1			8.3		8.3	5.2	1,456,000		2.2		36.9	34.7	29
15	2021			3.1		3.1			8.3		8.3	5.2	1,502,400		2.2		38.0	35.8	31
16	2022			3.1		3.1			8.3		8.3	5.2	1,548,800		2.2		39.2	37.0	32
17	2023			3.1		3.1			8.3		8.3	5.2	1,595,200	0.21	2.2	2.11	40.4	38.2	33
18	2024			3.1		3.1			8.3		8.3	5.2	1,641,600	USD/	2.2	USD/	41.6	39.4	34
19	2025			3.1		3.1			8.3		8.3	5.2	1,688,000	person/	2.2	person/	42.7	40.5	35
20	2026			3.1	8.27	11.4			8.3		8.3	-3.1	1,688,000	month	2.2	month	42.7	40.5	44
21	2027			3.1		3.1			8.3		8.3	5.2	1,688,000		2.2		42.7	40.5	35
22	2028			3.1		3.1			8.3		8.3	5.2	1,688,000		2.2		42.7	40.5	35
23	2029			3.1		3.1			8.3		8.3	5.2	1,688,000		2.2		42.7	40.5	35
24	2030			3.1		3.1			8.3	106.2	114.52	111.4	1,688,000		2.2		42.7	40.5	-71
25	2031			3.1		3.1			8.3		8.3	5.2	1,688,000		2.2		42.7	40.5	35
26	2032			3.1		3.1			8.3		8.3	5.2	1,688,000		2.2		42.7	40.5	35
27	2033			3.1		3.1			8.3		8.3	5.2	1,688,000		2.2		42.7	40.5	35
28	2034			3.1	8.27	11.4			8.3		8.3	-3.1	1,688,000		2.2		42.7	40.5	44
29	2035			3.1		3.1			8.3		8.3	5.2	1,688,000		2.2		42.7	40.5	35
30	2036			3.1		3.1			8.3		8.3	5.2	1,688,000		2.2		42.7	40.5	35
31	2037			3.1		3.1			8.3		8.3	5.2	1,688,000		2.2		42.7	40.5	35
32	2038			3.1		3.1			8.3		8.3	5.2	1,688,000		2.2		42.7	40.5	35
33	2039			3.1		3.1			8.3		8.3	5.2	1,688,000		2.2		42.7	40.5	35
34	2040			3.1		3.1			8.3		8.3	5.2	1,688,000		2.2		42.7	40.5	35
35	2041			3.1		3.1			8.3		8.3	5.2	1,688,000		2.2		42.7	40.5	35
36	2042			3.1	8.27	11.4			8.3		8.3	-3.1	1,688,000		2.2		42.7	40.5	44
37	2043			3.1		3.1			8.3		8.3	5.2	1,688,000		2.2		42.7	40.5	35
38	2044			3.1		3.1			8.3		8.3	5.2	1,688,000		2.2		42.7	40.5	35
39	2045			3.1		3.1			8.3	106.2	114.52	111.4	1,688,000		2.2		42.7	40.5	-71
40	2046			3.1		3.1			8.3		8.3	5.2	1,688,000		2.2		42.7	40.5	35
Total		0	0	102	41.35	144	197	196	274	212	880	736.3			73		1,337	1,264	527

Unit water price 1) willingness to pay
2) 3 % of average household income

Internal rate of return (EIRR)	6.3%

Table J.15 Calculation of Economic Indicator (Stage 2 (3))

Year in Order	Fiscal Year	Economic Cost (Million US$)											Economic Benefit (US$)						Cash Balance
		Without Project					With Project							Without Project		With Project			
		Construction Cost					Construction Cost												
		F/C portion	L/C portion	O & M Cost	Re-place -ment Cost	Total	F/C portion	L/C portion	O & M Cost	Re-place -ment Cost	Total	Additional Cost	Served Population	Unit water price 1)	Benefit	Unit water price 2)	Benefit	Additional Benefit	
	2006																		
1	2007					0.0	0.0	0.0			0	0.0	876,500						0
2	2008					0.0	0.5	0.3			0.8	0.8	946,000						-1
3	2009					0.0	5.1	3.1			8.2	8.2	1,015,500						-8
4	2010				8.27	8.3	14.9	10.1			25	16.7	1,085,000						-17
5	2011					0.0	45.2	27.5			72.7	72.7	1,119,400						-73
6	2012					0.0	35.4	21.4			56.8	56.8	1,153,800						-57
7	2013					0.0	35.2	21.2			56.4	56.4	1,188,200						-56
8	2014			3.1		3.1	0.0	0.0	8.1		8.1	5.0	1,222,600		2.2		31.0	28.7	24
9	2015			3.1		3.1	0.0	0.0	8.1		8.1	5.0	1,257,000		2.2		31.8	29.6	25
10	2016			3.1		3.1			8.1		8.1	5.0	1,296,800		2.2		32.8	30.6	26
11	2017			3.1		3.1			8.1		8.1	5.0	1,336,600		2.2		33.8	31.6	27
12	2018			3.1	8.27	11.4			8.1		8.1	-3.3	1,376,400		2.2		34.9	32.6	36
13	2019			3.1		3.1			8.1		8.1	5.0	1,416,200		2.2		35.9	33.6	29
14	2020			3.1		3.1			8.1		8.1	5.0	1,456,000		2.2		36.9	34.7	30
15	2021			3.1		3.1			8.1		8.1	5.0	1,502,400		2.2		38.0	35.8	31
16	2022			3.1		3.1			8.1		8.1	5.0	1,548,800		2.2		39.2	37.0	32
17	2023			3.1		3.1			8.1		8.1	5.0	1,595,200	0.21	2.2	2.11	40.4	38.2	33
18	2024			3.1		3.1			8.1		8.1	5.0	1,641,600	USD/	2.2	USD/	41.6	39.4	34
19	2025			3.1		3.1			8.1		8.1	5.0	1,688,000	person/	2.2	person/	42.7	40.5	36
20	2026			3.1	8.27	11.4			8.1		8.1	-3.3	1,688,000	month	2.2	month	42.7	40.5	44
21	2027			3.1		3.1			8.1		8.1	5.0	1,688,000		2.2		42.7	40.5	36
22	2028			3.1		3.1			8.1		8.1	5.0	1,688,000		2.2		42.7	40.5	36
23	2029			3.1		3.1			8.1		8.1	5.0	1,688,000		2.2		42.7	40.5	36
24	2030			3.1		3.1			8.1	106.2	114.32	111.2	1,688,000		2.2		42.7	40.5	-71
25	2031			3.1		3.1			8.1		8.1	5.0	1,688,000		2.2		42.7	40.5	36
26	2032			3.1		3.1			8.1		8.1	5.0	1,688,000		2.2		42.7	40.5	36
27	2033			3.1		3.1			8.1		8.1	5.0	1,688,000		2.2		42.7	40.5	36
28	2034			3.1	8.27	11.4			8.1		8.1	-3.3	1,688,000		2.2		42.7	40.5	44
29	2035			3.1		3.1			8.1		8.1	5.0	1,688,000		2.2		42.7	40.5	36
30	2036			3.1		3.1			8.1		8.1	5.0	1,688,000		2.2		42.7	40.5	36
31	2037			3.1		3.1			8.1		8.1	5.0	1,688,000		2.2		42.7	40.5	36
32	2038			3.1		3.1			8.1		8.1	5.0	1,688,000		2.2		42.7	40.5	36
33	2039			3.1		3.1			8.1		8.1	5.0	1,688,000		2.2		42.7	40.5	36
34	2040			3.1		3.1			8.1		8.1	5.0	1,688,000		2.2		42.7	40.5	36
35	2041			3.1		3.1			8.1		8.1	5.0	1,688,000		2.2		42.7	40.5	36
36	2042			3.1	8.27	11.4			8.1		8.1	-3.3	1,688,000		2.2		42.7	40.5	44
37	2043			3.1		3.1			8.1		8.1	5.0	1,688,000		2.2		42.7	40.5	36
38	2044			3.1		3.1			8.1		8.1	5.0	1,688,000		2.2		42.7	40.5	36
39	2045			3.1		3.1			8.1	106.2	114.32	111.2	1,688,000		2.2		42.7	40.5	-71
40	2046			3.1		3.1			8.1		8.1	5.0	1,688,000		2.2		42.7	40.5	36
Total		0	0	102	41.35	144	136	84	267	212	700	556.0			73		1,337	1,264	708

Unit water price 1) willingness to pay
2) 3 % of average household income

Internal rate of return (EIRR)	11.2%

Table J.16 Calculation of Economic Indicator (Stage 4-2 (3))

Year in Order	Fiscal Year	Economic Cost (Million USD)										Financial Benefit						Cash Balance
		Without Project					With Project						Without Project		With Project			
		Construction Cost					Construction Cost											
		F/C portion	L/C portion	O & M Cost	Re-place -ment Cost	Total	F/C portion	L/C portion	O & M Cost	Re-place -ment Cost	Total	Additional Cost	Served Population	Unit water price 1)	Benefit	Unit water price 2)	Benefit	Additional Benefit	
	2006																		
1	2007					0.0	0.0	0.0			0	0.0	876,500						0
2	2008					0.0	0.5	0.3			0.8	0.8	946,000						-1
3	2009					0.0	5.3	3.3			8.6	8.6	1,015,500						-9
4	2010				8.27	8.3	14.8	10.3			25.1	16.8	1,085,000						-17
5	2011					0.0	46.8	29.7			76.5	76.5	1,119,400						-77
6	2012					0.0	39.6	24.0			63.6	63.6	1,153,800						-64
7	2013					0.0	39.5	23.9			63.4	63.4	1,188,200						-63
8	2014			3.1		3.1	51.4	3.9	13.2		68.5	65.4	1,222,600		2.2		31.0	28.7	-37
9	2015			3.1		3.1	51.5	4.0	13.2		68.7	65.6	1,257,000		2.2		31.8	29.6	-36
10	2016			3.1		3.1			13.2		13.2	10.1	1,296,800		2.2		32.8	30.6	21
11	2017			3.1		3.1			13.2		13.2	10.1	1,336,600		2.2		33.8	31.6	22
12	2018			3.1	8.27	11.4			13.2		13.2	1.8	1,376,400		2.2		34.9	32.6	31
13	2019			3.1		3.1			13.2		13.2	10.1	1,416,200		2.2		35.9	33.6	24
14	2020			3.1		3.1			13.2		13.2	10.1	1,456,000		2.2		36.9	34.7	25
15	2021			3.1		3.1			13.2		13.2	10.1	1,502,400		2.2		38.0	35.8	26
16	2022			3.1		3.1			13.2		13.2	10.1	1,548,800		2.2		39.2	37.0	27
17	2023			3.1		3.1			13.2		13.2	10.1	1,595,200	0.21	2.2	2.11	40.4	38.2	28
18	2024			3.1		3.1			13.2		13.2	10.1	1,641,600	USD/	2.2	USD/	41.6	39.4	29
19	2025			3.1		3.1			13.2		13.2	10.1	1,688,000	person/	2.2	person/	42.7	40.5	30
20	2026			3.1	8.27	11.4			13.2		13.2	1.8	1,688,000	month	2.2	month	42.7	40.5	39
21	2027			3.1		3.1			13.2		13.2	10.1	1,688,000		2.2		42.7	40.5	30
22	2028			3.1		3.1			13.2		13.2	10.1	1,688,000		2.2		42.7	40.5	30
23	2029			3.1		3.1			13.2		13.2	10.1	1,688,000		2.2		42.7	40.5	30
24	2030			3.1		3.1			13.2	78.8	92	88.9	1,688,000		2.2		42.7	40.5	-48
25	2031			3.1		3.1			13.2		13.2	10.1	1,688,000		2.2		42.7	40.5	30
26	2032			3.1		3.1			13.2		13.2	10.1	1,688,000		2.2		42.7	40.5	30
27	2033			3.1		3.1			13.2		13.2	10.1	1,688,000		2.2		42.7	40.5	30
28	2034			3.1	8.27	11.4			13.2		13.2	1.8	1,688,000		2.2		42.7	40.5	39
29	2035			3.1		3.1			13.2		13.2	10.1	1,688,000		2.2		42.7	40.5	30
30	2036			3.1		3.1			13.2		13.2	10.1	1,688,000		2.2		42.7	40.5	30
31	2037			3.1		3.1			13.2		13.2	10.1	1,688,000		2.2		42.7	40.5	30
32	2038			3.1		3.1			13.2		13.2	10.1	1,688,000		2.2		42.7	40.5	30
33	2039			3.1		3.1			13.2		13.2	10.1	1,688,000		2.2		42.7	40.5	30
34	2040			3.1		3.1			13.2		13.2	10.1	1,688,000		2.2		42.7	40.5	30
35	2041			3.1		3.1			13.2		13.2	10.1	1,688,000		2.2		42.7	40.5	30
36	2042			3.1	8.27	11.4			13.2		13.2	1.8	1,688,000		2.2		42.7	40.5	39
37	2043			3.1		3.1			13.2		13.2	10.1	1,688,000		2.2		42.7	40.5	30
38	2044			3.1		3.1			13.2		13.2	10.1	1,688,000		2.2		42.7	40.5	30
39	2045			3.1		3.1			13.2	78.8	92	88.9	1,688,000		2.2		42.7	40.5	-48
40	2046			3.1		3.1			13.2		13.2	10.1	1,688,000		2.2		42.7	40.5	30
Total		0	0	102	41.35	144	249	99	436	158	942	798			73		1,337	1,264	465

Unit water price 1) willingness to pay

2) 3 % of average household income (average income=836,000 ID/household/month, 3% of income= 2.11 USD/person/month)

Internal rate of return (EIRR)	5.9%

J.5 Data Source of Electricity Cost for Economic Evaluation

Data Source: Middle East Economic Survey

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The Real Cost To Iraq Of Imported Electricity

By Isam AlKhalisi

The following article was written for MEES *by Isam AlKhalisi, an independent consultant who worked in the construction, operation and management of power plants for Iraq's National Electricity Administration, subsequently on design and project management of power plants and other public utility systems. Email: isam.alkhalisi@ntlworld.com*

Iraq's public electricity system has not satisfied consumers' needs since the 1991 war. But whilst the level of supply slowly climbed towards satisfying around 75% of the citizens' needs by March 2003, since then the demand for electricity has risen by a further 50%. There have been many expedient and short-fix solutions to the shortfall, some of which have been at best ineffectual, and others of vast waste to Iraqi and donors' funds.

Western press and official inspectors' and auditors' reports, as well as those in the Iraqi media, have covered some of the failings of the industry, but none has raised the implications of the long-term cost of imported electricity on Iraq's economy, one of the world's major producers of the primary feed for electricity production. Yet, at the official level, electricity importation is being proceeded with and promoted as being a major, even indispensable, factor to improve Iraq's public electricity supply situation for years to come.

In a recent article in an Arab newspaper, based on interviews with Iraqi officials on the state of the country's electricity industry, it was stated that "the Iraqis will have to request help from their neighbor Iran to extricate them from the energy crisis, sooner or later". Such a fatalistic declaration of helplessness provides negative hope for the future of the industry in Iraq and its management.

Jordanian Model

In order to put the cost of electricity imports to Iraq's national economy in the right perspective, the following observation is put forward:

The Jordanian Central Electricity Generation Company, in its published accounts for 2004, showed the inclusive cost elements of sold (exported) electricity from power stations to the national network per kWhr to be:

	Cost Of Exported Power To The Jordanian Network	
	Fils/KWr	**%**
Fuel	20.15	70.91
Depreciation	4.33	15.24
Interests on Loans	1.63	5.74
Operation and Maintenance	0.69	2.42
Salaries and Wages	0.84	2.94
Others	0.78	2.75
Unit Cost JFils/kWhr	28.42	100.00
Unit Cost USCent/kWhr	4.01	

The above figures are consistent with other international costing calculations for similar installations. No comparative calculations for the Iraqi system are known to exist or can be used with confidence.

Using the Jordanian figures as benchmarks, it will be noted that, when applied for Iraq, the cost per unit to the national economy of indigenously-generated electricity – which would include only capital payback, interests and O & M – would be 6.6 Jordanian fils per kWhr, less than 1 US cent. Other costs such as fuel, salaries and overheads are locally generated, and do not impose a drain on the national economy.

Indeed, if local elements, which range from 15% to 25% of the capital cost, are taken into consideration, and if the capital is treated as an outgoing expense as it is when purchasing electricity for consumption from abroad, ie no interest payable, then net generation cost to the country will be even less than 0.8 US cents per unit.

Power Supplied By Turkey

On the other hand, in February 2005 during the caretaker phase of the Provisional Government, a no-bid contract was signed with a Turkish electricity wholesale company to (1) supply 300mw for five years at 7.00 cents per unit, and (2) supply an additional 700mw for five years at 5.85 cents per unit. Both tariff figures are subject to annual escalation. The cost to Iraq's economy of buying imported electricity from the Turkish company is, therefore, up to seven times more than if the electricity was generated locally. Furthermore, nationally owned assets are normally financed by long-term loans, rather than on monthly accounts as is the case for the purchased electricity.

The potential total cost of the Turkish contract is $2.6bn, enough to engineer, purchase, install and set to work more than 2,000mw of generation capacity installed around the country, with all appurtenances and connections to the grid and all the long-term benefits that would entail.

As well as the Turkish imports, Iraq also imports smaller amounts of electricity from Syria and Iran, with plans to raise imports from the latter from the present 100mw to 1,500mw. Moreover, negotiations were ongoing for over a year until early 2006 to import electricity from a specially-formed private Virgin Islands/Kuwaiti company, also on a no-bid basis, of 100mw+500mw at 5.999 cents per unit for seven years. The potential minimum "take-or-pay" total cost of this contract to Iraq would be $1.89bn.

The level of tariff(s) for electricity imports from Iran have not been made public, but are assumed to be in the range of the imported or projected Turkish and Kuwaiti companies' tariffs. The Jordanian model above shows the actual cost of exporting electricity to the network is 28.42 J fils/kWhr (approximately 4.01 US cents/kWhr).

Jordan produces a modest amount of natural gas, and Turkey has hydroelectric power stations, but the majority of electricity produced in both countries is derived from imported fossil fuels. The cost of electricity generation in Turkey and Jordan must, therefore, be similar as both are related to fuel costs prevailing in the international market. Surpluses for the Turkish exporting company from sales of over 8.5bn kWhr units per annum can, therefore, be reasonably estimated even after allowing for a small amount of wheeling cost to the Iraqi borders. It also explains the willingness of Iran, with its own indigenous fuel sources, to invest $1bn in preparation for the ultimate export to Iraq of 1,500mw, or over 13bn kWhr units per annum.

Short-Term Imports Only

Imported electricity may be necessary for Iraq's immediate and urgent needs but it should not be allowed for the long-term periods envisaged at present. Most advanced countries are interconnected in grid systems and have two-way energy exchanges, mostly on a daily basis, to catch shifting peak loads. Only in exceptional circumstances where vast differences in production cost, such as from hydro sources against imported oils, is one-way electricity feed through national boundaries normally contemplated, as is the case in Italy and Switzerland. Even there, Italy is reviewing its energy policy so as not to be dependant on a foreign country.

In Iraq, with its unique primary energy production potential, electricity imports of such magnitude and long-term duration – and at international pricing levels – will drain considerable liquid assets. Such measures also deprive its people, at a time of such high unemployment, of thousand of quality job opportunities. Employment opportunities will also be lost in the related sector of the oil industry. Nor will imported electricity be more reliable than local generation, since it still has to be transported through long transmission lines which are the most vulnerable link in the chain of public electricity supply.