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Network on Water Technology in Asia and Pacific

Rawal Lake Water Treatment Plant
Rawalpindi, Pakistan

1. Background Information

Rawal Lake Water Treatment Plant is managed by the Water & Sanitation Agency (WASA) under the Rawalpindi Development Authority (RDA). It intakes water from the Rawal Dam/Lake, situated in Islamabad, and supplies water to the Potohar region in Rawalpindi. It has a catchment of 275 Km^2 which includes four major streams and 43 small streams contributing to its storage. The total storage capacity of the lake is 58.5 MCM with the live storage of 40 MCM[1].

Figure 1: Rawal Lake Source (Left) and Rawal Lake Water Treatment Plant (Right)

Figure 1 presents the Rawal Lake and the Rawal Lake Water Treatment Plant (RLWTP). Though RLWTP supplies water to the Rawalpindi city, the Rawal Lake catchment is located in the Islamabad city.

Table 1 Overall Information of Rawal Lake Water Treatment Plant

Raw Water Source	Rawal Dam/Catchment
Initial Construction	1962-63
Initial Capacity (m^3/d)	52,995
First Extension	1975-79
Extended Capacity (m^3/d)	79,493
Second Extension	2000-2002
Extended Capacity (m^3/d)	105,991
Water Source	Rawal Lake
Operating capacity (m^3/d)	79,500
Topography	Plain/Tropical
Date of access of the source information	31 March 2016

2. Water treatment process flow

The water treatment process at RLWTP is illustrated in **Figure 2**.

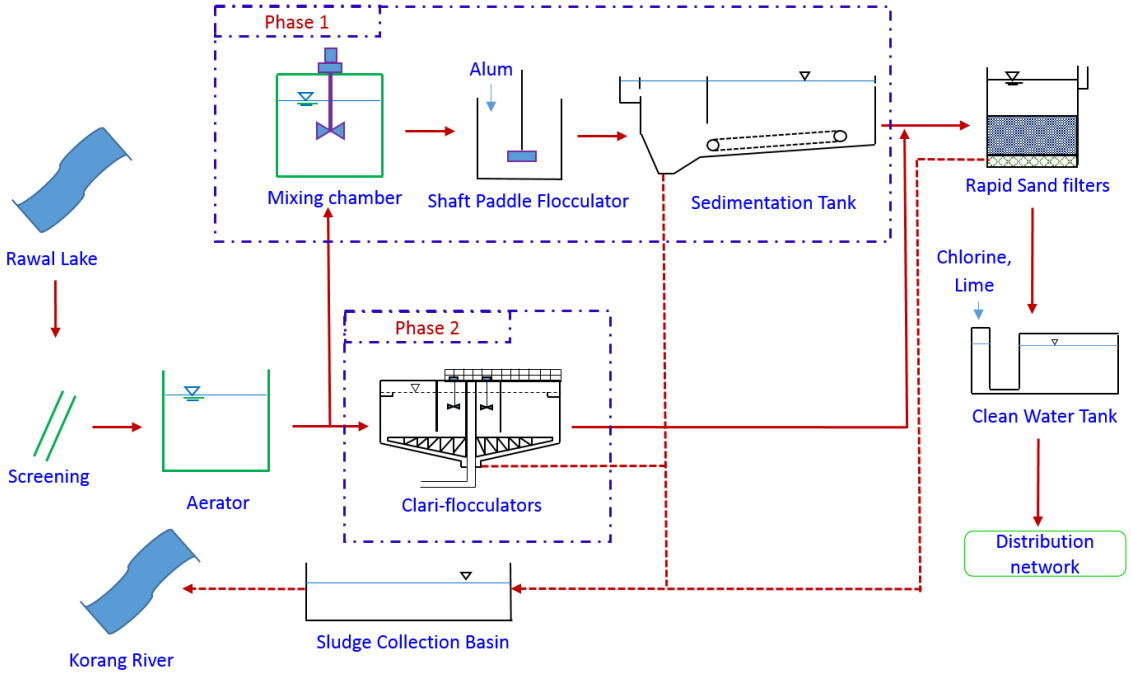

Figure 2 Schematic Diagram of Water Treatment Processes

The treatment process includes:

Screening → Aeration → Coagulation and Flocculation* → Sedimentation → Rapid Sand Filter → Disinfection → Storage → Distribution.

Sludge generated from sedimentation tank and filtration backwash is disposed of to Korang River.

*The RLWTP has two different technology for coagulation and flocculation as they were extended at different phases. The first phase consists of the Mechanical flash mixer, shaft paddle flocculator, and the rectangular type sedimentation tank. The second phase consists of the clariflocculator. The effluent from these phases is then conveyed to the rapid sand filter for the filtration.

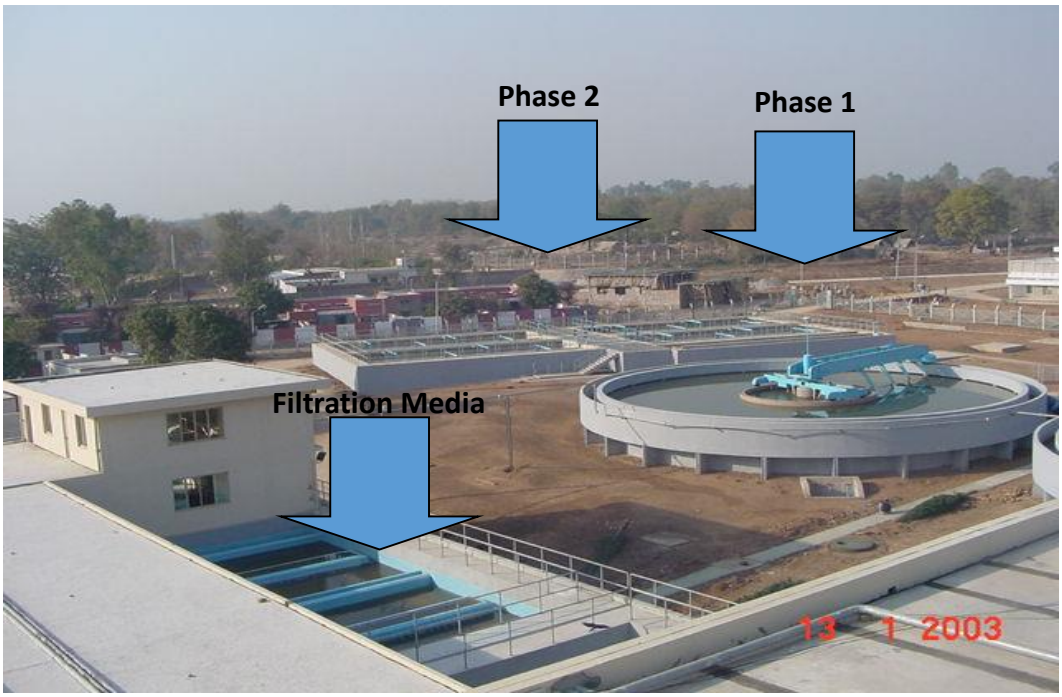

Figure 3: Phase 1 and Phase 2 treatment unit of RLWTP

The detail of the treatment process involved are as follow:

2.1 Water Intake

The water intake (**Figure 4**) consists of 3 bar screens which function to prevent large objects like branches, leaves, clothes, plastic bags, etc from entering the WTP.

Figure 4: Water Intake

2.2 Aeration

Aeration unit consists of 2 blower that operates with the air flow of 6 m^3/min. It functions to remove the taste and odor problem in the raw water and reduces the concentration of volatile organic compounds, hydrogen sulfide, methane, etc. Dissolved Oxygen (DO) level of water is enhanced by this process. From this unit the effluent is then distributed to the Phase 1 (Mixing Tank → Shaft Paddle Flocculator → Sedimentation Tank) and Phase 2 (Clariflocculator).

2.3. Phase 1: Mixing Tank → Shaft Paddle Flocculator → Sedimentation Tank

Coagulation is carried out with the help of 2 geared drives and a shaft mounted mixer for alum mixing. Alum is added and is rapidly mixed with the water. The suspended particles are then removed in the form of turbidity. RLWTP consists of four sedimentation tank. First, three sedimentation tank has mechanical flocculation mounted on a central rotating full bridge with sludge scraper rotating bridge with the clarifier area of 475 m^2, upflow velocity of 2.55 m/h and the total flow of 336 L/s. The fourth sedimentation tank has 4 flat bottom with hydraulic flocculators (Vertical baffles) with 16 sludge concentrator cones and the clarifier area of 760 m^2, upflow velocity of 2.2 m/h and the total flow of 475 L/s.

Figure 5: Sedimentation tanks (Rectangular shaped)

2.4 Phase 2: Clariflocculator

Phase 2 was constructed later and consists of clariflocculator for the coagulation, flocculation, and sedimentation. Large flocs are removed by the gravity settling. Clearwater is collected from the surface while the settled materials (sludge) are removed from the sedimentation tank with the help of rotating scrapper and sludge valves.

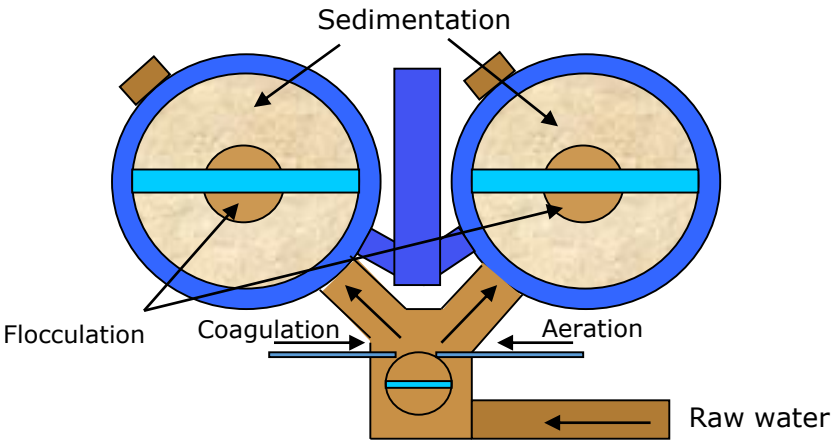

Figure 6: Phase 2 Clariflocculator

2.5 Rapid sand filtration

This unit process removes suspended non-settleable solids from the water and there are 16 rapid sand filters for this purpose in RLWTP. The water received from Phase 1 and Phase 2 is passed through 1.4-meter column of silica sand with the effective size of 0.95mm (± 10 %). It has the average filtration rate of 5.4 m/h and can filter at the maximum rate of 6.5 m/h. Filtration unit is equipped with conventional backwashing system which includes water washing and air scouring. Normally Rapid sand filters run for 2-3 days depending on the quality of raw water and it takes approximately 12 to 20 minute for the backwashing process. Backwashing is carried out when the sand becomes clogged and the turbidity of the water gets too high. Dirty backwash water is then pumped into a sludge collection pond. Backwash water is not recycled as it is highly turbid than the raw water. Recycling of backwash water demands large basin for sedimentation along with the increased alum dosing which is not cost effective for RLWTP.


Figure 7: Rapid Sand Filtration

2.6 Disinfection and pH control

Liquid chlorine is used for killing virus bacteria and protozoa in water and the dosage rate varies from 1.5 to 2.0 mg chlorine per liter of water is added depending upon the level of contamination, pH, and temperature to ensure the residual chlorine up to 0.3-0.5 mg/L.

Lime Dosing is the last unit process being applied at Rawal Lake water Filtration Plant. In this process lime is used to adjust the pH of the water and is the last unit process.

Figure 8: Lime Dosing

2.7 Purified water storage tank

Clean water received from the filtration unit is then collected in the concrete water storage tank. Chlorine dose is then provided in this tank to the kill the pathogens.

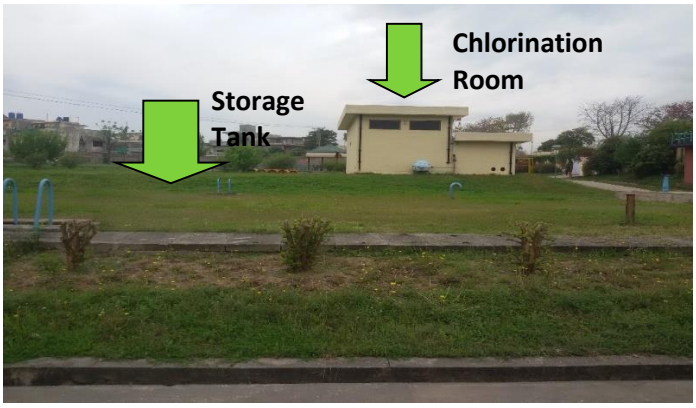

Figure 9: Purified water storage tank for chlorination

2.8 Sludge disposal

The sludge from the clariflocculator is released with the help of valves. Each clarifier has three sludge wasting valves while the rectangular sedimentation tank has sludge wasting cones which help the particles to settle down. These sludge are then collected in the collection basin (**Figure 10**) and then discharged to the Korang River.

Figure 10: Sludge wasting Valves and collection basin

2.9 Distribution system

The treated water then comes to the split chamber. Half of the treated water is then distributed to the Military Engineering Services (MES) and the half to the public of Rawalpindi city.

Figure 11: Distribution system

3. Aspects of treatment processes posing most difficulty for daily operation

Rawal Lake initially had the capacity to store up to 45 to 58 MCM and the quality of the water used to be very good. However due to the continuous deposition of silt and other sewerage into the lake, its color has now turned to be brownish[2]. The rapid filtration plant that was installed in 1962 is now overburdened because of the uncontrollable levels of organic pollution in the lake[3]. Raise in the pollution level has also increased the cost of the drinking water. Human settlement and commercial activity in the catchment has also continuously grown causing further pollution in the catchment water. The lake water is further contaminated with the runoff organic pollutant from both domestic and commercial activity and fertilizers which cause increased dosage of coagulant and disinfectant resulting in the rise of treatment cost.

Currently, the aerator which functioned to pretreat the water is not functioning and has increased the pressure to other units of the treatment plant. Thus, the treatment plant is in need of a pretreatment unit for the efficient performance.

4. Aspects of water services management in general posing most difficulty at the moment

Major sources of the pollution for the Rawal lake includes the wastes thrown from the poultry farms and buffalo sheds located at the upstream. Waste generated from other commercial areas and a university located upstream are also openly dumped in its catchment, which further pollutes the lake water. Rawal lake is also a recreational spot for the people of Islamabad and Rawalpindi. This recreational activity in the Rawal Lake is further deteriorating the quality of the raw water. The lake water was reported to be heavily contaminated by Fecal coliform due to the discharge of black water by the nearby settlement[3]. All these pollution sources are posing difficulty for smooth operation at the current moment.

Figure 12: Sources of Rawal Lake polluted in Upstream

5. Measures taken now to cope with 3) and 4)

Following measures are being considered:

- Pakistan Environmental Protection Authority has proposed to close down the Rawal Lake for recreational activity
- Four sewage treatment plant has been proposed to be installed in the upstream of the Rawal Lake
- Supreme court has decided to stop the unwanted disposal of sewage in the Rawal lake.

6. Recent investment made for the plant's improvement

Sedimentation basin is under construction for the purpose of pre-treatment.

7. Technologies, facilities or other types of assistance needed to better cope with operational and management difficulties in 3) and 4).

- Improving the water distribution system
- Upgrading the management quality by application of GIS-based information technology
- Innovating and diversifying revenue collection methods to improve labor productivity

8. Customer's opinion on water quality and water services in general

Customers are satisfied with the quality of treated water. Sampling and laboratory analysis of treated water is done twice a month to ensure safe drinking water for the public use.

9. Advanced technology used in this water treatment plant or any points to improve the process, water quality and capacity

In RWTP, the filter media for the rapid sand filter has not been replaced for many years. Over the years, the efficiency of the rapid sand filter has reduced. Basically, some of the particles are trapped inside the media even after the backwashing and these particles accumulates and degrade the media and reduces filter run and treated water quality[4]. These deposits are hard to remove and the possible solution to it could be its chemical treatment or replacement of the sand media[4].

10. Water quality data

Table 2 presents the quality of raw water and treated water at RLWTP.

Table 2 Raw Water and Treated Water Quality

No.	Parameters	Unit	Raw Water		Treated Water		Standard (Pak-EPA)
			Min	Max	Min	Max	
1	Hardness	mg/L	140	250	120	250	<500
2	Turbidity	NTU	16	1000	0.99	1.5	5
3	pH		6.2	7.5	7.18	7.25	6.5-8.5
4	Calcium	$mgCaCO_3/L$	50	60	40	46	---
5	Chloride	$mgCl^-/L$	15	20	11	13	<250
6	Dissolved oxygen (DO)	mgO_2/L	3.3	6	2.9	4	6-10
7	Total dissolved solids	mg/L	250	500	110	360	1000
8	Nitrite	mg/L	12	25	1.5	2.5	<3
9	Total Residual Chlorine	mg/L	NIL	NIL	0.5	1.2	0.5-1.5
10	Fecal Coliform	CFU/100mL	31	167	NIL	NIL	NIL

11. References

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4. Bhosale, M. G. M., & Salkar, V. D. Rehabilitation by Chemical Treatment for Sand Media of Rapid Sand Filtration units for Sangli City.

Prepared by:

Mr. Saimar Pervez
Assistant Director Water Quality
Water and Sanitation Agency (WASA), RDA
Pakistan

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URL: http://www.jwrc-net.or.jp/aswin/en/newtap

Email: newtap@jwrc-net.or.jp