Mao ChuWater Treatment Plant
Gelephu, Bhutan

1. Background Information

Gelephu Thromde (Municipality) is located on the Indian border in the central-southern part of the country and is one of the road entry points into Bhutan from India. It has an area of 12 km^2 and a resident population 13,800. The Mao Chu Water Treatment Plant (MWTP) supplies water to Gelephu Thromde through 870 pipe connections. The 4000 m^3/d water treatment plant along with the infiltration gallery was constructed on the bank of Mao Chu (river) in 2010. The background information on the WTP is given in **Table 1**.

Table 1 Overall Information of Mao Chu Water Treatment Plant

Year of commissioning	2010
Water source	Mao Chu (Infiltration gallery)
Design capacity (m^3/d)	4000
Operating capacity (m^3/d)	3000
Automated	Semi automated
No. of operators working at the plant	4
Population served	13,800 approx.
No. of connections	870
Treated water standard	WHO guidelines for drinking water quality
Date of access of the source information	2015
References	Water safety plan for MWTP

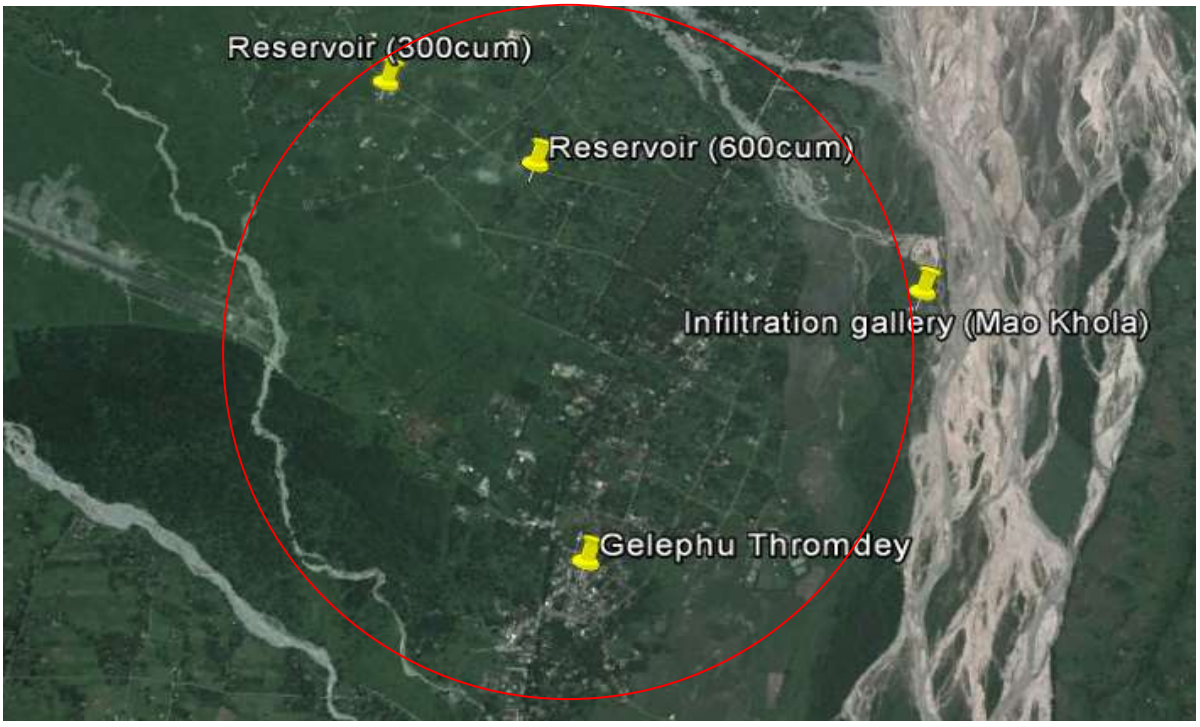

Figure 1 Gelephu Water Supply System

2. Water treatment process flow

The water treatment process at MWTP is illustrated in **Figure 2**.

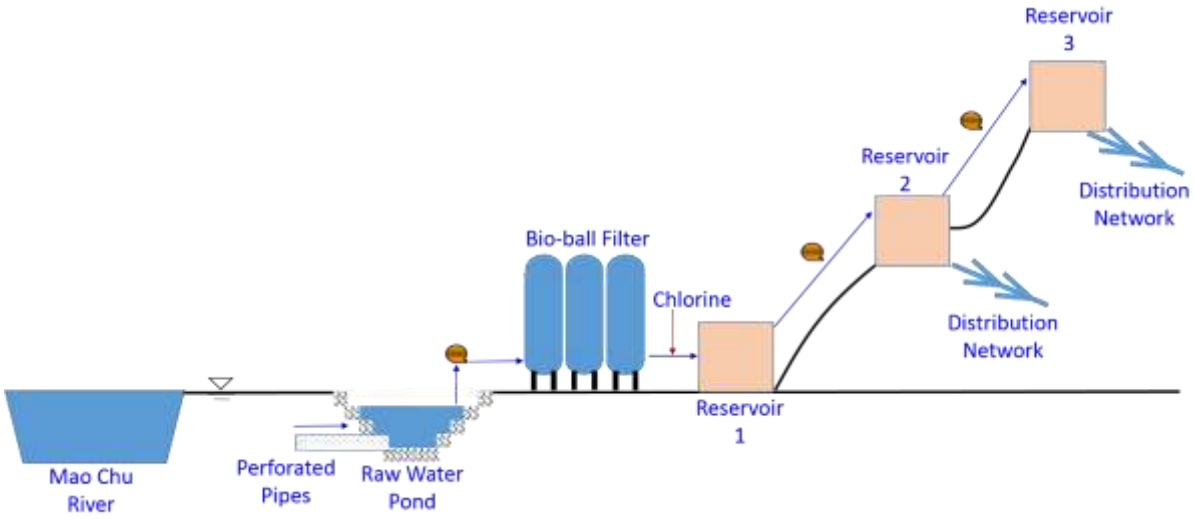

Fig 2: Schematic Diagram of Water treatment process

The major water treatment process at MWTP includes:

Raw water extraction (infiltration gallery) → Raw water pond (collection) → Pressure Filter → Chlorination → Clear Water Reservoir → Distribution.

The sludge discharged from bio-ball filter unit is discharged to a designated area within the treatment plant where it is left to dry while the backwash water is directly discharged to the storm water drain.

2.1 Raw water pond

The source for the treatment plant is the infiltrated water from Mao Chu River. Perforated 300 mm diameter HDPE pipes are laid along the bank of the river. The sub-surface water from the Maochu is infiltrated naturally to the raw water pond through the perforated HDPE pipes. The perforated pipes are laid about 2 to 3 meters below the surface. The water is infiltrated through the natural sand and gravel media before reaching the perforated pipes. Thus the subsurface flow through the natural media helps to remove the sediments naturally and is resilient to the high turbidity observed in the monsoon. The infiltrated water is then collected in the raw water pond through the perforated pipes. The raw water pond is located about 200 meters from Mao Chu and has the capacity of 2000 m^3. Water from the raw water pond is then pumped to the three units of pressure filters for filtration process. There are three pumps with the pumping capacity of 85 m^3/h each to pump water from the raw water pond to the three units of the pressure filter.

Figure 3 Raw Water Pond

2.2 Pressure filter

There are three units of pressure filters at the Mao Chu WTP and the media for these filters is bio-ball. The bio-ball filter media used for MWTP are plastic balls and are spherical in shape. The target pollutant to be removed by the bio-ball pressure filters is turbidity. The advantage of using bio-ball filters is that it does not get clogged up easily as compared to other filter media. Since pre-filtration already takes place through the natural sand media, most of the sediments are already removed reducing the pressure of this unit. The filter media filters impurities of the incoming water and are removed time to time by backwashing the filter media. Backwashing is done with the treated water from the clear water reservoir. Backwashing is done once in a week. The backwashed water is not recycled but is drained to the storm water drains. There is no proper sludge drying bed. The sludge is disposed in a designated are where it is left to dry.

Figure 4 Pressure filters

Figure 5 Control Panel for Backwashing

2.3 Chemicals

At the Mao Chu WTP, only one kind of chemical is used for the water treatment process namely bleaching powder (calcium hypochlorite) for disinfection. The mechanical dosing equipment consists

of a mixing tank with mechanical agitator and a dosing pump with connecting pipes and fittings. The required quantity of chlorine batch is prepared in the mixing tank and is agitated vigorously by the agitator until the bleaching powder is fully dissolved.

2.4 Disinfection process

Chlorination is carried out using bleaching powder through a mechanical chlorine dosing equipment. The dose is calculated based on the flow and the target chlorine dose in order to maintain a residual chlorine of 0.2 mg/L at the end point of the distribution. Standard operating procedures for chlorine batch preparation and calculation of chlorine dose are prepared and the operators are well trained to carry out these operations. Chlorine is dosed at the inlet of the clear water reservoir and is carried out daily. There are two sets of chlorine dosing equipment but only one set of it is used while the other set is for standby.

Figure 6 Chlorine dosing equipment

2.5 Clear water storage tank

The treated water is stored in steel reservoir of 600 m^3 capacity from which water is pumped to a reinforced cement concrete reservoir of 600 m^3 located at a higher elevation. Two pumps (one working and one standby) with pumping capacity 85 m^3/h each is used to pump water from the clear water reservoir at the treatment plant to the second reservoir. The core area is distributed from this second reservoir. Treated water is also pumped (through the pump with pumping capacity of 60 m^3/h) from this second reservoir to a third reservoir of 300 m^3 capacity which is located at higher elevation than the second reservoir. The water from the third reservoir is then distributed to the settlements in the extended area lying above the second reservoir.


Figure 7 Pumps

3. Aspects of treatment processposing most difficulty for daily operation

The MWTP is completely dependent on pumping. Energy is required to lift water from the raw water pond for treatment and then to the reservoirs for distribution. As such, the lack of capacity and resources for the regular maintenance of the mechanical equipment's is often an issue.

The workers also lacks skills for efficient handling and maintenance. Most of the workers have not been trained adequately.

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

Leakages and illegal connections resulting is highly unaccounted for water in addition to limited resources (financial as well as human) are the key challenges faced for proper management of water services. The non-revenue water is almost 30%.

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

The implementation of water safety plan for the Mao Chu water treatment plant since 2013 has significantly improved the management of the water supply system. Water Safety Plans are a valuable tool to prioritize system needs through a systematic, risk-based process. It also serves to maximize the effectiveness and sustainability of the water supply system by ensuring that appropriate operations and management systems are in place.

The water safety plan for MWTP identified the improvement requirements in addition to the development of operational monitoring plan which includes the schedule of maintenance for all the components of the water supply system. Moreover, the system operation and management has been strengthened through the training of operators, and development of standard operating procedures.

6. Recent investment made for the plant's improvement

Following improvements were made recently:

- Provision of roofing for the pumps at the treatment plant
- Training program for development of operational monitoring plan
- Provision of water quality testing kits for pH, turbidity and residual chlorine

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

- Improvement of laboratory facilities and equipment
- Need for online operational monitoring of the water treatment plant
- Development of skills of the operators on operational monitoring of the treatment plant

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

The municipality maintains a complaint register and majority of the complaints are related to the quantity of water such as water shortages, pipe breakages, etc.

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

In MWTP, the pressure filters are being used for filtration process. The media used for the pressure filters is bio-balls which is very effective in reducing the turbidity of the water.

10. Water Quality

The raw water and treated water quality of MWTP are as follow:

Table 2 Water quality data (2015)

Parameter	Unit	Raw Water		Treated water	
		Min	Max	Min	Max
Turbidity	NTU	0.25	7	0	2.0
pH		6.5	7.2	6.5	7.0
Residual Chlorine	mg/L			0.2	0.8

10. References

- Water safety plan for Moa Chu Water Treatment Plant (Internal Report)
- Operational monitoring plan for Moa Chu Water Treatment Plant (Internal Report)

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