Special FRWA Chloramination Study

The disinfection process for the Lake City Water System will be evaluated to identify the indicators of the stability and breakdown of chloramine in the water distribution system. The study will identify and document the effective process control and operational checks that can be made using low cost water testing equipment that can be used in the field by water distribution operators to predict chloramine breakdown. The study will also recommend preemptive adjustments when indicators of these potential problems occur.

The study will take place in the Lake City Water System. The Lake City Water System is unique in that it uses chlorimine as a secondary disinfectant for finished water at each of two water treatment facilities that have significantly different source waters. This will allow for identification of water quality contaminants that favor breakdown. The water systems also exhibits extremely long detention times for water to remote parts of the system. Secondary booster chloramination is used by the City to provide disinfectant residual in some remote areas. This situation will allow an evaluation of the effectiveness of booster chloramination as a means of maintaining residuals. The most remote parts of the system are also provided water from remotely located ground storage tanks. This type of storage of water is highly susceptible to nitrification, a phenomenon to be studied and addressed by this study.

The Lake City water system is ideal because it creates conditions that provide areas for monitoring and analysis that can be used to answer many important questions about the use of chloramination for secondary disinfection and provide recommendations to ensure its effectiveness under a variety of conditions. Thus the evaluation of the Lake City water system will provide useful information to the City as well as to other water treatment facilities in Florida where chloramination is used.

The questions to be answered in the special study are listed below:

1. What concentrations of chloramine are necessary throughout the water distribution system to prevent chloramine decay where long detention times exist?
2. What concentrations of chloramine are necessary to prevent the loss of the highly oxidative conditions that prevent the growth of bacteria inside water mains and storage tanks and eventually lead to biogrowth and nitrification?
3. What are the optimal ranges for water quality process control indicators that ensure are predictive of adequate chloramination for secondary disinfection?
4. What are the benefits in providing secondary disinfection with chlorimine using booster disinfection for remote areas in water distribution systems?
5. How significant is the draining of high volumes of water from ground storage tanks in affecting chloramine residual in the distribution mains and can more effective methods for moving the water improve disinfection conditions?

6. What simple, readily available and low cost process control methods can be used by water system operators to predict chloramine decay and pre-nitrification conditions and can preemptive measures be put into place to by water operators that reverse these trends?
7. Are simultaneous compliance with D-DBP's significant and under what conditions are TTHMs and HAA5s likely to occur when using chloramination and what are the water quality parameters are associated with these occurrences?

This study will proceed as follows:

Phase 1 - Compilation of System Records and Water System Mapping

1. Compile system schematic; include skeletonized water distribution main, average and peak water production, tank, pump and pipe sizes.
2. Identify the use of various disinfectants and dosing and residual disinfectant monitoring points to be used in the study.
3. Determine likely centroids of water use in the city based on a review of the City's meter records to determine water flow demands and flow patterns.

Phase 2 – Installation of Field Monitoring Devices and Evaluation of Source Water

4. Set up 3 pressure recording devices in strategic areas to determine pressure tank and system pressure fluctuations that are indicative of poor mixing.
5. Determine adequacy and effectiveness of dosing of chlorine and ammonia for chloramination production at WTPs and at remote dosing site. Perform bench scale disinfectant jar testing at the treatment facilities to identify ranges of ammonia addition for production of mono and dichloramine.
6. Collect key source water data from the various production wells and analyze the water for disinfection demands from sulfides, iron, ammonia, nitrate, and TOC.
7. Determine the treatibility of the TOC at both wastewater plants using SUVA identification as a possible indicator of precursor chloramine oxidation activity within the water distribution system. This information might be used for recommending addition of coagulants or oxidants such as permanganate to remove DBP precursors at the WTP facilities.

Phase 3 – Collection of Water Distribution Water Quality Data

8. Collect predictive water distribution system data including alkalinity, pH, total and combined chlorine residuals, temperature, ammonia, nitrate, nitrite and ORP water quality data (see #9 below).
9. Three different low cost ORP meters (< $200) will be used to determine their accuracy and reliability for water operator use as chloramine breakdown indicators.

Phase 4 – Data Compilation, Analysis and Documentation and Advanced Water Quality Evaluation

10. Compare field analytical results using colormetric (field readings), spectrophotomentric (laboratory analysis) and test strips (field readings) to determine correlation, accuracy and effectiveness of the various methods used for water quality monitoring in the study.
11. Collect water quality indicators such as TOC, SUVA, TTHM, and HAA5 data to demonstrate effectiveness of disinfection system in maintaining simultaneous compliance.
12. Assimilate and analyze data, identify major correlations..

Phase 5 – Summary and Recommendations

13. Assemble findings and make recommendations a Final Report.
14. Produce a follow-up concise guidance document for use by water system operators that use chloramination for secondary disinfection. It is anticipated that the Study's finding can be used to assist many small and medium systems in Florida that practice chloramination.

Estimated Cost: The estimated cost for equipment and reagents to be used in the Study are listed below:

Part	Item	Size or #	Estimated Unit Price	Total Cost
Group A	**Standards and Reagents**			
(Hach)	**(Description DR 890)**			
	Alkalinity (10 to 4000 ppm)	1	N/A*	
	Ammonia (0 to 0.5)	1	N/A*	
R501	Ammonia (0 to 2.5)	1	76.28	76.28
	Carbon Dioxide	1	N/A*	
	Chloride	1	N/A*	
R504	Chlorine Free (0 to 2.0 ppm)	1	19.62	19.62
R505	Chlorine Total (0 to 2.0 ppm)	1	19.94	19.94
	Hardness (10 to 4,000)	1	N/A*	
	Iron (0 to 3.0 ppm)	1	N/A*	
	Nitrate (0 to 30 ppm)	1	N/A*	
	Nitrite (0 to 3.5 ppm)	1	N/A*	
	PH	1	N/A*	
	Phosphate (0 to 2.5)	1	N/A*	
R526	Sulfide (0 to 0.7 ppm)	1	53.06	53.06
	TDS (10 to 1910 ppm)	1	N/A*	
	Temperature	1	N/A*	

(Hach)	**(Description DR 5000)**			
TNT 830	Ammonia (0.15 – 2.0 ppm)	1	37.80	37.80
TNT 831	Ammonia (1 to 12 ppm)	1	37.80	37.80
TNT 835	Nitrate Nitrogen (0.2 t o13.5 ppm)	1	30	30
TNT 839	Nitrite (0.015 to 0.6 ppm)	1	25.8	25.8
2925000	Nutrient (Ortho and Total P)	1	80	80
1407099	Free Chlorine (0.1 to 10.0 ppm)	3	20.70	62.10
1406499	Total Chlorine (0.1 to 10.0 ppm)	3	20.70	62.10
2635300	Std Low Range Chlorine (0 to 2 ppm)	1	110	110
2893300	Std High Range Chlorine (2 to 8 ppm)	1	110	110
25150025	DO (0.3 to 15.0 ppm)	1	21.5	21.5
103769	Fe++ (0.02 to 3.0 ppm)	1	21.5	21.5
2507025	Fe (0.20 to 3.0 ppm)	1	21.5	21.5
2805145	Monochloramine Reagent Set	1	74.20	74.20
2760345	TOC (0.3 to 20 ppm)	1	303	303
2790800	THM plus	1	435	435
2756707	Chloroform Ampules Stds	1	66.2	66.2
(Hach)	**(Description - Bacterial Analysis)**			
2812350	HPC m-R2A (MF) Ampules	1	54.8	54.8
2814215	Agar Plates	1	61.40	61.40
2724106	Sterile Agar	1	22.8	22.8
(Aquatic)	**(Description - Stds and Test Strips)**			
PH 4	10 capsules	2	6.24	12.48
PH 7	10 capsules	2	6.24	12.48
PH 10	10 capsules	1	6.24	6.24
7021	ORP 240 mv std	1	23	23
7022	ORP 470 mv std	1	23	23
H27448	Alkalinity Test Strip	1	7.14	7.14
H27553	Ammonia Test Strip	1	15.32	15.32
H27450	Chlorine Test Strip	1	9.18	9.18
H27454	Nitrate/Nitrite Test Strip	1	15.32	15.32
H27456	PH Test Strip	1	9.18	9.18
H27571	Phosphate Test Strip	1	15.32	15.32
R446	Chlorine/Chloramine Test Strip	1	7.87	7.87
CS	ORP/pH Probe Storage Solution	1	7.92	7.92
	* Reagents and standards provided with Analytical Equipment			
	Total Group A			1970.85

Group B	**Analytical Equipment**			
(Hach)	**(Description)**			
CEL 890	Advance Drinking Water Field Kit Lab	1	$2750.00	$2750.00
DR 5000-01	DR 5000 UV-Vis Spectrophotometer	1	$6240.00	$6240.00
4788000	Cooling Basket THM	1	64.4	64.4
2881600	Hot Plate Stirring	1	405	405
1864100	Test Tube Rack	1	37.4	37.4
N/A	DRB200 Reactor THM and TOC	1	675	675
	Total Group B			10,171.80
Group C	**Field Equipment**			
(Hach)	**(Description)**			
Hach	DR 890*	N/A*		
Hach	SensIon1 pH meter *	N/A*		
Hach	SensIon 5 Conductivity (TDS) meter*	N/A*		
USABlue Bk	**Description**			
MB61717	PR100 Pressure Data Logger	3	399	1197
MB61729	Serial Port Connection	3	69	207
MB45330	Gauge to Hose Bibb Connection	3	15.52	45.56
MB65257	Hydrant Adapter Connection	3	51.51	154.53
MB22512	Adj Fire Hydrant Wrench	1	26.76	26.76
MB35280	Hanna pH/ORP Tester	1	152	152
(Aquatic)	**(Description)**			
VS99	ORP Meter w/ pH	1	110	110
VSPW	ORP Probe	1	59	59
ORP3	ORP Meter	1	103	103
DO62	DO Meter	1	224	224
	* Equipment listed provided with Analytical Equipment			
	Total Group C			1630.35
	Total			13,773.00
	Tax @ 6%			826.38
	Shipping Estimated at 10% of Cost			1,459.94
	Total Cost of Study			16,059.32

Schedule for Completion: The study will approximately three weeks to complete and the schedule is shown below:

Phase (see descriptions above)	**Length to Complete**	**Assignment**
Phase 1 and Phase 2	One Week	FRWA staff
Phase 3 and Phase 4	One Week	FRWA and DEP staff
Phase 5	One Week	FRWA staff
Additional	Varies	DEP Review and Comment

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Work will be performed by FRWA and assisted in the efforts by DEP staff.

After receiving approval from DEP to proceed with the study, a specific work plan and PERT chart will be developed by FRWA to allow for identification of the work tasks and assignments to effectively collect the needed records, water distribution maps, collect field data, assemble the data, perform lab analysis and install pressure recording equipment in the field.

FRWA will be responsible for managing the project and for completing the final report.