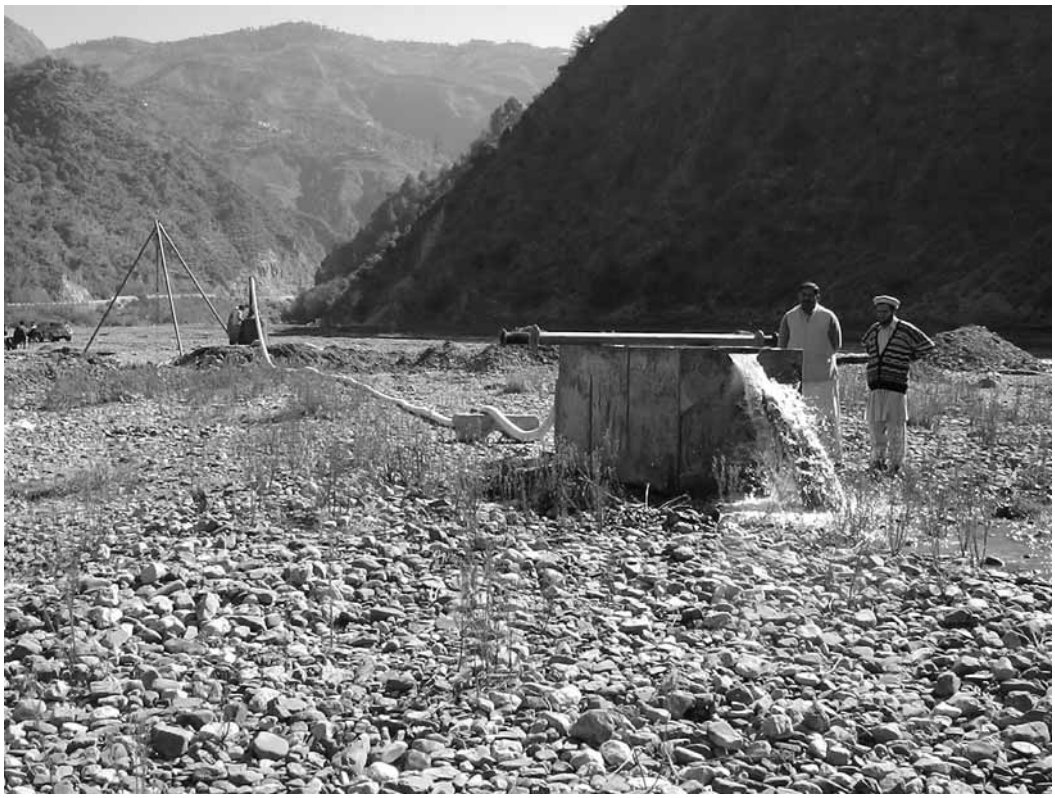
① Electric Prospecting （Damtor Site）

②Casing Pipe for Pumping Test

③ Damtor Test Digging and Pumping TestSite)

④ Installation of Casing Pipe for Pumping Test at Damtor Site



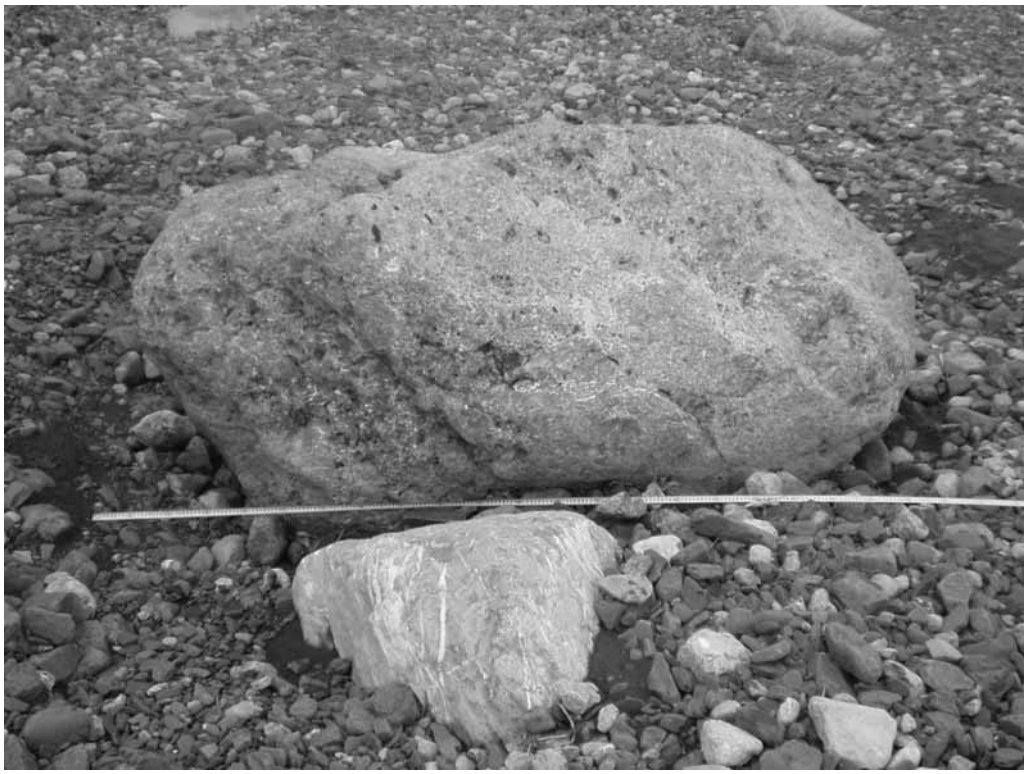
⑤ Pumping Test at Damtor Site

⑥ Pumping Test Site at Damtor

⑦ Pumping Test Site at Harnoi

⑧ Installation of Casing Pipe for Pumping Test at Harnoi Site

⑨ Pumping Test at Harnoi Site



⑩ Large Bolders at Harnoi Riverbed

Appendix 6-2 Population Projection in the Project Area

Area	Number of Houses				Population Projection with Census Data				Projection by the number of houses and taps		2010
	House	Out of Service Area	Enclave	Sum	Population in 1998 by Census Data	Population Growth Rate ('81–'98)	2003 Projection	2010 Projection	2003 8.7persons/house	2010 Population Projection	Population Projection in the Service Area
Abbottabad TMA	–	–	–	–	47,609	2.3%	53,340	62,540	–	–	62,540
Nawanshehr TMA	3,340	–	–	3,340	19,871	1.9%	21,830	24,910	29,060	33,150	33,150
Sheikhul Bandi UC	1,239	–	891	2,130	18,193	3.1%	21,190	26,240	10,780	13,350	13,350
Salhad UC	1,860	1,060	–	2,920	21,211	2.6%	24,120	28,860	16,180	19,360	19,360
Mirpur UC	1,691		–	1,691	18,765	3.9%	22,720	29,700	14,710	19,230	19,230
Jhangi UC											
Derawanda Area	1,107	–	–	1,107	–	–	–	–	9,630	12,090	12,090
Band Ali Khan											
Banda Quazi											
Banda Patang											
Jhangi Area	578	–	–	578	–	–	–	–	5,030	6,310	6,310
Lama Maira Area	542	–	–	542	–	–	–	–	4,720	5,920	5,920
Banda Ghazan Area	427	–	276	703	–	–	–	–	6,120	7,680	7,680
Banda Ghazan											
Banda Sher Khan											
Banda Faizullah											
Banda Noor Ahmed											
Banda Laman											
Banda Derazak Area	0	–	615	615	–	–	–	–	5,350	6,720	6,720
Banda Jalal											
Banda Derazak											
Banda Phugwarian	695	–	–	695	–	–	–	–	6,050	7,590	7,590
Dehli											
Banda Phugwarian											
Banda Patang											
Dobathar	1,024	–	–	1024	–	–	–	–	8,910	11,180	11,180
Banda Amlok											
Dobathar											
Jhungi Total	4,373	–	891	5,264	26,226	3.3%	30,850	38,720	45,810	57,490	57,490

Note: Survey of Housing Number was conducted by the Abbottabad Works & Services Dept.in Augast 2003

Population of Sheikhul Bandi UC enclave, which exists in Banda Ghazan area and Banda Derazak area, that belong to Sehkhul Bandi UC, counts each area as service population.

Appendix 6-3 Results of Water Quality Test

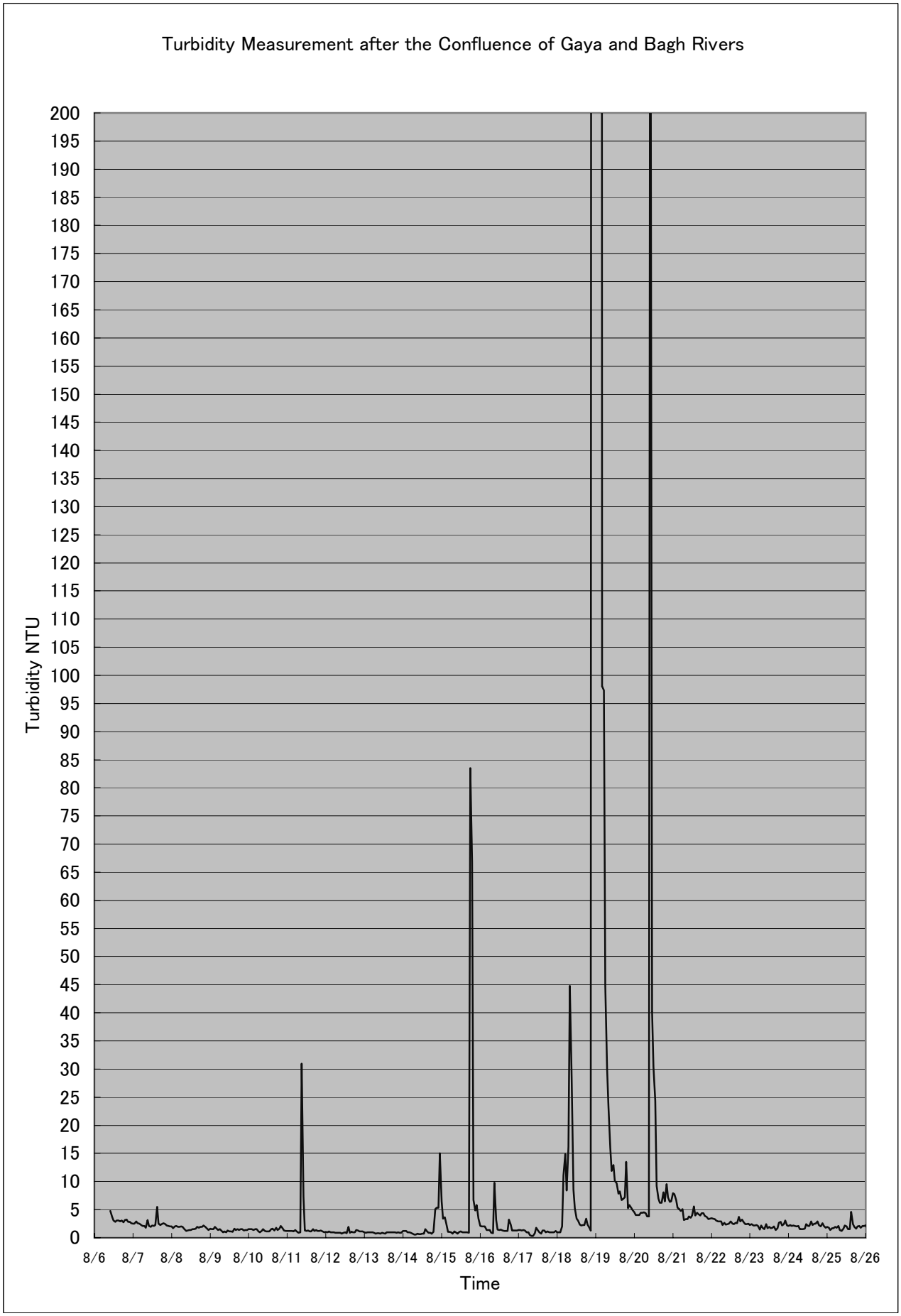
Water Quality in Intake Candidate River

Items		WHO	Gaya River	Bagh River	Namly Maira River
Date of water sampling			2003/08/11	2003/08/11	2003/08/11
Weather condition			fine	cloudy	fine
Air temperature ℃			28.6	24.2	28.6
Chracteristic					
1 Temperature of river			20.7	19.4	23.1
2 pH		6.5-8.5	8.56	8.50	8.60
3 Conductivity	micro-S/cm		295	298	329
4 Turbidity	NTU	5	4.06	2.49	1.66
5 Chromaticity	TCU	15	less	less	less
6 Odor			odorless	odorless	odorless
7 Taste			no objectionable	no objectionabl	no objectionable
8 Total Solid	mg/l	1000	166	169	194
Element					
9 Fe	mg/l	0.3	nil	nil	nil
10 Mn	mg/l	0.1	nil	nil	nil
11 Mg	mg/l	150	12	12	8
12 Cl	mg/l	250	3	3	3
13 Ca	mg/l		40	40	47
14 K	mg/l		1	0.7	1
15 Na	mg/l	200	3	4	5
16 CO3	mg/l		110	110	70
17 HCO3	mg/l		40	40	40
18 F	mg/l	1.5	0.07	0.14	0.17
19 Cr	ppb	50	bdl	bdl	bdl
20 Cu	ppb	2000	bdl	bdl	bdl
21 Cd	ppb	3	bdl	bdl	bdl
22 Hg	ppb	1	bdl	bdl	bdl
23 Pb	ppb	10	bdl	bdl	bdl
24 Se	ppb	10	bdl	bdl	bdl
25 Zn	ppb	3000	bdl	bdl	bdl
26 As	ppb	10	nil	nil	nil
Compound/others					
27 NH3	mg/l	1.5	nil	nil	nil
28 NO2	mg/l	3	nil	nil	nil
29 NO3	mg/l	50	1	1	1
30 SO4	mg/l	250	17	15	61
31 Alkalinity	m.mol/l		3	3	2.2
32 Hardness	mg/l	500	150	150	150
Bacteria					
33 Coliform group bacteria	MPN		nil	25	21	35
34 Fecal coliform	MPN		nil	>16	>16	>16
35 General bacteria	N/100ml		nil	115	32	110

bdl: below detection lim nil: not detected

Turbidity Fluctuation at the point below the confluence of Bagh and Gaya　2003/08/06～/25　　Unit: NTU

Date	Time	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6	7	8	9	Day Ave.
06th Aug	Climate	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◑	◑	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	
	Turbidity	4.8	3.7	3.1	2.8	3.1	3.0	2.9	3.1	2.8	3.2	3.3	2.8	2.8	2.6	2.5	2.5	2.9	2.6	2.5	2.3	2.1	2.1	1.8	3.1	2.9
07th Aug	Climate	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◑	◑	◑	◑	◑	●	●	◎	
	Turbidity	2.1	1.9	2.2	2.1	2.3	5.5	2.5	2.3	2.4	2.6	2.4	2.2	2.1	2.0	2.0	1.7	2.0	2.1	1.9	1.9	2.0	1.9	1.5	1.2	2.2
08th Aug	Climate	◑	◑	◑	◎	◎	◎	◑	◑	◑	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◑	◑	
	Turbidity	1.3	1.4	1.4	1.5	1.5	1.6	1.9	1.8	1.9	1.9	2.2	1.9	1.7	1.4	1.6	1.5	1.5	1.9	1.6	1.4	1.5	1.3	1.0	1.1	1.6
09th Aug	Climate	◑	◑	◑	◎	◎	◎	◎	◎	◎	◑	◑	◎	◎	◑	◑	◑	●	◑	◑	◑	◑	◑	◑	◎	
	Turbidity	1.0	1.3	1.1	1.1	1.0	1.6	1.4	1.5	1.4	1.5	1.5	1.3	1.4	1.4	1.5	1.5	1.5	1.4	1.5	1.5	1.1	1.0	1.2	1.5	1.3
10th Aug	Climate	◎	◑	◑	◑	◑	◑	◑	◑	◑	●	◑	◑	◑	◎	◎	◎	◎	◎	◎	◎	◎	◎	◑	●	
	Turbidity	1.2	1.1	1.1	1.1	1.5	1.6	1.3	1.8	1.4	1.6	2.1	1.7	1.3	1.2	1.2	1.2	1.2	1.2	1.1	1.4	1.1	0.9	1.0	31.0	2.6
11th Aug	Climate	●	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◑	◎	◎	
	Turbidity	7.3	1.3	1.2	1.3	1.1	1.1	1.5	1.2	1.4	1.2	1.2	1.3	1.1	1.0	1.0	1.0	1.1	1.0	1.0	1.0	0.9	0.9	0.9	0.9	1.4
12th Aug	Climate	◎	◎	◎	◎	◎	◎	◎	●	●	●	◑	◑	◑	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	
	Turbidity	0.7	0.9	1.0	0.8	1.9	0.9	1.0	1.0	1.0	1.4	1.3	1.1	1.1	1.1	1.0	0.9	1.0	1.0	1.0	1.0	0.9	0.7	0.8	0.8	1.0
13th Aug	Climate	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◑	◎	◑	◑	◑	◑	◑	◑	◑	◑	◑	◑	◑	◑	
	Turbidity	0.7	0.9	0.8	0.8	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	0.9	0.9	1.2	1.2	1.2	1.0	1.0	0.9	0.7	0.6	0.6	0.7	0.9
14th Aug	Climate	◑	◑	◑	◑	◑	◑	◑	◑	◑	●	●	◑	◑	◑	◑	◑	◑	◑	◑	◑	◑	◎	◎	◎	
	Turbidity	0.7	0.7	0.7	0.8	1.5	1.1	0.9	0.9	0.8	1.1	5.1	5.3	5.3	15	6.5	3.4	3.6	2.6	1.1	1.0	1.0	0.8	1.2	0.9	2.6
15th Aug	Climate	◎	◎	◎	◎	◎	◎	◎	◎	●	◑	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◑	◑	●	
	Turbidity	0.7	1.1	1.1	1.0	1.0	1.0	0.9	0.9	83.5	66.8	6.7	4.8	5.8	3.4	2.1	2	2	2	1.4	1.4	1.4	0.9	0.8	9.8	8.4
16th Aug	Climate	◑	◑	◑	◑	◑	●	◑		●	◑	◎	◎	◎	◎	◎	◎	◎	◎	◎	◑	◎	◎	◎	◎	
	Turbidity	3.1	1.5	1.4	1.5	1.3	1.3	1.2	1.2	3.3	2.3	1.3	1.3	1.3	1.3	1.4	1.4	1.3	1.4	1.3	1.0	1.0	0.5	0.4	0.3	1.4
17th Aug	Climate	◎	◎	◑	●	◑	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◑	●	●	◑	◑	●	●	●	
	Turbidity	0.8	1.8	1.3	1.0	0.8	1.3	1.3	1.0	1.1	1.0	1.0	0.9	1.0	1.2	1.0	1.0	1.0	2.1	11.1	14.9	8.4	16.2	44.8	28.6	6.0
18th Aug	Climate	◑	◑	◑	◑	◑	◑	◑		◑	◑	●	●	●	●	●	●	●	●	●	●	●	◑	◑	◑	
	Turbidity	8.6	5.3	3.4	3.1	2.3	2.2	2.3	2.3	3.4	2.4	1.8	1.3	1000	1000	1000	1000	1000	1000	98.1	97.3	44.9	30.1	23.4	16.0	14.5
19th Aug	Climate	◑	◑	◑	◑	◑	◑	◑	◑	◑	◑	◑	◎	◎	◎	◑	◑	●	◑	●	●	●	◑	◑	●	
	Turbidity	11.9	12.9	10.1	9.7	7.9	8.3	6.7	6.9	7.2	13.5	5.2	5.8	5.4	5.0	4.5	4.0	4.0	4.1	4.5	4.5	4.5	4.4	3.8	3.8	6.6
20th Aug	Climate	●	◑	◑	◎	◑	◑	◑	●	◑	◑	◑	◑	◑	◑	◑	◑	◑	◑	◎	◎	◎	◎	◎	◎	
	Turbidity	271	40.2	30.4	24.3	9.2	7.0	6.2	6.3	8.1	6.5	9.6	7.2	6.4	7.5	7.9	7.8	6.7	5.3	5.1	4.8	5.1	3.2	3.3	3.3	20.5
21th Aug	Climate	◑	◎	◑	◎	◎	◎	◎	◑	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	
	Turbidity	3.8	3.5	4.0	5.6	4.0	4.5	4.2	4.0	4.4	4.4	3.9	3.7	3.3	3.4	3.5	3.4	3.3	3.1	2.9	2.9	2.9	2.3	2.7	2.4	3.6
22th Aug	Climate	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	
	Turbidity	2.5	2.5	2.9	2.5	2.4	2.7	2.6	3.7	2.9	3.2	2.8	2.4	2.4	2.5	2.3	2.4	2.2	2.2	2.3	2.1	1.5	2.2	1.7	1.5	2.4
23th Aug	Climate	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	
	Turbidity	2.4	1.7	1.9	1.7	1.8	2.0	1.4	1.7	2.7	2.8	2.2	2.4	3.1	2.2	2.1	2.3	2.1	2.2	2.1	2.0	2.1	1.5	1.5	1.5	2.1
24th Aug	Climate	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	
	Turbidity	1.6	2.4	2.1	2.1	2.9	2.3	2.5	2.5	2.9	2.3	2.0	2.6	2.1	1.8	1.9	1.8	1.4	1.7	1.7	1.9	1.8	2.1	1.4	1.2	2.0
25th Aug	Climate	◎	◑	◑	◑	◎	◎	◎	◎	◎	◎	◎	◎	◑	◑	◑	◑	●	◑	◑	◑	◑	◑	◑	●	
	Turbidity	1.6	2.2	2.0	1.5	1.5	4.6	2.4	1.9	1.6	2.0	2.1	1.8	2.1	2.1	2.2	1.7	1.5	1.9	1.6	1.8	1.6	1.3	1.4	1.1	1.9
			◎	Fine		◑	Cloudy		●	Rain																4.3


Turbidity Measurement after the Confluence of Gaya and Bagh Rivers
Turbidity NTU
200
195
190
185
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8/6 8/7 8/8 8/9 8/10 8/11 8/12 8/13 8/14 8/15 8/16 8/17 8/18 8/19 8/20 8/21 8/22 8/23 8/24 8/25 8/26
Time

Appendix 6-3 Results of Water Quality Test

Existing Well (1)

Item		WHO	Derwanda	Zhange	Banda Phugwarian
Date of water sampling			2003. 07. 29	2003. 07. 29	2003. 07. 29
Weather condition			Fine	Fine	Fine
Air temperature ℃			26.5	29.8	28.5
Characteristic					
1 Temperature of river			19.1	19.8	21.1
2 pH		6.5-8.5	7.37	7.0	7.2
3 Conductivity	m-s/cm		438	598	386
4 Turbidity	NTU	5	0.02	0.02	0.01
5 Chromaticity	TCU	15	less	less	less
6 Odor			odorless	odorless	odorless
7 Taste			Non-objectionable	Non-objectionable	Non-objectionable
8 Total Solid	mg/l	1000	252	349	220
Element					
9 Fe	mg/	0.3	0.016	0.006	0.035
10 Mn	mg/	150	BLD	BLD	BLD
11 Mg	mg/	150	12	17	15
12 Cl	mg/	250	16	18	9
13 Ca	mg/		64	86	48
14 K	mg/		1.3	1.1	0.7
15 Na	mg/	200	11	15	11
16 CO3	mg/		210	280	195
17 HCO3	mg/		nil	nil	nil
18 F	ppb	1.5	0.17	0.14	0.22
19 As	ppb	10	0.2	0.1	0.4
Compound/others					
20 NH3	mg/l	1.5	nil	nil	nil
21 NO2	mg/l	3	nil	nil	nil
22 NO3	mg/l	50	4	7	4
23 SO4	mg/l	250	6	12	4
24 Alkalinity	m.mol/l		4.2	5.6	3.9
25 Hardness	mg/l	500	210	285	180
Bacteria					
26 Coliform group bacteria	MPN	nil	2	16	nil
27 Fecal coliform	MPN	nil	nil	5	nil

Existing Well (2)

Item		WHO	Suhad	Sheikul Bandi	Mirpur
Date of water sampling			2003. 07. 29	2003. 07. 29	2003. 07. 29
Weather condition			Fine		Fine
Air temperature ℃			30.3	30.8	
Characteristic					
1 Temperature of river			19.2	20.3	
2 pH		6.5-8.5	7.0	7.0	7.5
3 Conductivity	m-s/cm		532	698	580
4 Turbidity	NTU	5	Nil	0.01	4.8
5 Chromaticity	TCU	15	Less	Less	Less
6 Odor			odorless	odorless	odorless
7 Taste			unobjectionable	unobjectionable	unobjectionable
8 Total Solid	mg/l	1000	303	397	328
Element					
9 Fe	mg/	0.3	0.074	0.015	Nil
10 Mn	mg/	150	BLD	3.16	BLD
11 Mg	mg/	150	24	28	27
12 Cl	mg/	250	14	26	12
13 Ca	mg/		60	88	75
14 K	mg/		0.9	1.8	1.8
15 Na	mg/	200	17	16	8
16 CO3	mg/		250	295	280
17 HCO3	mg/		Nil	Nil	Nil
18 F	ppb	1.5	0.17	0.2	0.16
19 As	ppb	10	0.1	0.3	0.2
Compound/others					
20 NH3	mg/l	1.5	Nil	Nil	Nil
21 NO2	mg/l	3	Nil	Nil	Nil
22 NO3	mg/l	50	6	10	4.8
23 SO4	mg/l	250	7	16	15
24 Alkalinity	m.mol/l		5	5.9	5.6
25 Hardness	mg/l	500	250	335	300
Bacteria					
26 Coliform group bacteria	MPN	nil	Nil	16	Nil
27 Fecal coliform	MPN	nil	Nil	2	Nil

Existing Well (3)

Item		WHO	Stony Seal	Nawanshehr	Narian
Date of water sampling			2003. 08. 07	2003. 08. 07	2003. 08. 07
Weather condition			Fine	Fine	Fine
			31.4	29.5	30.5
Characteristic					
1 Temperature of river			18.4	20.4	21.2
2 pH		6.5-8.5	7.5	7.4	7.3
3 Conductivity	m-s/cm		610	430	525
4 Turbidity	NTU	5	3.6	1.6	0.3
5 Chromaticity	TCU	15	Less	Less	Less
6 Odor			odorless	odorless	odorless
7 Taste			unobjectionable	unobjectionable	unobjectionable
8 Total Solid	mg/l	1000	340	240	298
Element					
9 Fe	mg/	0.3	nil	nil	Nil
10 Mn	mg/	150	BLD	BLD	BLD
11 Mg	mg/	150	25	23	24
12 Cl	mg/	250	12	12	12
13 Ca	mg/		82	50	60
14 K	mg/		1.2	0.9	2
15 Na	mg/	200	8	3	9
16 CO3	mg/		300	220	260
17 HCO3	mg/		nil	nil	Nil
18 F	ppb	1.5	0.15	0.13	0.17
19 As	ppb	10	0.2	0.13	0.23
Compound/others					
20 NH3	mg/l	1.5	nil	nil	Nil
21 NO2	mg/l	3	nil	nil	Nil
22 NO3	mg/l	50	3.6	1.6	4
23 SO4	mg/l	250	15	9	12
24 Alkalinity	m.mol/l		6	4.4	5.2
25 Hardness	mg/l	500	310	220	250
Bacteria					
26 Coliform group bacteria	MPN	nil	16	5	5
27 Fecal coliform	MPN	nil	nil	nil	Nil

Existing Well (4)

Item		WHO	Social Action
Date of water sampling			2003. 08. 07
Weather condition			Fine
			31.4
Characteristic			
1 Temperature of river			19.8
2 pH		6.5-8.5	7.3
3 Conductivity	m-s/cm		524
4 Turbidity	NTU	5	0.02
5 Chromaticity	TCU	15	Less
6 Odor			odorless
7 Taste			unobjectionable
8 Total Solid	mg/l	1000	288
Element			
9 Fe	mg/	0.3	Nil
10 Mn	mg/	150	BLD
11 Mg	mg/	150	24
12 Cl	mg/	250	12
13 Ca	mg/		60
14 K	mg/		1.9
15 Na	mg/	200	9
16 CO3	mg/		260
17 HCO3	mg/		Nil
18 F	ppb	1.5	0.12
19 As	ppb	10	0.29
Compound/others			
20 NH3	mg/l	1.5	Nil
21 NO2	mg/l	3	Nil
22 NO3	mg/l	50	3
23 SO4	mg/l	250	11
24 Alkalinity	m.mol/l		5.2
25 Hardness	mg/l	500	250
Bacteria			
26 Coliform group bacteria	MPN	nil	Nil
27 Fecal coliform	MPN	nil	Nil

Appendix 6-4 Precipitation

At Kakul Station

(Unit : mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1961	122.2	74.2	73.7	254.3	109.5	47.2	255.0	231.4	190.2	57.9	94.7	34.5	1544.8
1962	12.4	79.2	151.6	81.0	79.2	39.6	292.4	271.8	102.1	7.9	21.1	87.4	1225.7
1963	0.0	76.7	167.6	127.3	96.8	30.0	171.2	202.2	125.0	22.4	92.5	38.6	1150.3
1964	171.2	52.6	63.8	105.9	50.0	10.4	344.7	152.7	204.7	6.1	3.0	64.0	1229.1
1965	52.8	216.9	141.0	251.7	130.6	37.1	134.9	129.5	58.2	29.5	47.5	15.5	1245.2
1966	0.0	151.1	191.8	107.9	112.8	98.0	220.0	262.6	128.5	136.1	0.0	50.3	1459.1
1967	3.0	191.3	146.6	140.5	85.3	31.0	245.9	356.4	103.9	37.8	9.9	129.0	1480.6
1968	115.1	82.8	67.6	63.5	90.2	86.9	230.1	296.9	4.8	81.3	54.4	93.2	1266.8
1969	38.6	132.6	111.5	75.9	83.1	20.6	183.6	208.8	78.5	173.0	22.4	0.0	1128.6
1970	69.8	104.6	145.3	36.8	36.6	55.9	160.3	298.4	150.6	82.5	0.0	18.0	1158.8
1971	20.6	212.9	16.5	106.2	28.4	374.9	151.9	235.2	39.9	4.8	15.5	23.4	1230.2
1972	113.5	112.8	140.2	99.1	36.1	51.6	85.3	322.1	88.4	91.9	61.7	90.2	1292.9
1973	134.6	97.3	145.3	64.0	89.2	195.1	253.7	373.1	85.3	43.7	1.3	23.4	1506.0
1974	45.0	116.4	61.6	35.9	103.2	80.3	276.8	254.7	105.3	1.3	0.0	79.8	1160.3
1975	62.8	148.4	124.6	149.7	84.8	115.9	315.7	358.4	98.2	1.0	10.7	22.6	1492.8
1976	110.5	194.5	189.1	82.4	64.9	136.2	313.3	300.6	100.4	78.3	0.0	10.0	1580.2
1977	123.2	40.9	35.6	223.7	164.8	125.7	302.4	254.8	135.6	100.3	31.8	59.8	1598.6
1978	77.1	70.8	199.5	52.1	32.0	144.5	494.6	291.9	153.8	7.4	84.8	6.3	1614.8
1979	85.5	100.1	170.5	160.5	69.6	34.6	242.6	182.8	49.6	36.8	52.1	25.2	1209.9
1980	75.8	145.0	140.6	11.3	29.0	287.5	241.6	193.4	59.0	78.2	33.1	42.1	1336.6
1981	77.4	105.3	259.1	182.0	116.6	29.0	346.9	231.4	39.5	35.9	2.1	0.0	1425.2
1982	74.8	173.3	188.4	129.5	142.3	23.0	191.8	312.7	7.7	48.3	66.3	64.7	1422.8
1983	91.8	39.6	208.2	175.4	99.1	62.2	272.0	254.6	55.6	75.3	17.7	8.6	1360.1
1984	2.6	103.7	144.4	152.2	13.2	55.8	277.3	352.2	171.2	6.6	50.1	54.3	1383.6
1985	62.8	21.2	57.8	90.4	60.0	12.2	362.4	218.9	111.6	37.5	17.5	186.8	1239.1
1986	19.0	84.4	235.7	128.2	66.2	100.7	274.8	253.8	28.3	140.8	123.2	147.6	1602.7
1987	11.4	141.2	195.5	119.5	198.9	93.1	98.2	224.2	152.6	156.3	0.0	28.0	1418.9
1988	54.7	120.5	166.3	15.0	21.2	117.5	442.5	188.8	35.0	26.2	1.0	105.4	1294.1
1989	51.0	59.3	102.1	50.6	143.8	23.3	295.9	254.7	70.5	74.2	32.2	64.7	1222.3
1990	64.5	159.4	227.6	81.7	11.2	38.6	270.1	369.0	173.3	27.6	8.6	271.2	1702.8
1991	49.7	206.9	215.1	214.0	102.2	58.0	154.2	308.6	138.6	6.5	3.5	41.9	1499.2
1992	232.6	76.7	209.4	104.8	95.6	31.2	299.7	167.0	449.6	44.0	39.0	9.8	1759.4
1993	89.2	66.9	211.2	44.7	60.1	77.4	286.1	62.3	142.9	20.7	34.9	2.1	1098.5
1994	68.9	90.3	116.4	182.7	47.9	148.0	239.7	404.2	38.2	94.4	0.0	169.3	1600.0
1995	21.0	65.8	135.1	170.5	55.6	32.5	305.0	268.0	62.3	15.0	41.9	61.7	1234.4
1996	73.9	112.2	256.2	143.5	44.6	161.9	163.3	206.1	89.0	119.8	19.3	19.3	1409.1
1997	36.0	27.3	135.6	155.0	114.9	219.1	225.1	413.1	69.1	136.2	35.1	15.6	1582.1
1998	64.5	204.0	111.2	222.5	55.7	82.2	185.8	211.6	97.7	45.7	0.5	0.0	1281.4
1999	121.9	45.9	104.0	19.8	37.3	29.9	250.7	237.1	149.5	14.3	93.6	0.0	1104.0
2000	87.0	58.5	70.4	10.8	26.9	99.8	287.6	288.5	130.9	29.6	2.0	50.2	1142.2
2001	0.5	8.8	100.2	95.6	46.7	242.5	201.6	161.1	33.0	10.1	36.1	3.5	939.7
2002	63.1	90.7	76.0	47.6	29.9	83.1	166.3	310.3	127.2	28.9	1.0	22.3	1046.4
Average	67.9	106.3	143.1	113.5	75.4	91.0	250.3	259.0	105.6	54.1	30.1	53.3	1349.5

At Baragali Station

AM&R to automatic rain gauge at Baragali

year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1994	211	433	284	404	331	465	302	293	293	283	362	351	4,012
1995	321	300	374	389	359	212	391	376	184	177	203	65	3,351
1996	362	391	324	475	194	308	359	366	371	314	87	173	3,724
1997	325	257	284	245	182	505	578	244	378	100	115	14	3,227
1998	268	381	116	431	380	148	310	395	243	349	330	305	3,656
1999	358	173	273	343	345	222	110	353	297	207	148	85	2,914
2000	38	211	354	340	352	344	376	181	378	372	466	447	3,859
2001	279	445	470	39	203	166	254	237	160	116	87	74	2,530
2002	186	193	183	145	189	351	245	385	310	190	171	193	2,741
Average	260.889	309.333	295.778	312.333	281.667	302.333	325	314.444	290.444	234.222	218.778	189.667	3,334.9

Appendix 6-5 Results of River Flow Measurement

DOR RIVER FLOW OBSERVATION RECORD (1999 - 2002, at Rojia Village)

unit: cfs

Year	1999				2000												2001												2002												2003							
Date	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	38
1	16.08	11.27	167.83	107.82	107.82	106.80	167.63	167.83	107.82	99.60	99.60	418.00	282.00	88.67	60.48	38.56	39.99	43.89	33.81	39.99	39.99	194.73	65.13	160.77	137.25	92.25	80.45	72.95	53.65	54.71	63.80	79.00	68.09	31.73	54.74	135.05	69.58	72.87	39.39	34.97	42.33	42.33	153.60	102.24	146.52	69.34	58.91	24
2	18.37	11.27	167.83	107.82	107.82	106.80	167.63	167.83	107.82	99.60	99.60	418.00	283.00	88.67	60.48	38.56	39.99	43.89	33.81	39.99	39.99	194.73	65.13	166.41	137.25	92.25	80.45	72.95	53.65	54.71	63.80	79.00	68.09	31.73	54.74	135.05	69.58	72.87	39.39	34.97	42.33	42.33	153.60	102.24	146.52	56.31	58.91	3
3	18.37	10.25	167.83	107.82	107.82	106.80	167.63	167.83	107.82	99.60	99.60	418.00	194.74	88.67	60.48	38.56	39.99	43.89	33.81	39.99	39.99	194.73	54.35	166.41	137.25	92.25	80.45	72.95	53.65	54.71	63.80	78.96	68.09	31.73	49.14	135.05	69.58	72.87	39.39	34.97	42.33	42.33	159.84	102.24	146.52	56.31	58.91	5
4	18.37	10.25	167.83	107.82	107.82	106.80	167.63	167.83	107.82	99.60	99.60	418.00	194.74	88.67	60.48	38.56	39.99	38.56	33.81	39.99	33.81	194.73	54.35	124.78	137.25	92.25	80.45	72.95	53.65	54.71	63.80	78.96	60.09	31.73	49.14	135.05	59.89	72.87	39.39	34.97	42.33	42.33	159.84	96.00	121.57	56.31	58.91	5
5	17.22	10.25	167.83	107.82	107.82	106.80	167.63	167.83	107.82	99.60	99.60	418.00	194.74	88.67	60.48	38.56	39.99	38.56	33.81	39.99	33.81	194.73	43.95	124.78	137.25	112.50	80.45	72.95	53.65	51.52	63.80	78.96	60.09	31.73	49.14	72.07	59.89	72.87	39.39	34.97	42.33	42.33	159.84	96.00	121.57	56.31	58.91	5
6	17.22	10.25	167.83	107.82	107.82	106.80	167.63	167.83	107.82	99.60	99.60	418.00	194.74	88.67	48.44	38.56	39.99	38.56	33.81	39.99	33.81	194.73	43.95	124.78	137.25	112.50	80.45	72.95	53.65	51.52	63.80	78.96	60.09	24.92	49.14	72.07	59.89	72.87	39.39	34.97	42.33	42.33	151.68	96.00	121.57	56.31	58.91	2
7	16.08	10.25	180.61	107.82	107.82	106.80	167.63	167.83	107.82	99.60	99.60	418.00	194.74	88.67	48.44	38.56	39.99	38.56	33.81	39.99	33.81	194.73	43.95	109.47	147.00	112.50	80.45	72.95	53.65	51.52	63.80	78.96	60.09	24.92	49.14	72.07	59.89	72.87	39.39	30.78	42.33	42.33	151.68	91.20	97.23	56.31	58.91	4
8	16.08	10.25	180.61	107.82	107.82	106.80	167.63	167.83	107.82	99.60	99.60	418.00	194.74	88.67	48.44	38.56	39.99	38.56	33.81	39.99	33.81	194.73	43.95	109.47	147.00	112.50	75.09	72.95	53.65	51.52	133.17	78.96	60.09	24.92	43.95	72.07	59.89	72.87	34.97	30.78	42.33	42.33	129.60	91.20	97.23	56.31	97.89	3
9	16.08	9.22	180.61	107.82	107.82	106.80	167.63	167.83	107.82	99.60	99.60	418.00	186.00	88.67	48.44	38.56	39.99	38.56	33.81	39.99	33.81	194.73	43.95	109.47	147.00	112.50	75.09	72.95	53.65	51.52	133.17	78.96	60.09	24.92	43.95	93.06	59.89	72.87	34.97	30.78	42.33	42.33	129.60	91.20	99.90	56.31	90.96	3
10	16.08	9.22	180.61	107.82	107.82	106.80	167.63	167.83	107.82	99.60	99.60	418.00	186.00	88.67	48.44	38.56	39.99	38.56	33.81	39.99	33.81	194.73	43.95	104.12	147.00	112.50	75.09	72.95	53.65	51.52	133.17	78.96	60.09	24.92	43.95	93.06	59.89	72.87	34.97	30.78	42.33	42.33	129.60	91.20	99.90	56.31	103.95	1
11	16.08	8.20	180.61	107.82	107.82	107.82	107.82	167.83	107.82	99.60	99.60	418.00	186.00	88.67	48.44	38.56	39.99	38.56	33.81	39.99	33.81	194.73	71.92	104.12	147.00	112.50	75.09	72.95	53.65	51.52	79.00	78.96	60.09	24.92	43.95	93.06	91.34	72.87	34.97	30.78	42.33	42.33	129.60	84.48	99.90	51.98	93.56	6
12	16.08	8.20	180.61	107.82	107.82	107.82	107.82	167.83	107.82	99.60	99.60	475.00	186.00	88.67	48.44	38.56	39.99	38.56	33.81	39.99	33.81	194.73	71.92	104.12	147.00	112.50	75.09	72.95	53.65	51.52	79.00	78.96	60.09	24.92	43.95	153.95	77.87	72.87	34.97	30.78	42.33	42.33	129.60	84.48	99.90	51.98	64.98	3
13	16.08	8.20	180.61	107.82	107.82	107.82	107.82	167.83	107.82	99.60	99.60	475.00	186.00	88.67	48.44	38.56	39.99	38.56	33.81	39.99	33.81	499.75	43.63	286.56	159.95	112.50	75.09	72.95	53.65	51.52	79.00	78.96	60.09	24.92	43.95	237.92	77.87	82.85	34.97	30.78	42.33	42.33	121.44	84.48	99.90	51.98	64.98	6
14	16.08	8.20	180.61	107.82	107.82	107.82	107.82	167.83	107.82	99.60	99.60	475.00	186.00	88.67	48.44	38.56	39.99	38.56	33.81	39.99	33.81	499.75	43.63	168.42	167.25	112.50	75.09	72.95	59.27	51.52	79.00	78.96	60.09	24.92	43.95	230.92	77.87	82.85	34.97	30.78	42.33	42.33	121.44	84.48	99.90	51.98	64.98	4
15	16.08	8.20	180.61	107.82	107.82	107.82	107.82	167.83	107.82	99.60	99.60	475.00	186.00	88.67	48.44	38.56	39.99	38.56	33.81	39.99	33.81	530.25	43.63	168.42	167.25	112.50	75.09	72.95	77.49	51.52	79.00	78.96	60.09	24.92	43.95	244.92	77.87	71.38	34.97	30.78	42.33	42.33	121.44	84.48	99.90	51.98	64.98	4
16	14.93	8.20	180.61	107.82	107.82	107.82	107.82	167.83	107.82	99.60	107.82	475.00	186.00	88.67	48.44	38.56	39.99	38.56	33.81	39.99	33.81	530.25	43.63	168.42	167.25	112.50	75.90	72.95	59.27	51.52	79.00	78.96	60.09	24.92	43.95	82.61	77.87	47.53	34.97	30.78	42.33	42.33	121.44	84.48	99.90	51.98	64.98	5
17	14.93	8.20	180.61	107.82	107.82	107.82	107.82	167.83	107.82	99.60	107.82	475.00	186.00	88.67	48.44	38.56	39.99	38.56	33.81	39.99	22.41	530.25	43.63	168.42	167.25	112.50	75.90	72.95	59.27	51.52	79.00	78.96	60.09	24.92	43.95	82.61	77.87	47.53	34.97	30.78	42.33	42.33	121.44	84.48	99.90	51.98	64.98	1
18	13.78	8.20	180.61	107.82	107.82	107.82	107.82	167.83	107.82	99.60	107.82	482.00	186.00	88.67	48.44	38.56	39.99	38.56	33.81	39.99	22.41	530.25	58.33	168.42	157.50	112.50	75.09	72.95	59.27	51.52	79.00	78.96	60.09	24.92	43.95	59.77	74.87	47.53	34.97	30.78	42.33	253.34	121.44	84.48	99.90	51.98	64.98	6
19	13.78	8.20	180.61	107.82	107.82	107.82	107.82	167.83	107.82	99.60	99.60	482.00	186.00	88.67	48.44	38.56	39.99	38.56	33.81	39.99	22.41	492.71	58.33	168.42	157.50	112.50	72.95	72.95	59.27	51.52	79.00	78.96	60.09	24.92	43.95	59.77	74.87	47.53	34.97	30.78	42.33	248.58	121.44	84.48	99.90	51.98	64.98	3
20	11.48	8.20	180.61	107.82	107.82	166.80	107.82	167.83	107.82	99.60	99.60	482.00	186.00	88.67	48.44	38.56	43.89	38.56	33.81	39.99	22.41	492.71	58.33	168.42	139.50	97.50	72.95	50.10	59.27	73.72	79.00	78.96	31.73	24.92	43.95	59.77	74.87	47.53	34.97	30.78	42.33	239.75	110.40	76.80	99.90	51.98	64.98	8
21	11.48	8.20	107.82	107.82	107.82	166.80	107.82	167.83	107.82	99.60	99.60	482.00	186.00	88.67	48.44	38.56	43.89	38.56	33.81	39.99	22.41	492.71	58.33	168.42	139.50	97.50	72.95	50.10	59.27	73.72	79.00	65.87	31.73	24.92	100.73	59.77	74.87	39.39	34.97	30.78	42.33	239.75	110.40	76.80	99.90	69.31	87.60	4
22	11.48	8.20	107.82	107.82	107.82	166.80	191.40	167.83	107.82	99.60	99.60	482.00	166.00	88.67	48.44	38.56	43.89	38.56	33.81	39.99	22.41	492.71	93.63	168.42	139.50	97.50	72.95	50.10	59.27	63.80	63.80	65.87	31.73	24.92	90.22	114.68	74.87	39.39	34.97	30.78	42.33	221.41	110.40	76.80	88.57	69.31	87.60	7
23	62.21	7.17	107.82	107.82	107.82	166.80	191.40	107.82	107.82	99.60	186.21	482.00	166.00	88.67	48.44	38.56	43.89	38.56	33.81	39.99	22.41	492.71	115.87	196.98	99.75	97.50	72.95	38.83	59.27	63.80	63.80	65.87	31.73	57.13	63.94	114.68	74.87	39.39	34.97	37.62	42.33	221.41	102.24	76.80	88.57	69.31	82.53	10
24	18.37	7.17	107.82	107.82	107.82	170.20	191.40	107.82	107.82	99.60	186.21	482.00	166.00	88.67	48.44	38.56	43.89	38.56	33.81	39.99	22.41	281.66	85.10	168.42	99.75	97.50	72.95	38.83	59.27	63.80	63.80	65.87	31.73	99.89	63.94	114.68	74.87	39.39	34.97	37.62	42.33	221.41	102.24	76.80	88.57	58.91	82.53	6
25	16.08	8.20	107.82	107.82	107.82	170.20	191.40	107.82	107.82	99.60	186.21	482.00	166.00	88.67	48.44	38.56	43.89	38.56	33.81	39.99	22.41	281.66	66.32	130.14	99.75	87.00	72.95	38.83	56.08	63.80	153.44	65.87	31.73	50.79	63.94	100.10	74.87	39.39	34.97	37.62	42.33	221.41	102.24	76.80	88.57	58.91	104.31	8
26	16.08	8.20	107.82	107.82	107.82	170.20	191.40	107.82	107.82	99.60	167.83	482.00	166.00	88.67	48.44	38.56	43.89	38.56	33.81	39.99	22.41	241.60	66.32	130.14	99.25	87.00	72.95	38.83	56.08	63.80	153.44	65.87	31.73	50.79	49.49	100.10	74.87	39.39	34.97	37.62	42.33	212.58	102.24	76.80	88.57	58.91	131.65	4
27	13.78	8.20	107.82	107.82	107.82	170.20	191.40	107.82	107.82	99.60	167.83	482.00	166.00	88.67	48.44	38.56	43.89	38.56	33.81	39.99	22.41	241.60	59.93	130.14	99.25	87.00	72.95	38.83	56.08	63.80	79.00	65.87	31.73	59.79	49.49	100.10	69.88	39.39	34.97	37.62	42.33	212.58	102.24	76.80	88.57	58.91	119.50	5
28	13.78	8.20	107.82	107.82	107.82	170.20	191.40	107.82	107.82	99.60	167.83	482.00	166.00	88.67	48.44	38.56	43.89	38.56	33.81	39.99	22.41	241.60	87.90	130.14	99.25	87.00	72.95	38.83	56.08	63.80	79.00	65.87	31.73	59.79	49.49	60.49	69.88	39.39	34.97	37.62	42.33	228.21	102.24	76.80	106.56	58.91	119.50	2
29	20.67	8.20	107.82	107.82	107.82	170.20	191.40	107.82	107.82	99.60	167.83	482.00	166.00	88.67	48.44	38.56	43.89		39.99	39.99	22.41	241.60	81.11	130.14	99.25	87.00	72.95	38.83	54.71		79.00	65.87	31.73	59.79	49.49	60.49	69.88	39.39	34.97	37.62	42.33		102.24	102.24	106.56	58.91	119.50	4
30	18.37	8.20	107.82	107.82	107.82		191.40	107.82	107.82	99.60	167.83	482.00	166.00	88.67	48.44	38.56	43.89		39.99	39.99	22.41	241.60	65.13	140.10	99.25	87.00	72.95	38.83	54.71		79.00	65.87	31.73	59.79	49.49	60.49	69.88	39.39	34.97	37.62	42.33		166.05	102.24	106.56	58.91	112.92	3
31		8.20		107.82	107.82		191.40		107.82		267.60	482.00		88.67		38.56	43.89		39.99		22.41		65.13	140.10		87.00		38.83	54.71		79.00		31.73		49.49	60.49		39.39		37.62	42.33		163.20		106.56		112.92	1

The results of the measurement of streamflows at the proposed intake points

The list of the results of the measurement of streamflows at the proposed intake points

Date	Bagh upstream	Gagh downstream	Gaya	Namly Maira
06/08/2003	206		127	148
10/08/2003	131		128	123
13/08/2003	148	256	123	124
Average	139.50	256	126.00	132

First results of the measurement of streamflows

River	Bagh	Gaya	Namli Maira
Position: latitude North	34° 06′ 31.7″	34° 06′ 51.9″	34° 06′ 36.3″
: longitude East	73° 19′ 18.3″	73° 19′ 41.7″	73° 22′ 03.0″
Date	06/08/2003 11:00	06/08/2003 13:00	06/08/2003 16:00
Width of the river (m)	4.37	2.85	2.40
The number of measurements	22	14	12
The average depth of water (cm)	13.8	7.5	14.0
The average velocity (cm/sec)	31.6	45.4	43.0
Streamflow (l/sec)	205.6	127.1	148.1

Second results of the measurement of streamflows

River	Bagh	Gaya	Namli Maira
Position: The north latitude	34° 06′ 31.7″	34° 06′ 51.9″	34° 06′ 36.3″
: The east longitude	73° 19′ 18.3″	73° 19′ 41.7″	73° 22′ 03.0″
Date	10/08/2003 10:30	10/08/2003 12:00	10/08/2003 14:00
Width of the river (m)	4.24	2.75	2.40
The number of measurements	21	13	12
The average depth of water (cm)	10.6	9.2	11.6
The average velocity (cm/sec)	28.5	42.3	46.9
Streamflow (l/sec)	130.8	128.1	123.1

Third results of the measurement of streamflows

River	Bagh	Gaya	Namli Maira
Position: latitude North	34° 06′ 31.7″	34° 06′ 51.9″	34° 06′ 36.3″
: longitude East	73° 19′ 18.3″	73° 19′ 41.7″	73° 22′ 03.0″
Date	06/08/2003 11:00	06/08/2003 13:00	06/08/2003 16:00
Width of the river (m)	4.00	2.2	2.50
The number of measurements	19	11	12
The average depth of water (cm)	12.4	10.5	11.3
The average velocity (cm/sec)	31.3	49.3	44.3
Streamflow (l/sec)	147.5	122.6	124.4

The other results of the measurement of streamflows

River	Bagh downstream (Upstream of the junction of Gaya)
Position: latitude North	34° 06′ 59.6″
: longitude East	74° 19′ 37.3″
Date	13/08/2003 13:45
Width of the river (m)	2.4
The number of measurements	12
The average depth of water (cm)	24.3
The average velocity (cm/sec)	43.9
Streamflow (l/sec)	256.0

Appendix 6-6　Study on Hydrogeology and Groundwater Recharge

1. Hydrogeological Structure of Abbotabad Area

The hydrogeological NE-SW cross section of the Orush plain where most of the project well construction sites are located is shown in Fig-1, and Fig-2 shows the catchment area of the Orush plain.

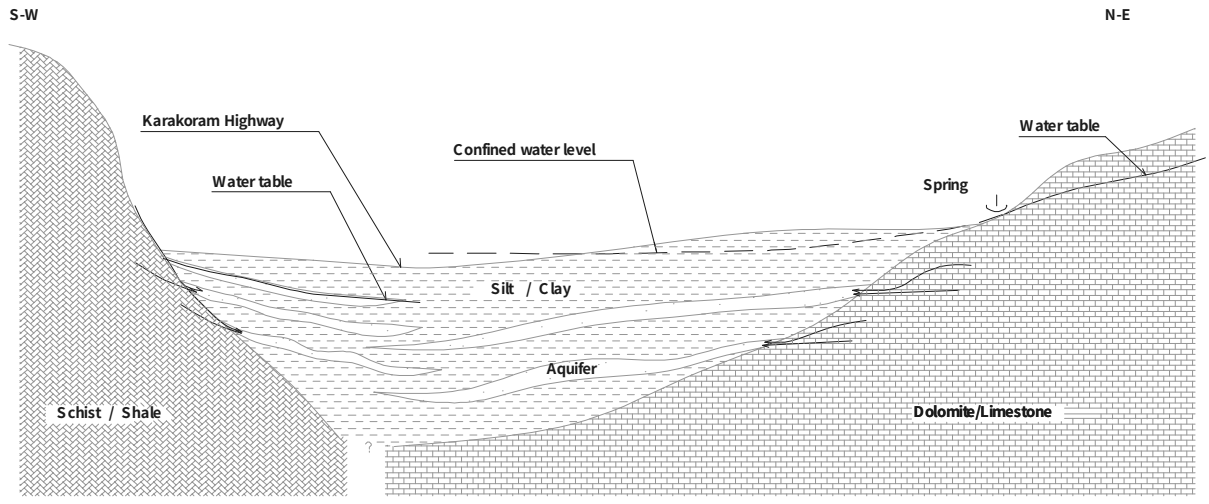


Fig-1 Hydrogeological cross section of Abbottabad area

The Orush plain is located in the watershed between the Dor river system and the Mangai river system, and tubewells which are in Mirpur and northern Dera Wanhah water supply area are located in the Mangai river system, while the others are located in the Dor river system.　The major catchment basin of the groundwater sources related to the project is mostly in the Dor river system with an area of about 76 km2, and more than 90% of the existing tubewells in the Orush plain are constructed downstream of these catchment areas.

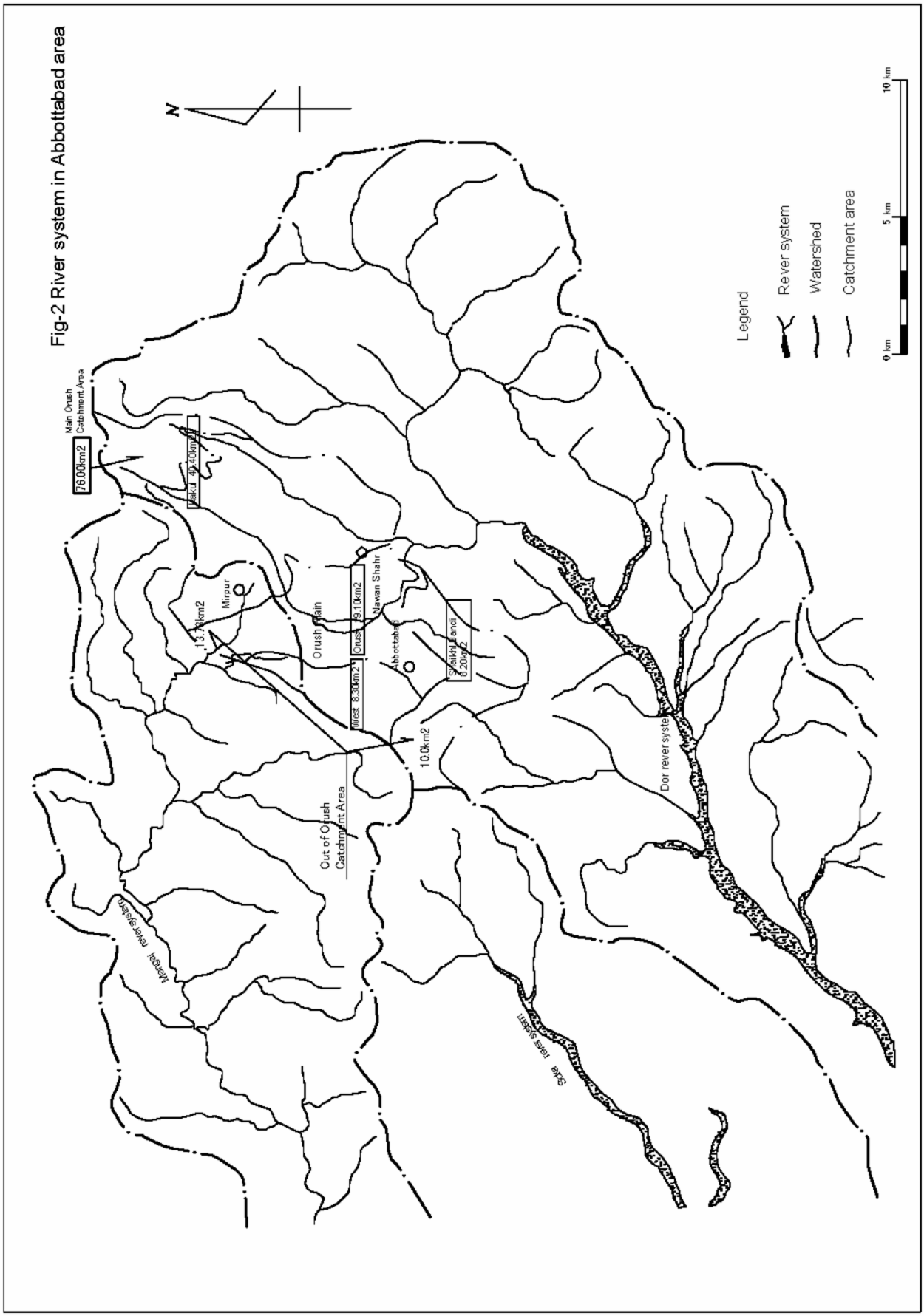


Fig-2 River system in Abbottabad area
N
Legend
Rever system
Watershed
Catchment area
0 km
5 km
10 km
Main Orush Catchment Area
76.00km2
Mirpur
Orush Main
Orush 19.10km2
Nawan Shahr
Abbottabad
10.0km2
Out of Orush Catchment Area
Dor rever system
Indus river system
Indus river system

Orush catchment area is divided into 4 areas by topographical and hydrogeological features.

a) Kakul area: This area is 53% (40.4km2) of the catchment area and mountainous which is underlain by dolomite and limestone spread out to the north-east, to form the groundwater recharge origin for the Orush plain. Some of the rainfalls in the mountain drain into the space of dolomite and limestone and reach at the north-east ledge of the Orush plain and the groundwater is retained by silt and clay beds, some of them flowing up to the ground as spring, while others are recharged in sandy gravel beds to become good confined aquifers, and the groundwater is finally pumped up or flow to the outside of the area through dolomite, limestone and sandy gravel.
b) Western area: This area is 11%(8.3km2) of the catchment area, underlain by schist or shale, and therefore rainfall is unable to infiltrate and flow on the ground or infiltrate from faults which are between the mountain and the plain, and recharge to the aquifer which is west of the Karakoram Highway through the sandy gravel in this area.
c) Shaekhal Bandi area: This area is 11% (8.2 km2) of the catchment area, mountainous and underlain by dolomite, and become the recharge area for groundwater of the tubewells in the urban area of Shaekhal Bandi.
d) Orush plain area: This area is 25%(19.1km2) of the catchment area, which includes Abbottabad urban and cantonment areas. The plain is underlain by silt clay and sandy gravel, and the rainfalls from the other three areas are recharged to these beds through the lower sandy gravel beds. However, rainfalls in this area are unable to infiltrate through some of the clay beds, but flow on the surface or through silt beds to the outside of the area, and therefore it is predicted that there is no recharge from this plain to the aquifer for pumping by the project wells. The groundwater in the shallow aquifer is being pumped up by hand pumps in the area.

Besides these catchment areas there are Mirpur and Dera Wandah catchment areas belonging to the Mangai river system and Salhad catchment area belonging to the Dor river system.

The features of each area are reflected on the difference in production of wells, where the confined aquifer recharged from the Kakul area is the main aquifer in the Orush plain, with most of the tubewells drilled in this area, and artesian wells are flowing in mid-downstream. The specific yields of these wells are 100 to 300 m3/day/m, and these productions are stable.

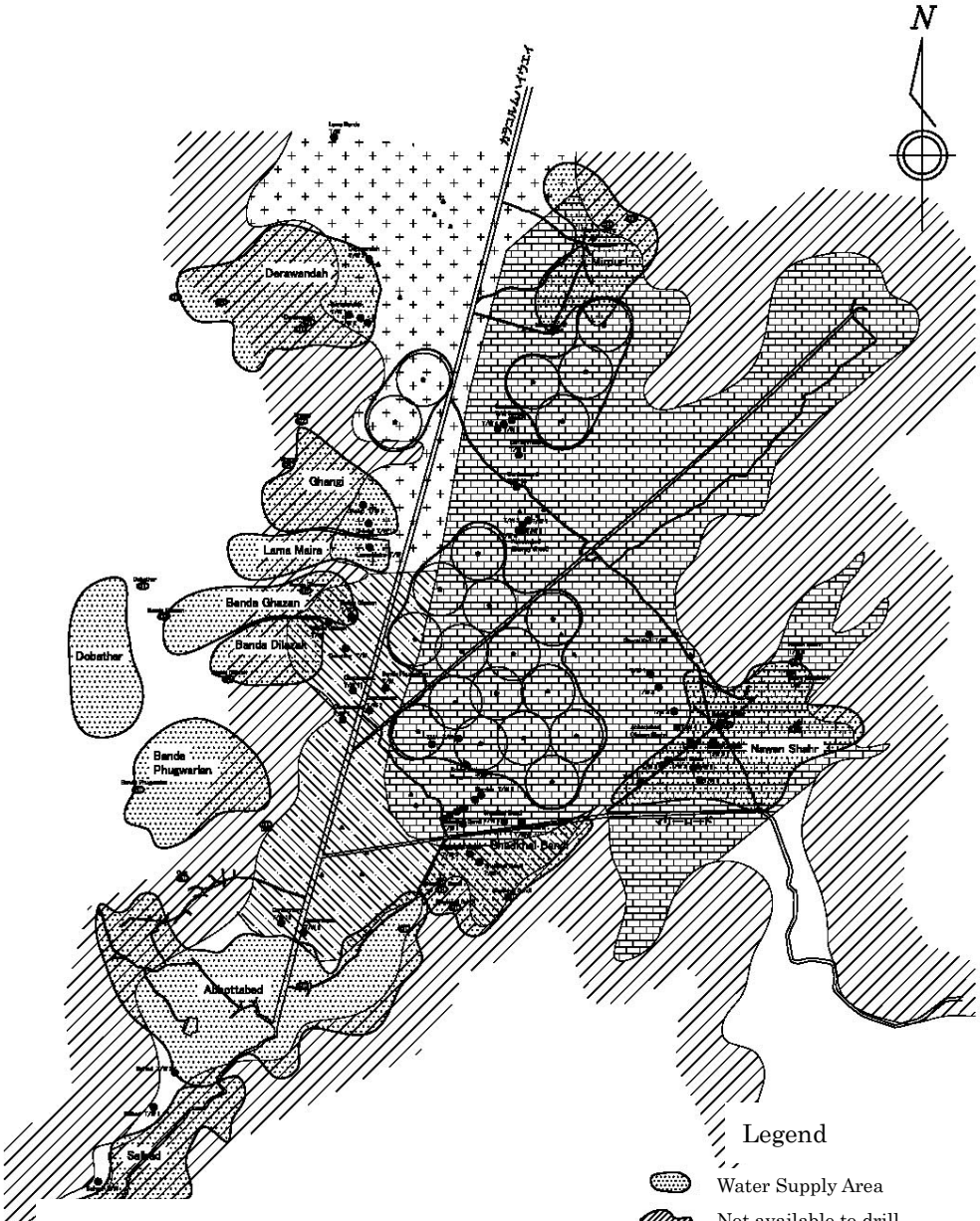
The aquifers recharged from the western area have lower specific yields of 50 to 100 m3/day/m, and water tables have tendencies of lowering in recent years. The existing

wells in the western supply area of the project are pumping from this aquifer.

The productions of wells, which are located in the hinterland area underlain by dolomite or limestone, are high, while on the other hand, hinterland underlain by shale or schist are lower. Fig-3 shows groundwater production capacity graded on three levels based on data of existing wells.

All existing wells except one (9 wells) in the western supply area, which are expected to supply water from groundwater constructed west of Karakoram Highway. There are more than eleven wells for the cantonment board, the small industrial area, and the hospital, and since housing development is progressing, it is difficult to find space for drilling wells in this area. Even if space for drilling is found, there are problems that the drilling point is too close to existing wells or it cannot produce the target pumping rate due to hydrogeological conditions.

Therefore new drilling points should be decided in undeveloped areas to the west of Karakoram Highway.



Notes:

The map shows it is possible that wells are drilled, the distance between next well are 500 m. Candidate points can be decreased, cause of land issue.

Military facilities, public facilities and houses are excluding

Candidate Drilling point for the west of the supply area

2. Consideration of groundwater recharge

It is necessary to set the following conditions to estimate the groundwater recharge in the Orush plain.

- Estimated recharge area: the aquifer for well drilling sites of the project as shown in Fig-3
- Amount of the discharge

ORGANIZATION	DISCHARGE		REMARK
	㎥/day	㎥/year	
Public Health Engineering Department	6,329	2,310,255	10 supply areas except Salhad in 2004
Municipal Committee(Abbottabad)	7,697	2,809,332	Abbottabad city in 2004
Cantonment Board	5,182	1,891,430	2004
Military Engineering Servies(Abbottabad)	2,891	1,055,215	ADB Report in 1997
Military Engineering Servies(Kakul)	1,626	593,490	
Communication and Works Department	1,752	639,480	
Private Concerns	637	232,505	
Total	26,114	9,531,707	

※ Public Health Engineering Department : Presently, Works & Services Department
ADB Report : GREATER ABBOTTABAD WATER SUPPLY SCHEME F/S Final

- Annual Average precipitation: 1,349.5mm (Kakul station)
  3,335 mm (Bara Gali station)
- Rainfall infiltration ratio 15%
- Discharge from springs 125 liter/sec
- Recharged groundwater is not lost to the outside of the area

From the above conditions, the recharge can be predicted as follows.

Recharge	Area（m2）		Precipitation（mm）	Rainfall infiltration rate	Recharge（㎥/year） Discharge（㎥/year）
	Kakul	30,900,000	1,349.5	15%	6,254,933
	More than 6000ft	9,500,000	3,335	15%	4,752,375
	Western Area	8,300,000	1,349.5	15%	1,680,128
	Shaikhal Bandi	8,200,000	1,349.5	15%	1,659,885
	Mirpur	5,700,000	1,349.5	15%	1,153,823
	Dera Wandah	1,500,000	1,349.5	15%	303,638
	total	64,100,000			15,804,638
Discharge	Flow from springs				3,942,000
	Discharge of wells				9,531,707
	total				13,473,707
Recharge—Discharge					2,330,930

This estimation excludes recharging from the Orush plain.

If precipitation continues as in average years, recharge is sufficient, but since precipitation is decreasing in recent years, the recharge is estimated for drought years, 1993, 1999, 2001, 2002.

Drought year	Precipitation（mm）	
	Abbottabat	BranGali
1993	1,098.5	2,940
1999	1,104.0	2,914
2001	937.7	2,530
2002	1,046.4	2,741

Year	Recharge（㎥/year）	Discharge（㎥/year）	Recharge – Discharge（㎥/year）
1993	13,186,215	13,473,707	-287,492
1999	13,194,210	13,473,707	-279,497
2001	11,301,393	13,473,707	-2,172,314
2002	12,475,941	13,473,707	-997,766

In the last 4 drought years, the estimates show that the amount of the discharge is higher than the recharge. The negative amounts are actually visualized in drying phenomena of springs in this area.
If these amounts are divided by daily discharge of springs (10,800m3/day):

Year	Days
1993	27 days
1999	26 days
2001	201 days
2002	92 days

The above shows the number days that springs dried up.

Data measured regularly at downstream of Iliyashi mosque shows the phenomena of drying up of springs. The measurement point is near the junction between the stream and the flow from the spring, and flow data are the total of both flows. According to the surveyor, the spring dries up when the flow rate is below 3 cusec (84 liter/sec).

Year	1999	2000	2001	2002	2003
No. of dry up days	0	177	194	298	47

*no data before August 1999

The above table shows dry up days of Iliyashi mosque spring. Although there is no data before August 1999, according to the counterpart and villagers who lived near the spring, the spring had not dried up that frequently before 1999. Since the calculated number of dry up days is less than the actual dry up days, when annual rainfall is below 1,100 mm in the plain area, it is correct to say the total pumping rate is in an over pumping state.

Since the above calculation presumes that recharged groundwater does not flow out of the area, and water is pumped at full rate from all wells, even if precipitation rate of the average year can be assured, we cannot say the present pumping rate has gone over the safe groundwater development rate, but that the present pumping rate is at the limit. Considering the limit of the pumping rate in the area, the exhaustion of springs is one of the indicators as the limit of groundwater development. The exhaustion of springs in northeast of Orush plain means that water pressure in the confined aquifer in the plain is decreasing. Accordingly it is implicated that the water table is declining and compression subsistence of the aquifer will follow resulting in exhaustion. Additionally the confined aquifer includes unconsolidated silt, and therefore some places are caving

where wells are being over pumped.

3. Necessity to control pumping rates in Abbottabad

The major consumers of the groundwater discharged in Abbottabad area are the cantonment board and this project. Though the cantonment board is believed to supply water to the military facilities, actually, they are supplying water to the people who live in the cantonment area. MES（Military Engineering Services）and PMA（Pakistan Military Academy）are actually supplying water to the military compounds.

10 tubewells pump up 1,387,584m3/year in the cantonment board area, however it is not enough to meet the demand. The cantonment board constructed a new tubewell this year and plans to drill 2 tubwells next year. According to the estimation, water demand in the cantonment area will be 3,565,320m3/year in 2010. The table shows the water balance between the demand and the recharge. The conditions below will be used for the estimate.
*the minimum rate of supply from groundwater in the project
*calculated by annual rainfall data in 1993

Recharge		13,186,215	㎥/year
Discharge	Flow out from springs	3,942,000	㎥/year
	Discharge for the project	3,279,744	㎥/year
	Discharge for others	6,086,010	㎥/year
	Total	13,307,754	㎥/year
Recharge - Discharge		-121,539	㎥/year

The result is over pumping in this area.
If groundwater is supplied to the demand of the cantonment area, groundwater will be over pumping in 2010.

It is necessary that the organization which controls the water balance between discharge and recharge set and have power to 1) plan, 2) control pumping rate, and 3) charge for pumping, and also groundwater monitoring should be conduicted continuously.

Appendices - B

PROPOSAL FOR INTRODUCTION OF
SOFT COMPONENT SCHEME

ISLAMIC REPUBLIC OF PAKISTAN

BASIC DESIGN STUDY ON
THE PROJECT FOR THE IMPROVEMENT OF THE WATER SUPPLY
IN ABBOTTABAD

PROPOSAL FOR INTRODUCTION OF SOFT COMPONENT SCHEME

July 2004

NIHON SUIDO CONSULTANTS CO., LTD.
J A P A N T E C H N O C O . , L T D.

ISLAMIC REPUBLIC OF PAKISTAN

BASIC DESIGN STUDY ON
THE PROJECT FOR THE IMPROVEMENT OF THE WATER SUPPLY
IN ABBOTTABAD

PROPOSAL OF INTRIDUCTION OF SOFT CONPONENT SCHEME

TABLE OF CONTENTS

Proposal for Introduction of Soft Component Scheme

1. Background

The water supply in Abbottabad and the surrounding area have been developed by using groundwater as water sources. The expansion project for Abbottabad TMA funded principally by the ADB was implemented for the period until 1997 with the target year of 2003. For Nawanshehr TMA, the water supply improvement project was implemented in 1998 by the aid of KfW, Germany. Further expansion and improvement of the water supply systems are, however, being required urgently to cope with the increasing population and expansion of the service areas in addition to decrease of the exploitation from the existing wells.

On the other hand, the District Government of Abbottabad prepared in 1990 the Greater Abbottabad Gravity Scheme taking the surface water from the valley at the east of the Abbottabad City, in addition to the groundwater, as stabilized water source for a long term, and conveying the water by gravity flow due to the concern of decrease of the groundwater exploitation in the future by its excessive pump-up in the area and due to the difficulty of the water supply management from high maintenance cost caused by high lift pump operation. However, this Project has not been realized until today due to no prospect of the fund. Under the above-mentioned background, the grant aid was requested to the Government of Japan for the said water supply project in December 2000. Upon the request, the Government of Japan dispatched the preliminary study mission for the review of the request, thereafter the basic design study of this Project has been carried out.

This Project is to develop the surface water sources and establish the gravity water supply system composing of raw water conveyance, water treatment, treated water transmission and distribution reservoirs by effective use of the existing tube wells and minimizing the groundwater exploitation from newly developed tube wells, based upon the results of evaluation on the groundwater resources.

Currently, three independent water supply agencies, namely, Abbottabad TMA, Nawanshehr TMA and Works and Services Department of the District, supply water in the subject areas using the groundwater.

After completion of this Project, the bulk water supply service[1]) using the surface water will be newly added to the present groundwater source for three agencies above-mentioned, and its sound operation and management will be indispensable for achieving the target of the Project effect. Also the sound management of the existing agencies is indispensable to support this bulk water supply service, therefore it shall be an important task to review the present flat rate water tariff system and revise the present low water tariff based on the beneficiary principle. Further, an appropriate tube well management will be also important for stabilized use of precious groundwater source.

Judging from the above-mentioned issues, the contents of soft component scheme will include (1) engineering support for operation and management for tube well and water treatment plant, and (2) managerial support for establishment of the new agency (bulk water supply service) and improvement of water tariff collection system (including installation of water meters) with revision of water tariff at appropriate level.

[1]) The bulk water supply service means a service to supply the bulk water to the respective water supply agencies who supply water, after receiving water from the bulk water supply agency, to the end user. In this Project, the bulk water is supplied to three above-mentioned agencies, after treatment of the surface water by newly organized surface water supply unit. The bulk water is actually transmitted to the water reservoirs managed by each agency.

2. Objectives

The soft component scheme for technical and management guidance will be carried out as consulting services in this Project. The soft component scheme is composed of the following four components.

1) Technical Training for Well Management and Operation & Maintenance of Pumps

It is necessary to provide training for the well operators regarding proper operation of well pumps newly installed or replaced by the Project.

2) Capacity Building for Operation and Maintenance of Slow Sand Filtration System

The Implementing Agency, Abbottabad District Government, has no experience of operation of a water treatment plant although it is now handling the operation and maintenance of more than 200 water supply systems in the District, which were constructed by the District Government. It is necessary to transfer the proper technical knowledge on water treatment by slow sand filtration and practical know-how on operation and maintenance of the water treatment plant. Sufficient training is required for the engineers and operators of the Gravity Water Unit (tentative name), who will be in charge of the management of the Surface Water Supply System.

3) Management Guidance for Organizing the Management Unit for Surface Water Supply System

The Surface Water Supply System will be managed by a new organization (Gravity Water Unit: tentative name) to provide bulk water supply to the three independent agencies as explained in the above. It is necessary to provide advices and guidance through discussion with the three agencies and other authorities concerned, and facilitate the preparation and coordination for establishing the Gravity Water Supply Unit.

4) Management Guidance for Improving Water Revenue

Flat rate water tariff systems presently adopted in Abbottabad TMA and the peripheral Union Councils will be replaced by metered tariff systems depending on the actual consumptions measured by water meters, which are to be introduced in the course of the Project. Management guidance is provided to support the revision of water tariff systems, introduction of water meters, improvement of tariff collection systems for the improvement of revenue and consumers' manners for water conservation.

3. Effects Anticipated

The following effects are anticipated as the outputs of the soft component scheme:

1) Proper Management of Tube Well Facilities

- Stable and long term use of the well facilities will be enabled by realizing proper operation of the tube well pumps by continuous monitoring of exploitation and water level of the wells.

2) To Secure Targeted Water Production and Water Quality by the Project through the Technical Transfer of Water Treatment Operation

- Water treatment can be achieved by appropriate operation of treatment facilities corresponding to change of water quality.
- The water intake, production of treated water and water transmission can be managed depending on the demand of each agency.
- Sustainable operation with intended production and water quality can be achieved according to the original target.

3) Start-up of Sound Bulk Water Supply Service

- Human resources can be ensured, which possess proper capability and qualifications in the technical and financial fields for the operation of bulk water supply service.
- The organization of Gravity Water Unit for sustainable bulk water supply service can be established based on proper provisions that are indispensable for bulk water supply service among the agencies (Gravity Water Unit and three existing water supply agencies who receive bulk water).
- The sustainable operation of bulk water supply service can be supported by the supervising organization (tentative name: Water Committee) to establish proper policy for bulk water supply service, to make coordination among the existing water supply agencies and to set adequate water tariff for bulk water supply. The Water Committee will comprise representatives of the District Government and the existing three water supply agencies.
- Sound operation of bulk water supply service can be maintained by preparing appropriate financial statements and relevant reports submitted periodically to the supervising organization, Water Committee.

4) Revision of Water Tariff and Water Tariff Collection System for Sound Operation of Water Supply Agencies

- The basis for operation of the existing water supply agencies can be established based on the benefit assessment principle by installing water meters for metered tariff collection.
- Reduction of waste of water and saving of precious water source as the results are expected by installing meters.
- Sound operation of each water supply agency can be achieved by setting proper water tariff.
- Sound operation of bulk water supply service can be sustained, supported by sound operation of water supply by each agency.
- Water supply service to the citizens can be improved by sound service operation of each agency.

4. Detailed Contents of Activities

The detailed work plan on four items of soft component scheme mentioned in "2. Purpose" is described in 4.1 ~ 4.4. Further, some items for social education/enlightenment other than water tariff collection will described in 4.5 as they are considered as important items.

4.1 Technical Training for Well Management and Operation & Maintenance of Pumps
4.2 Capacity Building for Operation and maintenance of Slow Sand Filtration System
4.3 Management Guidance for Organizing the Management Unit for Surface Water Supply System
4.4 Management Guidance for Improving Water Revenue
4.5 Guidance for Social education/Enlightenment

4.1 Technical Training for Well Management and Operation & Maintenance of Pumps

Guidance and assistance are provided for training of tube well operation and maintenance. In this Project, it is planned to newly install four tube wells and replace 12 existing well pumps. After grasping the problems of current tube well management, necessary guidance and assistance are provided.

1) Confirmation of Well Pump Operation Conditions

Instruct the operator for investigation of relation between well pump operation and water level changes and extent of deterioration of tube well and pump, and give the guidance to operator for their understanding how to utilize the results of investigation for future operation and maintenance of well and pump.

In the current pump operation, the ON-OFF operation is conducted only during the specified time zone. The relation between the pump operation and changes of groundwater level will be determined based on the results of the study carried out during the basic design stage in addition to the more detailed investigation on operation conditions of pumps, and guidance will be provided for understanding by operators on the extent of deterioration of the tube wells and well pumps. The investigation sheets are prepared from above results to facilitate future operation and maintenance of them.

2) Grasping of Work Contents and Capability of Operators

After grasping the work contents and work capability of the pump operators through hearing, provide the guidance for additional works that are required but not done at the present.

The role of operators is not limited to only starting and stopping of pumps as per instructed. Guidance is provided to encourage to carry out such assignments as monitoring of the pump

operation conditions, water level change and recording of these items, as these items are important.

3) Preparation of Operation Manuals of Tube Wells/Well Pumps

Prepare the operation manuals for proper operation and maintenance of tube well/pump in conjunction with continuous pump operation as intended in the Project.

As the operation of well pump will become continuous instead of the present intermittent operation, the operation manuals are prepared for pump operation including relation between pumping rate and water level changes and monitoring items to be recorded.

4) Education/Training of Operators

Provide the necessary re-education/training for improvement of tube well management for operators in conjunction with continuous pump operation.

Necessary re-education will be provided to the operator for improvement of well management in accordance with the above results of 2). Explanation/guidance is provided and training at the site to the operators will be carried out based on the manuals prepared in 3) including necessary items for operation and monitoring.

4.2 Capacity Building for Operation and Maintenance of Slow Sand Filtration System

The water treatment plant is newly introduced by the Project and therefore its operation is the first experience for the District of Abbottabad, where the existing water supply is the system using groundwater. For proper operation and maintenance to obtain the targeted water production and quality, the training is required for the operators prior to the actual operation start. The water treatment plants will adopt slow sand filtration process. Although the treatment process is relatively simple, sufficient training is necessary including training in the actual plant for important works such as scraping of filter sand → washing of sand → sand filling works.

1) Guidance for Flow Control

Set the production in accordance with the request for water transmission from the water supply agencies, followed by determining intake flow. Provide guidance for procedure of setting of intake and transmission flow control.

The slow sand filtration is a process to purify the water by microorganism membrane generated in filter layer, and the frequent change of filtration rate (velocity) gives impact on filtration membrane, which should be avoided. Accordingly, the production rate of the treatment plant is set once a day, and the operation at a fixed rate is desired through a whole day. The deliberation is made between the bulk water supply side (Gravity Water Unit) and each water receiving side (Existing Water Supply Agency) regarding the bulk

water supply amount according to demand forecast of each agency, in order to set the water production rate. Flow control is designed to be done by flow meter and control valve. The guidance will be provided to the operator for practical flow control method.

2) Guidance for Monitoring of Water Treatment Process

Provide explanation and guidance on the necessity and method of monitoring such as the raw water turbidity, the water level fluctuation of slow sand filter, the transmission flow, the water level fluctuation of clear water reservoir and the treated water quality. Especially, provide guidance on the operation method to stop the inflow of raw water into treatment plant when turbidity of raw water becomes very high and to restart the inflow when the turbidity lowers.

Although the maintenance of slow sand filter is relatively simple and easy, the filter cannot treat the raw water with high turbidity. When the raw water turbidity becomes approximately 300 degrees, the raw water intake is temporarily stopped but the treated water transmission can continue by the water stored (design volume for 3 hours) in the clear water reservoir. The raw water turbidity will lower at maximum within several hours though it varies according to rainfall intensity and time. Thus, the degree of lowering of turbidity is checked every 2 hours by opening the inlet valve, to restart the operation. In addition, the guidance is provided for the necessity and method of monitoring the water level fluctuation of clear water reservoir, the water level fluctuation of slow sand filter, the transmission flow, the treated water quality, etc.

3) Guidance for Chlorine Dosage/Control Method

Provide guidance on the methods of dissolving bleaching powder, preparing its solution of proper concentration and determining and control of dosage rate.

The disinfection is to be carried out as final stage of water treatment in order to assure the bacteriological safety of treated water. The design is of disinfection with bleaching powder and the guidance to the operators is provided on the preparation method of solution and the control method of dosage.

4) Guidance for Sludge Removal from Sedimentation Basin and Washing of Roughing Filter

Provide guidance on the methods of sludge removal and cleaning of sedimentation basin and washing of roughing filter with their frequencies.

Cleaning and washing are required according to the accumulation of sludge in the sedimentation basin and the extent of turbidity of filtered water of the roughing filter through the observation during the daily patrol. Cleaning and washing will be carried out once per 6 months for sedimentation basin and once per month for roughing filter. However, during rainy season, more frequent sludge removal and washing will be required as appropriate by observing sludge accumulation according to precipitation conditions.

Guidance is provided to the operators on the method for the above works and judgment of timing of them.

5) Guidance for Scraping, Washing and Filling of Sand in Slow Sand Filter

Provide guidance on the methods of scraping → washing → supplementing of filter sand to the operators. Since this work needs delicate workmanship, and the field training at an actual slow sand filter will be performed.

Clogging of slow sand filter is caused by continuous filtration for a period approximately one month. The operation is restarted after restoration to the original conditions by scraping surface layer of sand uniformly at 2~3 cm in thickness, where biofilm is generated. The series of work for scraping → washing → filling of the filter sand is the most important operation for treatment process. The operators will be well familiarized with the method of the above works by the field training.

6) Guidance for Water Quality Monitoring

Provide guidance on the water quality monitoring of turbidity and pH for raw water and turbidity, pH, residual chlorine for treated water in a concrete manner.

As the raw water is taken from mountain stream, its water quality is normally good. Accordingly, the water quality test will be enough for the items of turbidity and pH for raw water and turbidity, pH and residual chlorine for treated water to monitor water treatment process. It will be sufficient to test whole water quality items including the items indicating the contamination once or twice a year by an laboratory. By providing the monitoring program on water quality, the guidance is provided to the operators

7) Preparation of Operation and Maintenance Manual

Prepare O & M manual summarizing the design concept and the operation and maintenance method reviewed during design, and provide guidance on individual maintenance method based on the manual.

Items 1) ~ 6) mentioned as operation and maintenance of water treatment plant are summarized in the manual, and, based on that, explanation and guidance are provided to Pakistani side.

8) Recording and Reporting

Provide guidance on preparation of recording ledger for operation and maintenance items not only for the water treatment plant but also for the whole system and on that for annual report.

In order to operate and maintain the facilities with appropriate manner, it is important to refer to empirical values and statistical data from the past operation records. For this purpose, it is necessary to record the results of the operation and maintenance and the monitoring, and to prepare the annual reports by summarizing these results. Guidance is provided to understand the importance to prepare the recording ledgers for all the

operation and maintenance items mentioned above and the annual report.

4.3 Management Guidance for Organizing the Management Unit for Surface Water Supply System

The new surface water supply system, independent organization will be established and supply the bulk water to the three existing agencies. Assistance is provided for establishment of this organization and for necessary modification of organization for the existing agencies.

4.3.1 Assistance for Establishment of Organization for Surface Water Supply System

During the course of project implementation, the organization for surface water supply system is to be established and to develop the basis for its future activities.

1) Assistance for Establishment of New Organization

(1) Assistance for Activities of Preparatory Working Group (PWG)

It is proposed to set up preparatory work group for smooth implementation of soft component scheme.

PMU is the organization for implementation of the Project, and it has been already established by the Governor of Abbottabad District. On the other hand, it is proposed to set up the preparatory work group (PWG) who will be the counterpart of Pakistani side for the execution of the soft component scheme. PWG will be composed of PMU and representatives from the existing water supply agencies. The execution of soft component scheme is promoted under deliberation with PWG by guiding and supporting PWG.

(2) Assistance for Establishment of Organization for Surface Water Supply System, and its Role

Assist for preparation of definite plan for establishing organization of Surface Water Supply System by reviewing the organization chart, its role, number of personnel with their qualification and experience prepared during basic design stage.

At the event of establishment of the organization for the surface water supply service, the preparation of the definite plan is supported by reviewing the organization chart (see figure 1) and role, number of personnel with their qualification and experience, which were studied during B/D, under deliberation with PMU. The original plan of the organization chart was already explained to the Governor of Abbottabad District and the members of PMU, and the definite plan is to be prepared including the details such as duty system. It is important to determine the definite plan taking into consideration the concrete members for main posts, for which the assistance is provided.

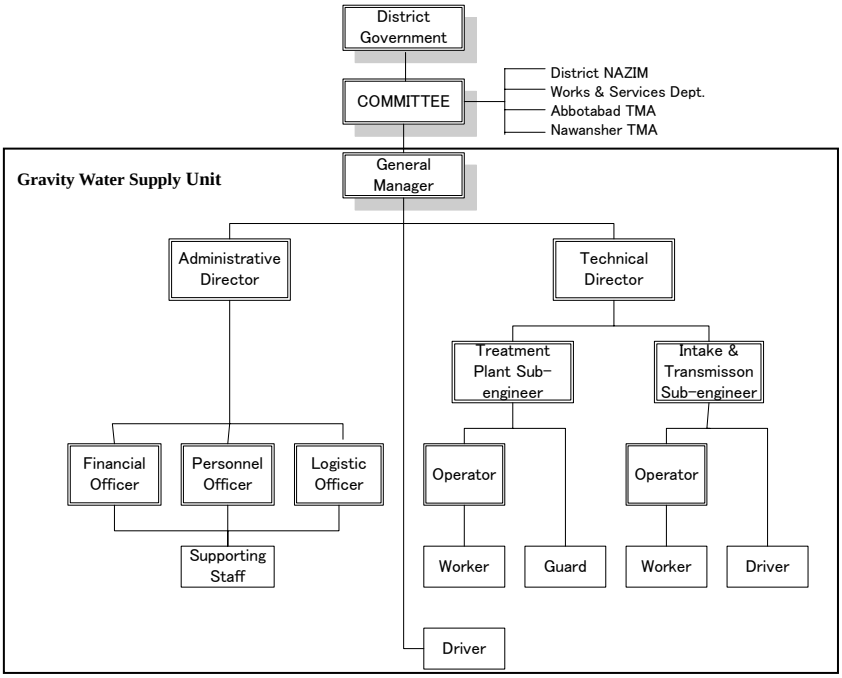


Fig. 1: Organization of Surface Water Unit

2) Assistance for Organizing Water Committee and Assignment of General Manager (GM)

At first, support organizing Water Committee who may be called the key of the organization and assignment of GM of Bulk Water Supply Unit. Also support the assignment for the key staff of organization.

After preparation of the definite plan of the organization, the Water Committee is organized first, which may be called the key of the organization, followed by the assignment of GM, for which the assistance is provided. Water Committee plays a role to make surveillance on the bulk water supply operation. The Committee will comprises the District, Works & Services Department of the District, Abbottabad TMA and Nawanshehr TMA. The personnel required for Gravity Water Supply Unit are selected by PWG and the GM and Approved by Water Committee. The advice is provided in order to proceed with these processes.

3) Assistance for Preparation of Articles for Water Committee

Support the preparation of the articles for establishment of Water Committee.

After completion of the definite plan, articles for establishment of Water Committee are prepared. PWG plays main role for preparation works, and it is necessary to obtain the consent after deliberation with the District Government, Works & Services Department of the District, Abbottabad TMA and Nawanshehr TMA. Advice and guidance are provided for preparation of the articles.

4) Assistance for Preparation of Provisions for Gravity Water Supply Unit

Support preparation of various internal provisions on (1) division of duties, (2) personnel affairs, (3) pay regulation, (4) personnel evaluation method, etc.

After completion of the articles for Water Committee, various internal provisions are required to be prepared. PWG and GM prepare (1) division of duties, (2) personnel provisions, (3) pay regulation, (4) personnel evaluation method, etc., for which the guidance and advice are provided.

5) Assistance for Preparation for Service Promotion of Gravity Water Supply Unit

Support preparation of forms of supply provisions and financial statements, etc. as preparation of commencement of operation of Gravity Water Supply Unit.

In order to facilitate commencement of operation smoothly for Gravity Water Supply Unit, guidance is provided for preparation of (1) provisions for bulk water supply and (2) forms for financial matters.

4.3.2 Assistance for Improvement of Organization of Existing Agencies

In relation with bulk water supply, the possibility of modification of organizations of existing agencies may appear. Guidance and advice are provided aiming at better organization.

1) Assistance for Organizational Improvement due to Change of Activities

The activities are changed after implementation of the Project including meter installation, meter reading and bill collection based on the metered consumption, surface water receiving, etc. Provide advice aiming at better organization, as required.

In case of Abbottabad TMA, operation of tube wells/well pumps is not required except standby operation (tube wells will remain as standby), as the groundwater is replaced with surface water after implementation of the Project. On the other hand, the activities will increase for the duties such as meter installation, meter reading and bill collection, etc. The organizational modification shall be required in accordance with the change of activities. Similarly, organizational modification will be required for other agencies. Advice is provided for these organizational modifications, as required.

2) Assistance for Improvement of Tariff Collection System

After implementation of the Project, the tariff collection method of Abbottabad TMA and peripheral 10 villages is changed. Provide guidance for appropriate tariff collection system due to the change of the system.

Water supply systems of Abbottabad TMA and peripheral 10 villages adopt the easiest method to collect flat rate water tariffs every 3 months. After implementation of the Project,

the process is changed as meter reading → estimation of water tariff → billing of tariff → tariff collection. Referring the tariff collection system of Nawanshehr TMA, guidance is provided for organizational set up for tariff collection aiming at 100% of collection rate.

4.4 Assistance for Water Tariff Collection Improvement

4.4.1 Establishment of Tariff Policy

It is the target for self-supporting accounting system for water supply agency to generate operational expenses by tariff revenue. It is important to establish the tariff policy to achieve this target. Provide guidance and advice for the above target.

The target is a self-supporting accounting system for water supply, where the service is sustained by tariff revenue. The tariff policy is determined based on the operation cost and affordability of inhabitant, etc., in accordance with the results of social survey conducted during the basic design study. As the current tariff is too low comparing with the operation cost, significant tariff increase will be required for self-supporting accounting. The reason of the current low tariff is supposed that organization of the water supply service is not independent (except Nawanshehr) and current low service level where the consumer will have less intention of payment for water. If the water supply service level is largely improved by the Project, it is expected that the understanding of the consumers for tariff increase can be obtained. The tariff policy is determined based on production cost and affordability of inhabitant. It is important to determine the tariff policy with a basis for sustainable water supply operation.

4.4.2 Assistance for Bulk Water Tariff Collection

The following shows the guidance and assistance for tariff setting and collection of bulk water supply by gravity surface water supply unit.

1) Trial Calculation of Unit Cost of Bulk Water Supply

After reviewing relevant cost items for operation and maintenance, calculate the unit cost of bulk water supply, verifying it in comparison with the unit cost estimated during B/D.

The unit cost of bulk water supply for each fiscal year is calculated based on the estimation of O/M cost such as personnel cost, power cost, chemical cost, etc., and the unit cost estimated during basic design is reviewed.

2) Trial Calculation of Bulk Water Tariff and Income and Expense Balance

Provide guidance of trial calculation of the bulk water tariff with balance between revenue and

expenditures.

The GM or accountant of Gravity Water Supply Unit will be instructed to estimate water tariff for bulk water supply based on unit cost estimated in the above. Trial analysis will be attempt for bulk water tariff by adding proper ratio of capital cost or depreciation expense, repair cost and contingency to the unit cost. The appropriateness of the tariff is evaluated and determined watching balance between revenue and expenditures. Guidance is provided for this trial calculation and evaluation.

3) Assistance for Establishment of Bulk Water Tariff/Collection

Provide guidance and advice for establishment of tariff system suitable for operation of Gravity Water Supply Unit.

If the consumption of the bulk water supply by the users (existing water supply agencies) is less than scheduled amount, the revenue intended does not balance with expenditures. Thus, it is necessary to devise the tariff /collection system. As an example, one idea is to adopt the responsible water volume system. This is a method to fix the minimum transmitted amount within a certain range. For example, within the range of 100% ~ 80% of scheduled amount, the tariff is charged in accordance with the actual consumption. However, in case actual consumption is less than scheduled one, i.e., less than 80%, the tariff corresponding to 80% is charged as the minimum charge. Guidance and assistance is provided for determination of tariff suitable for bulk water supply.

4.4.3 Assistance for Improvement of Water Tariff Collection

The change of water tariff and its collection system for the existing water supply agencies are described in the following paragraph.

1) Assistance for Introduction of Water Meters

Obtain understanding from consumers for significance and importance of meter introduction by utilizing each and every opportunity, and support early introduction.

Water meters are introduced aiming at fair water tariff collection and saving waste of water. The introduction of metered tariff system is the first experience for the consumers except those of Nawanshehr TMA. As the water supply service after implementation of the Project is planned to operate based on the metered tariff system, prompt meter installation is indispensable. Through the social education and enlightenment, every opportunity (holding an explanatory meeting and distributing pamphlets, etc.) should be used to obtain the understanding of inhabitants on significance and importance of introduction of water meter. Guidance and advice are provided for such activities.

2) Assistance for Estimation of Water Supply Cost including Bulk Water Tariff

Provide guidance for estimation of water supply cost including bulk water tariff. This contributes

to ensuring of basis for tariff setting.

After implementation of the Project, the water tariff of each water supply agency includes the bulk water tariff. The existing three water supply agencies are to estimate the water supply cost after receiving of bulk water, for which the guidance is provided.

3) Assistance for Determination of Tariff System Considering Tariff Level and Metered Tariff System/Cross Subsidy

Provide guidance and assistance for determination of tariff level (average tariff). Also provide guidance and advice for determination of water tariff system considering water tariff for domestic users, especially for low income families based on metered tariff system and cross subsidy policy.

Guidance and advice are provided for water tariff estimation after implementation of this Project based on water supply cost determined in the above. The trial analysis will be attempt to evaluate and determine adequate water tariff by adding proper ratio of capital cost or depreciation expense, repair cost and contingency to the above water supply cost. Even though the current tariff is too low, the basic design study estimates the tariff by 4 times higher than the current tariff to balance between revenue and expenditures. Accordingly, it is necessary to devise some method for the tariff system taking into account the inhabitants, especially the low income families. Basically, guidance and advice are provided for establishment of the tariff system taking mainly the following two points into account:

(1) Adopt such tariff system as: basic charge (minimum tariff) + consumption charge (metered tariff), and adopt the block progressive tariff system where the water rate becomes higher as consumption becomes bigger.

(2) Set the tariff for the domestic use lower than that for non-domestic use such as commercial or industrial use.

4) Trial Calculation of Income and Expense Balance

Provide guidance for trial calculation of the income and expense balance.

The income is calculated, which are the sum of the tariff revenue determined from water sold (own water + water receiving from bulk water supply) and the tariff level set in the above. The expense is the water supply cost other expenditures described in the above. Base on the demand forecast, income and expense balance is calculated by years.

5) Tariff Revision Schedule

Review the rough schedule for tariff revision to grasp the year when income and expense is balanced by gradually increasing water tariff. Provide guidance and assistance for this analysis.

It is the target that all expenses for water supply service operation are covered by water tariff revenue. On the other hand it is difficult to realize big tariff increase at a time.

During the basic design study stage, a preliminary calculation was made that the tariff is raised annually at 30% to achieve the self-supporting accounting in 2012. The rough scheduling for tariff revision is reviewed.

Based on the above series of analysis, the extent of first tariff revision, which will be made at the time of the project completion, will be determined

4.5 Social education and Enlightenment

This Project aims at improvement of water supply service, while it is necessary to raise water tariff for self-supporting accounting system of water supply operation which is also the target of the Project. The education and enlightenment of the local inhabitants who are consumers are an important theme to realize the above target for sustainable service operation.

4.5.1 Improvement of Water Supply Service

1) Explanation of Change to Continuous Water Supply

Fundamental change of water usage will occur, if the intermittent water supply is replaced with continuous water supply. Describe the above change with figures and tables for social education and enlightenment. Explain the above to the Pakistani personnel involved in this program, and provide guidance and assistance for explanation to inhabitants.

As the water supply hour is currently short depending upon the areas, the inhabitants use the water by always opening the water taps and storing the water in the buckets or tanks when the water arrives. Though there are some cases where the water overflows from the buckets or tanks, the waste of water will not be significant as the water supply hour is short. On the other hand, as the water arrives always at the water taps and water pressure always exists after the Project is completed, a lot of water is wasted if the taps are kept opened. These facts are explained with figures and tables to obtain the understanding of the inhabitants.

2) Explanation on Water Supply Service Improvement and Water Usage Convenience

Make public announcement to inhabitants on improvement of water supply services and water usage convenience, preparing the materials for social education and enlightenment.

It is important to make public announcement to the inhabitants on significant improvement of water supply services with continuous supply that results in convenient water utilization. For example, necessary water can be obtained at intended places in the house by installing interior piping and taps. The explanation materials are prepared for

explanation to the inhabitants.

3) Consensus Building of Tariff Increase

Obtain the understanding of the inhabitants that the water supply service level is largely improved, on the other hand the necessity of water tariff revision for sustainable water supply services with the fact that the current water tariff is far below from the water supply cost.

The water service operation after this Project aims basically at self-supporting accounting system. Though the tariff is largely lower than the water supply cost at present, this will be due to the fact that the water supply service level is low. In the occasion that the water supply level is largely improved by the Project, the consensus building of water tariff increase is required based on the water supply cost. It is indispensable to sufficiently explain to the consumers the fact that the current water tariff is far below from the cost required for water supply services, introduction of metered tariff system for fair tariff collection, and necessity to revise water tariff in accordance with the water supply cost for sustainable water supply services. Guidance is provided for social education and enlightenment from such a viewpoint.

4.5.2 Enlightenment of Water Saving

In the present conditions of intermittent water supply, there are houses that water taps are kept open and therefore potential for waste of water exists. When the water is continuously supplied by implementation of the Project and the water pressure is always applied on the water taps, the wasting of water and leakage are expected to increase, thus the enlightenment of water saving is important.

1) Abolition of Custom to Keep Water Tap Opened

Provide guidance and advice to obtain the understanding of consumers on forming of habit to close the water taps, on forming of consciousness of early reporting of water leakage and to respect the water saving principle.

Without changing the conventional habit to keep the water taps opened, large scale water wasting and consumption will be caused. It is important to form a habit to always close the water tap except during use of water and to form a consciousness to report on water leakage (for example leakage from the water taps) in an early stage. Guidance and assistance are provided to let the consumers understand these and promote the water saving.

2) Reporting of Water Leakage

Educate the consumers to promptly report on the water leakage from service pipe and water tap in the house.

Guidance and advice are provided for the activities to educate the consumers to promptly

report to the water supply agency on the water leakage from the service pipe and water tap in the house to ensure the restoration in an early stage, in the same manner as reporting of water leakage from transmission and distribution pipelines in the service area.

5. Work Contents and Results

Fig. 2 shows the work contents and results of soft component in each term.

Work Contents	Detailed Work Contents	Input										Output (Red figure in Phase 1, black figure in Phase 2)	Products (Red figure in Phase 1, black figure in Phase 2)	Remarks
		Japanese Specialist					Local Specialist			Assignment period				
		Well	Operation	Education	Organization	Tariff	Organization	Tariff	Education	Phase 1	Phase 2			
Technical Training for Well Management and Operation & Maintenance of Pumps	(1) Well Operation and Maintenance													
	- Confirmation of Well Pump Operation Conditions	◎								■		- Technology on well and well pump operation and	- Manual for well/well pump operation	
	- Grasping of Work Contents and Capability of Operators	◎								■			- Investigation Sheet for Well/Pump	
	- Preparation of Operation Manuals of Tube Wells/Well Pumps	◎								■				
	- Education/Training of Operators	◎								■				
Capacity Building for Operation and Maintenance of Slow Sand Filtration System	(1) Technology Transfer on whole Abbottabad Water Supply System													
	- Propagation of Understanding of whole Abbottabad Water Supply System										■	- System on Determination of Water Utilization is		Team Leader is responsible.
	- Guidance of Operation Method of Water Source										■			Team Leader is responsible.
	- Guidance of Operation of Water Transmission and Distribution Method of Bulk Water										■			Team Leader is responsible.
	(2) Operation and Maintenance of Slow Sand Filtration System													
	- Guidance for Flow Control		◎								■	- Operation and Maintenance Technology	- O&M Manual	
	- Guidance for Monitoring of Water Treatment Process		◎								■		- Leger of Water Treatment Plant	
	- Guidance for Chlorine Dodage/Control Method		◎								■		- Ledger Water Treatment Plant	
	- Guidance for Sludge Removal from sedimentation Basin and Washing of Roughing Filter		◎								■			
	- Guidance for Scraping, Washing and Filling of Filter Sand in Slow Sand Filter		◎								■			
	- Guidance for Water Quality Monitoring		◎								■			
	- Preparation of Operation and Maintenance Manual		◎								■			
	- Recording and Reporting		◎								■			
Management Guidance for Organizing the Management Unit for Surface Water Supply System	(1) Assistance for Establishment of Organization for Bulk Water Supply System													
	- Assistance for Establishment of New Organization				◎		◎			■		- Role of organization relevant to operation of	- Organization Chart of Operation of Surface	During D/D stage in Phase 1
	- Assistance for Organizing Water Committee and Assignment of GM				◎		◎			■		- Role of Gravity Water Supply Unit is clarified.	- Articles of Association of Operation of Surface	
	- Assistance of Preparation of Articles for Water Committee				◎		◎			■			- Provisions of Gravity Water Supply Unit	
	- Assistance for Preparation of Provisions for Gravity Water Supply Unit				◎						■			
	- Assistance for Preparation of Service Promotion for Gravity Water Supply Unit				◎			◎			■	- Accounting system is formed.	- Forms of Financial Statements	
	(2) Assistance for Improvement of Organization of Existing Agencies													
	- Assistance for Organizational Improvement due to Change of Activities				◎	◎		◎			■ □	- Organization of existing water suppliers is	- New Organization Chart of Existing Water	
	- Assistance for Improvement of Tariff Collection System				◎	◎		◎			■ □			
Management Guidance for Improving Water Revenue	(1) Establishment of Tariff Policy					◎		◎		■		- Appropriate water tariff policy is established.	- Tariff Policy	During D/D stage in Phase 1
	(2) Assistance for Bulk Water Tariff Collection													
	- Trial Calculation of Unit Cost of Bulk Water Supply					◎		◎			■ □	- Appropriate bulk water tariff is established.	- Bulk Water Tariff Table and Agreement of	
	- Trial Calculation of Bulk Water Tariff and Income and Expense Balance					◎		◎			■ □			
	- Assistance for Establishment of Bulk Water Tariff/Collection					◎		◎			■ □			
	(3) Assistance for Improvement of Water Tariff Collection													
	- Assistance for Introduction of Water Meters					◎		◎		■ □		- Installation of water meters is promoted.	- Tariff Revision Plan	
	- Assistance for Estimation of Water Supply Cost including Bulk Water Tariff					◎		◎		■ □		- Appropriate water tariff level is established.	- Water Tariff Table	During D/D stage in Phase 1
	- Assistance of Setting of Tariff Level and Metered Tariff System/Cross Subsidy					◎		◎			■ □	- Tariff revising plan is established.		
	- Trial Calculation of Income and Expense Balance					◎		◎			■ □	- Appropriate water tariff is established.		
	- Tariff Revision Schedule										■ □			
	- Assistance for First Tariff Revision										■ □			
Social Education and Enlightenment	(1) Improvement of Water Supply Service													
	- Explanation of Change to Continuous Water Supply			◎					◎	■ □		- New system and change of water tariff system are	- Pamphlet for Explanation to	
	- Explanation on Water Supply Service Improvement and Water Usage Convenience			◎					◎	■ □		- Water saving consciousness of		
	- Consensus Building of Tariff Increase			◎					◎	■ □				
	(2) Enlightenment of Water Saving													
	- Abolition of Custom to Keep Water Tap Opened			◎					◎	■ □				
	- Reporting of Water Leakage			◎					◎	■ □				

Note: ■ shows activities by Japanese specialist or Japanese + local specialist; □ activities by local

Figure 2. Work Content and Results of Soft Component Schem

6. Execution Schedule

Fig. 3 shows the execution schedule of soft component.

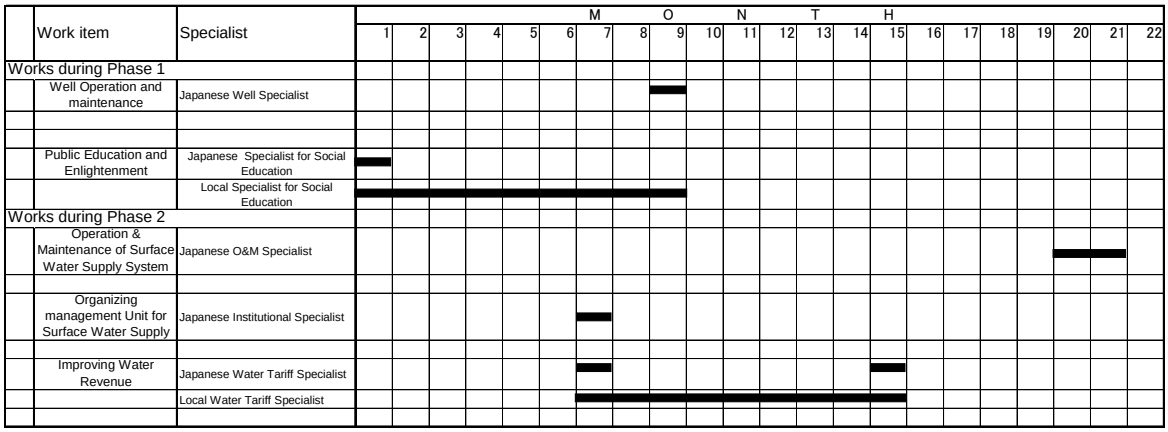


Figure 3. Execution Schedule of Soft Component Scheme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