International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD)
ISSN(P): 2249-6866; ISSN(E): 2249-7978
Vol. 7, Issue 1, Feb 2017, 45-54

PERFORMANCE EVALUATION OF WATER TREATMENT PLANT AT BHOKARPADA NAVI MUMBAI: CASE STUDY

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ABSTRACT

The objectives of any water supply system are to supply safe whole some water in adequate quantity at convenient points and at reasonable cost to the users. Potable water treatment is one of the most challenging and complex systems that municipalities need to deal with considering limited resources. The main objective of water treatment is to purify the polluted water and make it fit for the human consumption, through the removal and killing of pathogenic organisms and remove the taste, smell, unpalatable brownish discharge, some of the excess of dissolved metals and a range of items with the increasing interest and care of the government of India to the importance of the field of water production and supply, many new water treatment plants were either constructed or extended during the past few years . Performance of these plants is an essential parameter to be monitored and evaluated for the better understanding of design and operating difficulties in water treatment plants. This study is carried out to evaluate the treatability performance of water treatment plant at Bhokarpada Navi Mumbai.

KEYWORDS: Water Treatment Plant Performance Evaluation - Water, Case Study, Chemical & Energy Consumption

Received: Dec 24, 2016; **Accepted:** Jan 20, 2017; **Published:** Jan 27, 2017; **Paper Id.:** IJCSEIERDFEB20174

Case Study

INTRODUCTION

Navi Mumbai is a planned township on the west coast of the Indian state of Maharashtra. It was mooted in 1971 to be a new urban township of Mumbai by the Government of Maharashtra. Area: 344 km² Weather: 28 C, Wind W at 16 km/h, 79% Humidity Nearest city: Mumbai, Population: 1120547 (2011) Study of water treatment plant at Bhokarpada is carried out with all aspects and considerations including; engineering, physical, chemical & bacteriological characteristics to determine its efficiency. This study will define design and operating problems and difficulties of the case study that will allow for proper revision of these aspects to redefine and suggest recommendations for proper operations. The findings of work may be applicable for other WTP either under design or operation. Samples were collected from all WTP' sunits. Analysis was conducted for chemical, physical, bacteriological characteristics. All experiments were done and results were determined in accordance to the Standard Methods of American Water Works Association (AWWA) manual, 21st Edition (2009), Analysis was conducted for chemical, physical, CPHEEO manuals and Bureau of Indian standards: IS 10500:2012.

WATER TREATMENT PLANT

The Water supply to the Navi Mumbai city is provided from Bhokarpada treatment plant situated at village Bhokarpada. Bhokarpada Water treatment plant has capacity 450 MLD. Source of water is Morbe Dam at a

distance 5.4 km. The plant operates for 24 hours and 300 MLD water is being treated and supplied to the city. Rate of water supply is 150 lpcd. The design and construction of the plant is conventional one and comprises of various units such as Inlet Chamber, flash mixer, clariflocculator (Tube Setteler), rapids and filters, chemical house, and clear water sump, pump house and master balancing reservoir.

Figure 1: Google Image of Water Treatment Plant

Process Description

Bacteriological characteristics All experiments were done and results were determined in accordance to the Standard Methods of American Water Works Association (AWWA) manual, 21st Edition (2009),

The brief description of all Water treatment plant units, components facilities are as follows.

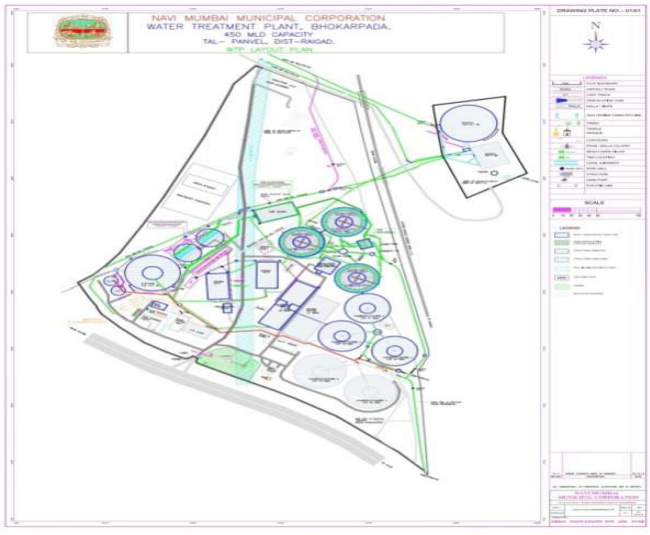

Figure 2: Layout Plan of Water Treatment Plant

Intake

The main source of supply to water treatment plant is Morbe Dam

Table 1: Salient Features of Morbe Dam

Parameters	Details
River name	Dharvi river (Branch of Patalganga River)
Type of dam	Earthen dam
Reservoir capacity	190.89 MCM
Supply capacity per day	450 MLD
Length of dam	3250 m (across river)
Full storage level	88.00 m

Raw Water Gravity Main from Dam to WTP

The Intake Structure is in body of Dam, Windrowing raw water from Morbe Dam Intake to Water Treatment Plant. This is 5.4 K.M. from Dam of MS main pipe 2354 mm diameter

Inlet Chamber

Function of actasa receiving chamber.

Table 2

No. of Units	2 Nos.
Capacity	12.5 Ml/Hr. + 20%overloading.
Detention Period	1 minute

Flash Mixer

This unit is provided for an instantaneous and through mixing of chemicals that are added to the raw water.

Table 3

No. of Units	2 Nos.
Discharge	12.5 Ml/Hr. + 20% over loading.
Diameter	5.10 M.
Bottom R.L.	46.656 M.
Top R.L.	49.341 M.
Detention period	30 seconds

Clarrifloculator

The function of CLF is to obtain gentle flocculation of the chemically closed water, so as to agglomerate the floc into a large size followed by the precipitation of the same in the sedimentation chamber, thus enabling clear liquid to flow to the Filters.

Table 4

No. of Units	3 No.	3 Nos.
Capacity	50 MLD	100 MLD
Detention Period		
a) Flocculator Zone	30 minutes	15 minutes
b) Clarifier Zone	2.5 Hours	30 minutes
Diameter (Inner)	49.70 M.	49.70 M.
Flocculator Zone Dia	18.30 M.	18.30 M.
Bottom R.L.	45.78 M.	45.78 M
Top R.L.	49.50 M.	49.50 M
F.S.L. R.L.	48.90 M.	48.90 M
Free board	0.60 M.	0.60 M

Filters Beds

The function of filter bed is to remove all turbidity and suspended solids from the settled water and also to reduce bacterial load.

Table 5

No. of Units	4 Nos.	1 No. (10 Filter Beds)	
size of filter unit	39.50x 24.00 M.	24.00 x 49.50 M	
Rate of flow	3,00,000, cum/day	1,50,000 cum/day	
bottom R.L.	44.25 M.	45.50 M	
F.S.L. R.L.	47.50 M.	47.50 M	
Top R.L.	48.00 M.	48.00 M	
Length of channel	45.00 M.	50.00 M	
Filter Media			
Filter media			
a) Sand	0.60 M.	Coconut shell	0.20 M
b) Gravel		Sand	0.20 M.
3 mm	0.12 M		
6 mm	0.12 M	5 to 10 mm	0.11 M
12 mm to 34 mm	0.11 M.	10 to 20 mm	0.20 M
34 mm. to 50 mm	0.10 M.	20 to 50 mm	0.20 M
Water required for back wash per bed	1884 m^3/Hr.		1500 m3/Hr.
Air flow rate for five bed	9420 m^3/Hr.		1080 m3/Hr m3/Hr.

Chemical House

Chemical house is provided for storage, preparation and distribution of chemicals that a readded to the raw water for its treatment. There are five tanks made up of R.C.C. First tank is for Alumsolution.

Alum Solution Preparation Tank

Five alum solution tanks capable of a continuous dose rate of 50 mg/l at a flow rate of 12.50 /Hrs at a concentration of 10%.

Chlorination

The object of Chlorination is to disinfect the filtered water to make it suitable for potable use.

- To act as a killer of algae in raw water when it is dosed for pre-chlorination.
- To kill all bacteria in filtered water when it is dosed for post chlorination.

Vacuum type chlorination each of 10 mg/1 capacity sufficient for flow of 12.50ML/Hrs.

The chlorine dosing system provide comprise of:

- 10 Vacuum type chlorinators each of 10 kg/hr. Two for pre-chlorination and eight for post chlorination.
- One always working for pre-chlorination, five working and three stand-by for post chlorination.

Pure Water Sump and Pump House

The object of pure water sump is to store the filtered water and topump it for distribution to meet the demand of potable water. Number of sump is two. It is made up of R.C.C. Capacity of pure water sump is 5ML. In The pump house 12 pumps of 1200hp are used for pumping pure water.

Recirculation Tank

The water is used for backwashing of the filter bed is pass to the recirculation tank. 2 no's of tank has capacity of 1.5 ML. The supernatant of the recirculation tank is send to the Inlet chamber unit.

Table 6

Sr. No	Test Parameter	Impure Water	Pure Water	Impure Water	Pure Water	Impure Water	Pure Water	Impure Water	Pure Water	Impure Water	Pure Water	Impure Water	Pure Water	BIS Specification IS 10500-2012 Normal Value	
														Desirable Limit	Permissible Limit
		Jan-16		Feb-16		Mar-16		Apr-16		May-16		Jun-16			
1	Physical Appearance	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	Slightly Turbid	Colorless		
2	Odour	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Agreeable	Agreeable
3	Turbidity (as NTU)	0.75	0.74	0.97	0.66	0.28	0.12	0.36	0.24	1.34	1.05	1.06	0.37	1	5
4	pH value	6.9	7.4	7.3	7.1	7.9	7.8	8.1	7.9	8.1	7.8	7	7.1	6.5 to 8.5	No Relaxation
5	Chloride (as Cl)	19.99	19.99	11.99	11.99	25.19	25.19	35.98	35.98	28.98	27.98	13.99	21.98	250	1000
6	Nitrates (as NO_3)	0.22	0.22	0.3	0.17	0.174	0.163	0.239	0.227	0.518	0.288	0.15	0.189	45	No Relaxation
7	Total Hardness (as $CaCO_3$)	76	76	76	52	32	32	28	28	8	8	50	42	200	600
8	Permanent Hardness (as $CaCO_3$)	36	24					36	36	-	-	-	-		
9	Alkalinity (as $CaCO_3$)	40	52	42	40	60	56	64	60	48	60	44	52	200	600
10	Total Dissolved Solids	118	107	95	80	83	77	126	106	81	71	74	71	500	2000
11	Total Solids	157	144					-	-	96	89	-	-		
12	Iron (as Fe)	0.126	0.118	0.42	0.471	0.388	0.146	0.769	0.104	0.518	0	0.519	0.095	0.3	No Relaxation
13	Fluride (as F)	0.237	0.256	0.492	0.435	0.181	0.237	0.002	0	0.002	0	NIL	NIL	1	1.5
14	E-coli							NIL	NIL	NIL	NIL	NIL	NIL	No E-coli in 100ml	No Relaxation

WATER QUALITY

Table 7: Turbidity Analysis for May and June May 2016

Date	Turbidity of Raw Water in NTU	Settled water Turbidity in NTU	Filtered Water Turbidity in NTU	Treated Water Turbidity in NTU
1	5.5	2.3	0.6	0.5
2	4.6	1.8	0.8	0.7
3	3.1	1.1	0.5	0.4
4	2.4	1.1	0.6	0.5
5	2.4	1.1	0.6	0.5
6	2.2	1.1	0.6	0.5
7	2.2	1	0.5	0.4
8	2.4	1.1	0.6	0.5
9	2.4	1.2	0.6	0.5
10	2.3	1.1	0.6	0.5
11	1.6	1.2	0.6	0.5
12	1.7	1.4	0.6	0.5
13	1.7	1.3	0.6	0.5
14	1.7	1.4	0.6	0.5
15	1.7	1.2	0.6	0.5
16	1.7	1.1	0.6	0.5
17	1.6	1.3	0.6	0.5
18	1.7	1.1	0.6	0.5

Table 7: Contd.,				
19	1.7	1.2	0.6	0.5
20	1.5	1	0.5	0.4
21	1.6	1.1	0.6	0.5
22	1.6	1.1	0.6	0.5
23	1.7	1.2	0.6	0.5
24	1.7	1.3	0.6	0.5
25	1.7	1.3	0.6	0.5
26	1.6	1.3	0.6	0.5
27	1.6	1.3	0.6	0.5
28	1.7	1.4	0.6	0.5
29	1.6	1.1	0.6	0.5
30	1.6	1.1	0.6	0.5
31	1.6	1.1	0.6	0.5
Maximum	**5.5**	**2.3**	**0.8**	**0.7**
Minimum	**1.5**	**1.0**	**0.5**	**0.4**
Average	**2.1**	**1.2**	**0.6**	**0.5**

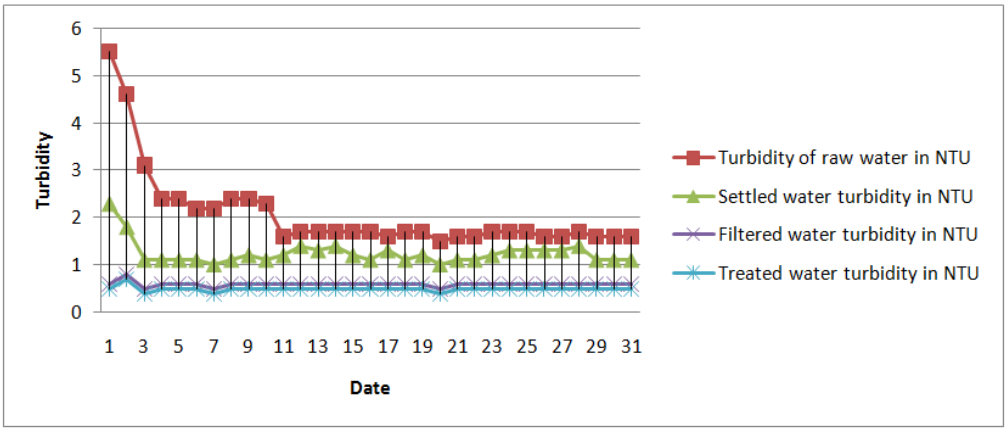

Figure 3: Turbidity

Table 8: June 2016

Date	Turbidity of Raw Water in NTU	Settled Water Turbidity in NTU	Filtered Water Turbidity in NTU	Treated Water Turbidity in NTU
1	1.6	1.1	0.6	0.5
2	1.7	1.2	0.6	0.5
3	1.5	1	0.6	0.5
4	2	1.4	0.7	0.6
5	1.6	1.1	0.6	0.5
6	1.6	1.1	0.6	0.5
7	1.7	1.3	0.6	0.5
8	1.7	1.2	0.6	0.5
9	1.8	1.4	0.6	0.5
10	1.8	1.4	0.7	0.6
11	1.9	1.4	0.6	0.5
12	2.4	1.1	0.7	0.6
13	2.4	2.2	0.7	0.6
14	2.5	1.4	0.6	0.5
15	2.3	2.2	0.7	0.6
16	2.2	2.1	0.6	0.5
17	2.2	1.1	0.6	0.5
18	2.2	1.2	0.5	0.5
19	2.4	1.2	0.7	0.6

Table 8: Contd.,

20	2.5	1.4	0.6	0.5
21	2.5	1.4	0.6	0.5
22	4	1.8	0.6	0.5
23	3.8	1.6	0.6	0.5
24	3.5	1.5	0.6	0.5
25	3.6	1.4	0.6	0.5
26	25.6	3.5	0.7	0.6
27	18.5	3.4	0.7	0.6
28	13	2.7	0.7	0.6
29	13.5	3.4	0.7	0.6
30	10	2.8	0.7	0.6
Maximum	**25.6**	**3.5**	**0.7**	**0.6**
Minimum	**1.5**	**1.0**	**0.5**	**0.5**
Average	**4.6**	**1.7**	**0.6**	**0.5**

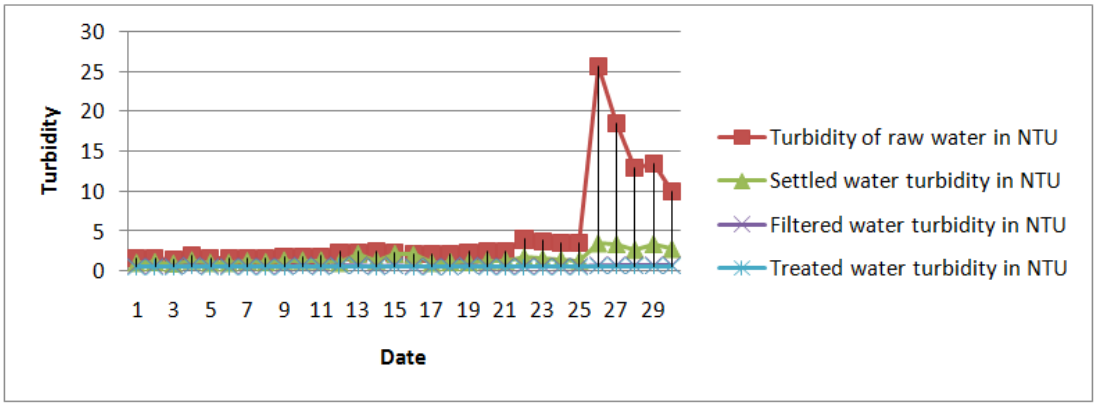

Figure 4: Turbidity

Table 9: Consumption Report

Year 2014	Flow (ML)		Alum Consumption (kg)	Chlorine Consumption (kg)	Electricity Consumption (Kwh)
	Raw	Treated			
January	13231	13125	29980	14400	2637720
February	12269	12129	40750	12600	2148120
March	13422	13274	31860	16200	2383944
April	12980	12830	37500	11700	2357220
may	13386	13242	38750	18000	2467974
June	12785	12634	40500	15300	2357424
July	12786	12624	72200	20700	2179200
august	12736	12575	107875	19800	2307200
September	12445	12306	38230	17100	2330300
October	12920	12766	38750	18000	2288900
November	12474	12323	36250	18900	2261700
December	13080	12923	36450	18900	2355600

Table 10

Year 2015	Flow (ML)		Alum Consumption (kg)	Chlorine Consumption(kg)	Electricity Consumption (Kwh)
	Raw	Treated			
January	13020	12867	35650	23400	2455600
February	11454	11326	32200	10800	2667500
March (recirculation tank used)	13064	12907	35650	19800	2280200
April	13281	13220	35800	21600	2782200
may	12888	12822	40300	21600	2222400
June	12695	12911	40500	16200	2315800
July	13464	13399	61690	19800	2570300
august	13466	13406	41850	21600	2381200
September	12840	12780	40500	28800	2462000
October	13028	12968	40300	20700	2335600
November	12217	12137	39000	23400	2331500
December	10522	10444	35650	20700	1718200
Year 2015	Flow (ML)		Alum consumption (kg)	Chlorine consumption (kg)	Electricity consumption (Kwh)
	Raw	Treated			
January	9595	9533	35650	21600	1657800
February	8920	8865	34800	19800	1394400
March(recirculation tank used)	9471	9412	37200	23400	1627000
April	9138	9083	36000	12600	1654800
may	9435	9373	37200	18000	1411400
June	9180	9118	53100	18000	1718000

Graphical

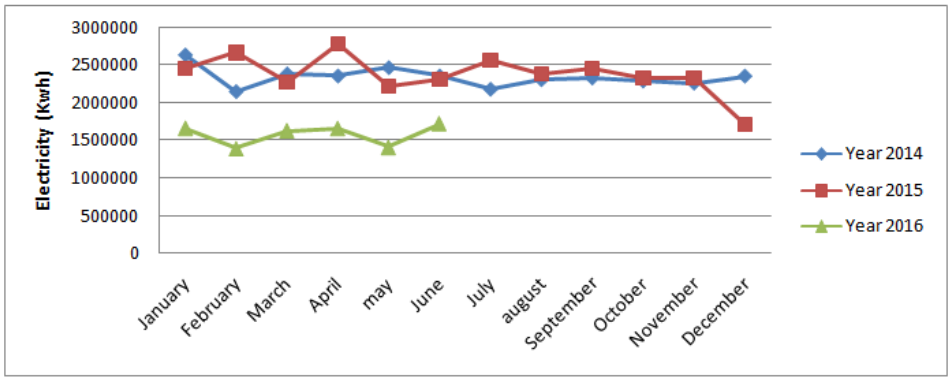

Figure 5: Electricity Consumption (KWH)

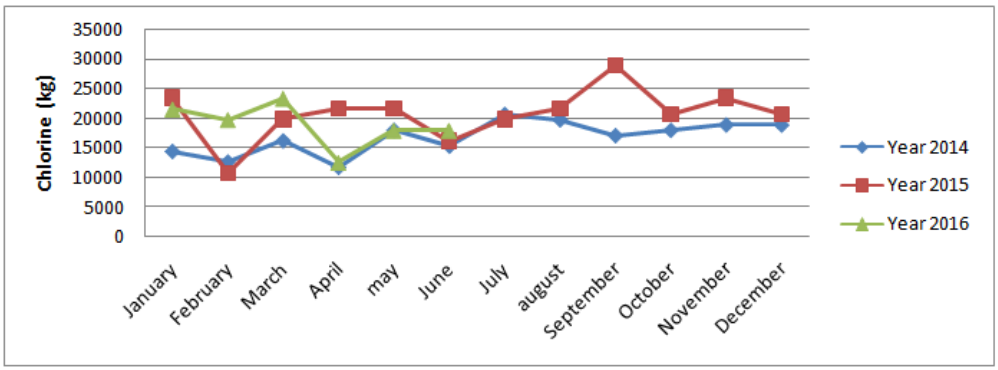

Figure 6: Chlorine Consumption (kg)

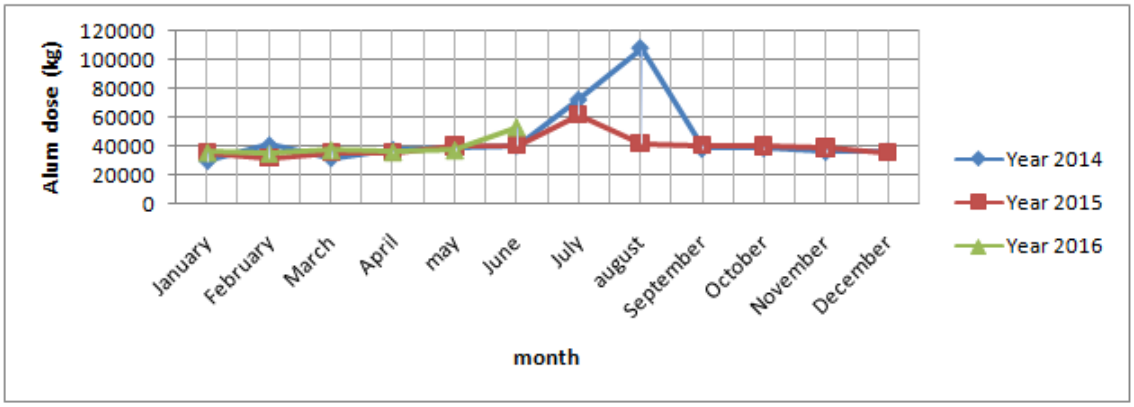

Figure 7: Alum Consumption (kg)

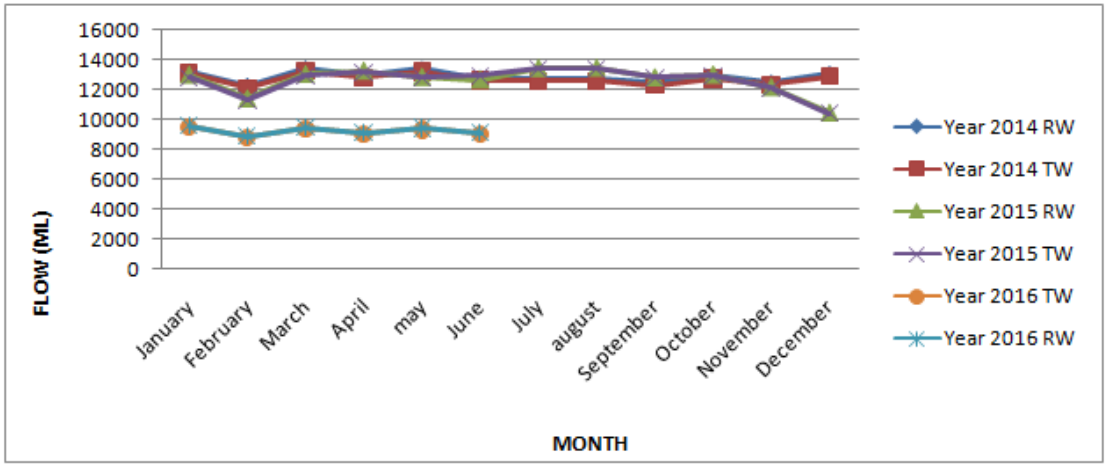

Figure 8: Flow Consumption (Ml)

CONCLUSIONS

The overall performance of treatment plant found to be satisfactory. All parameter are within limits of drinking Water standard defined by BIS specification IS 10500-2012.

- Consumption of flow is reduced
- Consumption of Chorine is high as compare to previous result
- Consumption of Electricity is reduced
- Consumption of Alum is high as compare to previous result
- Pollution in dam catchment needed to check
- Based on the turbidity coagulant dose is decided. So the jar test is performed for better turbidity removal
- Leakages and spillages are observed on the plant those are needed to repair.
- Plant is ISO 9001-2008 certified
- Wastewater from CLF drain needed to reuse.

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