NewTap
Network on Water Technology in Asia and Pacific

Chinaimo Water Treatment Plant
Vientiane City, Lao PDR

1. Background information

Vientiane is the largest city and the capital of Laos, situated on the banks of the Mekong River bordering with Thailand. Chinaimo water treatment plant (CWTP) is owned and operated by Nam Papa Nakhone Luang (NPNL), a state-owned company established in 1971. This water treatment plant is one of the 4 water treatment plants under NPNL. It was constructed in 1980 with the capacity of 40,000 m^3/d. It was later expanded to 80,000 m^3/d capacity in 1996. **Table 1** presents the background information of CWTP.

Table 1 Overall Information of Chinaimo Water Treatment Plant

Constructed /Expanded Year	1980/1996
Water Source	Mekong River
Number of connections	44,966
Peak Operating Flow (m^3/h)	4,462
Design capacity (m^3/d)	80,000
No. of operators working at the plant	8
Treated water standard	Ministry of Health (2005)
Automation	No
Date of access of the source information	2014
Reference	NPNL's Annual Report (2012, 2013)

Raw water source is extracted from the Mekong River. Main units of the treatment process are hydraulic mixing, manual cleaning collector system, fine sand, and up flow water backwash with air scour. In 2013, CWTP averagely supplied 85,053 m^3/d of tap water (exceeding the design capacity) to 44,966 households of 7 towns in Vientiane capital.

2. Water treatment process flow

The major water treatment process is presented as below (**Figure 1**):

- Raw water extraction (Mekong river) → Raw water pumping → Pipe-line static mixing (alum) and hydraulic jump (pre-chlorination) → Flocculation (baffled channel type) → Sedimentation (rectangular, mechanical sludge collector) → Rapid sand filters → Disinfection (post-chlorination) → Clean water tank → High lift pump building

There is no sludge treatment process at CWTP. Sludge generated from sedimentation and backwashing is drained directly to Mekong River.

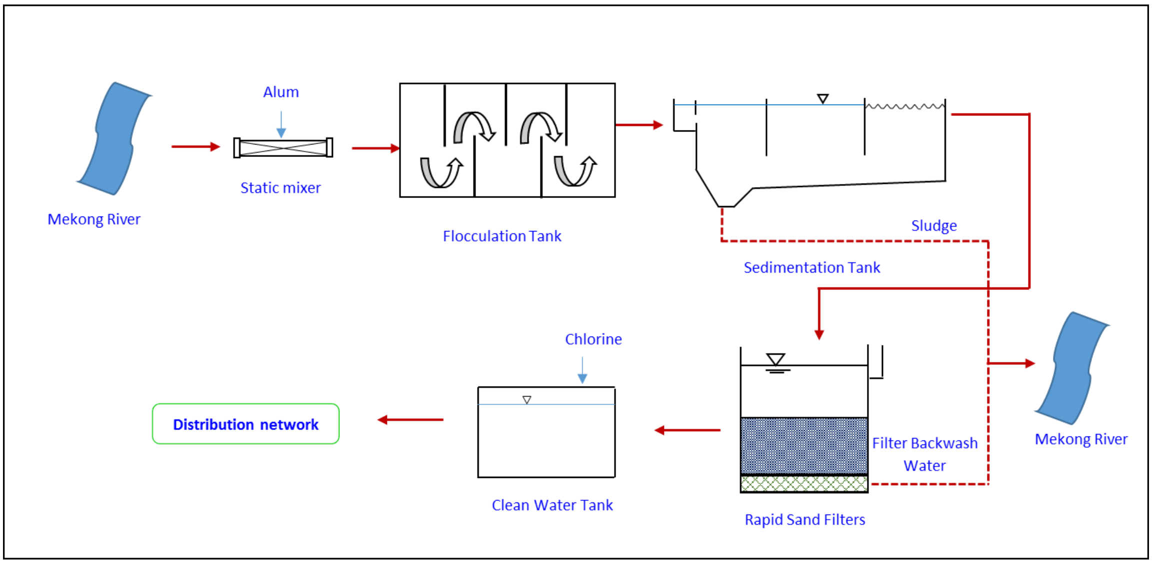

Figure 1 Water Treatment Process

2.1 Chemicals used

Three types of chemicals are used for water treatment; solid alum as a coagulant and calcium hypochlorite ($CaOCl_2$) for pre-and-post chlorination, and polymer for coagulant aid. However, polymer is used temporarily only when raw water is highly turbid (during wet season). Solid alum is first dissolved in water in the solution tank (**Figure 2**). Then, it is transferred to the alum storage tank to inject into the static mixer. Calcium hypochlorite is dissolved in water in the solution tank (**Figure 3**), and is transferred to the receiving tank and clear well to inject into hydraulic jump. Polymer is injected inlet part of flocculation basin from storage tank **(Figure 4)**. All chemicals are imported from Thailand.

Figure 2 Alum Solution Tank

Figure 3 Calcium Hypochlorite Tank


Figure 4 Storage Tank of Polymer (left) and Injection Site (right)

2.2 Rapid mixing

A static mixer is installed as a part of the influent pipeline (**Figure 5**). Here, alum is injected into raw water. Chlorine is injected into receiving tank by a hydraulic jump **(Figure 6)**. The main purpose of pre-chlorination is to prevent algae growth in flocculation and sedimentation basins. Due to the high alkalinity concentration (around 90 - 110 mg/L), lime is not used in the treatment process.

Figure 5 Static Mixer (Alum)

Figure 6 Hydraulic Jump (pre chlorine)

2.3 Flocculation

There are usually two kinds of baffle channel types, the horizontally baffled (around-the-end flow) and the vertically baffled (over- and under flow) channels. The CWTP is now using vertical baffle channel type **(Figure 7 and 8)**, and the hydraulic retention time of water in flocculation tank is 20 minutes.

Figure 7 Vertical baffle channel (8 basins)

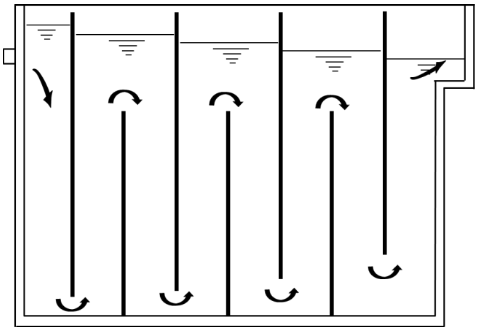

Figure 8 Over-and under type (section)

2.4 Sedimentation

Sedimentation tank at Chinaimo WTP is designed with the rectangular type. The surface loading rate of sedimentation tank at Chinaimo WTP is 23 $m^3/m^2 \cdot d$. It satisfies the suggested guideline (the typical surface loading rate should be in the range from 20 to 60 $m^3/m^2.d$). Settled sludge in sedimentation tank is cleaned manually. The regular cycle in the dry season is once every two months and once every month in the rainy season. The generated sludge is drained to Mekong River **(Figure 9)** without any treatment. The hydraulic retention time of the sedimentation tank at Chinaimo WTP is 2.7 h while this value for conventional basins ranges from 1.5 to 3.0 h (Kawamura, 2000).

Figure 9 Sedimentation Tank (4 basins) and Manual Cleaning in Chinaimo WTP

2.5 Filtration

The media utilized in CWTP is single media deep-bed filter (coarse sand) with the effective size of 1.0 mm, and filter depth of 100 cm. There are two basic types of filter backwashing system, fluidized-bed backwash with surface wash and air scour and water backwash. Backwash method of CWTP is water backwash with air scour, using backwashing pump. The average filter run time is 1 to 2 days **(Figure 10)**.

Figure 10 Filter Tank (8 basins) and Backwash Control Panel

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

To remove settled sludge, CWTP cleans the sedimentation basins manually with a constant schedule (once every two or three months). Manual cleaning basins are suitable for developing countries with low labor rates (AWWA, 2005). However, this method has a great disadvantage, which is, the basin must be taken off-line during the cleaning period. Consequently, it causes lack of water supply by decreasing the plant capacity.

Figure 11 Sedimentation cleaning of Chinaimo WTP

Filters are the most important part of water treatment process. Thus, the plant operators should routinely evaluate filter performance for optimizing the filtration process. CWTP ideally developed the design of filtration system such as coarse sand media, and backwash with air scour. **Figure 12** shows that one filter basin currently has serious problems. Some sand bags which are located in the underdrain system are moved up to the surface of filter media during backwashing.

Figure 12 Filter basin of Chinaimo WTP

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

The water production in CWTP has exceeded the design capacity of the plant. As it could be seen in **Figure 13,** CWTP excessively produced tap water every month, excluding March for meeting water demand. The reason is that the water supply rate in Vientiane capital was around 70 percent of population in 2013. Especially it is difficult to supply continually tap water to the consumer when sedimentation basin and clean well are manually cleaned.

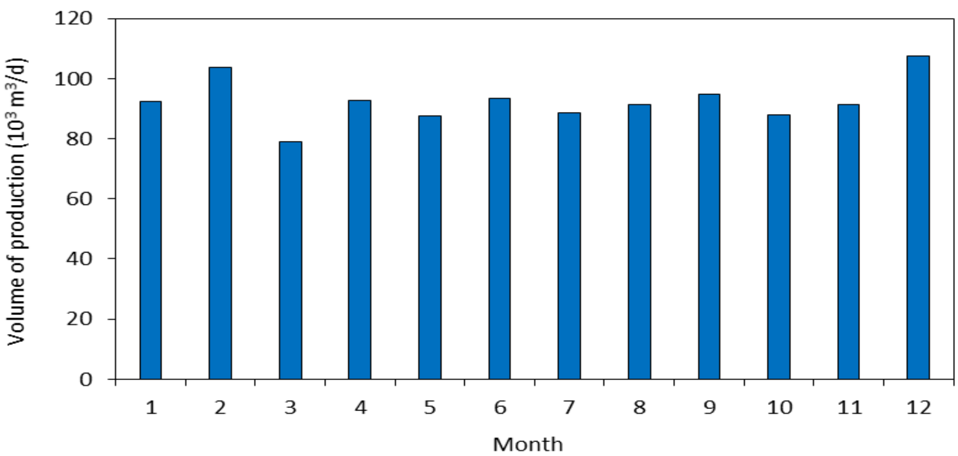

Figure 13 Average Volume of Water Production in 2013 (Chinaimo WTP)

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

As it can be observed in **Figure 14**, NPNL has constructed new big water treatment plant (100,000 m^3/d of capacity). After finishing the construction of the new WTP by 2015, water supply rate will increase up to 90 percent of Vientiane's population.

 

Figure 14 New water treatment plant under construction

6. Recent investment made for the plant's improvement

The CWTP was constructed in 1980 with the initial capacity of 40,000m^3/d. The WTP was rehabilitated and expanded to 80,000m^3/d during the period from 1992 to 1996 with the support from Japanese Grant Aid. There is no investment for the water treatment plant in recent. In the near future, CWTP will be expanded more by the support from the Japan International Cooperation Agency (JICA).

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

The CWTP discharged sludge directly to the water source (Mekong River) because there is no any sludge disposal facility in Chinaimo WTP. Aluminum from alum coagulant is known to cause toxicity to aquatic habitat. In addition, aluminum in water has also proven to produce chronic toxicity in a variety of species (Cleveland et al. 1986; Burton and Allan 1986; France and Stokes 1987; Allin and Wilson 1999). Chinaimo WTP needs to introduce sludge disposal process for preventing the environmental issue in the future.

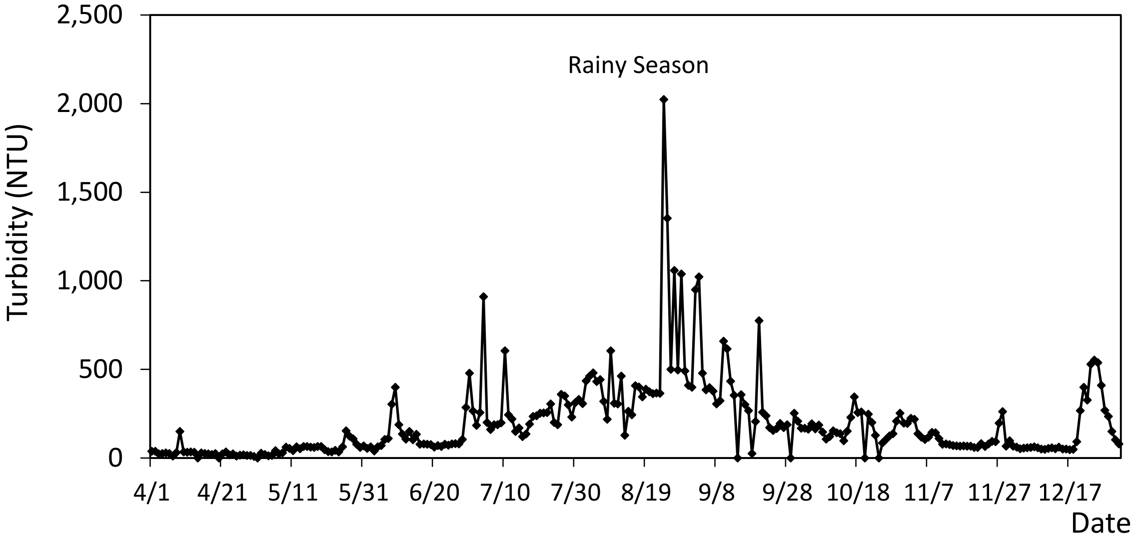

Figure 15 Turbidity Change in Mekong River (2013)

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

Most customers have suffered from low pressure and lack of water volume. However, NPNL cannot solve these problems because lack of capacity and high leakage rate (aging pipe line)

Many customers want to be provided tap water from Chinaimo WTP, but it also is limited to connect now due to lack of capacity.

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

In filtration, single sand deep bed filter was already introduced in 1980. Backwash method had used up flow water wash with air scour since 1980

10. Water quality data

Table 3 shows the raw water and treated water quality, which are obtained from CWTP annual report (2013)

Table 3 Water quality data

Parameters	Unit	Raw water		Treated water		Standard (Lao PDR)
		Min	Max	Min	Max	
pH	-	8.0	8.9	7.5	8.5	6.5-8.5
Turbidity	NTU	15	1,806	less than 1		10
Alkalinity	mg/L	90	110	85	98	-
Conductivity	µs/cm	219		208		-
Total hardness	mg/L	154		108		100-300
NO_3-N	mg/L	5.4		0.8		40
Iron	mg/L	0.3		0.03		0.3
Manganese	mg/L	0.3		0.03		0.5
Chloride	mg/L	12		11.4		-

11. References

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Prepared by:

Mr. Khambay Vongsayalath
General Manager of Water and Environment Engineering State Enterprise (WES)
Email: kvongsayalath@yahoo.com

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Date: 20 July 2015

NewTap
Network on Water Technology in Asia and Pacific

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

Email: newtap@jwrc-net.or.jp