APPENDIX FOR CHAPTER B7 PRIORITY PROJECT

AB7.1 Designs for Priority Project

Appendix AB7.1 is composed of Preliminary design of Water Treatment Plant and Transmission /Distribution System.

AB7.1.1 Water Treatment Plant

1. Technical Parameters

1.1 Background

The captioned project is for renewal of the existing water treatment plant which is composed of Slow Sand Filtration and Rapid Gravity Sand Filtration Plants. Raw water is taken from Rhak Branch Canal (RBC) for irrigation purpose. The production capacity of the existing plant is 3.5 mgd (approx. 16,000 m3/d), while the plant capacity for renewal is 10 mgd (approx. 45,500 m3/d). The existing plant has three raw water storage cum pre-settling tanks, from where pre-settled water is taken by gravity to Slow Sand Filtration Plant and pumped up to Rapid Gravity Sand Filtration Plant. (refer to attached plant layout drawing)

There is a water treatment plant constructed under French assistant, which production capacity is 10 mgd and it is planned near future extended to 15 mgd. Thus the design of this plant required to refered to for the captioned plant design. (refer to attached O & M Manual of the plant)

1.2 Design Basis

The existing slow sand filtration plant is considered to be operated during construction of new plant, while rapid sand filtration plant will be abandaned, since the plant capacity is small and require extensive rehabilitation works which is however considered as not cost effective.

Available space is rather narrow for the construction of 10 mgd plant, thus one raw water storage tank, out of three is planned to be abandoned for layout of new water treatment faciltes. It is noted that the remaining capacity of two tanks is still large enough as about 2 days retension time, for pre-settling of canal water. According to WASA's data, the volume capacity of three raw water tanks is as follows:

Tank No.1: 51,800 m3 Tank No.2: 49,700 m3 Tank No.3: 39,100 m3

Out of three tanks, tank No.3 will be abandaned. The volume of remaining two tanks is, therefore 101,500 m3 which is about 2days for treatment capacity of new plant, which is 47,900 m3/d (5% of loss in treatment process is estimated).

Major operation cost is composed of power cost, chemical cost and personnel cost as the main three costr items, where power cost is especially high.

From the above site conditions and consideration of low O & M cost, the plant design aims at the followings:
- Compact layout of the plant with effcient palnt facilities,
- Low costs for power and chemicals, and
- Effect of raw water storage cum pre-settling tanks, i.e., reduction of raw water turbidity of canal, is taking into accout for design.

3. Plant Design

The design of captioned plant will be:
- Raw water intake and transmission. It is not clear at the present that the existing intake facilities is capable enough to allow extended raw water intake capacity, thus new intake and transmission facilities are pplanned to be constructed.

Intake and transmission facilities are composed of an Intake mouth, raw water main (intake mouth ~ existing Raw Water Storage Tanks)since there is public road between RBC and Plant Site, Intake pipes from Raw Water Storage Tank to a Raw Water Pump Station. Coarse and fine screens be installed at Raw Water Distribution Valve Chamber in the Plant Site and raw water Pump Station respectively.
- Water purification facilities composing of receiving tank cum distribution tank, flash mixing tank, clarifier (flocculation and settling tank), rapid gravity sand filter, clear water reservoir, mechanical & electric equipment and buildings.
- In addition, sludge dewatering facilities will be designed (existing French Plant uses sludge drying bed which will be suitable for climatic condition in Faisalabad; small precipitaion, long dry season and high temperature and evapolation)

Site survey required:

Since no reliable drawings of the existing plant, the following site survey will be required:
- Topographycal survey
- Collection of information on Geotechnical data from the design of French plant, otherwise geotschnical investigation may be required.
- Raw water data, especially turbidity.
- Power sourve and availability for the requirement.

4. Technical Parameters

Table 1.1 below summarize the technical parameters of intake and water purification process facilities based on the process design and chemical applications.

Table 1.1 Techncal Parameters of Intake and Water Process Facilities

1)

Sl. No.	Description			unit	Dimensions	Note
1	**Raw Water Intake and Transmission**					
1.1	**Intake Sorce**			-	Rakh Branch Canal	
a.	Flow	Design maximum		m^3/s	9	
b.	Cross section of canal:	Width		m	10.5	bottom width
		Water depth		m	0.8	WASA's data on rehabilitation works of plant in 2008
		Free board		m	0.4	-ditto-
1.2	**Intake method**			-	gravity	
1.3	**Intake mouth**					
a.	Number of intake mouth:			unit	1	
b.	Intake capacity:			m^3/d	47,900	5% loss in treatment process
b.	Intake water level:	HWL		m	184.71	WASA's data on rehabilitation works of plant in 2008
		LWL		m	184.26	WASA's data on rehabilitation works of plant in 2008
c.	Intake velocity:	(at LWL)		m/s	1.0	maximum velocity
d.	Dimensions:	Width		m	1.6	
		Water depth		m	0.76	at HWL
				m	0.34	at LWL
e.	Appurtenat equipment:	Stop log		l.s.	1	at LWL
1.4	**Raw Water Main**					
a.	Materials			-	DCIP	
b.	Mimensions	Number		line	1	
		Diameter		mm	800	
		length (apprx.)		m	25	
		velocity		m/s	1.10	
d.	Screen and Raw Water Distribution Chamber					
		Screen	(manual operation)	unit	1	bar screen (9mm) with 60mm pitch
1.5	**Raw Water Storage Tank:**					
a.	Number of tanks			units	2	
b.	Dimensions:	No.1	area	m^2	14,800	
			water depth	m	3.5	
		No.2	area	m^2	14,200	
			water depth	m	3.5	
c.	Volume capacity (total)			m3	101,500	
	note: A total volume of the existing raw water (tank no.1 to 3) is approximately 140,000 m3, out of which tank No.3 will be abandaned for new WTP construction. The remaining tank volume becomes about 100,000 m3 2 days detention time of new plant treatment capacity, which is enough to settle solid in canal water.					
1.6	**Raw Water Transmission**					from raw water tank to Receiving Tank
a.	Intake Pipe each	Materials		-	DCIP	
		Diameter		mm	800	
b.	Raw Water Pump Station					
	Receiving Well:	Width		m	6.6	
		Length		m	3.6	
		Water depth		m	6.0	
		Appurtenance equipment		-		
			Fine screen	unit	2	refer to 5. mechanical Equipment
	Pump Suction Well:	Width		m	6.6	detention time as about 10 min. at LWL
		Length		m	19.6	
		Water depth		m	6	
	Pump cum Electric:	Width		m	7	
	Room	Length		m	20	
		Height		m	3.5	
		Appurtenance equipment		-		refer to 5. Mechanical Equipment
c.	Raw Water Intake Pump			-		refer to 5. Mechanical Equipment
d.	Raw Water Transmission Main (RWTM)					
		Material		-	DCIP	
		Diameter		mm	700	
		Appurtenent equipment				
		Flow meter:	type	-	ectromagnetic	
			diameter	mm	600	
		Flow controller:	type	-	butterfly valve	
			diameter	mm	600	

Sl. No.	Description	unit	Dimensions	Note
2	**Water Treatment Facilities**			
2.1	**Treatment capacity**	m3/d	47,900	5 % loss in treatment operation
2.2	**Purification Process Facilities**			
a.	**Reciving Tank (Distribution Tank)**			
	Number of tank	unit	1	two independent cpmpartments
	Dimensions (internal) Width:	m	3.0	each compartment
	Length:	m	3.7	
	Water depth:	m	5.5	
	Free board:	m	0.6	
	Detention time			
	Effective volume:	m^3	122	
	Detention time:	min	3.6	
	Appurtenant Equipment Inlet pipe: Number	unit	1	with butterfly valve (manual)
	Materials	-	DCIP	
	Diameter	mm	700	
	Inlet gate: Number	units	2	
	Materials	-	DCIP	
	Size	mm	600 x 600	
	Interconnecting gate: Number	unit	1	at outlet channel
	Materials	-	DCIP	
	Size	mm	500 x 500	
	Outlet pipe: Number	units	2	with butterfloy valve each
	Materials	-	DCIP	(manual operation)
	Diameter	mm	500	
	Overflow pipe: Number	unit	1	at Effluent channel
	Materials	-	DCIP	
	Diameter	mm	400	
	Drain pipe: Number	units	2	with gate valve each (manual)
	Materials	-	DCIP	
	Diameter	mm	150	
b.	**Flash Mixing Tanks**			
	Mixing Method	-	hydraulic	water fall
	Number of Tanks	units	2	one for each treatment stream
	Dimensions Detention time:	sec	60 (30)	receiving part (mixing part)
	Width:	m	3.0 (3.0)	
	length:	m	3.0 (3.0)	
	Water depth:	m	4.5 (3.0)	
	Water Fall Height	cm	60	
	Mixing Intensity	sec^{-1}	approx. 500	
	Appurtenant Equipment Alum diffuser	unit	1	for each tank
	Distribution chamber of Alum solution	unit	1	placed at Receiving Tank
c.	**Flocculation Tank**			
	Mixing Method	--	hydraulic	up-and-
	Detention Time	min	30	
	Number of Tanks	units	4	two for each stream
	Dimensions No. of raws (channels)	nos	4	
	Width	m	1.85	
	length	m	9.70	
	Water depth	m	ave. 3.6	
	Free board	m	0.4	
	Mixing Intensity	sec^{-1}	30 ~ 60	
	Energy Dissipation (GT-Value)	-	apprx. 85,000	
	Appurtenant Equipment Sludge extraction pipe: Materials	-	HDPE	each row
	Diameter	mm	200	
	Drain valve Materials	-	DCIP	
	Diameter	mm	150	gate valve

Sl. No.	Description	unit	Dimensions	Note
d.	**Settling Tanks**			
	Type	--	Tube Settler	
	Detention Time	min	approx. 40	
	Number of Tanks	units	4	two for each stream
	Number of Compartments per Tank	nos	2	
	Dimensions of Compartment			
	Width:	m	4.0	net width (width of tube settler)
	Length:	m	12.0	excl. stilling zone (1.5m in length)
	Water depth	m	3.5	
	Water depth above module:	m	0.8	
	Height of module:	m	1.0	excl. support of module
	Height below module:	m	1.5	below support of module
	Length of inlet stilling zone:	m	1.5	
	Free board:	m	0.4	
	Effective volume of compartment:	m3	336	
	Inclining Tube Module Width:	m	1.0	reference
	Lemgth:	m	1.0	
	Installation height:	m	1.0	
	Tube size:	m	80	reference
	Thickness of plate:	mm	min 1.0	
	Installation angle to horizontal:	deg.	60	
	Effective settline area of module:	m^2	635	per tank
	Surface Loading	$m^3/hr/m^2$	< 0.8	
	Upflow Velocity	$m^3/hr/m^2$	5.2	
	Clarified Water Collector			
	Method/type of collector	-	Pipes (ND 150mm)	
	Total length of collector	m/tank	33.6	
	Weir loading	m^3/day/m	180	
	Sludge Extraction (per tank)			
	Method:	-	hopper type	
	Number of hpppers:	nos.	16	per settling tank
	Sludge extraction piping:			per tank
	Materials	-	HDPE	in tank
		-	DCIP	outside of tank
	Diameter	mm	150	header pipe (200mm)
	No. of extraction valves	units	8	horizontal butterfly valve
		-		(Pneumatic operation)
	extraction header	mm	ND 200	
	Drain pipe Number of pipes:	nos.	4	gate valve (manual operation)
	Materials:	-	DCIP	
	Diameter:	mm	150	
e.	**Rapid Sand Filter**			
	Type of Filtration Control	-	Constant filteration rate	equal split at inlet
	Filtration Rate	$m^3/d/m^2$	140	
	Number of Filters	units	8	
	Dimensions of Filter			
	Number of cell per filter:	nos	1	
	Width:	m	4.5	
	Length:	m	9.4	
	Side water depth:	m	4.85	
	Water depth above sand	m	1.4	
	Thickness of filter media	m	1.2	sand: 1.0 + gravel: 0.2
	Height of underdrain	m	1.1	incl. false slab
	Free board	m	0.9	
	Width of washdrain gutter	m	0.9	net width
	Filter Media (Filter Sand)			
	Effective size	mm	0.9~1.0	
	Uniformity Co-efficient	-	1.4	
	Filter Media (suporting gravel)			
	Number of layer	nos.	4	
	Range of size	mm	2 - 25	
	Thickness of each layer	mm	50	

Sl. No.	Description		unit	Dimensions	Note
e.	**Rapid Sand Filter (continued)**				
	Underdrain System				
	Type		--	Nozzle type	type of partition block is acceptable
	Total area of plunk pipe		%	1.6	reference
	Installation spacing		mm	< 150	
	Net clearance below false slab		cm	100	
	Maximum head loss		cm	70	at backwashing rate as 0.6 m/min
	Filter Washing				
	Method of washing		-	Air + Backwash	
	Washing rate	air scouring	$m^3/min/m^2$	1	10 min
		backwash with air	$m^3/min/m^2$	0.25	2 min
		backwashing	$m^3/min/m^2$	0.5	8 min
	Washing Trough				
	Number of trough		nos.	4	
	Material of fabrication		-	Pre-stressed Concrete	alternative is applicable
	Dimensions:	width	mm	400	
		height (inside)	mm	400	
	Piping				refer to 5. Mechanical Equipment
	Inlet gate:		mm	300 x 300	
	Wash drain gate:		mm	600 x 600	
	filtered water pipe:		mm	250	
	Air scouring pipe:		mm	250	
	Backwash pipe:		mm	450	
	Filtered water header:		mm	800	
	Air scouring header:		mm	300	
	Backwash header:		mm	500	
	Filter drain pipe & header:		mm	150	with manual gate valve
	Air Blower				refer to 5. Mechanical Equipment
	Backwash pump				refer to 5. Mechanical Equipment
f.	**Clear Water (CW) Reservoir and Pumping Station**				
	CW Reservoir				
	Number of Reservoir		no.	1	independednt two compartments
	Dimensions (per compartment)				
	Width:		m	15.6	
	Length:		m	24.8	
	Effective water depth:		m	4.5	
	Free baord:		m	0.6	
	Effective volume		m3	1,741	detention time as approx.1.9 hors
	Piping				
	Inlet pipe:		mm	600	with manual butterfly valve
	Outlet gate:		mm	600 x 600	manual operation
	Overflow pipe:		mm	400	
	Drain pipe:		mm	200	
	CW Pumping Pumps				refer to 5. Mechanical Equipment
	Transmission Main	Materials	-	DCIP	
		Diameter	mm	800	
		Flow meter:	600	Electro-magnetic	
		Control Valve:	600	Butterfly	metal sheet. Motored

Sl. No.	Description			unit	Dimensions	Note
3	**Waste Water Treatment**					
a.	**Waste Water Tank**					
	Sludge Inflow			m^3/time	150	for one settling tanks
	Waste Backwash Water Inflow			m3/time	230	for one filters
	Tank Volume				380	
	Number of Tank			unit	1	with independent two compartments
	Dimensions					ample safety of volume is designed
	(per compartment)	Length:		m	11.45	
		Width:		m	7.5	
		Water depth:		m	2.5	
		Free board:		m	1.9	
	Piping	Inlet pipe:	materials	-	DIP	
			diameter	mm	800	
		Inlet gate	materials	-	DCIP	
			number	units	2	-
			size	mm	600 x 600	
		Overflow pipe:				
			materials	-	DCIP	
			diameter	mm	300	to raw water storage tank
	Appurtenant Equipment	Submersible mixer				refer to 5. Mechanical Equipment
	Waste Water Transfer Pumps			-		refer to 5. Mechanical Equipment
		Type			Nonoclog Submersible	
		Number		units	$^{W}2 + {}^{S}2$	
b.	**Sludge Thickener**					
	Solid Weight			Kg/day	5330	
	Loading of Thickener			Kg/day	20	
	Number of Thickener			units	2	
	Type of Tjickener			-	Center Feed Gravity Thickener	
	Dimensions of a Thickener (per thickener)					
		Diameter::		m	13.0	
		Water depth:		m	4.0	
		Effective Volume :		m^3	531	
		Free board:		m	0.6	
		Depth of sludge deposit:		m	0.5	
		Bottome slope:		%	10	
		Sludge deposit:		m3	110	
		Center feed well:	diameter	m	2.5	
	Appurtenant Equipment	Sludge scraper:				refer to 5. Mechanical Equipment
	Piping	Inlet pipe:		mm	200	materials: HDPE
		Supernatant water pipe:		mm	200	
c.	**Sludge Extraction Pump House**					
	Structure			-	2 stories RC	pump room (basement) FL and
	Dimensions	Width:		m	5.0	electric room (ground FL)
		Length:		m	10.0	
		Height:		m		
	Sludge Extraction Pumps (to sludge drying beds)					refer to 5. Mechanical Equipment
d.	**Sludge Drying Bed**					
	Annual Average turbidity			NTU	20	
	Alum dosage (as solid Alum)			mg/l	15	
	Sludge (solid weight)	Sludge (solid weight)		kg/d	1,281	
				kg/year	467,565	
	Loading	Loading:		kg/m^2	150	
		Number of beds:		units	$^{W}6 + {}^{S}1$	
		Area per bed:		m^2	600	
		Dimensons:				
			Width	m	20	
			Length	m	30	
			Water depth	m	1.5	
			Filter sand	cm	20	
			gravel	cm	30	
			Moisture protection (base slab)	-	lean concrete	with geotextile underneath

Sl. No.	Description		unit	Dimensions	Note
4	**Major Buildings in Water Treatment Plant**				
4.1	**Raw Water Pump Station**				
	Structure			Two Stories RCC	
	Dimensions	Width	m	7	
		Length	m	24	
		Height (below beam soffit)	m	4.5	
	Total Area		m2	168	
		Rooms:			
		Screening Room	m^2	28	Fine Screen (2)
		Pump room	m^2	84	Pump (3)
		Electric/control room	m^2	56	Power Panel, MCC (3), Instrumentation
4.2	**Administration Building**				
	Structure			Single Story RCC	
	Dimensions	Width	m	18	
		Length	m	20	
		Height (below beam soffit)	m	3.5	under beam
	Total Area		m^2	360	
		Rooms:			
		Entrabce hall & reception	m^2	21.6	
		Manager's office	m^2	18.0	
		Offices	m^2	60.0	
		Meeting/Break room	m^2	42.0	
		Duty room/Pray Room	m^2	23.0	
		Wash Room	m^2	16.6	
		Storage Room	m^2	10.5	
		Electro-Mech. Room	m^2	15.0	
		Monitoring/Control Room	m^2	38.4	
		Laboratory	m^2	90.0	incl. storage
		Pantry	m^2	2.9	
		Collider	m^2	22.0	
4.3	**Mechanical Room for Sludge Extraction of Settling Tanks**				above pipe gallery
	Structure		-	RCC	
		Rooms:			each for 2 settling tanks
		Mechanical Room	m^2	64	air compressure and piping
4.4	**Operation Gallery of Filter**				above pipe gallery
	Structure			RCC	
		Rooms:			each for 2 filter group (4 filters each)
		Electrical Room	m^2	90	Washing control panel (console)
4.5	**Filter House**				
	Structure			Two Storis RCC	
	Total Area		m^2	122	each floor
	Rooms	Rooms:			
		Backwash air blower and Electric panels	m^2	61	ground floor
		Filtered water effluent and flow meter	m^2	61	basement floor
4.5	**Clear Water Pumping Station**				
	Structure			2 stories RCC	
	Total Area		m^2	393.6	
		Rooms: (base floor)			
		Pump Room	m^2	288	transmission pumps and piping
		Rooms: (ground floor)			
		Electric/Control Room	m^2	100	power, MCC and instrumentation panels
		Hatch Room	m^2	16.8	
		Entrance Hall	m^2	16.8	
4.6	**Chemical Building**				
	Structure	(w10 x L24 x H5.5m)		Single Story RCC	
	Total Area		m^2	240	
	Rooms	Rooms:			
		Alum Solution, Stotage, Dosage Pump	m^2	142	
		Lime Solution, Stotage, Dosage Pump	m^2	70	
		Polymer Solution. Storage, Dosage Pump	m^2	14	
		Electric/Control Room	m^2	14	

Sl. No.	Description		unit	Dimensions	Note
4.7	**Chlorine Building**				
	Structure	(w11.0 x L20 x H5.5m)		Single Story RCC	
	Total Area		m^2	180	
	Rooms	Room:			
		Chlorine Cylinder Room	m^2	90	
		Chlorinator Room	m^2	18	
		Booster Pump Room	m^2	18	
		Chlorine Gas Neutralization Room	m^2	36	
		Electric/Control Room	m^2	18	
4.8	**Waste Water Transfer cum Recycling Pump House**				
	Structure	(w9 x L14 x 2.5m)		RCC	above Waste Water Tank cum Recycling Sump
	Total Area		m^2	126	
4.9	**Sludge Thickened Extraction Pump House**				
	Structure			2 Stories RCC	
	Total Area		m^2	120	
	Rooms	Room: (Base Floor)			
		Pump Room	m^2	60	
		Room: (Ground Floor)			
		Electric/Control Room	m^2	40	
		Hach Room	m^2	14	
		Stare Case	m^2	6	
4.10	**Minor Buildings**				
a.	Workshop		m^2	108	$^{w}9 \times {}^{l}12$ m
b.	Power Sub-station		m^2	60	$^{w}5 \times {}^{l}12$ m
c.	Generator House		m^2	50	$^{w}5 \times {}^{l}10$ m
d.	Guardhouse		m^2	15	$^{w}3 \times {}^{l}5$ m
5	**Major Mechanical Equipment**				
5.1	**Major Pumps**				
1)	**Raw Water Pumps**				
a.	Type of Pumps		-	Submersible Pump	at Rwa Water Intake Pump Sta.
b.	Number of Pumps		units	$^{w}2 + {}^{s}1$	
c.	Dimensions	Pump Discharge	m3/min	17	
		Dianeter	mm	500	
		Pump Head	m	10	
		Rated Speed	RPM	1500	reference
		Motor Output	kWH	45	Voltage: 400 V
		Motor Control	-	Fixed Speed	
2)	**Clear Water Transmission Pumps**				at Water Transmission Pump Sta.
a.	Type of Pumps		-	Horizontal Volute	
b.	Number of Pumps		units	$^{w}2 + {}^{s}1$	
c.	Dimensions	Pump Discharge	m3/min	16	
		Diameter (Ds / Dd)	mm	400 / 250	
		Pump Head	m	35	
		Rated Speed	RPM	750	reference
		Motor Output	kWH	110	Voltage: 400 V
		Motor Control	-	Variable Speed	
3)	**Backwash Pump**			Horizontal Volute	at Water Transmission Pump Sta.
a.	Type of Pumps				
b.	Number of Pumps		units	$^{w}2 + {}^{s}1$	
c.	Dimensions	Pump Discharge	m3/min	13	
		Diameter (Ds / Dd)	mm	350 / 300	
		Pump Head	m	13	
		Rated Speed	RPM	1000	reference
		Motor Output	kWH	55	Voltage: 400 V
		Motor Control	-	Fixed Speed	

Sl. No.	Description		unit	Dimensions	Note
4.7	**Chlorine Building**				
	Structure	(w11.0 x L20 x H5.5m)		Single Story RCC	
	Total Area		m^2	180	
	Rooms	Room:			
		Chlorine Cylinder Room	m^2	90	
		Chlorinator Room	m^2	18	
		Booster Pump Room	m^2	18	
		Chlorine Gas Neutralization Room	m^2	36	
		Electric/Control Room	m^2	18	
4.8	**Waste Water Transfer cum Recycling Pump House**				
	Structure	(w9 x L14 x 2.5m)		RCC	above Waste Water Tank cum Recycling Sump
	Total Area		m^2	126	
4.9	**Sludge Thickened Extraction Pump House**				
	Structure			2 Stories RCC	
	Total Area		m^2	120	
	Rooms	Room: (Base Floor)			
		Pump Room	m^2	60	
		Room: (Ground Floor)			
		Electric/Control Room	m^2	40	
		Hach Room	m^2	14	
		Stare Case	m^2	6	
4.10	**Minor Buildings**				
a.	Workshop		m^2	108	$^{w}9 \times {}^{l}12$ m
b.	Power Sub-station		m^2	60	$^{w}5 \times {}^{l}12$ m
c.	Generator House		m^2	50	$^{w}5 \times {}^{l}10$ m
d.	Guardhouse		m^2	15	$^{w}3 \times {}^{l}5$ m
5	**Major Mechanical Equipment**				
5.1	**Major Pumps**				
1)	**Raw Water Pumps**				
a.	Type of Pumps		-	Submersible Pump	at Rwa Water Intake Pump Sta.
b.	Number of Pumps		units	$^{w}2 + {}^{s}1$	
c.	Dimensions	Pump Discharge	m3/min	17	
		Dianeter	mm	500	
		Pump Head	m	10	
		Rated Speed	RPM	1500	reference
		Motor Output	kWH	45	Voltage: 400 V
		Motor Control	-	Fixed Speed	
2)	**Clear Water Transmission Pumps**				at Water Transmission Pump Sta.
a.	Type of Pumps		-	Horizontal Volute	
b.	Number of Pumps		units	$^{w}2 + {}^{s}1$	
c.	Dimensions	Pump Discharge	m3/min	16	
		Diameter (Ds / Dd)	mm	400 / 250	
		Pump Head	m	35	
		Rated Speed	RPM	750	reference
		Motor Output	kWH	110	Voltage: 400 V
		Motor Control	-	Variable Speed	
3)	**Backwash Pump**			Horizontal Volute	at Water Transmission Pump Sta.
a.	Type of Pumps				
b.	Number of Pumps		units	$^{w}2 + {}^{s}1$	
c.	Dimensions	Pump Discharge	m3/min	13	
		Diameter (Ds / Dd)	mm	350 / 300	
		Pump Head	m	13	
		Rated Speed	RPM	1000	reference
		Motor Output	kWH	55	Voltage: 400 V
		Motor Control	-	Fixed Speed	

Sl. No.	Description		unit	Dimensions	Note
4)	**Waste Water Transfer Pump**				at Waste Water Tank
a.	Type of Pumps			Non-Clog Submersible	
b.	Number of Pumps		units	$^{W}2 + ^{S}2$	
c.	Dimensions	Pump Discharge	m3/min	0.75	
		Diameter	mm	80	
		Pump Head	m	8	
		Rated Speed	RPM	1,450	reference
		Motor Output	kWH	2.2	Voltage: 400 V
		Motor Control	-	Fixed Speed	
5)	**Recycling Pump**				at Waste Water Tank
a.	Type of Pumps			Non-Clog Submersible	
b.	Number of Pumps		units	$^{W}2 + ^{S}2$	
c.	Dimensions	Pump Discharge	m3/min	0.75	
		Diameter	mm	80	
		Pump Head	m	10	
		Rated Speed	RPM	1450	reference
		Motor Output	kWH	3.7	Voltage: 400 V
		Motor Control	-	Fixed Speed	
6)	**Sludge Extraction Pump**				at Sludge Extraction Pump Sta,
a.	Type of Pumps			Screw Impeller Sludge Pump	
b.	Number of Pumps		units	$^{W}2 + ^{S}2$	
c.	Dimensions	Pump Discharge	m3/hr	11	
		Diameter	mm	100	
		Pump Head	m	15	
		Rated Speed	RPM	1450	reference
		Motor Output	kWH	5.5	Voltage: 400 V
		Motor Control	-	Fixed Speed	
7)	Sampling Pumps				
a.	Type of Pumps		-		
b.	Number of Pumps (at each location)		units	$^{W}2 + ^{S}1$	
d.	Dimensions			$^{ND}25mm \times ^{H}20m$	
c.	Installation Location	Raw water	-	Receiving tank	at inlet chamber
		Chemical treated water	-	Flash Mixing tank	at outlet chamber
		Clarified water	-	Sedimentation tank	at clarified water channel
		Filtered water	-	Filter	at filtered water effluent channel
		Finished water	-	Transmission Pump sta.	from transmission main
5.2	**Major Valves and Gate**				
a.	**Motored / Control / Air acutuated / Check Valves**				
	Raw water pumps	Check valve	units	$^{W}2 + ^{S}1$	spring type, ND500mm
		Delivery valve	units	$^{W}2 + ^{S}1$	butterfly (short body), ND 500mm
	Transmission pumps	Check valve	units	$^{W}2 + ^{S}1$	tilting type, ND350mm
		Delivery valve	units	$^{W}2 + ^{S}1$	butterfly (short body), ND 350mm
	Backwash pumps	Check valve	units	$^{W}2 + ^{S}1$	tilting type, ND350mm
		Delivery valve	units	$^{W}2 + ^{S}1$	butterfly (short body), ND 350mm
	Waste water transfer	Check valve	units	$^{W}2 + ^{S}2$	spring type, ND100mm
	pumps	Delivery valve	units	$^{W}2 + ^{S}2$	gate valve (rising stem), ND100mm
	Recycle pumpe	Check valve	units	$^{W}2 + ^{S}2$	spring type, ND100mm
		Delivery valve	units	$^{W}2 + ^{S}2$	gate valve (rising stem), ND100mm
	Sludge extraction	Check valve	units	$^{W}2 + ^{S}2$	spring type, ND100mm
	pumps	Delivery valve	units	$^{W}2 + ^{S}2$	gate valve (rising stem), ND100mm
	Filter piping	Filtered water pipe	units	8	butterfly (short body), ND 250mm
	(in pipe gallery)	Air scouring pipe	units	8	butterfly (short body), ND 250mm
		Backwash pipe	units	8	butterfly (short body), ND 250mm
	Flow control valves	Raw water intake	unit	1	butterfly (teeth vane), ND 600mm
		Finished water transmission	unit	1	butterfly (teeth vane), ND 600mm
		Backwash flow	units	1	butterfly (steel vane), ND 400mm
	Sludge extraction	Air actuated valve (Flocculation tank)	units	20	butterfly (short body), ND 150mm
		Air actuated valve (Sedimentation tank)	units	32	butterfly (short body), ND 150mm

Sl. No.	Description			unit	Dimensions	Note
a.	**Motored / Control / Air acutuated / Check Valves (continued)**					
b.	Gates					
	Raw water pump sta.	inlet gate (manual)		units	2	ND800mm (flanged), w/floor stand
	Receiving Tank	interconnecting (manual) at outlet chamber		unit	1	500x500mm, w/floor stand
	Flocculation tank	inlet gate (manual)		units	4	600x600mm, w/floor stand
	Filter	inlet gate (motored)		units	8	300x300mm, w/floor stand
		waste wash water drain		units	8	600x600mm, w/floor stand
	Waste water tank	inlet gate (manual)		units	2	600x600mm, w/floor stand
	Waste water recycling tank, inlet gate (manual)			units	2	300x300mm, w/floor stand
5.3	**Pneumatic Air System / Air Blower**					
a.	Pneumatic Air System for Sludge Extraction					two units (one unit each stream)
	Air compressure unit	number of units		units	$^{w}1 + {}^{s}1$	at operation gallery of sedimentation
		capacity		l/min	150	tank
	Air tank w/air dryer	number of units		unit	1	
		capacity		l/min	300	
	Solnoid valve box and valves			lot	1	
	Pneumatic power piping			lot	1	header pipe: SGP
						valve box to pipe tray: copper pipe
b.	Air Blower for Filter Washing					
	Type of Air Blowers			-	Rotary Root Blower	with Acoustic Box
	Number of Air Blowers			units	$^{w}1 + {}^{s}1$	
	Dimensions	Discharge Pressure		m	4	
		Diameter		mm	150	
		Discharge		m3/hr	48	
		Motor Output		kWH	45	Voltage: 400 V
5.4	**Other Mechanical Equipment**					
a.	Screen					
	Coarse Screen					
	Type			-	Bar Screen	installed at Intake valve chamber
	Number of Screens			unit	1	
	Dimensions	Width		m	1.6	
		Height		m	1.2	from base floor to top slab
		Screen	size (flat bar)	mm	9	
			net spacing	mm	50	
			installation angle to horizontal	deg.	25	
b.	**Fine Screen**					at Raw water pump sta.
	Type			-	Mesh Screen (automatic)	
	Number of Screens			units	2	
	Dimensions	Width		m	1.0	
		Height		m	6.5	from base floor to top slab
		Screen	spacing	mm	12	
			installation angle to horizontal	deg.	90	
c.	Flow meter					
	Type			-	Electro-Magnetic	
	Location and Diameter	Raw water intake flow		mm	600	
		Filtered water flow		mm	700	
		Finished water flow		mm	600	
d.	Crane and Hoist					
	Traveling crane w/chain hoist					motored operation
		Transmission pump sta.				at transmission pump sta.
			unit	unit	1	
			capacity	ton	3	
	Hoist	Raw water intake pump sta.				
			unit	unit	1	
			capacity	ton	5	
		Waste water tank				
			unit	unit	1	
			capacity	ton	1	
		Recycle sump				
			unit	unit	1	
			capacity	ton	1	
		Chemical building				
			unit	unit	1	
			capacity	ton	1	
		Chlorine building				
			unit	unit	1	
			capacity	ton	2	

Sl. No.	Description		unit	Dimensions	Note
e.	Submersible Mixer and Sludge Scraper				
	Submersible mixer	number of units	units	4	at waste water tank
		capacity	m3/hr	86	
	Sludge scraper	type	-	center rotated sludge scraper	at sludge thickner
		number of units	units	2	one each thickener
f.	Laboratory Equipment				
	Thermometer		unit	1	
	pH Meter		unit	1	
	Spectrophotometer		unit	1	
	Turbid meter		unit	1	
	Conductivity Meter		unit	1	
	Residual Chlioine Meter		unit	1	
	Vacum Pump		unit	1	
	Dry Oven		unit	1	
	Analitical Balance		unit	1	
	Autoclave		unit	1	
	Incubator		unit	1	
	Digital Colony Counter		unit	1	
	Stirrer		unit	1	
	Jar Tester		unit	1	
	Refrigerator		unit	1	
	Hot Plate		unit	1	
	Draft Chamber		unit	1	
g.	Workshop Equipment and Tools				
	Main Equioment				
		Metal turning lathe	unit	1	
		Drilling machine	unit	1	
		Welder	unit	1	
		Portable diesel engine welder	unit	1	
		Portable engine generator	units	2	
		Pipe machine	units	2	
		Bench grinder, Portable electric disc grinder	unit	1	
		Portable electric drill	unit	1	
		Bench electric cutter	unit	1	
		Oxy-Acethlene torch set	unit	1	
	Miscellaneous Equipment				
		Pipe cutter with spare cutting wheel (10 sets)	units	3	each φ3.2~32 and φ25~80mm
		Ring pipe cutter with spare cutting blades (10 sets)	units	2	φ75~300mm
		Pipe vice w/steel leg	units	2	
		Pipe reamer	units	2	φ12.7~3.2mm
		Pipe threads cutter w/spare die set and cutting collant	units	2	φ15~50mm
		Portable electric axial fan	units	2	dia.300mm
		Single and 3 phase power cable reel	units	2	each
		Engine drive air compressor w/air tank	unit	1	295 l/min, 18 lit tank, 2.6lW output
	Tools				
		suitable for measureing, piping	lot	1	
	Materials Handling Equipment				
		Hand pallet truck	unit	1	20 ton
		Hand lifter	units	2	5 ton
		Steel playfprm truck	units	2	1.5 ton
		Hand truck	units	2	2.2 ton
		Step ladder	units	2	h = 4.2m Aluminium fram
	Hardware				
		Work desk	unit	1	
		Drilling machine table	unit	1	
		Bench vice table	unit	1	
		Welding bench	unit	1	
		Too wagon	units	2	
		Ultrasonic rays isolation partitions	units	5	
		Storage racks	lot	1	

Sl. No.	Description	unit	Dimensions	Note
5.5	**Chemical Dosage Equipment**			
1)	**Estimated Raw Water Quality**			
a.	Water temperature	℃	15 ~ 28	
b.	pH	-	7.2 ~ 8.2	
c.	Turbidity (after pre-settling in Raw Water Tank)	NTU	10 ~ 100	average 20 NTU
d.	Alkalinity	mg/l	70 ~ 90	
e.	Ammonium	mg/l	0.01 ~ 0.1	
f.	Iron	mg/l	1.0 ~ 2.0	
g.	Manganese	mg/l	0.01 ~ 0.05	
2)	**Chemical Applications (Chemical used and Dosage point)**			
a.	Coagulation			
	Chemical	-	Solid $Al_2(SO_4)_3$, 18 H_2O	
	Dosage Point	-	Flash Mixing Tank	
b.	pH Adjustment			
	Chemical	-	Hydrated Lime (power; 95%)	
	Dosahe Point	-	Flash Mixing Tank, Flocculation Tank	
b.	Coagulation Aid			
	Chemical	-	Polymer	
	Dosage Point	-	Flocculation Tank	piping arrangement for flexible dosage points
c.	Oxidization/Disinfection			
	Chemical	-	Liquid chlorine	
	Dosage Point	-	Flash Mixing Tank	Pre-chlorination
		-	Filter Effluent	Post-chlorination
3)	**Alum Dosage Facilities/Equipment**			
a.	Dosage Rate			
	Maximum	mg/l	30	as Solid Alum
	Average	mg/l	15	as Solid Alum
b.	Alum Requirement (weight as solid form)		(as $Al_2(SO_4)_3$, 18 H_2O)	
	Maximum	kg/day	1,440	
	Average	kg/day	720	
c.	Alum Solution		(as 10% concentration)	
	Maximum	l/day	14,400	
	Average	l/day	7,200	
d.	Alum Storage			
	Period of Storage	days	30 days for Ave. dosage	
	Storage Weight	kg	43,200	
	Storage Area Required	m^2	30	
e.	Major Facilities/Equipment			
	Alum Dilution/Mixing Tank			
	Number of Tanks	nos.	2	one for each tank
	Tank Dimensions	m	2.0 x 2.0 x 2.1	
	Inside Lining	-	Anti-acid or Ceramic Tile	
	Mixer			
	Type	-	Flat Blade Radial Turbine	
	Number	units	(one per tank)	
	Motor Output	kW	1.5	
f.	Alum Solution Dosage Pump			
	Type of Pump	--	Simplex diaphragm type metering pump or Progressive cavity	
	Number of Pumps	units	$^{W}2 + {}^{S}1$	
	Capacity	l/hr	300	
	Pump Head	m	50	
g.	Alum Solution Dosage Distribution Chamber			locate at Receiving Tank for equal
	Materials	-	SS 316	split w/gravity flow
	Dimensions (W x L x H)	mm	$^{w}30x^{l}50x^{h}30x^{n}2$	
	Triangle weir (width)	mm		provisions of dilution water piping
4)	**Lime Dosage Facilities/Equipment**			
a.	Dosage Rate			
	Maximum	mg/l	20	
	Average	mg/l	10	
b.	Lime Requirement (weight as solid form)			purity: 95%
	Maximum	kg/day	1010	
	Average	kg/day	500	
c.	Lime Solution			as 10% concentration
	Maximum	l/day	6,730	
	Average	l/day	3,330	
d.	Lime Storage			
	Period of Storage		30 days for Ave. dosage	
	Storage by Weight	kg	15,000	
	Storage Area Required	m2	25	

Sl. No.	Description	unit	Dimensions	Note
e.	Major Facilities/Equipment			
	Lime Dilution/Mixing Tank			
	Number of Tanks	nos.	2	
	Storage Capacity	m^3	3.5	
	Dimensions (width x length x depth)	m	1.3x1.3x2.1	
	Inside Lining	-	Epoxy (250µ x 3 coats)	
f.	Mixer			
	Type	-	Flat Blade Radial Turbine Type	
	Number	units	2 (one for each tank)	
	Motor output	kW	1	
h.	Lime Solution Dosage Pump		Completely sealed	
	- type	-	Magnetic Drive Chemical or Progressive Cavity	
	- number of pumps	units	$^{W}2 + {}^{S}1$	
	- capacity	l/hr	150	
	- pump head	m	50	
5)	**Polymer Dosage Equipment**			
a.	Dosage Rate			
	Maximum	mg/l	1	
	Average	mg/l	0.2	
b.	Polymer Requirement			
	Maximum	kg/day	48	
	Average	kg/day	10	
c.	Dosage of Polymer Solution			
	Maximum	l/hr	400	
	Solution Storage Tank	m3	1	
d.	Polymer Storage		30 days for Ave. dosage	
	Storage by weight	kg	300	
	Storage Area Required	m^2	18	
f.	Solution System		Packaged full automatic polymer solution preparation unit	
g.	Solution Dosage Pump			
	Type of Pump	-	Positive displacement progressing cavity (2-stage)	
	Number of Pumps	units	$^{W}2 + {}^{S}1$	
	Discharge	l/hr	420	
	Pump Head	m	50	
6)	**Chlorine Dosage Equipment**			
a.	Dosage Rate			
	- Pre-Chlorination Dosage			
	Maximum Rate	mg/l	3	
	Average Rate	mg/l	1	
	- Post-Chlorination Dosage			
	Maximum Rate	mg/l	2	
	Average rate	mg/l	1	
b.	Chlorine Requirement for Pre- and Post-Chlorination			
	Maximum Rate	kg/day	240	
	Average Rate	kg/day	100	
c.	Dosage of Chlorine			
	- Pre-Chlorination			
	Maximum	l/day		0.02% of solution
	Average	l/day		
	- Post-Chlorination			
	Maximum	l/day		
	Average	l/day		
e.	Chlorine Storage		30 days for Ave. dosage	
	Storage by Weight	Kg	3,000	
	Storage Area Required	m^2	90	include 4 cyliners for dosage
f.	Major Equipment			
	- weighing scale			
	type Type	-	Lifting Type	Steel frame w/electric load cell
	Capacity (no. of Cylinders)	nos.	2	Suitable to lift 900 kg tonner
	Number of Units	units	$^{W}1 + {}^{S}1$	
	- evaporators	-	Natural Evaporation	
	- chlorinators (Pre-Chlorination)			
	Type	--	Vacuum Operated Solution (Feed Sonic Flow)	
	Capacity	kg/hr	7.5	
	Number of Unit	units	$^{W}1 + {}^{S}1$	

Sl. No.	Description		unit	Dimensions	Note
	- chlorinators (Post-Chlorination)				
		Type	-	Vacuum Operated Solution (Feed Sonic Flow)	
		Capacity	kg/hr	5.0	
		Number of Unit	units	$^{W}1 + {}^{S}1$	
	- booster pumps				
		Type	-	End Suction Volute Pump	
		Capacity	l/min	120	solution rate as 0.02%
		Number of Units	nos.	$^{W}1 + {}^{S}1$	each for Pre & Post-Cl2
g.	Chlorine Gas Neutralization System				
	- capacity		kg/hr	45	NaOH
	- reaction reagent		-	Caustic Soda Solution (15 %)	
	- regent storage Tank				1 (unsufficient)
		Capacity	m^3	1	
		Number	nos.	1	
		Materials of Construction	-	FRP/PP	
	- absorption tower				
	materials	Materials of Construction	-	FRP	
	diameter	Diameter	mm	600	
e.	- blower				
		Type	-	Turbo Blower	
		Materials of Construction	-	FRP	
	capacity	Capacity	l/hr	720	
	number of unit		nos.	$^{W}1 + {}^{S}1$	
f.	- Regent Circulation Pumps				
		Type	--	hemical Pump	
		Materials of Construction	--	PP	
		Capacity	l/hr	17	
		Number of Units	nos.	$^{W}1 + {}^{S}1$	
7	**Electrical Equipment**				
7.1	**Power Receiving, Distribution and Emergency Generator**				
1)	**Power Receiving**				
a.	FESCO Tariff Category		-	B3	B: Industrial Supply Tariffs 3: For All Loads up to 5000kW (at 11kV)
b.	Number of Incoming Line		no.	1	
c.	Incoming voltage		V	11,000	
d.	Transformer	Type	-	Oil Immersed Type	
		Capacity	kVA	1,000	
		Primary Voltage	V	11,000	
		Secondary Voltage	V	400	
2)	**Distribution**				
a.	Distribution voltage		V	400	
3)	**Emergency Generator**				
a.	Engine Type		-	Diesel	
b.	Capacity		kVA	1,000	
c.	Voltage		V	400	
d.	Daily Service Fuel Tank		L	600	
e.	Main Fuel Tank		L	10,000	providing at least 45 hrs operation at full load
7.2	**Instrumentation Equipment and UPS**				
1)	**Field Instruments**				
a.	Intake Bay Water Level		set	1	Immersion type level sensor
b.	Pump Sump Pit Level		set	1	Immersion type level sensor
c.	Raw Water Flow		set	1	Electromagnetic flowmeter
d.	Filter Inlet Water Level		set	1	Immersion type level sensor
e.	Clear Water Reservoir Water Level		set	2	Ultrasonic type level sensor
f.	Sludge Extraction Pump Well Water Level		set	1	Gauge pressure type
g.	Waste Water Tank Water Level		set	1	Immersion type level sensor
h.	Recycling Pump Sump Water Level		set	1	Immersion type level sensor
i.	Pump Sump Pit Level Switch		set	1	Float type
j.	Filter Inlet Water Level Switch		set	1	Electrode type
k.	Clear Water Reservoir Water Level Switch		set	2	Electrode type
l.	Polymer Tank Level Switch		set	2	Electrode type
m.	Alum Tank Level Switch		set	2	Electrode type
n.	Lime Preparation Tank Level Switch		set	2	Electrode type
o.	Finished Water Flow		set	1	Electromagnetic flowmeter
p.	Transmission Flow		set	1	Electromagnetic flowmeter
q.	Backwash Flow		set	1	Electromagnetic flowmeter

Sl. No.	Description		unit	Dimensions	Note
f.	Major Equipment (continued)				
	- chlorinators (Post-Chlorination)				
		Type	-	Vacuum Operated Solution (Feed Sonic Flow)	
		Capacity	kg/hr	5.0	
		Number of Unit	units	$^{W}1+{}^{S}1$	
	- booster pumps				
		Type	-	End Suction Volute Pump	
		Capacity	l/min	120	solution rate as 0.02%
		Number of Units	nos.	$^{W}1+{}^{S}1$	each for Pre & Post-Cl2
g.	Chlorine Gas Neutralization System				
	- capacity		kg/hr	45	NaOH
	- reaction reagent		-	Caustic Soda Solution (15 %)	
	- regent storage Tank				1 (unsufficient)
		Capacity	m^3	1	
		Number	nos.	1	
		Materials of Construction	-	FRP/PP	
	- absorption tower				
	materials	Materials of Construction	-	FRP	
	diameter	Diameter	mm	600	
e.	- blower				
		Type	-	Turbo Blower	
		Materials of Construction	-	FRP	
	capacity	Capacity	l/hr	720	
	number of unit		nos.	$^{W}1+{}^{S}1$	
f.	- Regent Circulation Pumps				
		Type	--	hemical Pump	
		Materials of Construction	--	PP	
		Capacity	l/hr	17	
		Number of Units	nos.	$^{W}1+{}^{S}1$	
7	**Electrical Equipment**				
7.1	**Power Receiving, Distribution and Emergency Generator**				
1)	**Power Receiving**				
a.	FESCO Tariff Category		-	B3	B: Industrial Supply Tariffs 3: For All Loads up to 5000kW (at 11kV)
b.	Number of Incoming Line		no.	1	
c.	Incoming voltage		V	11,000	
d.	Transformer	Type	-	Oil Immersed Type	
		Capacity	kVA	1,000	
		Primary Voltage	V	11,000	
		Secondary Voltage	V	400	
2)	**Distribution**				
a.	Distribution voltage		V	400	
3)	**Emergency Generator**				
a.	Engine Type		-	Diesel	
b.	Capacity		kVA	1,000	
c.	Voltage		V	400	
d.	Daily Service Fuel Tank		L	600	
e.	Main Fuel Tank		L	10,000	providing at least 45 hrs operation at full load
7.2	**Instrumentation Equipment and UPS**				
1)	**Field Instruments**				
a.	Intake Bay Water Level		set	1	Immersion type level sensor
b.	Pump Sump Pit Level		set	1	Immersion type level sensor
c.	Raw Water Flow		set	1	Electromagnetic flowmeter
d.	Filter Inlet Water Level		set	1	Immersion type level sensor
e.	Clear Water Reservoir Water Level		set	2	Ultrasonic type level sensor
f.	Sludge Extraction Pump Well Water Level		set	1	Gauge pressure type
g.	Waste Water Tank Water Level		set	1	Immersion type level sensor
h.	Recycling Pump Sump Water Level		set	1	Immersion type level sensor
i.	Pump Sump Pit Level Switch		set	1	Float type
j.	Filter Inlet Water Level Switch		set	1	Electrode type
k.	Clear Water Reservoir Water Level Switch		set	2	Electrode type
l.	Polymer Tank Level Switch		set	2	Electrode type
m.	Alum Tank Level Switch		set	2	Electrode type
n.	Lime Preparation Tank Level Switch		set	2	Electrode type
o.	Finished Water Flow		set	1	Electromagnetic flowmeter
p.	Transmission Flow		set	1	Electromagnetic flowmeter
q.	Backwash Flow		set	1	Electromagnetic flowmeter

Sl. No.	Description	unit	Dimensions	Note
1)	**Field Instruments (continued)**			
r.	Transmission Pressure	set	1	Gauge pressure type
s.	Raw Water pH	set	1	Combination electrode type
t.	Raw Water Turbidity	set	1	Surface-scattered light type
u.	Chemical Treated Water pH	set	1	Combination electrode type
v.	Clarified Water Turbidity	set	1	Surface-scattered light type
w.	Filtered Water Turbidity	set	1	Surface-scattered light type
x.	Finished Water Residual Chlorine	set	1	Reagentless free type
2)	**Instrumentation Panels**			
	Instrumentation Panels for Major Electrical Room	lot	1	Administration Bldg.
3)	**UPS**			
	Uninterruptible Power Supply System for Instrumentation and Control	set	1	Back-up time : 30 min
7.3	**SCADA System**			
1)	Equipment for WTP			at Administration Bldg.
a.	Operator Station	unit	1	
b.	Engineering Station	unit	1	
c.	A4 Color Laser Printer	unit	1	
d.	A3 Monochrome Laser Printer	unit	1	
e.	Power Distribution Panel	unit	1	
f.	Telemeter Panel	unit	1	
g.	Graphic Monitoring Panel	unit	1	
h.	Security Camera	unit	1	for intake mouth
i.	Camera Server	unit	1	
2)	Equipment for Local Stations			
a.	Local Station Panel for Local Stations	unit	3	for Distribution Center's information
b.	Distribution Flowmeter for Local Stations	unit	12	for DMA's information
c.	Distribution Pressure Transmitter for Local Stations	unit	12	for DMA's information

2. Raw Water Intake and Water Purification Process Design

2.1 Plant Capacity

Production Capacity	10	mgd =	45,500	m3/d =	1,900	m3/hr =	0.527 m3/s
Treatment Capacity							
loss in purification process							5 %
Capacity							47,900 m3/d
							2,000 m3/hr
							33.3 m3/min
							0.554 m3/s

2.2 Raw Water Intake

1) Water Source

Rakh Branch Canal

Dimensions of Canal	Design Flow of Canal	(New JK WTP by French Project)					9 m3/s
	Cross section of Canal	(New JK WTP by French Project)					
	width:					(bottom)	10.5 m
						(upper)	14.1 m
	height:	top EL +	185.11	bottom EL +	183.93		1.18 m
	side bank slope:	height (m)	1.6	width (m)			1: 1.5
	water depth:	HWL	184.71				0.78 m
	free board:						0.40 m
	Velocity :	width (m)	10.50				1.10 m/s

2) Raw Water Intake Facilities

Water level	High water level				+	184.71 m
	Low water level				+	184.26 m
	bed level of intake mouth				+	183.92 m
Intake Mouth	Intake flow					0.554 m3/s
	Number of intake mouth					1 nos.
	Intake water depth	area per mouth				1.26 m2
		width per mouth				1.60 m
		water depth	at HWL			0.79 m
			at LWL			0.34 m
		velocity	at HWL			0.44 m/s
			at LWL			1.02 m/s
	Appurtenances					
		Intake flow control	flow measuring			non
			stoppage of intake			stop logs
Raw Water Main	Number of Pipeline					1 line
	Diameter					800 mm
	Length				approx.	25 m
	Velocity					1.10 m/s
	PCL				+	182.66
Coarse Screen Raw Water Distribution Chamber						
	Location					in WTP site
	Coase Screen	Type				manual operation bar screen
		Number				1 units
					pitch	60 mm
		Dimensions			width	1.60 m
					height	3.00 m
	Branch Pipe to raw storage water tank					
		Number				2 nos.
		Diameter				800 mm
		Velocity				0.55 m/s

3) Raw Water Storage cum Pre-settling Reservoir (existing)

Number of Tanks 2 nos.

Dimensions of Tanks			area	depth	volume	
No. 1 tank	11,391,281	gallons	14,800	3.50	51,800	m3
No.2 tank	10,931,100	gallons	14,200	3.50	49,700	m3
Total Capacity	22,322,381	gallons			101,500	m3
Detention Time					2.1	days
Water Level	HWL			+	184.36	m
	LWL			+	180.71	m

Tank Effluent

Dimensions of outflow	Effluent weir	Elevation of weir edge		+	180.60	m
	Effluent pipe	size	at each tank		800	mm
		flow	usual operation		0.277	m3/s
			one tank out of order		0.554	m3/s
		design velocity	usual operation		0.55	m/s
			maximum		1.10	m/s
		PCL		+	179.11	m
	Effluent Pit	Structure			RC	
		width	(4 x d)		3.2	m
		length (both sides of pit)	(3 x d)		4.8	m
		depth	from tank bottom		1.7	m
			Elevation +		178.51	m

4) Raw Water Pump Well and Pump House

Structure Pump well (under ground) + Pump House (ground level)

Pump Well

Volume	detention Time		10	min
	volume		330	m3
Dimensions	width		7.0	m
	length		20.0	m
	water depth	≧	2.4	m

Raw Water Pump

Type of Pump	fixed speed		Submersible Pump	
Number of Pumps	duty		2	
	standby		1	
Discharge			33.3	m3/min
	per pump		16.7	m3/min
Pump head	flow		0.554	m3/s
	pipe materials		DCIP	
	Dia.		600	mm
	length		240	m
	velocity		1.96	m/s
	hydraulic gradient		4.6	‰
	friction loss		1.1	m
	minor loss (flow control)		1.0	m
	residual head		1.5	m
	statistic head		11.4	m
	total loss		15.0	m

Pump Well

Dimensions	width		7.0	m
	length	(including Receiving Sump)	24.0	m
	height	(effective water depth)	2.5	m
Appurtenances	Fine Screen			

Pump House

Dimesions		width	7.0 m
		length	20.0 m
		height	3.5 m
Appurtenances	Traveling crane	type	traveling girder with hoist
		number	1 no.
		capacity	5 t

2.3 Water Purification Facilities

1) Treatment Capacity

47,900	m3/d
2,000	m3/hr
33.3	m3/min
0.554	m3/s

2) Purification Process

Water Quality	Water temperature		max.	27 ℃
	pH			8
	Turbidity	Maximum (assumed)		600 NTU
		Average (consider effect of RW tank)		30 NTU
	Total Suspended Solid			
	Alkalinity			70 mg/l
	Calcium			21 mg/l
	Magnecium			8.7 mg/l
	Ammonium		<	0.010 mg/l
	Iron			1.8 mg/l
	Manganese		<	0.010 mg/l

Chemical Application	Coagulation	Chemical	Alum (solid)
		dosage rate	10 ~ 40 mg/l
	Coagulation aid	chemical	Polymer (nonion)
		dosage rate	0.2 ~ 1.0 mg/l
	pH adjustment	Chemical	Slaked Lime (powder)
		dosage rate	5 ~ 20 mg/l
	Oxidization/Disinfection	Chemical	liquid Chlorine
		dosage rate (pre-Chlorine)	1 ~ 3 mg/l
		(post-chlorine)	1 ~ 2 mg/l

3) Purification Process Facilities

The prefication process, after Receiving cum Distribution Tank is composed of two streams each having a Flash Mixing Tank, two Flocculation and Sedimentation Tanks and four Rapid Sand Filters.

Receiving cum Distribution Tank

Treatment flow			47,900 m3/d
Detension time			2 min
Number of tanks			2 units
Dimentions of tank (each unit)		width	3.5 m
		length	3.5 m
		water depth	4.5 m
		volume	110.25 m3
		Detention time	3.3 min

Appurtenant Facilities	inlet pipe		700 mm
	inlet gate (each unit: manual operation)		600 x 600 mm
	by-pass gate (inter connecting at outlet channel)		600 x 600 mm
	outlet pipe		500 mm
	overflow pipe (one at outlet channel)		400 mm
	drain pipe (two for ech tank)		150 mm

Flash Mixing Tank

Type			hydraulic coagulation (water fall)	
Mixing intensity (G-value)			approx. 500	1/sec
No. of tank			2	units
Flow rate		receiving	0.277	m3/s
Detention time	time	146	30	sec
	volume	40.5	8.3	m3/tank
Dimensions	width	3.0	3.0	m
	length	3.0	0.8	m
	water depth	4.5	3.0	m
	water fall height		60	cm
	mixing intensity		temperature 15	℃
			mixing intensity 497	1/sec

Mixing Intencity of Flash Mixing

$G = (1/\mu*(\rho*g*q*hf / V))^{0.5}$ = 497 sec^{-1}

where,

μ :	viscosity (15 ℃)		0.00098	kg/m/s
ρ :	specific gravity of water		1,000	kg/m3
g :	gravity acceleration m/sec		9.8	m/sec^2
q :	flow rate		0.277	m3/sec
h :	free fall depth below weir crest		0.532	m
hf :	head loss	(1/2*hw + hd)	0.600	m
V :	volume	($^{W}0.8*^{L}3.0*^{D}2.8$)	6.72	m3
hw :	overflow depth		0.136	m
hd :	free fall		0.464	m

Flocculation Tank

Type		hydraulic by up-and down flow	
Flow rate		0.1385	m3/s
Mixing intensity (G-value)		approx. 20 ~ 60	1/sec
Number of tanks		4	nos.
Number of rows		4	nos./tank
Dimensions	width	1.60	m
	length	9.50	m
	water depth	approx. 3.5~3.8	m
Detention time (see attached table)		1,880	sec
Energy dissipation	GT-value	85,000	

Mixing Intensity and Energy Dissipasion of Flocculation Tank

Descripions	unit	Number of Row				
		No.1	No.2	No.3	No.4	Total
No. of Baffle Walls	nos.	5	5	5	5	20
No. of Baffle Plates	nos.	3	4	5	6	18
Slit size of baffle plate	mm	$^{w}300 \times {}^{h}75 \times {}^{n}4$				
Area of slit per baffle	m2	0.27	0.36	0.45	0.54	-
Velocity at slit	m/sec	0.513	0.385	0.308	0.256	-
Head loss of slit	m	0.186	0.105	0.067	0.047	0.358
Volume of channel	m3	69	66	64	62	261
Width	m	1.85	1.85	1.85	1.85	-
Length	m	9.70	9.70	9.70	9.70	-
Water depth	m	3.84	3.65	3.55	3.48	3.63
Detention time	sec	500	470	460	450	1,880
Mixing intensity	sec^{-1}	61	47	38	32	44
Energy dissipation	G	30,600	22,000	17,500	14,500	84,600

note: Mixing intensity is calculated by the following formula:

$G = (1/\mu*(\rho*g*q*hf / V))^{0.5}$ sec^{-1}

where,

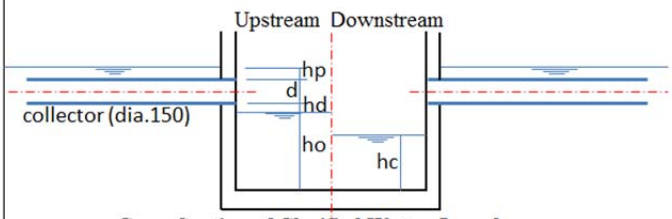
μ :	viscosity (15 ℃)	0.00098	kg/m/s
ρ :	specific gravity of water	1,000	kg/m3
g :	gravity acceleration m/sec	9.8	m/sec^2
q :	flow rate	0.1385	m3/sec
hf :	head loss (hor = n x 1/C^2 x v^2/2g)		m
	C: orifice coefficient as 0.6		
V :	volume	variable	m3

Sedimentation tank

Type			Tube Settler
Flow rate			2,000 m3/hr
Number of tanks			4 units
Surface loading			1.0 m3/hr/m2
Efficiency			80 %
Module of tube	size of tube		80 x 80 mm
	installation height		1.0 m
	installation angle to horizontal		60 deg.
	effective area of tube		0.577 m2/m
	area of module (1.0 x 1.0m)		7.22 m2/module
	area required per tank		625.0 m2/tank
	number of modules required		87 units/tank
Dimensions of tank (incl. wall/slab thickness)	width (net)	no. of compartment	2 nos.
		no. of module per length	4.0 nos.
		clearance between module and wall	0.1 m
		width of clarified water launder	1.1 m
		width of tank	9.50 m
	length (net)	mumber of module	11 units
		clearance between module and wall	0.9 m
		length of stilling zone (1.5+0.2)	1.7 m
		total length	13.6 m
	depth (net)	above module	0.8 m
		module	1.0 m
		support of module	0.2 m
		below module	1.5 m
		free board	0.4 m
		total depth	3.9 m

Clarified water colletion	collector	flow rate per tank		12,000	m3/d
		weir loading	approx.	200	m3/d/m
		weir length	>	60	m/tank
		width of compartment		9.5	m
		no. of colletors per ccompartment		4	nos.
		size of colletor	dia.	150	mm
	collecting launder	flow		0.139	m3/s
		width		0.8	m
		critical water depth		0.150	m
		upstream water depth	approx.	0.260	m
Pipe gallery for Sludge Extraction		width (w 4.0 + t 0.3)		4.6	m
		height		9.6	m
		length		13.6	m

Head Loss of Clarified Water Effluent



Cross Section of Clarified Water Launder

hp:	loss of inflow to collector (orifice loss)		0.039	m
d:	size of collector		0.165	m
hd:	free fall height		0.102	m
ho:	upflow water depth of launder		0.260	m
hc:	critical water depth at effluent		0.150	m
h:	Head loss of clarified water intake (hp + d + hd + ho - hc)		0.415	m
Loss of Collector				
Flow per tank			0.139	m3/s
Collector size			150	mm
number			8	nos.
Velocity of collector			0.98	m/s
Number of slit holes	(ctc 1000mm)		10	nos/collector
			80	nos/tank
Size of slit hole			65	mm
Area of slit holes			0.265	m2
Velocity			0.522	m/s
loss		hor:	0.039	m
pipe dia.		OD :	0.165	m
Freefall deth		hd:	0.102	m
Total loss	(hor + OD + hd)		0.306	m
Loss of Launder				
Critical water depth	hc =(α x q^2 / (9.8 x B^2))^1/3 =		0.150	m
	where, α =	1.1		
	B =	0.8		
Upstream water depth	ho = 1.732 x hc =		0.260	m
Loss of Launder			0.110	m
Loss of Clarified Water Collection			0.415	m

Rapid Sand Filter

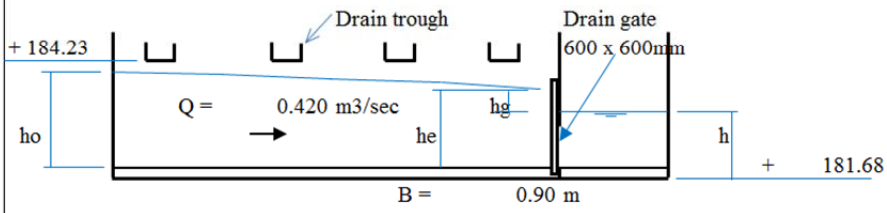
Treatment Flow	loss of purification process		3	%
	treatment flow		46,900	m3/d
			5,900	m3/d/filter
Number of Filter			8	units
Type of Filter			constant rate filtration with equal split of inflow	
Filtration rate			140	m3/d/m2
Filter media	filter sand	effective size	0.9	mm
		uniformity coefficient	1.4	
		thickness of sand layer	100	cm
	supporting gravel	no. of layers	4	nos.
		thickness of each layer	5	cm
		size	2 ~ 50	mm
		total thickness	20	cm
Underdrain System		type	nozzle type or partition block type	
		maximum head loss	< 1.0	m
Dimensions of Filter (net)	Filter area	per filter	42.1	m2
	filter bed	filter beds	1	beds/filter
		width	4.5	m
		length	9.4	m
		area (check)	42.3	m2/filter
		water depth above sand	1.4	m
		Clogging loss of sand	1.15	m
		Filter media thickness	1.2	m
		Underdrain height	1.1	m
		free board	0.9	m
		Total height of Filter	5.75	m
	wash water drain gutter	width	0.9	m
		length	9.4	m
		water depth	4.5	m
	operation cum	width	4.0	m
	pipe gallery	length	44.0	m
		height	6.0	m
Filter washing	method		air + backwash	
	air scouring	rate	0.9 ~ 1.0	m3/min.m2
		period	10	min
	backwashing	initial rate (air + water)	0.25	m3/min.m2
		period	2	min
		final rate (water only)	0.5	m3/min.m2
		period	8	min
	wash water trough	number per filter cell	4	nos/cell
		width	0.35	cm
		depth	0.30	cm
		length	4.65	m

piping

Pipes	velocity (m/s)	Size (mm)	Pipes	velocity (m/s)	Size (mm)
inlet gate	0.76	300 x 300	air scour pipe	15.3	250
wash water gate	1.10	600 x 600	air scour header pipe	7.80	300
filtered water pipe	1.51	250	filter drain pipe		150
backwash pipe	2.48	450	filtered water header pipe	1.00	800
backwash header pipe	2.01	500			

Wash Drain of Filter

Wash water:	Area:	42.30	m2
	Backwash: (max)	0.5	m3/min/m2
	Flow:	21.2	m3/min
		0.353	m3/s
	Allowance:	20%	
	Design flow:	0.420	m3/s
Trough:	Length of filter	0.00	m
	Spacing	0	m
	Number of trough	4	nos.
	Flow per trough	0.105	m3/s
	Width	0.40	m
	Critical w. depth	0.192	m
	Upstream w. depth	0.332	m
	height of torough	0.35	m
Gutter:	Drain flow	0.420	m3/s



he^3 - ho^2*he + 2 hc^3 =		0.0000
hc :	critical water depth	0.290 m
	hc = $3\sqrt{}$ α*Q/gB^2 =	0.281 m
he :	water depth at channnel effluent	**2.200** m
ho :	water depth at channel upstream	2.205 m
hg :	loss of drain gate	0.193 m
h :	water depth of drain channel (assumed)	2.007 m
	width of drain channel:	1.00 m
	Velocity:	0.209 m/s
	Area:	2.007 m2
	H. diameter (R):	0.400 m
	Roughness (n):	0.015
	H. dradient:	0.03 ‰

Clear Water Reservoir	Production Flow	45,500	m3/d
	Detention time	1.5	hrs
	Volume	2,800	m3
	Dimensions (per compartment)		
	width	15.6	m
	length	19.6	m
	water depth	4.5	m
	free board	0.6	m

2.4 Waste Water Treatment

1) Waste Water Volume

Sludge Volume

Treatment capacity				47,900	m3/d
Maximum turbidity				100	NTU
Alum Dosage			Solid Alum	30	mg/l
Sludge factor				1.0	
Solid weight				5,440	kg/d
	turbidity of clarified water as 7 mg/l			5,059	kg/d
Water content of sludge extraction				1	%
Sludge extraction volume				506	m3/d
Sludge extraction cycle				2	hrs/tank
Sludge extraction per tank		no of tank:	4	127	m3/tank/d
		sludge extraction		1	tank
		allowance	20%	150	m3

Waste Backwash Water Volume

Filter area	width: 4.5	length: 9.4		42.3	m2
Backwash Rate & time	initial rate	0.25	m3/min/m2	2	min
	final	0.5	m3/min/m2	8	min
Backwash water volume	net			190	m3/filter
	retained solid in filtration			6	mg/l/d
		Waste backwash water		230	
		allowance		20%	
	solid weight			326	kg/d
	washing filter per day		8	4	filters
	solid content		214	429	mg/l

2) Waste Water Tank

Total volume of tank	Sludge inflow		for one tank	150	m3/time
	Waste backwash water inflow		for one filter	230	m3/time
	Total volume			**380**	m3/time
	Solid weight	sludge extraction		1,265	kg/tank
		waste washwater		81.5	kg/time
				1,428	kg/time
		slusge content		**0.38**	%
Dimensions of tank	Tank volume	for 2 times of waste water discharge		380	m3
	number of compartments			2	units
	width			7.5	m
	length			11.45	m
	water depth			2.5	m
	volume			429	m3
Waste water transfer pump	time for transfer			2	hrs/time
	type of pump			Non-clog Submersible	
	no. of pumps		duty	2	units
			standby	2	units
	size of suction/delivery			80	mm
	pump capacity		(43 m3/hr)	0.70	m3/min
	pump head			8	m
	motor output	efficiency	38%	2.8	kW
			rounded	3	kW

3) Sludge Thickener

Type				gravity thickener
Number				2 units
Solid weight				2,720 kg/d
Sludge loading				20 kg/d/m2
Surface area				136 m2/unit
Dimensions	dia.			13 m
	water depth			4.0 m
	sludge deposit	depth		0.5 m
		volume		110 m3
	bottome slope			10 %
	center feed well		dia.	2.5 m
	center sludge pit		dia.	2.2 m
Appurtenances				Center rotate sludge scraper

4) Thickened Sludge Extraction/Transfer Pump

Type of pump			progressive cabity (screw pump)
Pump discharge	sludge content as 1%	per hour	528 m3/hr
Pump operation hours			24 hrs/d
Number		duty	2 units
		standby	2 units
Discharge			11.0 m3/hr
Size of suction/delivery			100 mm
Pump head			15 m
Motor output			5.5 kW

5) Sludge Drying Bed

Sludge inflow (from Thickener)	annual average (refer to attachment)			17 NTU
	Alum dosage rate (liquid form 8%)			27 mg/l
	Solid weight			1,127 kg/d
				411,177 kg/year
Annual Loading				150 kg/m2
Area of Drying Bed				2,741 m2
Number of Beds	Working			6 beds
	Standby			1 bed
Dimensions of Bed (per bed)	Area		rounded	460 m2
	Width			12 m
	Length			40 m
	Filter Gravel and Sand	sand: thickness		0.3 m
		gravel:		0.2 m
	Water depth of bed above filter			1.5 m
	Free board			0.3 m
	Total height of bed			2.3 m
Appurtenant Facilities	Inlet chamber with gate valve			
	Outlet chamber with stop logs			
	Drain manifold with slope (1 : 200) for longitudinal diection of bed			
	Lateral (1 : 150) section of bed			
	Ramp for drying sludge ectraction			
	Drain pipes for supernatant/seepage water for recycle use			

Operation of Sludge Drying Bed

- Sludge extracted from Sedimentation Tank is stored in Sludge Buffer Tank and Pumped to Sludge Thickener
- Sludge in Thickener is transfer to Drying Bed through Sludge Extraction Pumps
- Supernatant water / seepage water of Drying bed is remobed by operation of stop log installed in outlet chamber / drain manifold to outlet chamber
- Supernatant water of Drying Bed is drained to Recycling Sump by gravity
- Supernatant water (Thickener and Sludge Drying Bed) and waste backwahwater by gravity or pumped to Recycling Sump is pumped to Receiving Tank by pumps
- Stop log is to be operated periodically (especiallyfor high turbid raw water) to maintain water level below design level.

6) Recycling Waste Water Sump

Drain Water

- Supernatant from Thickener

Inflow of waste water			2,026	m3/d
Solid weight			5,385	kg/d
Outflow from Thickener to Drying Bed			539	m3/d
Solid content of thickened sludge			1	%
Supaernatant of Thickener	volume		1,487	m3/d
	sludge content	assumed	100	mg/l
	solid weight		149	kg/d

- Supernatant from Drying Bed

Inflow to Drying Bed			539	m3/d
			5,236	kg/d
Outflow from Drying Bed	slughe content		35	%
	sludge volume		15	m3/d
	supernatant/seepage volume		524	m3/d

- Total of supernatant 2,011 m3/d

Dimensions of tank (refer to attachment)	number of compartments		2	units
	width		6.0	m
	length		6.0	m
	water depth		2.5	m
	volume	1.5 hours retention	180	m3
			0	

Recycle Pump	type of pump		Non-clog Submersible	
	no. of pumps	duty	2	units
		standby	2	units
	size of suction/delivery		150	mm
	pump capacity		42	m3/hr
			0.70	m3/min
	pump head		12	m
	motor output efficiency	50%	3.2	kW
		rounded	3.7	kW

2.5 Chemical Applications

1) Designed Treatment Flow and Raw Water Quality

Production Capacity 10 mgd = 45,500 m3/d = 1,900 m3/hr = 0.527 m3/s

Treatment Flow

loss in purification process	5 %
Capacity	47,900 m3/d
	2,000 m3/hr
	33.3 m3/min
	0.554 m3/s

Raw Water Qulality

Raw water quality of RBC is estimated based on WASA Research Laboratory and Test by Consultant Team as follows:

		Canal Water		Raw Water Tank	
Paramaters	unit	Maximum	Average	Maximum	Average
Temperature	℃	28	20	28	20
pH	-	8.0	7.2	8.0	7.2
Turbidity	NTU	1000	100	100	20
Total Suspended Solid	mg/l	1000	100	100	20
Alkalinity	mg/l	90	70	90	70
Ammonium	mg/l	0.1	0.01	0.1	0.01
Iron	mg/l	2	1	2.0	1.0
Manganese	mg/l	0.05	0.01	0.05	0.01

Regarding settling efficency is assumed at 90% and 80% in turbidity of canal water at 1000 and 100 NTU respectively.

2) Chemical Used

- Aliminium Sulphate (Alum; solid)	Coagulation
- Calcium Hydraoxide (Lime; powder)	pH Adjustment
Purity rate	95%
- Polymer (PE; powder) for water purification	Coagulation Aid
for sludge handling	
- Chlorine (CL: liquid)	Oxidization cum Disinfection
- Caustic soda (CA; liquid)	Cl_2 gas leakage neutralization

3) Dosage of Alum Sulphate (ALUM)

Alum Dosage (solid Alum)

Dosage rate	maximum	(with polymer)	30 mg/l
	average		15 mg/l
Dosing point			Flash Mixing Tanks (2)

Alum Solution Tank

			Max.	Ave.	
Alum Solution:					
	Solid weight:		1,440	720	kg/d
	Solution rate		10	10	%
Solution tank:	Number of tanks	duty	1	1	
		standby	1	1	
	Tank volume		14.4	7.2	m3
	Dimensions:	with/length	2.0	2.0	m
		side depth	2.1	2.1	m
	Solution operation		2	1	times/day

Alum Dosing Pump

Type:		Simplex diaphragm type metering pump		
Number:		duty	2	units
		standby	1	unit
Pump dimensions:		discharge	300	l/hr
		head	0.5	Mpa
		stroke <	60	per min

Alum Storage

storage days		for average dosage rate	30	days
Storage volume		weight	21,600	kg
		unit weight	25	kg/lump
		no. of lump	864	nos.
		rounded	870	
Storage area			30	m2

Dimensions of Alum Storage Room

		Store	
width		2.7	m
length		12	m
height	(under beam)	4.5	m

3) Dosage of Polymer

Polymer Dosaage

Dosage rate		maximum	1.0	mg/l
		minimum	0.2	mg/l
Dosing point			Flocculation tanks (4)	

Polymer Solution System

Packaged full automatic polymer solution preparation unit

System Component:	Dry screw feeder of granular powder form of polymer			
	Wetting unit for mixing polymer with treated water using hydraulic swirl			
	Ejector of jet pump transfer wetted polymer to an aging tanks			
	Tanks for aging and storing polymer solution			
	Number of System	duty	1	unit
		standby	1	unit
	Capacity of the system		1.0	kg/hr
	Solution rate		0.5	%
	Polymer solution		200	l/hr
Storage tank	number		1	unit
	material		FRP	
	volume		1	m3
	dimensions		D1.0 x 1.2H	m

Polymer Feed Pump

Type		Positive displacement progressing cavity (2-stage)		
		solution rate	0.02	%
		dosage	5,000	l/d
Number of pumps		duty	2	units
		standby	1	unit

Polymer Feed Pump (continued)

Pump dimensions	discharge		208	l/hr
	pump rotation		400	rpm
	head		0.5	Mpa
	control		Fixed Speed	

Flow Control

Flow meter	type		Rotameter	
	number		1	unit
	maximum flow rate			m3/hr
	accuracy	±	2	%
	measuring range		1:10	minimum
	working pressure		0.98	MPa

High Pressure Water Supply Unit	Type		package type	
	number	duty	1	unit
		standby	1	unit

Feeding System

Dilution tank	number		1	unit
	material		SS316	
	capacity	min.	0.5	m3

Polymer diffuser for uniform feeding of diluted polymer solution.

number		2	units

4) Dosage of Calcium Hydroxide (Lime)

Lime Dosage

Doashe rate	maximum		20	mg/l
	average		10	mg/l
Dosing point			Receiving Tank	

Lime Solution Tank

			Max.	Ave.	
Alum Solution:	Solid weight:		1,008	504	kg/d
	Solution rate		15	15	%
Solution tank:	Number of tanks	duty	1	1	
		standby	1	1	
	Tank volume		6.7	3.4	m3
	Dimensions:	with/length	1.3	1.3	m
		dside depth	2.1	2.1	m
	Solution operation		2	1	times/day

Lime Dosing Pump

Type:		magnetic drive chemical or Progressive cavity		
Number:	duty		2	units
	standby		1	unit
Pump dimensions:	discharge		150	m3/hr
	head		50	m

Lime Storage

storage days	for average dosage rate		30	days
Storage volume	weight		15,126	kg
	unit weight		40	kg/bag
	no. of lump		378	nos.
		rounded	380	
Storage area			20	m2

Dimensions of Lime Dosage Room

width		2.7	m
length		8	m
height	(under beam)	4.5	m

5) Dosage of Chlorine

Chlorine Dosage		Pre-Cl2	Post-Cl2	total	
Dosage rate	maximum	3	2	5	mg/l
	average	1	1	2	mg/l
Dosage	maximum	144	96	240	kg/hr
	average	48	48	96	kg/hr

Dosage Equipment

Weighning of Cl2 container	type			Lifting Type	
	number of containers			2	nos.
Chlorinator:	type			vacuum	
Pre-Cl2	number	duty		1	unit
		standby		1	unit
	capacity		5.9875	7.5	kg/hr
Post-Cl2		duty		1	unit
		standby		1	unit
	capacity		4.0	5.0	kg/hr
Total Dosage Requirem Total	capacity			10.0	kg/hr
Evaporator			Apply natural evaporation		
	number of containers			2	nos.
	room temperature			10	℃
	evaporation rate			363	kg/d/container
				15	kg/hr/container

Leaked Chlorine Gas Neutralization

Capacity	45	kg/hour

Annex 1 to Appendix B7.1.1 RAW WATER QUALITY DATA

1 **Turbidity Summary - WASA Data**

Year	Season	Monthly*1 Precipitation	Canal Water Sample No.	Range	Average	Raw Water Tank Sample No.	Range	Average
2012		mm		NTU	NTU		NTU	NTU
January	transit	53.2	-	-	-	-	-	-
February	dry	17.7	12	7.1 ~ 57	34.3	2	1.4 ~ 1.5	1.4
March	dry	25.0	8	10.7 ~357	87.5	2	1.9 ~ 4.4	3.1
April	transit	58.2	3	103 ~460	230	3	4.7 ~17.8	10.9
May	dry	15.4	2	128 ~139	139	2	1.8 ~28.5	15.1
June	dry	24.6	3	18.2 ~138	119	3	3.6 ~ 6.3	5.1
July	wet	109.6	1	136	-	1	16.1	-
August	wet	89.5	3	158 ~799	396	3	16 ~24.1	18.9
September	transit	34.1	-	-	-	-	-	-
October	dry	5.9	-	-	-	-	-	-
November	dry	3.6	-	-	-	-	-	-
December	dry	9.1	-	-	-	-	-	-
Annual			32	7.1 ~799	163	16	1.4 ~28.5	10.1
2013								
June	dry	-	1	273	-	-	-	-
2014								
February	dry	17.7	1	17.1	-	-	-	-
March	dry	25.0	4	3.2 ~ 5.6	3.9	-	-	-
April	transit	58.2	5	3.4 ~ 4.7	3.9	-	-	-
Average			10	3.2 ~17.6	6.3	-	-	-
2016								
November*2	dry	-	1	28	-	1	8.5	-

note *1: CLIMATICAL DATA - from M/P by World Bank (1953~1991)

*2: by JICA Mission Team

2 Effect of Turbidity Reduction of Raw Water Tank

Range	sample no.	Raw water	Clarifird	Reduction
< 50	1	35.8	1.4	
	2	48.5	1.9	
	3	10.7	4.4	
	4	18.2	5.5	
	average	28.3	3.3	88%
50 - 100	1	52.0	1.5	97%
100 - 150	1	103.0	4.8	
	2	126.0	10.2	
	3	149.0	28.5	
	4	128.0	1.8	
	5	138.0	3.6	
	6	136.0	16.1	
	average	130.0	10.8	92%
150 - 200		158.0	16.6	89%
200 - 250		232.0	16.0	93%
250 - 300		-	-	-
300 - 400		-	-	-
400 - 500		460.0	17.8	96%
>500		799	24.1	97%

3 Raw Water Quality Data

3.1 Raw Water and Clarified Water Quality of Rakh Branch Canal

Data by WASA

Date	Water	Canal Water			Clarified Water			Filtered Water			Season
	Temperature	Turbidity	pH	E.C	Turbidity	pH	E.C	Turbidity	pH	E.C	
2012	℃	NTU	-	µs/cm	NTU	-	µs/cm	NTU	-	µs/cm	
'12.02.14	15.3	42.1	7.4	258							
'12.02.15	15.3	45.6	7.6	246							
'12.02.16	15.7	22.2	7.2	246							
'12.02.17	15.7	57.0	7.2	248							
'12.02.18	15.8	34.0	7.3	231							
'12.02.20	20.1	52.0	7.1	227	1.5	7.3	215	0	7.0	246	
'12.02.21	20.6	7.1	7.5	244							
'12.02.22	20.6	11.9	6.5	254							
'12.02.23	20.5	31.5	7.5	248							
'12.02.24	20.5	36.2	7.6	250							
'12.02.25	20.6	36.2	7.6	247							
'12.02.27	21.0	35.8	7.6	240	1.4	7.7	247	0	7.4	259	
average	18.5	**34.3**	**7.3**		**1.4**						dry season
'12.03.02	20.6	51.0	7.6	258							
'12.03.05	20.8	48.5	7.4	274	1.9	7.2	230	0	7.2	280	
'12.03.06	20.6	25.5	7.3	271							
'12.03.07	20.5	12.4	7.7	271							
'12.03.09	21.5	103	7.7	264							
'12.03.10	20.5	357	7.6	258							
'12.03.12	23.6	10.7	8.2	251	4.4	8.1	246	0	8.3	454	
'12.03.21	22.5	92.0	8.2	295							
average	21.3	**87.5**	**7.7**		**3.1**						dry season
'12.04.02	29.6	103	7.7	349	4.8	8.0	305	0	7.9	367	
'12.04.18	28.3	460	8.2	258	17.8	8.7	280	1.11	8.04	489	
'12.04.24	28.4	126	8.5	282	10.2	9.0	260	1.81	8.45	536	
average	28.8	**230**	**8.1**		**10.9**						transit
'12.05.07	33.6	149	8.0	212	28.5	8.5	234	0.42	7.7	615	
'12.05.12	35.0	128	7.8	199.2	1.8	7.5	213	0	7.65	251	
average	34.3	**139**	**7.9**		**15.1**						dry season
'12.06.05	37.4	138	6.7	184	3.6	8.0	183.7	0	7.05	349	
'12.06.12	36.4	202	7.6	184.6	6.3	7.6	174.6	1.05	7.35	227	
'12.06.26	38.3	18.2	8.4	154	5.5	8.6	151	0	7.86	275	
average	37.4	**119**	**7.5**		**5.1**						dry season
'12.07.24	34.6	**136**	8.3	156	**16.1**	8.7	158	3.88	8.57	190	wet season
'12.08.01	35.3	158	7.9	176	16.6	7.75	161	0	7.76	246	
'12.08.07	34.1	**799**	8.0	164	24.1	8.6	157	1.0	7.9	263	
'12.08.15	33.6	232	7.6	189	16.0	8.0	167	0	7.44	301	
average	34.3	**396**	**7.8**		**18.9**						wet season
Average	19.9	**163**	**7.8**		**10.1**						
2013											
'13.11.06	25	**0**	7.8	273	-						dry season
2014											
'14.02.26	20	17.1	7.7	222							dry season
'14.02.26	20	17.1	7.7	222							dry season
'14.03.14	24	3.2	7.6	246							dry season
'14.03.14	24	5.6	7.6	362							dry season
'14.03.29	24	3.3	7.4	288				0	7.3	560	dry season
'14.03.31	25	3.5	7.6	275				0	7.4	555	dry season
'14.04.01	26	3.4	8.1	263				0	7.9	381	transit
'14.04.02	26	3.4	7.6	264				0	7.4	600	transit
'14.04.03	26	3.9	7.9	253				0	7.9	499	transit
'14.04.04	26	4.7	7.8	262				0	7.7	437	transit
'14.04.07	24	4.1	8.0	282				0	7.9	581	wet season
average	24.1	**6.3**			?						
2016*											
'16.11.21	-	28	8.5	210	6.0	9.0	195				

* measured by JICA Team

3.2 Raw Water Quality Summary RBC-French Project

Period	Water Quality			Climate*	
	Sample no.	Temperature ℃	Turbidity NTU	Temp. Range ℃	Rainfall mm/mon
'15. Nov.	3	22	20 ~ 75	20.3~27.6	3.6
'15. Dec.	4	20 ~ 22	9 ~ 39	5.4~21.7	9.1
'16. Jan.	1	22	21	4.2~19.4	53.2
'16. Mar.	1	23	115	7.2~22.3	17.7
'16. Apr.	4	24 ~ 26	26 ~ 71	12.5~27.9	25.0
'16. May.	6	25	14 ~ 61	18.1~34.4	58.2
'16. Jun.	2	26	101~141	22.9~38.4	15.4
'16. Jul.	5	26 ~ 28	85 ~172	27.1~40.7	24.6
'16. Aug.	2	26	75 ~ 85	26.7~36.2	109.6
'16. Sep.	3	24 ~ 25	75 ~ 90	23.9~35.4	89.5
'16. Oct.	2	23 ~ 25	50 ~ 65	17.4~27.6	34.1
Annual	33	20 ~ 28	9 ~ 172	4.2~40.7	4.2~40.7
('15.Nov~'16.Oct)		range	90.5		

* 1953~1991 period, Master Plan by World Bank

3.3 Raw Water Quality Survey Results by JICA Mission Team

No.	Parameter	Unit	Standard Values for Pakistan	WHO Guideline (2011)	SW 3 (RBC) Dry Season 2012/11/16	SW 3 (RBC) Wet Season 2012/9/23
1	Temperature	˚C	-	-	18.8	27
2	Turbidity	NTU	5	5	36	57
3	Colour	TCU	15	15	0.8	5.5
4	pH		6.5-8.5	(6.5-8.5)	8.83	8.3
5	EC	µS/cm	-	-	197	193
6	Hardness	mg/L	500	-	104	88
7	Total alkalinity	mg/L	-	-	120	70
8	Chloride (Cl-)	mg/L	250	(250)	30	70
9	Total dissolved solids (TDS)	mg/L		(1000)	141	140
10	DO	mg/L	-	-	5.04	5.64
11	Nitrite (NO2-)	mg/L	3	3	0.05	0.19
12	Nitrate (NO3-)	mg/L	50	50	4.9	5.5
13	Ammonia	mg/L	-	-	<0.01	<0.01
14	CODCr	mg/L	-	-	22	32
15	Sulphate (SO42-)	mg/L	-	(500)	32	22
16	Fluoride (F-)	mg/L	1.5	1.5	0.11	4.8(0.95)
17	Manganese (Mn)	mg/L	0.5	(0.4)	< 0.010	<0.02
18	Iron (Fe)	mg/L	0.3	-	0.36	1.83
19	Calcium (Ca)	mg/L	-	-	30	21
20	Sodium (Na)	mg/L	-	(200)	13.8	55
21	Magnesium (Mg)	mg/L	-	-	7	<0.01
22	Aluminum (Al)	mg/L	0.2	0.2	<0.020	<0.020
23	Antimony (Sb)	mg/L	0.005	0.02	0.298	0.139
24	Barium (Ba)	mg/L	0.7	0.7	< 0.70	<0.70
25	Cadmium (Cd)	mg/L	0.01	0.003	< 0.002	<0.002
26	Chromium (Cr)	mg/L	0.05	0.05	<0.01	0.30
27	Copper (Cu)	mg/L	2	2	< 0.002	<0.002
28	Lead (Pb)	mg/L	0.05	0.01	< 0.01	<0.01
29	Mercury (Hg)	mg/L	0.001	0.006	< 0.001	<0.001
30	Nickel (Ni)	mg/L	0.02	0.07	< 0.02	<0.02
31	Selenium (Se)	µg/L	10	10	<0.04	0.35
32	Zinc (Zn)	mg/L	5	(3)	< 0.05	<0.05
33	Cyanide (CN-)	mg/L	0.05	(0.07)	< 0.002	<0.002
34	Total Arsenic (As)	mg/L	0.05	0.01	0.002	0.002
35	Soluble Arsenic (As)	mg/L	-	-	0.002	0.002
36	Standard plate count bacteria	MPN/ 100mL	-	-	4.1×10^2	120
37	E. coli	MPN/100mL	0	0	2.5×10^2	5.1×10^2

Annex 2 to Appendix B7.1.1 POWER RECEIVING and EMERGENCY GENERATOR

1. Power Demand

The maximum demand of the Old JK WTP is estimated as 769kW. Load list is shown below.

Name of Equipment	kW	Q'ty	Total kW	Remarks
Raw Water Pump No.1 to 3	45	2	90	
Raw Water Pump Discharge Valve No.1 to 3	0.2	2	0.4	
Fine Screen No.1 and 2	7.5	1	7.5	
Raw Water Pump Room Monorail Hoist	1	5	5	
Raw Water Flow Control Valve	0.4	1	0.4	
Receiving Well Sampling Pump No.1	0.4	1	0.4	
Air compressor No. 1 and 2 (for Clarifier: Flocculation and Settling tank)	5.5	1	5.5	
Clarified Water Sampling Pump No.1 and 2	0.4	1	0.4	
Settling tank Sludge Conveyance Pump No.1 to 4	7.5	2	15	
Settling tank Sludge Recycling Pump No.1 to 4	7.5	2	15	
Submerged Mixer No.1 to 4	5	4	20	
Chain Hoist No.1 and 2	3.7	2	7.4	
Sludge Thickener No.1 and 2	5.5	2	11	
Sludge Extraction Pump No.1 to 4	5.5	2	11	
Sludge Extraction Pump Control Valve No.1	0.2	2	0.4	
Monorail Hoist No.1 and 2 (Waste & Recycling Pump Room)	3.7	2	7.4	
Filter No.1 Inlet Gate No.1 to 4	0.4	1	0.4	
Filter No.2 Inlet Gate No.1 to 4				no simultaneous washing of filter
Filter No.1 Backwash Valve No.1 to 4	0.2	1	0.2	
Filter No.2 Backwash Valve No.1 to 4				no simultaneous washing of filter
Filter No.1 Air-Scouring Valve No.1 to 4	0.2	1	0.2	
Filter No.2 Air-Scouring Valve No.1 to 4				no simultaneous washing of filter
Filter No.1 Filtered water Valve No.1 to 4	0.2	1	0.2	
Filter No.2 Filtered water Valve No.1 to 4				no simultaneous washing of filter
Filter No.1 Washing water drain gate No.1 to 4	0.75	1	0.75	
Filter No.2 Washing water drain gate No.1 to 4				no simultaneous washing of filter
Floor Drain Pump No.1 and 2	1.5	4	6.0	

Filtered Water Sampling Pump No.1 and 2	0.4	2	0.8	
Clear Water Reservoir Drain Pump	2.2	1	2.2	
Reservoir Water Sampling Pump No.1 and 2	0.4	1	0.4	
Transmission Pump No.1 to 3	110	2	220	
Transmission Pump Discharge Valve No.1 to 3	0.2	2	0.4	
Transmission Pump Room Traveling Crane	5.5	1	5.5	
Transmission Pump Room Monorail Hoist	4.5	1	4.5	
Floor Drain Pump No.1 and 2	1.5	2	3	
Transmission Flow Control Valve	0.4	1	0.4	
Alum Solution Tank Mixer No.1 and 2	1.5	1	1.5	
Alum Solution Dosing Pump No.1 to 3	0.24	2	0.48	
Chlorine gas neutralization	6	1	6	
Deadline motorized valve	0.2	1	0.2	
Chemical Solution Tank Room Monorail Hoist	3.7	1	3.7	
Polymer Coagulant Aid Solution Tank Mixer No.1 and 2	0.75	1	0.75	
Polymer Coagulant Aid Dosing Pump No.1 to 3	0.24	2	0.48	
Lime Solution Tank Mixer No.1 and 2	1.5	2	3	
Lime Solution Dosing Pump No.1 to 3	0.75	2	1.5	
Building Lighting, Instrumentation equipment and other miscellaneous load	25%	1	154	
Total [kW]			**769**	

2. Power Receiving

Electric power will be supplied from FESCO by one or two circuit(s) of 11kV power line. General features of the supplied power are as follows:

- Power Source: FESCO
- Tariff Category: B3
- Voltage System: 11kV AC, 50Hz, 3 phase 3wire

In Old JK WTP, 11kV is stepped down to 380V for raw water pump, transmission pumps and other auxiliary equipment and lighting. For main substation, oil type transformer is selected taking advantage of its lower cost and availability in Pakistan. The required capacity of main transformer is calculated using following formula.

$$\text{Capacity of transformer} = \frac{\Sigma P}{\eta \times \varphi} \times \beta \times \alpha \ [\text{kVA}]$$

Where,

φ	: total power factor	0.85
η	: total load efficiency	0.85
β	: demand factor	0.8
α	: allowance rate	1.1
ΣP	: sum of the load [kW]	769

Required capacity of transformer

$$\frac{769}{0.85 \times 0.85} \times 0.8 \times 1.1 = 936[\text{kVA}]$$

Therefore, **1000 [kVA] x 1** is selected.

3. Emergency Power Supply

The same criteria as French project will be applied to this WTP. That is, the target load for generator = 100% of total load. The capacity of generator is determined using following formulas.

a) PG_1 is the capacity necessary for all load operation

$$PG_1 = \frac{\Sigma P_0}{\eta_L \times \varphi_L} \times \alpha \times S_f \quad [\text{kVA}]$$

Where,

ΣP_0	: sum of the load	769 [kW]
η_L	: total load efficiency	0.85
φ_L	: total power factor	0.8
α	: demand factor	0.8
S_f	: the increase coefficient of electric current by unbalanced load	1.0

$$= \frac{769}{0.85 \times 0.8} \times 0.8 \times 1.0 = \mathbf{904\ [kVA]}$$

b) PG_2 is the capacity necessary against voltage drop

$$PG_2 = P_m \times \beta \times C \times X_d' \times \frac{1 - \Delta E}{\Delta E} \quad [\text{kVA}]$$

Where,

P_m	: maximum motor capacity	110 [kW]
β	: starting kVA per 1kW of maximum motor capacity	1.2
C	: coefficient by starter	1
X_d'	: generator's constant	0.25
ΔE	: allowable voltage drop rate	0.25

$$= 110 \times 1.2 \times 1 \times 0.25 \times \frac{1 - 0.25}{0.25} = \mathbf{99\ [kVA]}$$

c) PG_3 is the capacity necessary for starting maximum motor lastely

$$PG_3 = \frac{f_{v1}}{\gamma_G} \{ (\Sigma P_0 - P_m) \times \frac{\alpha}{\eta_L \times \varphi_L} + P_m \times \beta \times C \} \quad [\text{kVA}]$$

Where,

f_{v1}	: decrease coefficient of loading	1.0
ΣP_0	: sum of the load	769 [kW]
η_L	: total load efficiency	0.85
α	: demand factor	0.8
P_m	: maximum motor capacity	110 [kW]

β	: starting kVA per 1kW of maximum motor capacity	1.2
C	: coefficient by starter	1
γ_G	: generator strength against momentary overload	1.5

$$= \frac{1}{1.5} \{ (769 - 110) \times \frac{0.8}{0.85 \times 0.8} + 110 \times 1.2 \times 1 \} = \mathbf{604\ [kVA]}$$

d) Generator Capacity

$PG_1 =$ 904 **(MAXIMUM)**

$PG_2 =$ 99

$PG_3 =$ 604

Therefore, **1,000 [kVA]** will be selected.