



Improvement of Trihalomethanes Removal for Water Distribution System

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Abstract:

Potable water good quality should be a priority for the worldwide population distribution systems. The agency that distributes the majority of the water in the island of Puerto Rico, the Puerto Rico Aqueduct and Sewage Authority. The United States Environmental Protection Agency (USEPA) has made, since the 1970's, different regulations to improve the quality of the water of human consume with the SDWA which is the guide of the PRHD to regulate the PRASA and non-PRASA potable water systems. This government agency ensures the public safety of the drinking water they receive in their homes. The daily water monitoring enrolls pH, chlorine, turbidity and nutrients tests. There are another tests related to TOC and THM's concentration. The case studied exhibits an excess on THM's concentration into the distribution system. The filter plant has been dealing with an almost high THM concentration of the outflow which increases during the distribution, so the parameter exceeds when arrives to the consumer. The THM's can cause different health effects such as cancer and reproductive problems. The principal cause of THM's in water is the TOC and Chlorine mixture. The water disinfection creates byproducts that are not safe in high concentration to human health. This is why PRASA have to monitor constantly, and specially, to prevent health risks in the public that consumes its water. There were some improvements that were suggested to get better results in the jar test performed, improvement of the calculus and procedure to diminish the errors, the coagulant sample freshness to make the test and the equipment optimization.

Key Terms: chlorine, drinking water treatment, THM's, TOC.

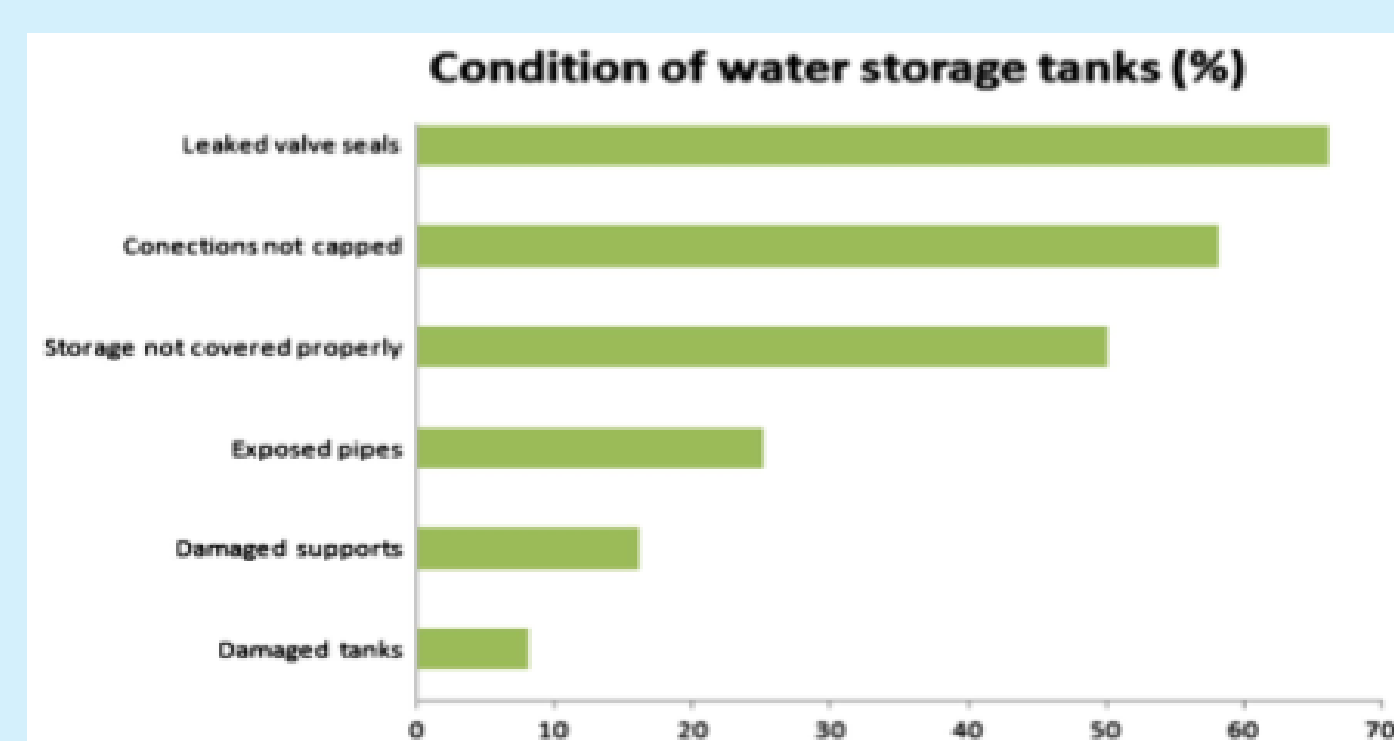
Introduction:

- PRASA is the majoritarian potable water distributor in PR
- Drinking water regulations of PRHD and EPA
- What are the THM's and how are they created?
- THM's effects to health

Literature Review:

It is normal to observe an increasing of the THM's concentration as water travels through the distribution pipes and tank, but this is not a reason to exceed the 0.08 mg/L parameter established by EPA. The reasons that should be considered in the THM's increasing are:

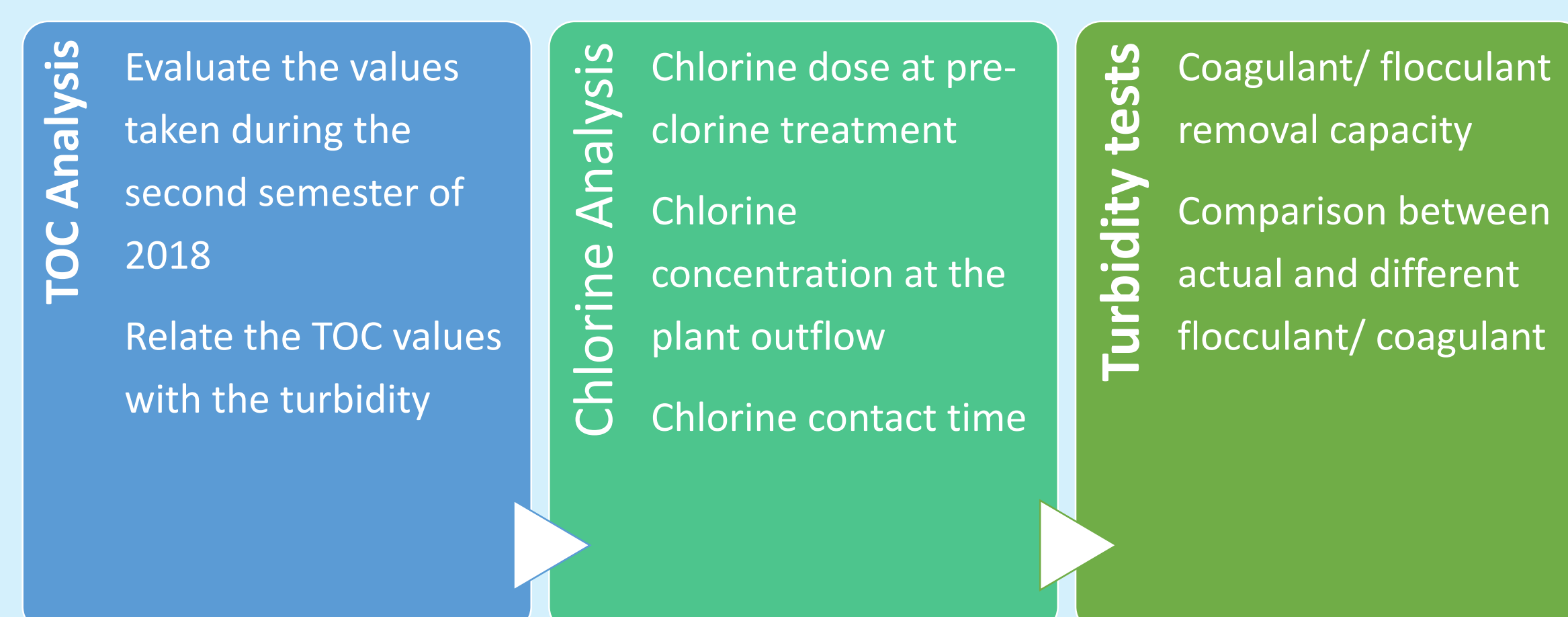
- Distribution tanks conditions
- TOC removal effectivity
- Chlorine dose



Storage Tanks	TC cfu/100 mL		FC cfu/100 mL	
	Before storage	After storage	Before storage	After storage
B	2.6	4	1.3	4.6
AJ1	8.33	8.36	6.33	7.66
AJ2	8.33	14.33	6.33	9.33
AJ3	8.33	12	6.33	7.33
Gate 4 A	5.66	7.33	4.6	7
Gate 4 B	5.66	10.6	4.6	7.33

Methodology:

The methodology of this investigation will be based on the analysis of the TOC values that were taken on a monthly and quarterly basis. The following terms were the main focus of this work.



Case study:

- PRASA drinking water plant and its water distribution system
- 2 treatment plants
- Excess of trihalomethanes
- Turbidity removal relation to TOC
- Jar test realized
- Data and results

THM's results of the 2018's last semester

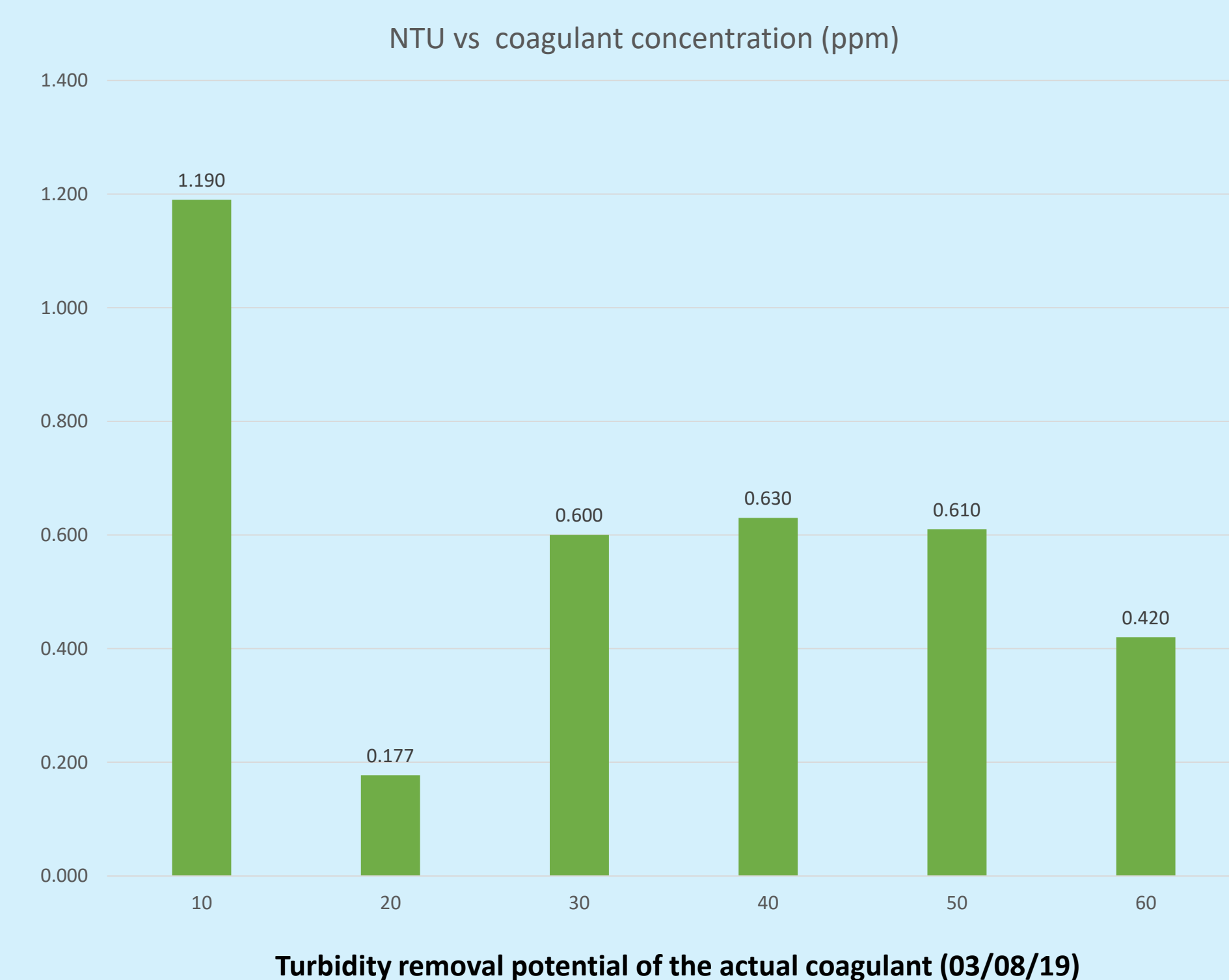
Date	Res. Chlorine	pH	Total THM
6/2/2018	1.8	7.56	0.04
6/20/2018	2.2	7.49	0.05
7/11/2018	2.4	7.46	0.06
8/8/2018	1.85	7.66	0.04
9/1/2018	1.87	7.72	0.05
10/10/2018	1.92	7.61	0.06
11/28/2018	1.83	7.53	0.09

The value of 0.08 mg/L of total THM's by EPA is a parameter that has to complain at the sample point individually and in average. The determination of the THM's compliance at the tap water is evaluated with the regulation that is based in collect samples at different points of the distribution system.

Jar test coagulant effectiveness evaluation (02/09/19)

Primary solution	Secondary solution	Turbidity (NTU)	pH	T °C
0	0	16.5	8.05	25.5
2.8	0.4	1.87	7.87	25.6
3.0	0.4	6.92	7.91	25.6
3.2	0.4	6.11	7.89	25.6
3.4	0.4	6.14	7.89	25.6
3.6	0.4	4.3	7.87	25.6

The difference at the inflow treatment of both plants can indicate that there is an improvement opportunity. Flocculation and sedimentation processes runs normal on both plants, as it does filtration and disinfection processes. Jar test has been executed to ensure the coagulant/flocculant effectiveness, but the test was not as favorable as expected.

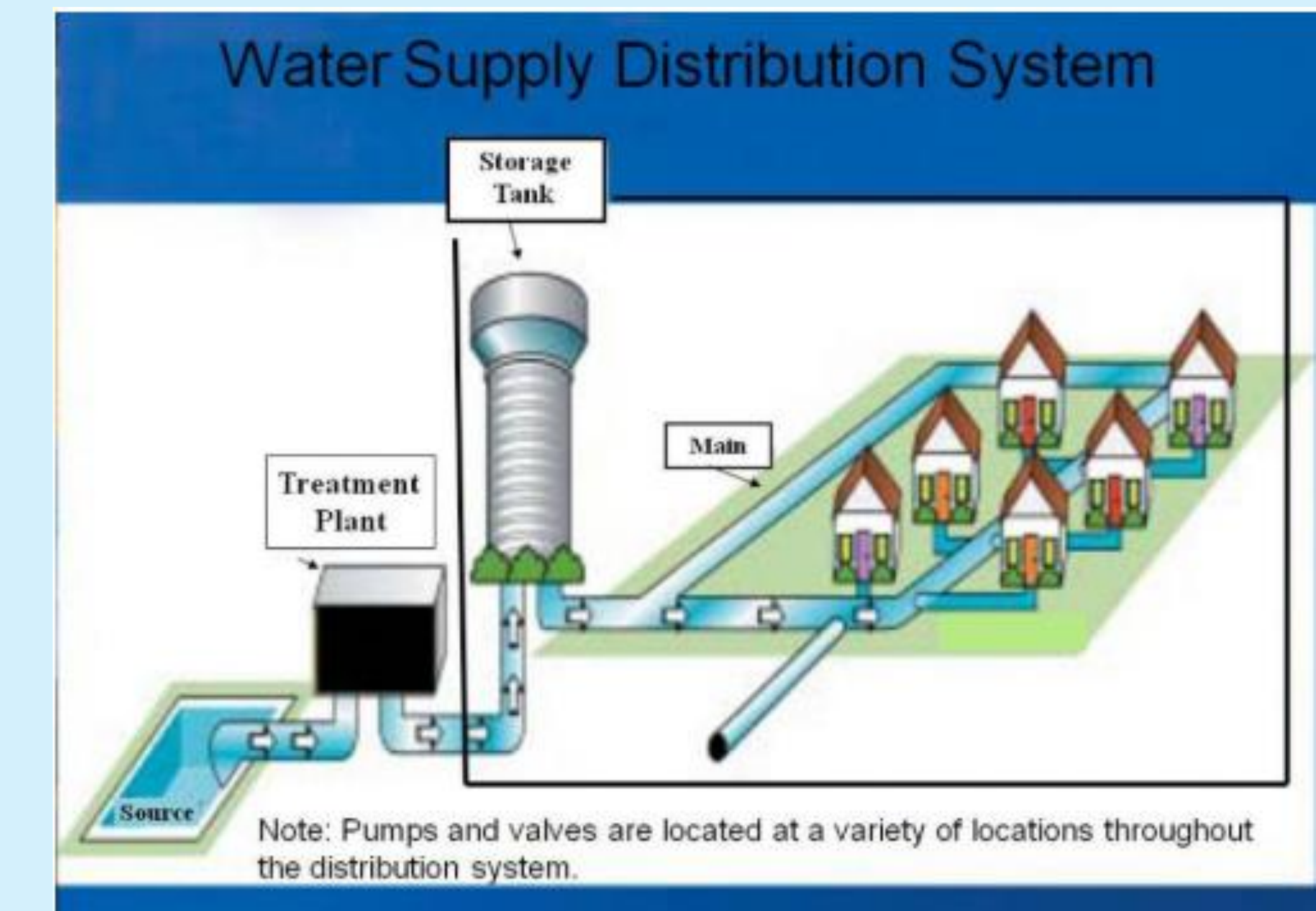


Jar Test: Coagulants Comparison (03/08/19)

Coagulant	Concentration (ppm)	NTU
680325014	10	2.51
680325014	20	1.03
680325014	30	0.96
6803	20	0.92
2800	20	1.42
M-4000	20	1.75

The optimum dose of the actual flocculant was 20 ppm per 2 L of entering raw water for the turbidity removal, results are shown in figure 4. Also were tested different coagulants in the jar test, this test revealed that there are better results on other coagulant than the one used in the plant.

- A possible high chlorine dose may also affect the plant effluent if the TOC removal is not as effective as expected. The application of the chlorine dose may vary during the day, by temperature or pH commonly. This filter plant distributes water to Lajas and San German municipalities and may affect the consumers of the area.



Conclusions and future work:

- Although the first coagulant reaction test was no as expected it was productive because some ameliorations has been done to the known procedure and the equipment.
- The second jar test performed was successful and gave good results to evaluate the effectiveness of the actual coagulant optimum dose and some coagulants introduced just for execute the test.
- The TOC removal was requested to an external laboratory but they are waiting for the result in which it will be known the real capacity of the TOC removal of the different coagulants and which one is the best one for the potable water plant.
- The comparison of the results between both the actual chemicals and the introduced ones will determine if the plant needs to change the chemicals used for those steps. Those coagulants could work different in the process of the filtration plant.
- The plant inflow system of open channels should be verified and maintained in good conditions to prevent the organic matter excess.
- The water source of the inflow is a lake that should be dragged any time soon to diminish the possibility of contamination or organic matter transportation.
- Other recommendations that could improve the plant system as the chlorine adjustment during the operation to lower the risk of the creation of THM's at the distribution system.
- Another application that could be considered are the micro-sand filtration and granular activated carbon adsorption.

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