

# Hiriwadunna Water Treatment Plant

## Kegalle, Sri Lanka

### 1. Background information

Hiriwadunna water treatment plant is located about 6 km away from Rambukkana, a town nearly 85 km East of Colombo. The Hiriwadunna water treatment plant is owned and operated by the National Water Supply & Drainage Board (NWSDB) of Sri Lanka. Commissioned by the Government of Sri Lanka in 1963, the plant was rehabilitated in 1997 with financial assistance from Asian Development Bank. The rehabilitation work was conducted between 1993 and 1997, with a total investment cost of US\$ 3 million. The plant's design details are presented in Table 1 below.

**Table 1 Overall information of Hiriwadunna water treatment plant**

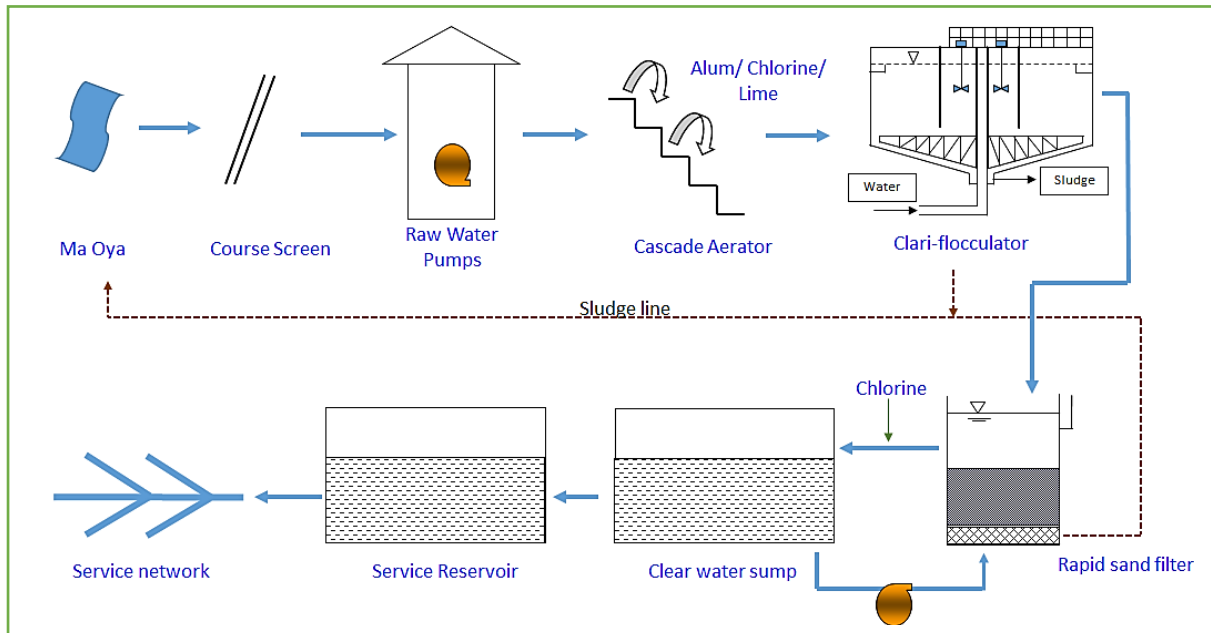
<b>Constructed Year</b>	1963 (Rehabilitated – 1997)
<b>Water Source</b>	Ma Oya stream
<b>Number of connections</b>	9,200
<b>Peak Operating Flow (m<sup>3</sup>/h)</b>	400
<b>Design capacity (m<sup>3</sup>/h)</b>	350
<b>Peak/Design flow</b>	1.14
<b>No. of operators working at the plant</b>	3
<b>Date of access of the source information</b>	2015
<b>References</b>	(Mott Mackdonold Consultants, 1993; NWSDB,2014)

This water treatment plant (WTP) provides safe water to about 40,000 consumers living in Rambukkana and Kegalle area. The service area is a mountainous area with altitude varying from 200m to 300m. The treated water complies with the Drinking Water Standard of Sri Lanka, SLS 614-1983.

### 2. Water treatment process flow

The major water treatment unit processes are presented below (Refer Figure 1- 9):

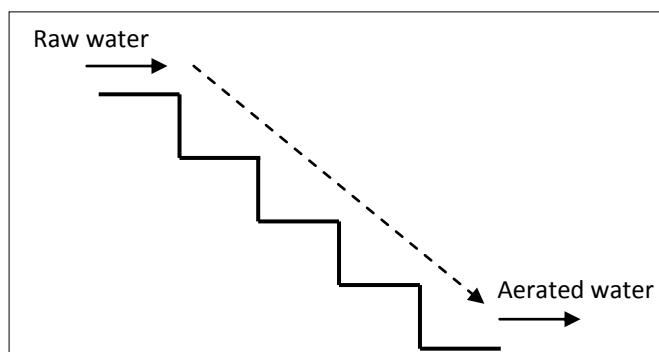
- ❖ Raw water extraction (*direct intake*) → Raw water pumping → Aeration (*cascade type aerator*) → Coagulation with alum & lime (*hydraulic jump*) → Flocculation & sedimentation (*vertical flow clarifier*) → Filtration (*rapid sand filters*) → Disinfection (*gas chlorination*) → Clear water tank → Treated water pumping
- ❖ Sludge treatment: Sludge is disposed to the raw water source Ma Oya river without any treatment (this is the current operation)



**Figure 1 Water Treatment Process**

**2.1 Aeration**

Cascade type aerator has peak loading rate of 41.2 m<sup>3</sup>/m<sup>2</sup> per hour, however, the recommended rate is 85 – 105 m<sup>3</sup>/m<sup>2</sup> per hour (Quasim et al, 2012). The specific functional requirement of the aerator at Hiriwadunna WTP is to increase DO, since the raw water intake is near a low flow weir and the water is stagnated at the dam in the dry season. DO of raw water is 3.0 mg/L and DO of aerated water is 6.9 mg/L.



**Figure 2 Sketch diagram of cascade aerator**

**2.2 Chemical feeding and rapid mixing**

Alum, lime and gas chlorine are used for water treatment. Lime is used for pH adjustment; the minimum pH of the raw water is 6.5 and the pH after adding lime is 6.8. Alum is used as the coagulant. Alum and lime are fed to a hydraulic jump at the entrance of clari-flocculator through a constant flow feeding arrangement. Post chlorine is added at the entry of the clear water sump.



**Figure 3 Cascade aerator**



**Figure 4 Alum**



**Figure 5 Hydraulic mixing**



**Figure 6 Gas chlorine cylinder on weighing gauge**

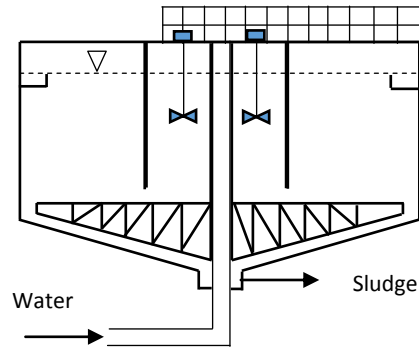
Chlorine is dosed using vacuum feed chlorinators and the maximum dosing rate of the chlorinator is 1.5 kg/h. However, the current dosing rate is 1.2 kg/h. Alum, lime and gas chlorine is purchased by a competitive bidding procedure from the local agents of Indian Industrial Chemical companies. The total cost for chemical of this WTP is 3.98 US\$ / 1000 m<sup>3</sup> of water.

### **2.3 Flocculation & Sedimentation**

Hiriwadunna WTP has two clari-flocculator units with mechanical flocculation and up flow sedimentation allocated in one unit. The actual detention time in flocculator is 20 minutes and the designed velocity gradient (G) is 15 s<sup>-1</sup> to 50 s<sup>-1</sup>. The recommended detention time is 20 – 30 min (Kawamura, 2000). Sedimentation compartment consists up flow type hopper bottom sedimentation tanks with V-notched weir. The detention time is 74 min and surface loading is 3.6 m<sup>3</sup>/m<sup>2</sup>·h. Sludge is removed from the bottom by sludge valve. The amount of sludge produced in the sedimentation tank is 0.011 m<sup>3</sup>/m<sup>3</sup> of treated water.



**Figure 7a Clari-flocculator (2 units)**



**Figure 7b Up flow clarifier with mechanical flocculation**

## 2.4 Filtration

There are three in-house single media rapid sand filters in Hiriwadunna WTP. The media utilized in rapid filters is fine sand with 1.0 mm of effective size, 1.4 of uniform coefficient and 1 m of filter depth. Filter backwash method consist of water wash followed by air scouring. The filtration rate is 6.2 m/h.



**Figure 8 Filters**



**Figure 9 Treated water pump house**

The filters are backwashed every 48 hours or after head loss in filter reach 1.2 m, whichever happens first. The filters are cleaned 4 times a month to remove algae growth. The loss of filter media due to backwash is about 8 % per year. The treated water turbidity varies from 0.8 to 1.6 NTU.

## 2.5 Sludge disposal

There is no sludge treatment system in the current operation of this WTP. The sedimentation sludge and filter backwash water is sent back to the river Ma Oya without any treatment. Total volume of sludge produced is 113 m<sup>3</sup>/d.

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

- The mechanical system of the two clari-floculators breaks down at least once a month, which causes difficulty in maintaining the expected quality of treated water. The reason for these frequent mechanical breakdowns is the age of this mechanical system. Therefore, the mechanical system has to be replaced as soon as possible.
- When there are sudden heavy rains, the WTP receives shock loads of turbidity. The Jar test has to be carried out to decide the optimum alum dosage for flocculation. The Jar test takes about 45 minutes to decide the optimum alum dosage (Kawamura, 2000). During this time period, the treated water produced by the WTP does not comply with the recommended turbidity value by SLS 614:1983 (SLSI, 1983).
- The sludge disposal system of the Hiriwadunna WTP does not function properly, as the mechanical cleaning system gets stopped due to friction of accumulated sludge at the bottom of the clari-floculator. It has been identified that this is because of the inadequate slope and diameter of the sludge disposal line. Therefore, an alternate sludge disposal arrangement has to be introduced to this WTP.
- The sludge produced at the clari-floculators and at filter backwash is disposed to the Ma Oya River without any treatment. This is against the sludge management policy of National Water Supply and Drainage Board - Sri Lanka and effluent standard specified by the Central Environmental Authority of Sri Lanka. Therefore, a proper sludge management system has to be introduced in the Hiriwadunna WTP.
- It is extremely important to monitor and identify water quality of water treatment process continuously. Thus, monitoring equipment requires to be properly maintained for measuring exact value of pH, turbidity and color of the water at all time. There is no online water quality monitoring system at Hiriwadunna WTP and this reduces the safety of produced water.

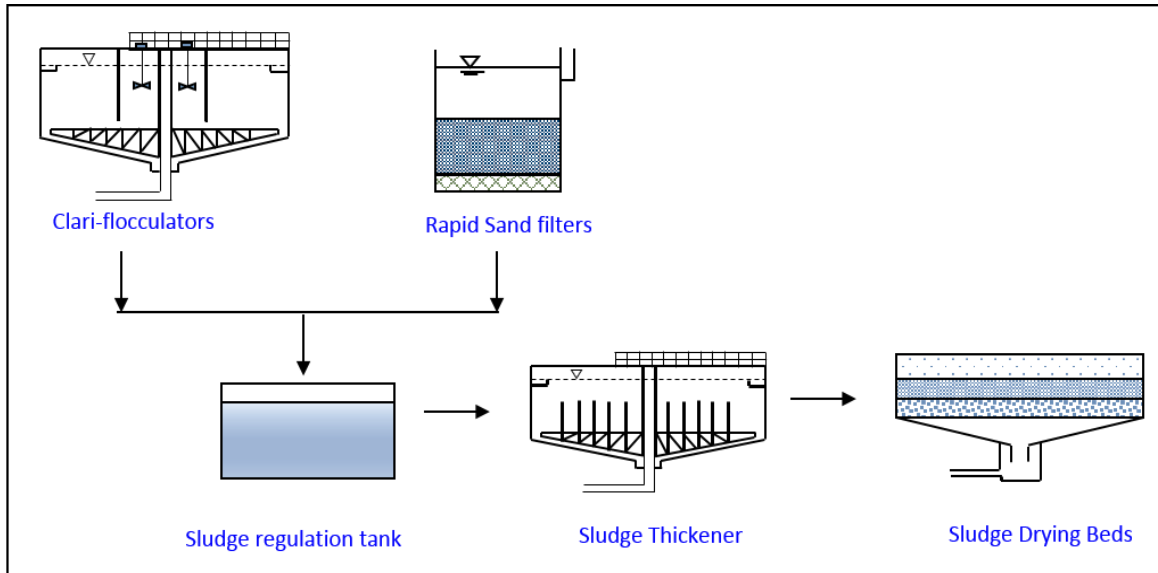
### **4. Aspects of water services management in general posing most difficulty at the moment**

- The major problem at Hiriwadunna WTP is that the WTP is operated at a rate higher than the designed rate. The current operating rate is 400 m<sup>3</sup>/h, whereas the designed operating rate is 350 m<sup>3</sup>/h. If the production is stopped for few hours, most of the high elevated areas do not receive water. Therefore the production capacity of the treatment plant has to be increased.
- In addition, it is very difficult to produce treated water in rainy season due to the frequent mechanical breakdowns of the clari-floculators. Turbidity of treated water in the rainy season is 7 NTU.
- An online water quality monitoring system for influent and effluent of each unit process is required for proper process control.

### **5. Measures are now being taken to cope with 3) and 4)**

- It is planned to rehabilitate the mechanical system entirely to remove the sedimentation sludge and it is decided to install sludge pumps to pump the sludge out of the tank. In addition, a sludge management system has already been designed as per the Sludge Management Policy of NWSDB and is awaiting financing. The proposed system is shown in Figure 10. The tentative cost

is around 47,000 US\$.



**Figure 10 Proposed sludge disposal system**

**6. Recent investment made for the plant's improvement**

- No investment for improvement has been made after rehabilitation works carried out in 1997 by the ADB.

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

- Online pH, turbidity and color measuring system
- Proper sludge management system
- Improve the mechanical system in clari-flocculators by changing to the better materials and motors

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

- Customers complain about poor quality water during rainy season. Sometimes they also complain about service level (low water pressure).

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

- Advanced technology: none
- Laboratory facility is equipped to measure simple parameters only (pH, turbidity, jar-test, alkalinity etc.).

**10. Other Highlights**

- Chemical usage: Alum, lime and gas chlorine. Alum and lime are fed using a constant flow gravity feeding arrangement
- Average water tariff: Domestic – 0.2 US\$ /m<sup>3</sup>, Commercial – 0.65 US\$/m<sup>3</sup>

## 11. Water quality data

Source water and raw water quality of Hiriwadunna WTP is presented in Table 2 below. Treated water quality parameters complies with the Sri Lanka standard for drinking water SLS 614:1983 (SLSI, 1983).

**Table 2 Raw water and treated water quality (NWSDB, 2014)**

Parameter	Unit	Raw water (2014)		Treated water (2014)		Standard SLS 614:1983
		Maximum	Minimum	Maximum	Minimum	
pH	-	7.6	6.5	7.2	6.6	7.0 – 8.5
Turbidity	NTU	380	1.6	7	0.8	2
EC	mS/cm	143	56	153	58	750
Total hardness	mg/l	84	20	82	18	250
Total alkalinity	mg/l	80	20	76	14	200
Cl	mg/l	26	12	28	12	200
N-NO <sub>3</sub>	mg/l	<0.01	<0.01	<0.01	<0.01	Nil
N-NO <sub>2</sub>	mg/l	<0.001	<0.001	<0.001	<0.001	Nil

## 12. References

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**Published on:** 16 June 2015



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