No. 8 Water Treatment Plant, Mandalay, Myanmar

1 Background Information

Located in the north west of Mandalay city, just beside the Ayeyarwady river bank, No. 8 water treatment plant is treating 27,000 m^3/d of water to serve the need of Mandalay. This is, however, much less than the theoretical capacity of the treatment plant, which is 45,000 m^3/d. The construction of this plant started in February 2010 and has been in operation since March 2013. The main water source is the surface water coming from the Ayeyarwady River. However, due to the higher demand of the growing population and limitations of the existing technology such as longer processing time to get the required capacity of output water every day, ground water is needed to supplement the amount of water for the distribution. Four ground water wells were constructed and combined with the treated river water before distribution. Water from both the sources is chlorinated prior to pumping out to the city.

2 Water treatment process flow

The treatment process flow of No. 8 WTP has been shown in Figure 1. It comprises the following steps:

Ayeyarwady river → Intake Structure (Pontoon) → Sedimentation Basin → Pre-roughing filtration tank → slow sand filtration tank → storage tank → chlorination → pumping station

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Groundwater

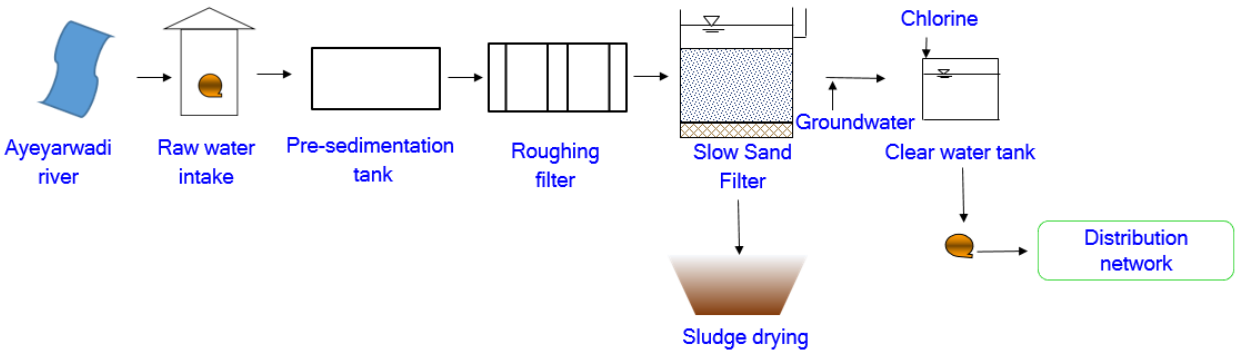

Figure 1: Water treatment process flow diagram

2.1 Water Intake

The main pontoon (14m x 8.5m) with pipe foundation (55m x 3m) is built as an intake structure. At that structure, four submersible pumps are installed to pump the water from the Ayeyarwady River to water treatment units. The capacity of the pumps is described below in table 1. Each day, 9000m^3 of water is brought into the treatment plant.

Table 1: Specification of pump

Item	Description
No. of pump (submersible)	4
Pump head	25 m
Capacity	27264 m^3/d or 316 L/s

2.2 Pre-Sedimentation

The incoming water is put into the two sedimentation tanks each with a size of 76m x 30m x 5m. The total area of the pre-sedimentation tank is 2287 m^2 and includes 12 compartments in total. The hydraulic capacity of the sedimentation tank is 44640 m^3/d. The detention period in the sedimentation tank is 6h. Other technical details of the sedimentation tank have been summarised in Table 2. As can be seen in Figure 2, the incoming river water is in very muddy colour. It is mostly due to the silt and mud present in the water. This problem gets worse in the rainy season, and it leads to the clogging of the filter media. Algae blooming is also another major issue here, as it requires cleaning of the units very often.

Table 2: Technical details of sedimentation unit

Particulars	Values
Quantity	2
Length (m)	76.3
Width (m)	30.0
Depth (m)	4.87
Area (m^2)	2287
Total area (m^2)	4573
Loading rate (m/h)	0.4
Hydraulic capacity (m^3/d)	44,640

Figure 2: Water input to the pre-sedimentation tank

2.3 Roughing Filtration

Three stages of roughing filtration are designed to reduce the sediment of the intake water before sending it to the slow sand filtration units. The three stages of roughing filtration have different sizes of gravel media: large (50-100mm), medium (25-50mm) and small (10-12mm). Water is passed from one unit to the next through a gravity flow as shown in Figure 3. It consists of 16 sub-tanks: 4 with coarse gravel media, 4 with medium gravel media, 4 tanks with fine gravel media, and the 4 storage tank. Each gravel filtration tank has the gravel depth of 2m. Other technical details of the roughing filtration units have been summarised in Table 3.

Table 3: Technical details of roughing filtration tanks

Particulars	Coarse filters	Medium filters	Fine filters
Length (m)	12.3	6.3	5.8
Width (m)	14.9	14.9	14.9
Area (m^2)	183	94	86
Total area (m^2)	733	374	343
Filtration rate (m/h)	2	1.5	1
Hydraulic capacity (m^3/d)	35,184	13,440	8,400

Figure 3: Pre-roughing filters

Figure 4: Screen vibrators for gravel media size separation

2.4 Slow Sand Filtration

The slow sand filtration process is used as final and main filtration process in this treatment plant. The slow sand filtration tank comprises 4 sub-units. The hydraulic capacity of the unit is 24, 912 m^3/d. The filtration rate of SSF is 0.2m/h. The sand particle size (D10) is 0.24 mm, which is too small for an efficient operation. The technical details of SSF have been summarised in Table 4. Operating this unit is often a challenge due to the raw water impurity, as the filter medium gets clogged, which retards and stops the functioning of the unit. Consequently, slow sand filters often require filter medium cleansing. Algae blooming was also a big issue in this unit. However, it was solved by installing a roof over it.

Table 4: Technical details of SSF

Particulars	Values
Quantity	4
Length (m)	85.3
Width (m)	15.2
Area (m^2)	1297
Total area (m^2)	5187
Filtration rate (m/h)	0.2
Hydraulic capacity (m^3/d)	24,912

Figure 5: Slow sand filters

2.5 Filter Media

The filter media of the sand filtration unit is designed as shown in the model below. It has the gravel layer of 30 cm and the sand layer of 1m. The filter media is cleaned manually, whenever the filter media is clogged. Once a year, all the sand layer is taken out and washed in the locally made sand washing machine.

Figure 6: Filter media model for SSF unit (left) and locally made sand filter media washing machine (right)

2.6 Clean Water Storage

The clean water storage tank has the capacity of 5700 m^3, with the size of 30m x 36.6m x 6.4m. This unit receives the treated water from the slow sand filtration tank and from the ground water well. Chlorine is also added to this unit, before pumping out for distribution.

Figure 7: Clean water storage tank

2.7 Ground Water Intake

Four ground water wells are constructed and used to supplement the requirement of the quantity of water for distribution. The ground water is pumped into the final clean water storage tank, where the chlorination also takes place. The ground water extraction rate is 190 m^3/h (or 4560 m^3/d) well, and the total ground water production from the four wells is 18000 m^3/d.

Figure 8: Ground water input to the clean water storage tank

2.8 Chlorination

NaCl (Rough Table salt) is electrolyzed to produce chlorine, and the chlorine is added to the clean water storage tank. A total of 24 salt bags (each – approximately 15 kg) is used every day for this chlorination process. The salt and water are fed to the machine, and it electrolyzes approximately 1 salt bag per hour. The electrolyzer is often cleaned with HCl to protect salt corrosion on the metal unit.

Figure 9: Electrolyzer (left) and salt bags for chlorination process (right)

2.9 Pumping Station

There are four booster pumps installed in the pumping station (12m x 23m x 8.84m). The capacity of the pumps is as shown in the table below.

Table 5: Capacity of the pumps for distribution

	Pump No. (1) & (2)	**Pump No. (3) & (4)**
Type	Horizontal, Double Suction, Split Casing Pump	Horizontal, Double Suction, Split Casing Pump
Pump head	50 m	80 m
Capacity (m^3/h)	1364	910
Horse power	280 KW	355 KW

Two pumps are used to send the water to the water storage tank on the Mandalay hill. Those pumps send out the water with a pipe that is 1 ft. (30cm) in diameter and 5.2 km long to the storage tank at the Mandalay hill, where the water is again distributed to the Chanayetharsan and Aungmyaetharsan townships. Every day, 10, 200 m^3 of water is sent to the Mandalay hill storage tank by pump No.3 and 4. On the other hand, another two pumps are used to pump out 16, 000 m^3 of water to the Malwon water distribution unit.

Figure 10: Booster pumping station at No. 8 Water treatment plant in Mandalay

2.10 Sludge Removal

The sludge collected from the SSF is cleaned manually every four months. During times when water contains higher impurities (such as rainy seasons), the sludge is cleaned whenever the filter media in the treatment unit is clogged. The removed sludge from the treatment units are open sun dried and sent to the landfill.

3 Water quality Data

The daily water quality tests are performed by collecting intake and output water samples. The following table shows the output water quality results from this water treatment plant. It shows average monthly data.

Table 6: Water quality data of WTP No. 8

Date / Unit		June 2016	July 2016	Aug 2016	Sept 2016	Oct 2016
Temperature	°C	32	32.6	28.9	29.8	32.2
pH value	Scale	6.8	6.8	6.8	6.8	6.8
Color	Units	>50	>50	>50	>50	>50
Turbidity	NTU	13.7	27.5	20.2	55.7	18.7
Conductivity	µs/cm	85.1	135.6	236	215	190.2
Ca	mg/L	48	12	16	16	16
Hardness	mg/L	160	40	64	68	80
Mg	mg/L	5	2	5	5	1
Cl	mg/L	5	5	8	8	8
Alkalinity	mg/L	68	48	80	80	88
Fe	mg/L	>0.2	>0.2	>0.2	>0.2	>0.2
Mn	mg/L	0.03	0.03	0.03	0.03	0.03
SO_4	mg/L	<200	<200	<200	<200	<200

4 Operational Challenges

Based on discussion with the operators of the treatment plant, as well as site observation, the following were seen as some of the major operational challenges:

- Filter media clogging, particularly in the rainy season, causing problems in the operation of the treatment plant
- Slow operation of system, mainly because of the head losses in the sedimentation and roughing filtration units
- Problems of algae bloom in the pre-sedimentation tank and roughing filtration units. This problem has been addressed by constructing roofs over the respective units.
- Daily requirement of large quantities of table salt for electrolysis (24 bags each weighing 15 kgs) to produce chlorine for disinfection process

5 References

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