Saidabad Water Treatment Plant
Dhaka, Bangladesh

1. Background information

Dhaka Water Supply and Sewerage Authority (DWASA) provides water supply in its service areas of about 400 km^2 in Dhaka city and its surroundings. It has been relying heavily on groundwater as a source of water supply and at present 78% supply is from groundwater. However, the current groundwater abstraction is beyond sustainable yields, as groundwater table in Dhaka is declining at some 2 to 3 meter per year. DWASA has now planned that majority of its new water source will be from rivers. Saidabad Water Treatment Plant (SWTP) is presently the major surface water treatment plant in Dhaka.

The SWTP is planned to be constructed in three phases in an area of about 89,000 m^2. Currently, Phase-1 and Phase-2 has been constructed and are in operation. Phase-1 of the SWTP was constructed in 2002 under the 4th Dhaka Water Supply Project and has the capacity of 225,000 m^3/d. The total project cost of Phase-1 was USD 73 million and was financed by World Bank, French Government and Government of Bangladesh. Under, Phase-2 similar treatment plant was constructed with the capacity of 225,000 m^3/day in 2012 by Danish companies MT Højgaard and Grontmij A/S, and the French company Degremont with the budget of about USD 34 million. Phase-2 aimed at doubling the capacity of the plant and upgrading the pretreatment of the system as the raw water source continuously tends to deteriorate. Phase-3 of the SWTP, with the capacity of 450,000 m^3/d is planned to be constructed by 2020 which will eventually raise the capacity of the SWTP to 900,000 m^3/d.

Treated water from the SWTP is transmitted to the distribution network where it is mixed with the groundwater abstracted by deep tube wells which are located within the distribution network. There are 631 deep tube wells with the depths ranging from 200 m to 400 m.

Table 1 Overall information of Saidabad water treatment plant

Constructed Year	2002 Phase-1 capacity 225,000 m^3/d 2012 Phase-2 capacity 225,000 m^3/d
Water Source	Sitalakhya River
No of Connection	About 230,000 connections including bulk connections to multi-storied apartment buildings.
Peak Operating Flow (m^3/d)	450,000 m^3/d
Design capacity (MLD)	450,000 m^3/d
Automation	Yes, operations automated
No. of employees	100
Date of access of the source information	2016
References	Water Supply Master Plan for Dhaka city, 2015 and personal communication with DWASA staff

2. Water treatment process flow

The treatment line and steps are shown in **Figure 1** and the treatment process includes:

Water Intake → Aeration → Biological Pretreatment → Clarifier → Rapid Sand Filter → Chlorination → Storage → Distribution Network

Aeration and Biological pretreatment (nitrification) were added during the Phase-2 in addition to increasing the capacity of each treatment process.

Sludge generated from the clarifier and backwash water is either pumped to the lagoon (Phase-1) or to the sludge thickener (Phase-2). The thickened sludge is then discharged to the sludge drying bed from the lagoon and sludge thickener.

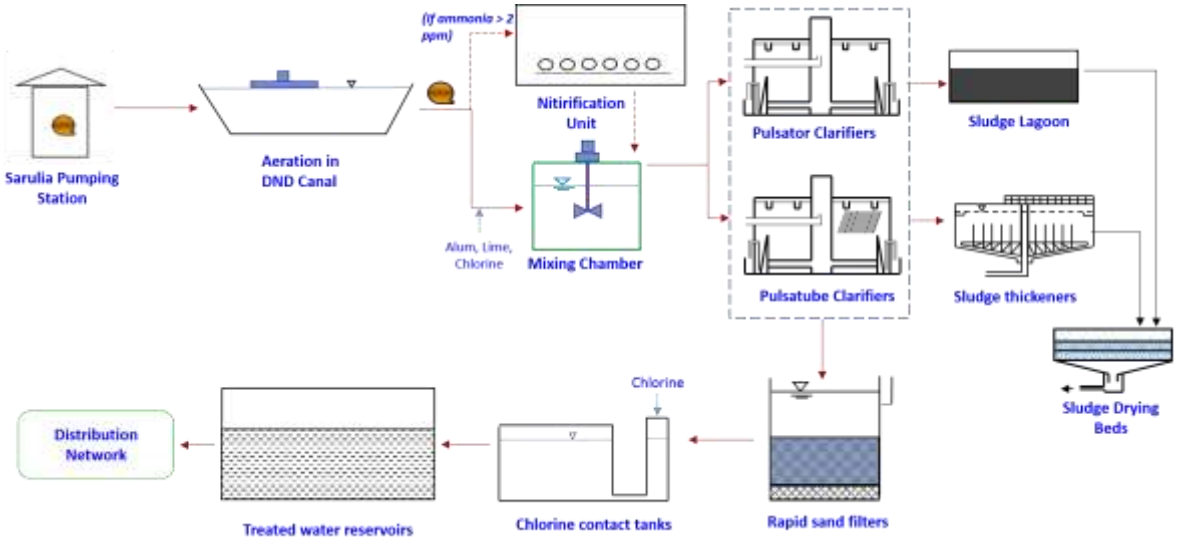

Figure 1: Schematic Diagram of Water Treatment Processes

2.1 Raw Water Collection

Raw water is drawn from the Sitalakhya River through an intake pumping station known as 'Sarulia pumping station'. It is then transmitted through a 40 m wide and 4.6 km long canal, known as the 'DND canal'. As a part of the Phase-2 to improve the pretreatment, 3 sets of 4 surface aerator (**Figure 2**) has been installed at a varied location in the DND canal to increase the oxygen level in the raw water. At the tail end of the canal water flows to a twin box culvert (each 2.0 m X 1.5 m). The culvert is 1.6 km long and ends at the sump of the pumping station at the entrance point of the treatment plant.

Figure 2 Surface aerator

2.2 Raw water pumping station

There is five vertical shafts driven centrifugal pump (3 on duty and 2 standby) for each phase of the treatment plant. The pumped water is conveyed to the biological pre-treatment units.

2.3 Biological Pre-treatment

Biological pretreatment system (**Figure 3**) was installed during the Phase-2. In 2007, a higher level of algae in the DND canal during the dry season was observed which indicated the significant eutrophication level. The growth of the algae is very high in the DND canal during the dry season. The ammonia level in the wet season was generally found out to be 0.5 mg NH_4-N/l while during the dry season the level went up to 10 mg NH_4-N/l according to the feasibility assessment report prepare by DWASA. The report also suggested the level rise upto 15 NH_4-N/l by 2013. The Phase-1 was unable to treat the ammonia. Thus during the Phase-2, Meteor hybrid growth system was installed to pretreat the ammonia.

Meteor 660 biofilm carriers (a product of Degremont) and medium bubble air diffuser is used as a biological pre-treatment unit (10 units). The system aims the removal of ammonia thus reducing organic compounds and precursors to Trihalomethane (detrimental to human health). Additional benefits are the removal of odor and taste from treated water and removal of algae development at settling and filtration process. The main purpose of the biological pretreatment is to reduce the ammonia concentration to prohibit the reaction of excessive ammonia in the raw water with the chlorine during the treatment process which leads to the formation of chloramines which has many drawbacks.

Figure 3 Biological Nitrification System

The Meteor system employs biofilm carriers that have very high surface-to-volume ratio and allows a high concentration of biological growth. The Meteor system is used in wastewater treatment and possibly for the first time applied in water treatment in SWTP. The neutrally buoyant HDPE biofilm carriers within the aeration zones provide a stable base for growth of a diverse community of microorganisms including nitrifiers. Pretreatment units are operated when raw water ammonia exceed 2 ppm, else the water is conveyed directly to the next stage.

2.4 Chemical feeding and mixing

In the flash mixing chamber, mixing of chemical is done through hydraulic mixing. Chemicals are injected in the weir (**Figure 4**). Aluminum sulfate, lime, and chlorine are three main chemicals used at SWTP. Aluminum Sulphate is used as a coagulant and is added in the mixing chamber before the clarifier. Chlorine is injected in the raw water or pre-treated water for pre-chlorination and after the filtration for post-chlorination (as disinfectant) while the lime is used during the flocculation or in the clear water tank for pH adjustment.

The average alum dose for SWTP is 36 mg/l. However, the dosage varies according to the season. Maximum monthly average alum dosage was recorded for the month of May 2012 (82 mg/l) while the minimum was recorded for August 2011 (16 mg/l). For pre-chlorination, monochloramine is used during dry seasons and whereas during the rainy season a low dosage of chlorine is used.

Figure 4 Injection of Alum

2.5 Clarifier

The chemical mixed water is passed through 4 Pulsator clarifiers (Phase-1) and 4 Pulsatube clarifier (Phase-2) which facilitate particle separation mechanism by both flocculation, and sedimentation.

The Pulsator clarifier (Phase-1) is based on sludge blanket process and consists of the vacuum chamber and flat-bottomed tank with a series of perforated distribution pipes with deflectors at its base to distribute the raw water uniformly over the entire bottom. It also consists clarified water collection channels. Pulsator clarifier with its components is shown in **Figure 5**.

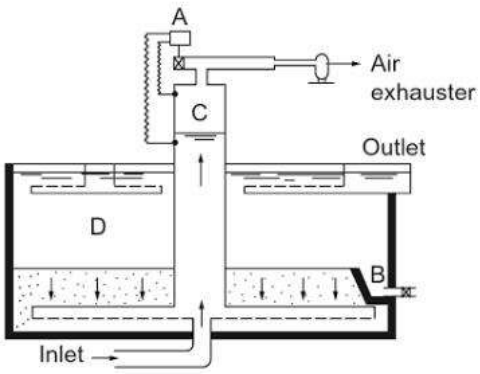

Figure 5 Pulsator Clarifier

Pulsatube clarifier (Phase-2) is similar to Pulsator clarifier (**Figure 6**) but also consist of tube modules which provides larger settling area. It achieves greater performance at the same upward flow rate due to this modification.

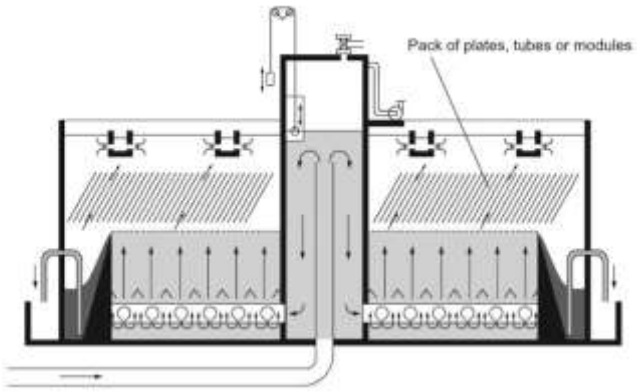

Figure 6 Pulsatube Clarifier

2.6 Filtration

Water from the clarifiers is filtered with rapid sand filters (Aquazur V ™ type, a product of Degremont). There are 24 units (12 units for Phase-1 and 12 units for Phase-2) of rapid sand filter each with the surface area of 121 m^2 and filtration rate of 6.56 m/h. The media utilized in the rapid sand filter is coarse sand with the effective size of 0.9 mm, uniform coefficient of 1.6 and filter depth of 100 cm. The backwashing is done by water washing and air scouring and is usually done once a day. The backwash water rate of the filter is 1800 m^3/h and the air scours rate is 6600 Nm^3/h. About 2 to 3% of treated water is used for backwash.

Figure 7: Filter units during filtration (left) and during backwashing (right)

2.7 Chlorine contact tank

Clearwater from the filters is passed to the chlorine contact tank where chlorine is added. There are four chlorine contact tanks (2 for Phase-1 and 2 for Phase-2) with the volume of 5000 m^3 each. A chlorine contact time of 30 minutes is provided.

2.8 Clearwater tank

SWTP consists of four clear water tanks (2 units for Phase-1 and 2 units for Phase-2), each with the capacity of 9000 m^3. Occasionally, lime is also injected in this unit for pH adjustment depending on the raw water quality.

2.9 Treated water pumping station

The pumping station consists of 7 horizontal centrifugal pumps (6 on duty and 1 standby). Treated water is then pumped to the distribution network through a transmission line.

2.10 Sludge Disposal

Sludge water from the clarifier and backwash water for the filters are pumped to the lagoon (Phase-1) and sludge thickeners (Phase-2) which then treats and sends it to the sludge drying bed. Each thickener unit is of 16 m diameter and 3 m high and capacity of 160 m^3/h. The suspended solids (including chemical) produced by the SWTP is approximately 14,000 kg/day. The thickened sludge is then discharged by pumping to the sludge drying bed.

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

In recent years, the water quality in the river has deteriorated tremendously. The contamination of organic matters, nitrogen, and phosphate supplemented with high temperature and the sunshine promotes the proliferation of phytoplankton, algae, and aquatic plants. Thus, the dissolved oxygen level in the raw water is below the acceptable limit. Moreover, the ammonia concentration increases excessively (ammonia-N as high as 20 mg/l) during the dry seasons (November to April) making it difficult to comply with the WHO 1993 Guideline (< 1.5 mg/l). The high ammonium concentration in raw water causes unpleasant taste and odor and also increases the usage of chlorine in the treatment plant.

The pollution level in the DND canal as it is not protected from the waste water discharge and storm water sewer discharge, and it further degrades the raw water quality.

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

The upstream pollution from the drainage canals and industrial effluent is continuously deteriorating the raw water quality of Sitalakhya River and DND canal and causing difficulty in the treatment at SWTP.

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

Currently, in order to improve the water quality of DND canal, surface aerators are installed to increase the dissolved oxygen level. As a long-term solution to the problem of rising pollution in the Sitalakhya river, it is planned to shift the source of raw water from Sitalakhya to Meghna river which is 30 km east of Dhaka where has no significant industrial pollution. The Department of Environment (DOE) is also preparing plans to control industrial pollution in that area.

6. Recent investment made for the plant's improvement

In order to cope with the deteriorating water quality, especially ammonia in dry seasons, the aeration unit in the raw water canal and the biological pre-treatment units was added in the Phase-1 treatment line. Pretreatment units are also installed in the newly constructed Phase-2 treatment plant.

Phase 3, is currently in progress and it aims to support Dhaka to reach the goal of supplying its residents with 30% groundwater and 70% surface water by 2035. Phase 3 also includes the construction of raw water pumping stations and 54-kilometer distribution line.

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

Pollution control and better management river water quality are vital for the sustainability of the treatment plant.

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

Customers are quite satisfied with the quality of the drinking water and SWTP do not normally receive complaints regarding the water quality. However, during the peak, dry season customers often complain about the odor in the supply water.

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

SCADA has been installed for continuous monitoring of treatment units as well as water quality after different stages. METEOR technology for biological pretreatment has been used for the first time for the drinking water treatment at SWTP. Pulsatube used in the SWTP is a compact clarifier system.

10. Other Highlights

A gas generators power plant with 4 X 1415 kW capacity that been installed for a continuous supply of energy for the treatment plant in additional to the electricity from the national grid.

11. Water quality data

The treated water quality of the SWTP is presented in the table below.

Table 2 Treated Water Quality of SWTP

Turbidity	<1NTU
Ammonia	<0.5mg/l
Sulfide	<0.05 mg/l
Algae	<1 µg/l

12. References

- Water Supply Master Plan for Dhaka city (2015). (Internal Report)
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