Dhulikhel Water Treatment Plant
Dhulikhel, Nepal

1. Background Information

Dhulikhel Water Treatment Plant (DWTP) is located at about 30km east of the capital city of Nepal, Kathmandu. Dhulikhel did not have enough sources of drinking water due to its geographical location. So the people in Dhulikhel requested the Government of Nepal to manage the drinking water problem in the area. Then, the Government of Nepal with the help of German Co-operation Agency started the Dhulikhel Drinking Water Supply Project in 1987. It was handed over to local water users committee in 1992. It is one of the oldest systems managed by the users committee. The users committee are effectively managing the system and supplying the water to more than 10,000 populations. The system used to supply water 24 hours a day but now water is supplied only eight hours a day due to decrease in water discharge at source, increase in population, extension of water supply to other areas which were not included in the design phase and high demand of water for institutions, hotels, restaurants, etc. The general information of DWTP is shown in **Table 1**.

Table 1 Overall Information of Dhulikhel Water Treatment Plant

Constructed Year	1987
Design Population	14,387
Population covered by project	23,650
Source capacity (yield)	2785 m^3/d in dry season
Designed flow	1274 m^3/d
Present production	1382 m^3/d
Project type	Gravity Flow
No. of taps	2200 household and 27 public taps
Transmission Length	13.5 km
Transmission Line	Bhumi Dada VDC, Malpi, Panauti, Taukhel and Subba Gaun villages and Dhulikhel Municipality.
Distribution area	Ward number 2, 3, 4, 5 (whole) and 1, 6, 7 (partial), Extension going on in wards number 8 and 9.
Distribution Length	15 km (Initial designed length) 42 km (Extension)
Water demand	Base Year (1987)- 500 m^3/d Design Year (2017)- 2300 m^3/d

2. Water treatment process

The components of DWTP are presented in **Figure 1**.

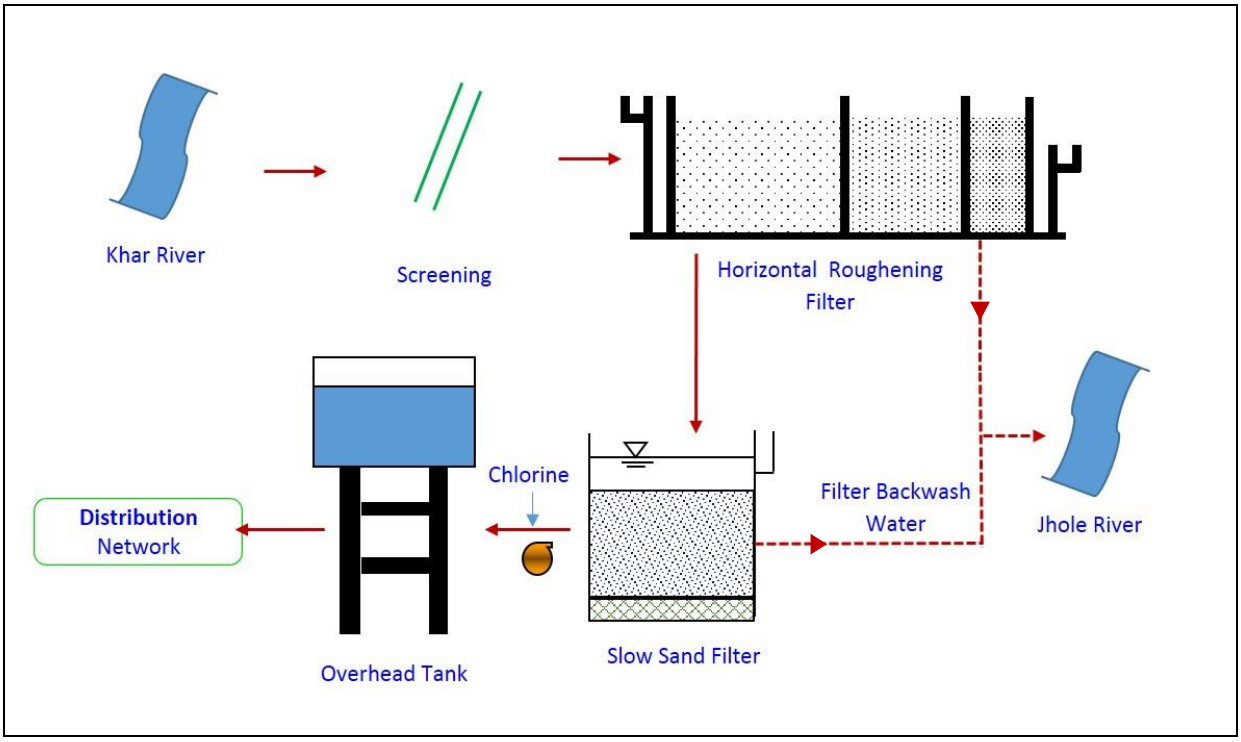

Figure 1 Schematic Diagram of Water Treatment Processes

The major water treatment process at DWTP includes:

Raw water extraction →Screening →Roughening Filter→Slow Sand Filter → Disinfection →Storage Reservoirs → Distribution network.

The wash water generated from the cleaning operation of the 'Slow Sand Filter' and the 'Roughening Filter' is discharged to the nearby stream.

2.1 Water intake

The source of raw water to the DWTP is 'Khar khola' or 'Khar Stream' which is located 14 km away from Dhulikhel. The channel used for the diversion of the raw water from the source consists of three check dams which function to protect the channel from the flood water. The raw water is then passed through the bar screens before being transferred to the main transmission line which conveys water to the treatment facility. However, the screens are hardly visible due to the accumulated dirt and algae. The flow of water from intake to the treatment facility is through gravity flow.

Figure 2: Intake works of DWTP at the Khar Stream

2.2 Chemicals Used

As the turbidity of the water is usually low, coagulation and flocculation are assumed to be not required. Usually, the turbidity of the raw water is about < 1 NTU during the dry season. However, the turbidity increases during the monsoon season and therefore, both treatment units of Roughening Filter and Slow Sand Filter are used during the monsoon. Bleaching powder is used as the disinfecting agent for chlorination.

2.3 Horizontal Roughening Filter

Horizontal Roughening Filter (HRF) has a dimension of 16 m x 8.5 m. The gravel size varies from 25 to 15 mm in the first compartment (3.5 m long), 15-8 mm in the second compartment (2.5 m long) and 8-4 mm in the third compartment (2.5 m long). There are two units of horizontal roughening filters. The cross-sectional area of HRF is 12 m^2 and has the loading rate of 0.16 m/h. The filters are cleaned manually every six months through flushing the settled sediments from the bottom of the three compartments. The generated wash water is discharged to the Jhole dry stream. During dry season, only one filter is used while in the rainy seasons both the filters are used. HRF mainly improves the physical water quality by removing suspended solid and reducing the turbidity of the water and acts as pretreatment for the slow sand filter. However, HRFs are backwash every two weeks during the rainy seasons when the turbidity level can reach as high as 200 NTU.

Figure 3: Horizontal Roughening Filter

2.4 Slow Sand Filter

There are two units of the slow sand filter (SSF) which has the dimension of 15 m x 10 m each. Both the SSF has the sand depth of 150 cm, water depth of 100 cm and supporting gravel of 45 cm. Filters are normally cleaned every six months similar to the HRFs. Only one SSF is used during the dry season and both the SSF are utilized during the rainy season due to the increased flow of water. However, only one SSF is currently functional at the DWTP. The designed loading rate of the filtration unit is 0.012 m/h. However, the present loading rate is 0.38 m/h with only an SSF working. The filters are manually cleaned by scraping the top layer of the sand followed by washing, cleaning and reusing of the scraped layer. It takes 3 – 7 days to clean the filter. The generated waste water from the cleaning process is drained to the Jhole dry stream.

Figure 4: Slow Sand Filter

2.5 Disinfection process

Bleaching powder is used as a disinfecting agent in DWTP. There is a single drip chlorinator unit which consumes around 7.5 kg of bleaching powder per day. Dosing is based on a calculation of 5.4 g/m^3 water. The calculated contact time is approximately 98 – 100 min (Contact Time, T = V_{eff} x BF/peak flow, Baffling factor = 0.2, flow = 16 L/s, Effective volume (V_{eff}) = 250,000 x 0.95 L). The treatment plants target to maintain a residual chlorine of 0.1 mg/L to 0.2 mg/L. However, the priority is given at meeting the demand of all users for quantitative aspect of the system rather than the qualitative aspects.

Figure 5: Chlorination unit and chemical storage room

2.6 Storage and distribution

The treated water is stored in the reservoir. There are two reservoirs in the DWTP with the storage capacity of 250 m^3 each. The system was designed to distribute the water to the core areas (ward no. 2, 3, 4, 5) but at present, it covers some parts of wards 1, 6, and 7 of the municipality in additional to the core-ward.

2.7 Sludge and wash water disposal

There is no sludge and wash water treatment facility inside the DWTP. The scrapped sand from the slow sand filters is cleaned and reused. The wash water generated from cleaning is discharged into the Jhole dry stream.

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

- Lack of automation
- Lack of laboratory for water quality analysis
- Damage of distribution pipe by unknown factor
- The DWTP previously consisted of a sedimentation unit which is no longer functional. The lack of this unit has causes problem in the treatment process during the monsoon season when the turbidity peaks.

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

- Insufficient water to meet the demand
- Low discharge during winter or dry season
- Stone quarry nearby water source which might be threat to the water source

Figure 6: Stone quarry nearby might be threat to the water source

- After 2015 earthquake, although the treatment plant was not affected, the DWTP office was damaged and needs to be dismantled (**Figure 7**). The staffs have been living and working in a temporary tent.

Figure 7: Water Supply Office damaged after earthquake

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

At present DWTP is not in a situation to allocate resources to tackle the issues mentioned in (3) and (4) due to budget limitation. However, currently, DWTP is constructing 500 m^3 reservoir tank to increase their storage capacity. Also, a project termed as Kavre Valley Integrated Water Supply Project (KVIWSP) is under construction and it is designed to supply water to Dhulikhel as well as Banepa and Panauti municipalities (adjacent to Dhulikhel Municipality).

6. Recent investment made for the plant's improvement

There has been no recent investment to improve the service area and treatment of the WTP.

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

- The Dhulikhel water supply project is not able to meet the demand of the consumers at present. The water is supplied only a few hours a day. So, it looks like it is necessary to increase the size of the reservoir. If the reservoir size is increased, then the project will be able to meet the demand of the consumer.

- There is an immediate need of dismantling the DWTP office and rebuilding a new one for smooth operation of the treatment plant.
- The treatment plant lacks a laboratory to monitor the quality of the treated water. The construction of laboratory will increase the operational performance of the water treatment plant.

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

The DWSP is not able to meet the current water demand as it supplies water to more number of wards than it was designed for. The water is distributed only for 3.5 hours in the morning and 3.5 hours in the evening in the core areas (Wards 2, 3, 4 and 5 for total 1156 taps). However, in some areas the water supply is not consistent and is being supplied for only 15 minutes in an area called Pakucha and for 2 hours in every two days at Bansghari. Also, there have been complaints regarding the odor during the winter season.

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

Since the plant was constructed back in 1987 and no improvement has been made for its improvement, DWTP does not have any advanced technology. Roughening filter is a new technology for water treatment plants in Nepal, however, the study of its efficiency and its replication to other parts of the country is lacking.

10. Water quality data

Table 4 represents the raw water and treated water quality of the DWTP.

Table 4 Raw Water and Treated Water Quality (Raut, 2014)

No.	Parameters	Unit	Raw water	Treated water	NDWQS 2005
1	pH	-	7.5 (at 19.5 °C)	8.2 (at 18.5 °C)	6.5-8.5
2	Electrical conductivity	(µS/cm)	205	212.5	1500
3	Turbidity	NTU	<1	<1	5
4	Total hardness	mg/Las $CaCO_3$	121	116	500
5	Fluoride	mg/L	<0.5	<0.5	0.5 – 1.5
6	Iron	mg/L	<0.05	<0.05	0.3
7	Manganese	mg/L	<0.05	<0.05	0.2
8	Ammonia	mg/L	<0.05	<0.05	1.5
9	Nitrate	mg/L	1.4	1.2	50
10	Total *Coliform*	MPN/100mL	190	0	0
11	*E. coli*	MPN/100mL	80	0	0

11. References

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Prepared by:

Anish Ghimire, PhD., M.E.
Varsha Niraoula, B.Tech.
Nawa Raj Khatiwada, D.Eng.
Department of Environmental Science and Engineering
Kathmandu University
Dhulikhel, Nepal

Date: 29 March, 2016

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

Email: newtap@jwrc-net.or.jp