Siddhipur Water Treatment Plant
Lalitpur, Nepal

1. Background Information

Siddhipur is located 10 km southeast of Kathmandu in Lalitpur district. Siddhipur Water Treatment Plant (SWTP) was started with the initiation of Siddhipur Drinking Water Supply and Sanitation Users Committee (SDWSSUC), funding support UN-HABITAT and Water Aid and technical support of Environment and Public Health Organization (ENPHO), Nepal. The construction of SWTP was completed in 2007 with a budget of approximately 175,675 US Dollars (13 million Nepalese Rupees), 23 % from the user communities and remaining in the form of aid. The SWTP is being managed by the SDWSSUC, who elects a working committee of President, Vice President, Secretary, Treasurer and seven General Members for five-year tenure under the regulation of Nepal Drinking Water Regulation 2055 (1998 A.D.). Additionally, six technical and non-technical staffs have been appointed to support the daily activities and operation. The general information of SWTP is shown in **Table 1**.

Table 1 Overall Information of Siddhipur Water Treatment Plant

Water Supply Scheme	Siddhipur
Type of source	Surface water
Name of source	Godavari River
Climate	Warm temperate
Year of commissioning	2007
Design capacity (m^3/d)	864
Design period (yr)	20
Design number households	2000
Number of connected households	1350
Present production (m^3/d)	691
Distribution length (km)	16
Automation	No
Treatment technology	Tube settler, slow sand filter, chlorination

2. Water treatment process flow

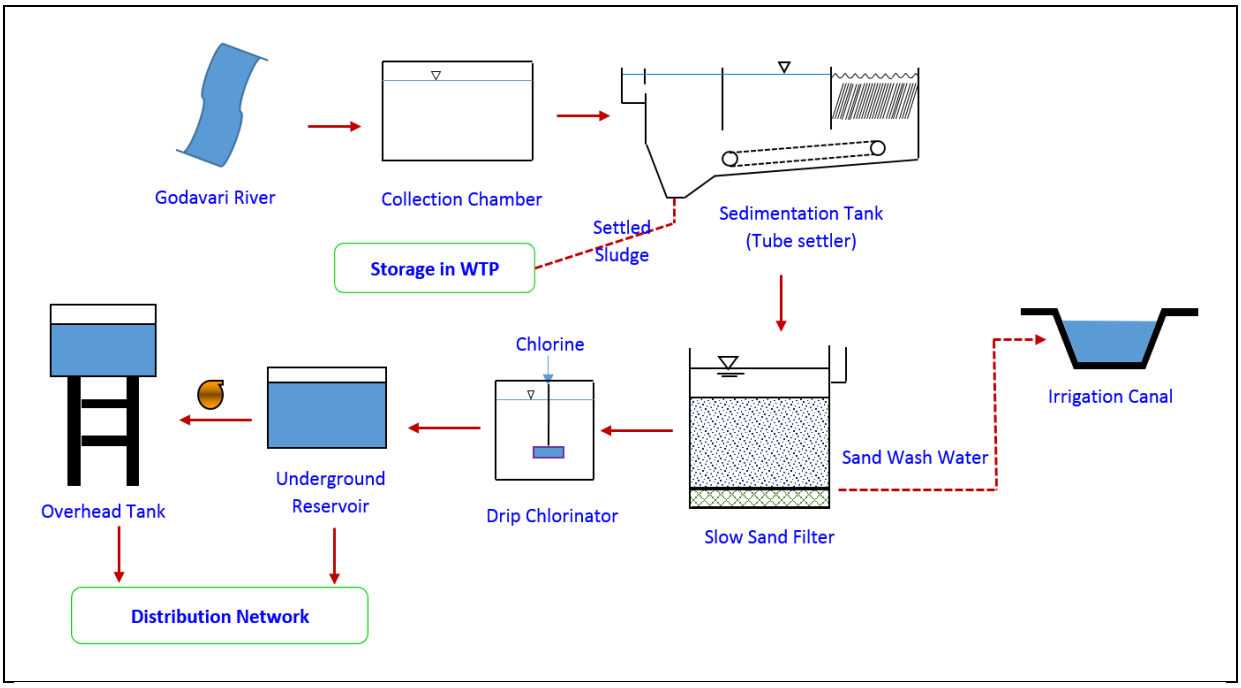

Figure 1: Schematic Diagram of Water Treatment Processes

The major water treatment process (**Figure 1**) at SWTP includes:

Raw water extraction → Collection Chamber → Tube Settler → Slow Sand Filter→ Chlorination Unit → Reservoir → Pumping Station → Overhead Tank → Distribution network.

Sludge generated from tube settler and the slow sand filter is disposed in the open fields close to the WTP and sometimes reused as filling material during construction works while the scrapped sand from the Slow Sand Filter is washed and reused.

2.1 Water intake

The surface water from Godavari River is being used as the main source of water supply for the SWTP. **Figure 2** shows the catchment and the intake works of SWTP. The collected water at the intake is diverted to the WTP by a 3.5 km transmission using high-density polyethylene pipe of diameter 140 mm, with two air valves along the transmission line.

Figure 2: Catchment (left) and Intake works for SWTP at the Godavari river (right)

2.2. Collection chamber

The intake structure consists a weir and water collection chamber of 6 m^3 volume with a dimension of 2 m length, 1.5 m breadth and 2 m of depth (**Figure 2**). The chamber is cleaned manually as required when it is filled with debris. The chamber needs to be cleaned frequently during the monsoon season.

2.3 Sedimentation

The water treatment system at SWTP includes one tube settler (**Figure 3A**) with 4500 tubes of 90 cm length of 50 mm diameter. The tubes are inclined at a 60° from horizontal. The present surface loading rate is 2.4 m/h while the design loading rate is 3.0 m/h. In general, the tube settlers are cleaned every 3 months (clearing of the surface in every 2 days) however it can vary during the monsoon as the water quality is deteriorated due to the surface runoff in the catchment. No chemical coagulants are used during the sedimentation process. The quality of raw water during the winter season is shown in **Table 2**

Table 2: Water quality data (February 2016)

S.N.	Parameter	Observed
1	pH	6.5
2	Temperature	12
3	Turbidity (NTU)	5
4	Hardness (mg as $CaCO_3$/L)	184
5	Ammonia (mg N-NH^+_4/L)	0.2
6	Nitrate (mg NO^-_2/L)	15
7	Iron (mg/L)	0.3
8	Coliform presence	Yes

The sludge from the tube settlers during the cleaning operation is collected through a drain pipe located at the bottom of the Tube Settler unit (**Figure 3B**). The sludge generated is collected and disposed of in the open fields near the treatment plant.

Figure 3: (A) Tube Settler Unit and (B) Drain pipe for Tube Settler

2.4 Slow sand filter

The effluent after sedimentation is treated by slow sand filtration (SSF) unit with a dimension of 12 length, 8 m breadth, and 3 m depth and with media depth of coarse gravel - 50 cm, fine gravel- 40 cm and sand - 90 cm. The designed filtration or loading rate of all three filter units is 3.0 $m^3/m^2/d$ while the current loading rate of two filter units is 3.6 $m^3/m^2/d$. There are two operational SSF at SWTP and the standby SSF is alternated with the SSF which undergoes cleaning process. SSF are cleaned every 15 days during the monsoon (June – August) when the turbidity is very high and in the normal circumstances (at normal turbidity) it is cleaned in every 1 – 1.5 months. The filters are cleaned manually by scraping the layer of sand from the top of the filter beds. The scrapped sand is washed and reused as filtration media. The generated wastewater is then discharged in the irrigation canal that distributes water to the nearby agricultural fields.

Figure 4: Slow Sand Filter

2.5 Disinfection process

The treated water is disinfected in drip chlorinator unit (Figure 5). There is a single chlorinator unit. The water treatment plant does not have a laboratory facility for water quality analysis. Bleaching powder is used for chlorination and dosing is based on an approximate calculation of 300 gm/100 m^3 of water, so, around 2.1 kg of bleaching power is consumed for 691 m^3 per day. The calculated contact time is approximately 60 – 80 min (Contact Time, T = V_{eff} x BF/peak flow, Baffling factor = 0.2, flow = 10 L/s, Effective volume (V_{eff}) = 250,000 x 0.95 L).

Figure 5: Chlorination Unit

2.6 Storage and distribution

The disinfected water is then stored in a single reservoir unit of 250 m^3 and then pumped to the overhead tank (50 m^3). During non-peak hours, the clean water stored in a ground reservoir can be distributed directly with gravitational flow through the distribution networks. The clean water from storage reservoir is pumped to the overhead tank which is utilized during the peak hours (**Figure 6**). The water is then distributed to the residential areas.

Figure 6: Storage tank (left) and Overhead tank (right)

2.7 Sludge disposal

There is no sludge treatment facility at the SWTP. The primary sludge and/or sediment sand collected during the cleaning of SSF are stored inside the water supply facility (**Figure 7**). The scrapped sand from the Slow Sand Filters are washed, cleaned and reused for SSF. It takes 2-3 days to clean the filter.

Figure 7: The waste sand deposit collected from slow sand filter

2.8 Distribution system

The SWTP delivers uninterrupted water supply to all the connected 1350 households through the distribution systems. The drinking water is being supplied mostly to the residential areas.

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

- The SWTP lacks a storage reservoir to collect the treated water during the low demand. The operation of the plant is manual, therefore, the treated water is overflown during the night when there is no demand for water.
- The SWTP has a single tube settler unit with no other alternative, therefore, the supply is interrupted during the cleaning operation.
- The average annual dry weather discharge in the source river is decreasing gradually leading to a reduction in production of drinking water.
- Lack of supply of electricity from the government to run the treatment plant.
- Lack of laboratory facility water quality monitoring.

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

- The water tariff has not been reviewed since the establishment of the plant in 2008, this makes it difficult to cope with the operation, management and future expansion of the SWTP with the generated revenue at present.
- The water treatment plant should be scaled-up to cater the additional demand.
- Due to the recent earthquake in 2015, the distribution line has been damaged at several place which needs to be replaced.

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

Due to the deficit of revenue generation, SWTP has not been able to improve its treatment and service. However to cope with the unstable power supply of Nepal, SWTP has installed a diesel generator as the power backup for pumping operations.

6. Recent investment made for the plant's improvement

No recent investment has been made to improve the SWTP.

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

The SWTP needs the following improvements:

- Storage reservoir with the capacity of 300 m^3 to store the treated water during the night time when the water demand is low. The stored water can then be used to supply to new areas.
- Either a sedimentation tank for the intake or another tube settler unit as SWTP has only one tube settler which needs to be shut down during the cleaning operation.

- Water tariff revision with the consultation of SDWSSUC and users as it is impossible to cover the operational and maintenance cost under the current generated revenue.

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

The SWTP is able to meet the current demand of the consumers. SWTP is providing 24 hours of uninterrupted supply of water. The water quality data suggest that the drinking water quality is palatable for drinking purpose.

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

There is no advance technology at the treatment facility. However, tube settler unit is a new technology for community water treatment facilities in Nepal.

10. Other Highlights

The raw water from the intake to the distribution networks flows gravitationally, therefore, SWTP does not rely strongly on the pumps for lifting the water for the generation of the head. Nonetheless, the treated water has to be lifted to the overhead tank to cope with the demands during the peak hours.

11. Water quality data

Table 3: Water quality data (February 2016)

S.N.	Parameter	Observed	NDWQS2005
1	pH	7.5	6.5 – 8.5
2	Temperature	18	-
3	Turbidity (NTU)	< 5	5 (10)
4	Total hardness (mg/L as $CaCO_3$)	160	500
5	Ammonia (mg N-NH^+_4/L)	0.2	1.5
6	Nitrate (mg NO^-_2/L)	10	50
7	Iron (mg/L)	0.3	0.3(3)
8	Residual Chlorine	0.1	0.1 – 0.2
9	Coliform presence (MPN/100 ml)	0	0
10	E. coli presence (MPN/100 ml)	0	0 in 95 % samples

12. References

NDWQS. (2005).Nepal Drinking Water Quality Standards. Retrieved From: http://www.wsportal.org/uploads/IWA%20Toolboxes/WSP/NDWQS%20Nepal.pdf. Accessed on 10 April 2016

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