2013 Vancouver Water Utility Annual Report

2013

CITY OF VANCOUVER

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Acronyms

AO	Aesthetic Objective
BCCDC	British Columbia Centre for Disease Control
BCDWPR	British Columbia Drinking Water Protection Regulation
CFU	Colony forming Units
CoV	City of Vancouver
DBP	Disinfection By-product
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency (USA)
GCDWQ	Guidelines for Canadian Drinking Water Quality
HAA	Haloacetic Acid
HPC	Heterotrophic Plate Count
MAC	Maximum Acceptable Concentration
N/A	Not available
NEU	Neighbourhood Energy Utility
mg/L	Milligram per litre
mL	Millilitre
NTU	Nephelometric Turbidity Unit
pH	Measure of acidity or basicity of water; pH 7 is neutral
ppb	Parts per Billion
SCFP	Seymour-Capilano Filtration Plant
THM	Trihalomethane
WHO	World Health Organization
WQMRP	Water Quality Monitoring and Reporting Plan

1.0 City of Vancouver's Water Utility

As a member municipality of Metro Vancouver, the City of Vancouver Waterworks Utility purchases bulk treated water and operates a City-wide transmission and distribution system to deliver water to customers. The Utility consists of the Design Branch which designs and administers the Utility, and the Operations Branch which builds, operates and maintains the system. Together these groups purchase and deliver more than 109,600,000 cubic metres of high quality drinking water to more than 100,000 properties within Vancouver annually.

The Water Utility is self-funded. Revenues collected each year completely offset costs to build and maintain the water system over the same period. Of the total budget of $104.3M in 2013, $66.4M was used to purchase bulk water from Metro Vancouver and the remaining $37.9M was spent rebuilding and maintaining the water system.

The three core functions of the Water Utility are:

1) Ensuring that the drinking water quality delivered to customers meets all relevant health and quality guidelines,
2) Ensuring that water system assets are well managed and resilient, and
3) Making progress on the City's water consumption and water quality targets adopted as part of the Greenest City Action Plan's Clean Water goal, effectively offsetting population growth through efficient water use.

2.0 Source Water

Vancouver's water originates from three mountainous watersheds protected and managed by Metro Vancouver. These watersheds collect surface water from rain and snowmelt and all three are closed to the public such that no recreational, agricultural and/or industrial activities are permitted within watershed boundaries. This significantly reduces the risk of human contamination within the watersheds.

Metro Vancouver is responsible for source water quality monitoring and treatment to ensure high quality water is delivered to its member municipalities. Water treatment by disinfection destroys disease-causing or pathogenic organisms and secondary chlorine disinfection of the water downstream of the watersheds helps to prevent bacterial re-growth in the distribution systems. Metro Vancouver is responsible for both primary and secondary treatment. The City of Vancouver does not further treat the water. To learn how drinking water is treated by Metro Vancouver, visit: http://www.metrovancouver.org/services/water/qualitytreatment/Pages/treatment.aspx

To view summaries of source water quality for the Capilano, Seymour and Coquitlam watersheds, see Appendix A – Source Water Quality.

3.0 Protecting Vancouver's Drinking Water Quality

Vancouver's drinking water continues to meet provincial, federal and relevant international standards and guidelines for drinking water quality. The following sections describe drinking water quality standards, the City's monitoring program,

sampling frequency and water quality parameters that substantiate Vancouver's drinking water potability for 2013.

3.1 Drinking Water Standards

Drinking water delivered by the City of Vancouver to its customers must comply with the health standards set out by the British Columbia Drinking Water Protection Regulation (BCDWPR). In addition, the British Columbia Drinking Water Protection Act (BCDWPA) places specific requirements and responsibilities on drinking water suppliers.

To ensure compliance with provincial drinking water legislation, a regional plan has been jointly developed by the lower mainland Medical Health Officers, Metro Vancouver and member municipalities, including the City of Vancouver. This plan has been accepted by Vancouver Coastal Health and the Fraser Health Authority.

The regional Water Quality Monitoring and Reporting Plan for Metro Vancouver and Member Municipalities (WQMRP) states that each water supplier (such as the City of Vancouver) is required to hold an annual operating permit issued by the region's Medical Health Officer approving water potability, monitoring, reporting protocol and emergency response.

3.2 Monitoring Program

The City of Vancouver has a long-standing Water Quality Monitoring Program to ensure water quality data is routinely collected throughout the City's distribution system. Water samples are taken from fifty-three dedicated sampling stations. Appendix B contains a map to show the spread of these stations within the City.

Samples are analyzed for:

- Regulatory compliance against provincial health standards.
- Regional compliance as per the WQMRP.

These samples are further scrutinized against:

- Health Canada's Guidelines for Canadian Drinking Water Quality (GCDWQ).
- International recommendations by the United States Environment Protection Agency (US EPA) and World Health Organization (WHO) for chlorine residual.

Sample results are reported to Metro Vancouver and the region's Medical Health Officer through weekly, monthly and annual reporting. Sample results are available to the public on the City's website at http://vancouver.ca/home-property-development/drinking-water-monitoring-and-results.aspx.

In addition to regulatory monitoring, the City also collects continuous water quality data from two online monitoring stations. This technology supports regulatory compliance, security monitoring, and detects changes in source waters more immediately.

3.3 Sample Collection Frequency

Schedule B of the BCDWPR requires the number of water samples collected to correspond with population size. The City of Vancouver continues to exceed the minimum number of samples required per month for monitoring.

In 2013, 169 samples per month were collected from fifty-three dedicated sampling stations. This equals 2,025 samples for the year, or 39 samples per week collected over four days. The requirement from Schedule B of the BCDWPR and the actual sample collection frequency by the City of Vancouver (CoV) is summarized below:

Table 1: Required Frequency of Monitoring (BCDWPR)

Population Served by the Prescribed Water Supply System	Number of Samples Per month
Less than 5 000	4
5 000 to 90 000	1 per 1 000 of
more than 90 000	90 plus 1 per 10 000 of population in excess of 90 000

Table 2: CoV Compliance w/ Required Frequency of Monitoring (BCDWPR)

Year	CoV Population	Number of Sample Sites	Number of Samples per Month *Required**	Number of Samples per Month *Collected*	Number of Samples per Year Collected
2013	**626 000**	**53**	**144**	**169**	**2025**
2012	632 840	53	144	169	2028
2011	625 133	53	144	168	2020
2010	642 843	53	145	172	2060
2009	628 621	53	144	169	2028

*Minimum Number of Samples per Month as Required by Schedule B of the BCDWPR

The WQMRP further details specific parameters and testing frequencies for at least 10% of the sample sites within a distribution system. A summary of both the BCDWPR and WQMRP parameters are provided along with the actual testing frequency by the City's Water Quality Monitoring Program in Table 3.

The City's monitoring program continues to meet or exceed the minimum testing frequencies for all listed parameters.

Table 3: Frequency of Monitoring Samples, Summary of BCDWPR, WQMRP & CoV Compliance

Category	Parameter	Location	Required Frequency	Actual CoV Frequency
Bacteriological (bac-T)	*E. coli*	All[1]	BCDWPR – See Table 1 & 2	See Table 2
	Total coliform	All	BCDWPR – See Table 1 & 2	See Table 2
	HPC	All	Not required	Run with bac-T
Chemical	Chlorine – free (residual)	All	WQMRP – run with bac-T	Run with bac-T
	Chlorine – total	All	Not required	Run with bac-T
	Conductivity	All	Not required	Run with bac-T
	pH	Representative sites	WQMRP – semi-annual	Run with bac-T (all sites)
Physical	Temperature	Representative sites	WQMRP – Quarterly	Run with bac-T (all sites)
	Turbidity	All	WQMRP – run with bac-T	Run with bac-T
Metals	Copper	Representative sites	WQMRP – semi-annual	Semi-annually
	Iron	Representative sites	WQMRP – semi-annual	Semi-annually
	Lead	Representative sites	WQMRP – semi-annual	Semi-annually
	Zinc	Representative sites	WQMRP – semi-annual	Semi-annually
	Other [2]	Representative sites	Not required	Semi-annually
Disinfection By-products	Haloacetic Acids	Representative sites	WQMRP – Quarterly	Quarterly
	Trihalomethanes	Representative sites	WQMRP – Quarterly	Quarterly
Volatile Organic Compounds	Vinyl Chloride	Representative sites	WQMRP – Semi-annual	N/A[3]
Aesthetic	Odour & Taste	Any site	WQMRP – Complaint basis	Complaint basis

1. Location – "All" – refers to all CoV sampling sites (53).
2. The methodology for metals analysis produces additional results; see Appendix C – Metals Analysis.
3. Vinyl chloride testing is required where PVC pipe is used in the distribution system. Ratio of PVC pipe in Vancouver is less than 0.1% and deemed insignificant for testing at this time.

3.4 Water Quality Results

This section provides the overall drinking water quality summary for the City of Vancouver's distribution system in 2013.

3.4.1 Bacteriology

Table 4: CoV Water Quality Results – Bacteriology - 2013

Parameter	*Results*	*Standard*	*Reference*
E. coli	*0 samples contained E. coli*	*No detectable E. coli bacteria per 100 ml*	*BCDWPR – Water Quality Standards for Potable Water*
Total coliform	*1 sample was positive for TC – retesting revealed no further TC.* *0 samples contained more than 10 total coliform bacteria per 100 mL*	*a) No more than 10% of the samples in a 30 day period should be positive for total coliform bacteria when more than one sample is collected* *b) No sample should contain more than 10 total coliform bacteria per 100 mL*	*BCDWPR – Water Quality Standards for Potable Water*
Heterotrophic Plate Count (HPC)	*96% of the samples measured zero CFU/mL* *100% of the samples were less than 10 CFU/mL (pour plate, 35 °C)*	*None*	*GCDWQ*

Bacteriological monitoring conducted by the City of Vancouver includes testing for *E. coli* bacteria, Total Coliform bacteria and Heterotrophic Plate Count (HPC).

All bacteriological samples are analyzed at the water lab within the BC Centre for Disease Control (BCCDC). This laboratory has been approved for use by the region's Medical Health Officer for assessing Vancouver's drinking water safety.

E. coli

Zero samples were positive for *E. coli* in 2013.

The analysis for Escherichia coli (*E. coli*) is an indicator test of fecal contamination that has been used in place of fecal coliform testing since April 2006.

The *E. coli* group has a stringent standard of zero maximum acceptable concentration (MAC). If *E. coli* is found in the water, under the BCDWPA, the laboratory conducting the analysis must immediately notify the City and the Medical Health Officer. Together, an assessment will be made to determine the possible health risks and the most effective approach to protecting the public. This assessment will include a review of the bacteriological records, chlorine residuals, pressure levels; and other relevant factors. The water will be resampled immediately. If the risk assessment indicates the water system is operating within expected parameters, then a decision may be made to wait for confirmation of the follow-up sample results. However, if the assessment identifies a risk to water quality, immediate intervention may be necessary including issuing a boil water notice and corrective action taken in accordance with the City's Waterworks Emergency Response Plan.

Total Coliform

One sample in 2013 was positive for total coliform. The sampling station was retested immediately, and no subsequent total coliform was found.

Zero samples contained more than 10 total coliform bacteria per 100 mL. Total coliform is a test of all bacteria within the coliform group. The detection of total coliform indicates possible conditions for pathogen or parasite contamination.

HPC

Results for Heterotrophic Plate Count (HPC) were predominately zero CFU/mL for 2013. This is consistent with previous years.

HPC is a count of all heterotrophic micro-organisms and is a useful indicator for monitoring the effectiveness of disinfection and early signs of bacterial re-growth. HPC is not listed as a health standard; however, it serves to monitor general bacteriology in the drinking water distribution system.

3.4.2 Chemical and Physical Parameters

Table 5: CoV Water Quality Results - Chemical and Physical Parameters – 2013

	Results				
Parameter	*Avg*	*Max*	*Min*	*Guideline*	*Reference*
Chlorine – free (mg/L Cl_2)	*0.52*	*1.03*	*0.00*	>0.2 mg/L Cl_2	EPA/WHO
Chlorine – total (mg/L Cl_2)	*0.59*	*1.10*	*0.00*	<4 mg/L Cl_2	EPA
Conductivity (µs/cm)	*26*	*35*	*14*	None	
pH	*7.25*	*8.15*	*6.16*	6.5 – 8.5	GCDWQ
Temperature (°C)	*11.7*	*24.3*	*4.6*	<15 deg C	GCDWQ
Turbidity (NTU)	*0.25*	*6.22*	*0.05*	<1 NTU	GCDWQ

Chlorine

Chlorine levels in the majority of the City's distribution system continued to be above minimum recommended levels in 2013. However, low chlorine residual did occur at a few stations – this may be due to location (such as distribution endpoints), or chlorine demand caused by localized turbidity and/or higher water temperatures (as seen in summer months). However, all sampling stations identified with low chlorine residual had no indication of bacteriological impairment and were closely monitored by the City.

Appendix E (Sampling Site Characterization) provides residual chlorine levels by month at each sampling station within the City.

Chlorine is used to disinfect the water and safeguard against microbial re-growth or contamination in the distribution system. International guidelines recommend a chlorine residual (free) of at least 0.2 mg/L to protect drinking water.

Conductivity

Readings for conductivity in 2013 remained similar to previous years.

Conductivity is a measure of the ability of water to pass an electrical current. The US EPA describes that conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge).

Conductivity in Vancouver depends on which source waters are feeding the distribution system at different

times of the year. Generally higher conductivity is seen during Seymour service periods and lower conductivity is seen during Capilano service periods. Overall, however, conductivity in Vancouver is considered low. See Appendix A – Source Water Quality for the differences in conductivity levels of each watershed.

pH

Routine sampling of Vancouver's fifty-three stations showed average pH of 7.25 in 2013. This is similar to 2012.

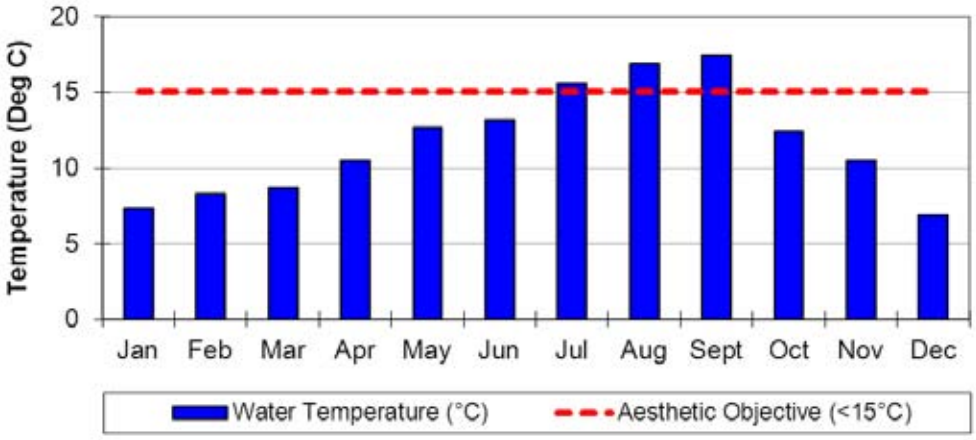
The region's source waters are a combination of rainfall and snowmelt. This type of supply results in very soft water defined by low amounts of dissolved calcium and magnesium. The region also experiences slightly acidic water. Soft and acidic water has the capacity to corrode. To reduce the corrosiveness of the water and lengthen the service of plumbing systems, Metro Vancouver utilizes pH adjustment under its Corrosion Control Program.

Temperature

Average water temperatures in the distribution system remained below 15°C for most of the year, with the exception of summer months.

Temperatures in the distribution system are directly related to source water seasonal changes. Temperatures above the aesthetic objective of15°C enhance the growth of micro-organisms, which can impact aesthetic properties of taste, colour, odour, as well as accelerate corrosion. However, even during warmer periods, there was no sign of bacteriological impairment to the water in the City's distribution system.

Figure 1: Monthly Average Water Temperatures in the Distribution System – 2013



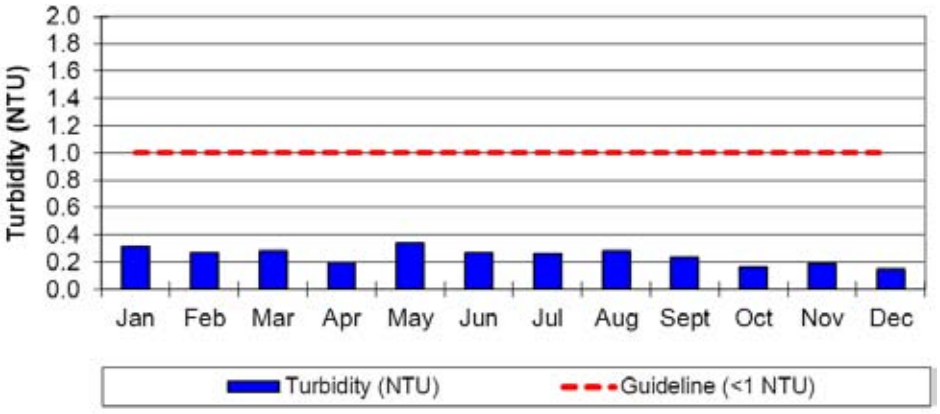
Turbidity

Since the launch of the Seymour Capilano Filtration Plant (SCFP), filtered water from the Seymour watershed has been improving the clarity of water throughout Vancouver. As such, turbidity levels have decreased considerably. In 2013, the City's dataset included numbers as low as 0.05 NTU.

Turbidity is a measure of the relative clarity or cloudiness of water caused by fine suspended matter such as clay, silt, and organics. Turbidity is not a direct measure of these particles, but rather a general measure of the effect these particles have on light. Turbidity levels in Vancouver are most often related to levels at the source where periods of heavy rainfall can cause sediment and runoff to enter the watersheds. The SCFP has greatly reduced impacts to water quality during storm periods.

Localized turbidity events can also be caused by water main flushing or construction work within the distribution system. Elevated turbidity events can pose an aesthetic concern for customers and can limit the effectiveness of disinfection. Appendix E shows turbidity levels for individual sampling stations. Turbidity above 1.0 NTU was briefly observed at some stations in 2013; however, these sites showed no signs of bacteriological impairment.

Figure 2: Monthly Average Turbidity Levels in the Distribution System - 2013



3.4.3 Metals, Disinfection By-Products, VOCs, Aesthetics

Table 6: CoV Water Quality Results - Metals, DBPs, VOCs, Aesthetics – 2013

Category	Parameter	Results	Guideline	Reference
Metals	Copper	All tested sites were below guidelines See Appendix C – Metals Analysis	≤ 1.0 mg/L (A/O)	GCDWQ
	Iron		≤0.3 mg/L (A/O)	GCDWQ
	Lead		0.010 mg/L (MAC)	GCDWQ
	Zinc		≤5.0 mg/L (A/O)	GCDWQ
	Other		Parameter specific	GCDWQ
Disinfection By-products (DBPs)	Haloacetic Acids (HAAs)	All tested sites were below guidelines See Appendix D – Disinfection By-products Results	MAC 100 ppb	GCDWQ
	Trihalomethanes (THMs)		MAC 80 ppb	GCDWQ
Volatile Organic Compounds	Vinyl Chloride	Not applicable	MAC 0.002 mg/L	GCDWQ
Aesthetic	Odour & Taste	Case-by-case assessment	Not specified	GCDWQ

A/O = Aesthetic objective
MAC = Maximum acceptable concentration

Metals

Water in the City's distribution system consistently meets the Guidelines for Canadian Drinking Water Quality.

In 2013, metal concentrations in the City's water distribution system were assessed on two separate occasions, once in the spring and again in the fall. These samples were collected by City staff and the analysis was performed by Metro Vancouver's laboratories. A summary of the results for metals is provided in Appendix C.

Metal concentrations in drinking water at consumers' taps can be affected by the age and materials used in household plumbing. In homes with metallic piping systems, leaching of metals can occur when Vancouver's

naturally soft and slightly acidic water sits stagnant in the pipes. To monitor the extent of dissolved metals in drinking water from household piping, the City, in partnership with Vancouver Coastal Health, conducted testing for metals at the taps of sixty-seven homes over a four year period. The results consistently showed that running the water for 20 seconds significantly lowers dissolved copper and lead (from plumbing systems with lead based solder and brass faucets) to below the Canadian guideline levels.

DBPs

In 2013, the running locational averages for trihalomethanes (THMs) in Vancouver's drinking water were below the guideline's maximum acceptable concentration.

The running locational averages for haloacetic acids (HAAs) in Vancouver's drinking water were also below the guideline's maximum acceptable concentration. See Appendix D for total quarterly average results for THMs and HAAs by sampling location.

Disinfection By-products (DBPs) are compounds formed by the interaction between chlorine and naturally occurring organic substances in the water, such as breakdown products of decaying leaves and vegetation.

Two groups of DBPs are monitored within Vancouver's drinking water, THMs and HAAs. Within the THM group, chloroform is the compound found in the highest concentrations in drinking water, and as such has been most extensively studied with respect to health. Under the Canadian Guidelines the maximum acceptable concentration (MAC) for total THMs is 100 ppb (0.10 mg/L) and the MAC for HAAs is 80 ppb (0.08 mg/L). Both are based on locational running annual averages from quarterly samples. The guidelines are set conservatively and are based on a person consuming 1.5 litres of water per day over a seventy-year lifetime.

VOCs

Vinyl chloride testing is listed under the Volatile Organic Compounds category as per the WQMRP (see Table 3).

Testing is required where poly-vinyl chloride (PVC) pipe is used in the distribution system. The ratio of PVC pipe in Vancouver is less than 0.1% and deemed insignificant for testing at this time.

Aesthetic

Customers are able to contact the City to discuss concerns regarding water quality by dialing 3-1-1 or 604-873-7000. The City makes every effort to provide timely follow-up to water quality inquiries.

Common concerns seen in 2013 included chlorine smells from drinking water, occasional turbidity from local construction or flushing, and general questions regarding water treatment at the source waters.

Aesthetic properties such as odour and taste can be subjective parameters. However, the City is able to use nearby sampling stations as markers for typical levels that should be seen up to a customer's property line. In some cases, private-side plumbing can impact water quality depending on the age of the internal plumbing system or types of materials used. Therefore, matters beyond the distribution system remain under private jurisdiction. Customers can use City water quality monitoring data as benchmarks for expected parameter levels within property lines.

Water quality results are reported publicly through the City's water quality webpage - http://vancouver.ca/home-property-development/drinking-water-monitoring-and-results.aspx.

4.0 Ensuring Assets are Well Managed and Resilient

The City maintains more than 1,400 km of water mains, 100,000 service connections, 6,400 hydrants, 25,000 valves, and 25 pressure reducing valve (PRV) stations. The Utility also maintains a Dedicated Fire Protection System (DFPS) which consists of 11 km of 600 mm diameter steel pipeline that is designed to withstand the maximum credible seismic event for Vancouver.

Expenditures fall into one of two major programs – Capital and Operating. The capital program includes all expenses related to building new components of the water system which consists mainly of replacing infrastructure that has reached the end of its service life. The Operating program includes all works related to the ongoing cost of operating the water system, also referred to as system maintenance.

4.1 Capital Program Summary

The capital investment in replacing and upgrading the water system in 2013 was approximately $12.3M and includes the replacement of distribution mains, transmission mains, valves, hydrants, services, pressure reducing valve (PRV) stations and various other minor appurtenances. The table below summarizes capital expenditures in 2013.

Table 7: 2013 Waterworks Capital Program Expenditures

Program Area	Budget	Expenditures
Distribution Main Replacement[1]	$ 6,450,947	$ 8,556,616
Transmission Main Replacement	6,070,000	1,518,003
Aging Service Replacement	1,930,000	1,407,390
Aging Meter Replacement	300,000	345,240
Fire Hydrant Program	250,000	257,909
PRV Replacement	100,000	-
New Meter Purchases	-	21,130
System Extention & Minor Improvement	275,000	-
Dedicated Fire Protection System[2]	(50,000)	-
Access to Water	60,000	50,104
Water Conservation Capital	40,000	28,633
Emergency Preparedness	125,000	-
Telemetry System	65,041	51,650
Engineering & Site Investigation	150,679	56,283
Misc Water Quality Capital[3]	(53,874)	25,915
Total	15,712,793	$ 12,318,873

Notes:

1 Purposely overspent to cover previous year's underspend.

2 Purposely underspent to cover previous year's overspend.

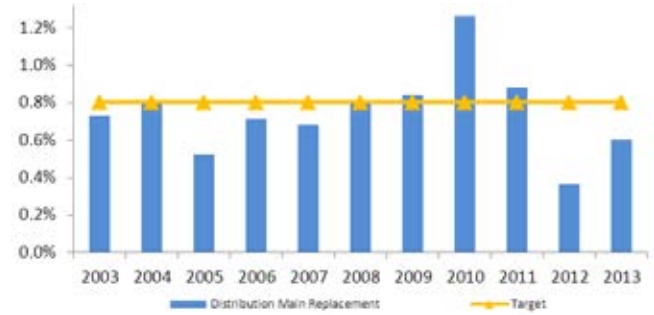
3 Budget reduction because work was not required for 2013.

4.1.1 Distribution Main Replacement Program

The single largest component of Waterworks annual Capital Plan is the Distribution Main Replacement Program. Since the early 1980's, Vancouver has conducted an annual water main replacement program to manage the frequency and impacts of water main failures, and to improve system reliability. Since 2003, the target replacement rate for the distribution system has been 0.8% based on analysis regarding the lifespan of the City's water mains.

Here is a summary of historic replacement rates:

Figure 3: Annual Distribution Main Replacement Rate (2003-2013)



Note: 2012 underspent the budget to compensate for overspend in 2011.

In 2013, approximately 8,800 metres, or 0.6% of distribution mains were replaced using City forces at a cost of approximately $8.6M. The 2013 replacement rate of 0.6% was below the long-term target of 0.8%, in response to a stable break rate in recent years. In addition, there was a reallocation of resources as the City's three water main construction crews worked on other programs for part of the year. These programs include the Pender Transmission Main, NEU Expansion, and site investigations.

A large component of the 2013 replacement program included a number of significant infrastructure upgrades on downtown and arterial streets in advance of planned street reconstructions. Some of the highlights of the 2013 program include:

- West Georgia Street from Thurlow to Pender Street,
- West 4th Avenue from Burrard to Granville Street, and
- West King Edward Avenue from Marguerite to Arbutus Street.

The average unit cost for typical distribution water main capital replacement on residential streets and arterial streets was $950 and $1,577 per metre respectively. The values are within 5% of the previous year's rates. Construction on arterial roads is more costly due to the extra effort necessary to manage traffic and higher street restoration costs associated with a thicker pavement to support heavy vehicles and traffic volumes.

The figure below illustrates unit costs over the past 10 years:

Figure 4: Distribution Main Replacement Costs

These costs include the installation of water mains, services, hydrants, air valves, and street restoration costs.

4.1.2 Transmission Main Replacement Project

In November 2013, the City started construction on the Pender Transmission Main. The costs for 2013 were approximately $0.8M and the crews were able to install 50 meters of 750mm and 180 metres of 600mm ductile iron cement lined pipe. The pipe was installed along Pender Street east of Clark to Vernon Street and along Vernon Street south of Pender Street. This main will service the western portion of zone 442 and will provide a reliable water supply to the area.

Figure 5: East Pender Street Transmission Main Construction

4.1.3 Georgia Street Trenchless Slip-lining Project

Waterworks selects suitable water mains for trenchless rehabilitation. Relative to the open-cut alternative, trenchless rehabilitation has the potential to disrupt the environment less than the traditional open-cut installation.

In 2013, approximately 600 metres of water main was installed trenchlessly by Waterworks Operations staff along West Georgia Street from Thurlow to Nicola Street. The project cost $1.0M and it is estimated that $120K to $170K in costs were saved relative to the open-cut installation alternative.

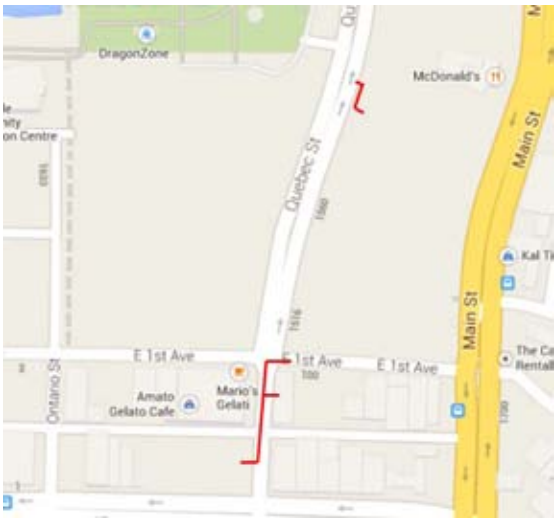
Figure 6: Sliplining on Georgia Street

4.1.4 Neighbourhood Energy Utility Expansion

In the summer of 2013 Waterworks assisted the City's Neighbourhood Energy Utility (NEU) to construct branch and service connections to its existing system. The expansion was designed by a consultant but the construction was delivered using a combination of City Waterworks staff and private contractors.

The branch and service connections were made in the Southeast False Creek area and capital costs were approximately $0.3M.

Figure 7: 2013 Neighbourhood Energy Utility Branch & Service Connections



There are plans to further expand the NEU system in 2014 using Waterworks resources.

4.1.5 Service Installations

The City conducts a replacement program for leaking service connections where it is more cost effective to replace than repair the service. Services are replaced according to the prescribed criteria when leaks are found, when the water main is being replaced, for new buildings or developments and as part of a service renewal program. In 2013, Waterworks Operations crews installed a number of services:

Table 8: Service Installations

Program Area	Installations
Existing Aging Services	115
Existing Leaking Services	319
New Commercial Services	152
New Residential Services	20
New Residential Services*	945
Total	1551

*Installed by a combined Water-Sewer crew for small redevelopments that require both a new water and sewer service.

4.2 Operating and Maintenance Programs

The Water Utility's Operating and Maintenance budget supports maintenance of the water system to:

- Maximize the life of each of its components,
- To get the best value out of our assets, and
- To ensure that components are in good working order.

The budget also allows for water utility staff to conduct reactive repairs in the case of system breaks and leaks to minimize service disruption to customers.

In 2013, highlights include:

- All hydrants in the water system were inspected to ensure proper operation and checked for leakage, thereby meeting the water industry standard and best practice,
- Crews flushed approximately 30% of the system's water mains; just below the 33% target, and
- Large valves were exercised and maintained to ensure operation in the case of an emergency.

In regard to operating and maintenance, the budget, expenditures, and revenues are shown in Table 9.

Table 9: 2013 Operations and Maintenance Budget, Expenditures, and Revenues

Program Area	Budget	Expenditures	Revenues	Net Expenditure
Water Main Maintenance	$ 942,480	$ 1,002,399	$ (911)	$ 1,001,488
Water Service Maintenance	1,050,160	932,891	(13,853)	919,038
Trouble/Shutoff Cal	264,410	300,450	(43,464)	256,986
Discontinue Service & Meter	150,380	91,973	-	91,973
Meter Maintenance	954,960	697,765	(400)	697,365
Hydrant Maintenance	475,700	431,102	(7,900)	423,202
Valve Maintenance	799,810	779,781	-	779,781
Flushing Program	238,930	129,778	-	129,778
Musqueam Maintenance	35,130	783	-	783
Proactive Leak Detection	153,240	79,279	-	79,279
Ops General Supply	142,660	189,263	(115)	189,148
Hydrant Damage Repairs	104,680	9,202	(1,196)	8,006
Telemetry & System Op	209,880	189,324	-	189,324
General Ops Expenditure	312,610	421,934	(57,072)	364,862
Connection Control	50,250	31,905	-	31,905
AMR Metering Program	180,870	211,393	-	211,393
TEOB Service	-	4,574	-	4,574
Total	**$ 6,066,150**	**$ 5,503,796**	**$ (124,911)**	**$ 5,378,885**

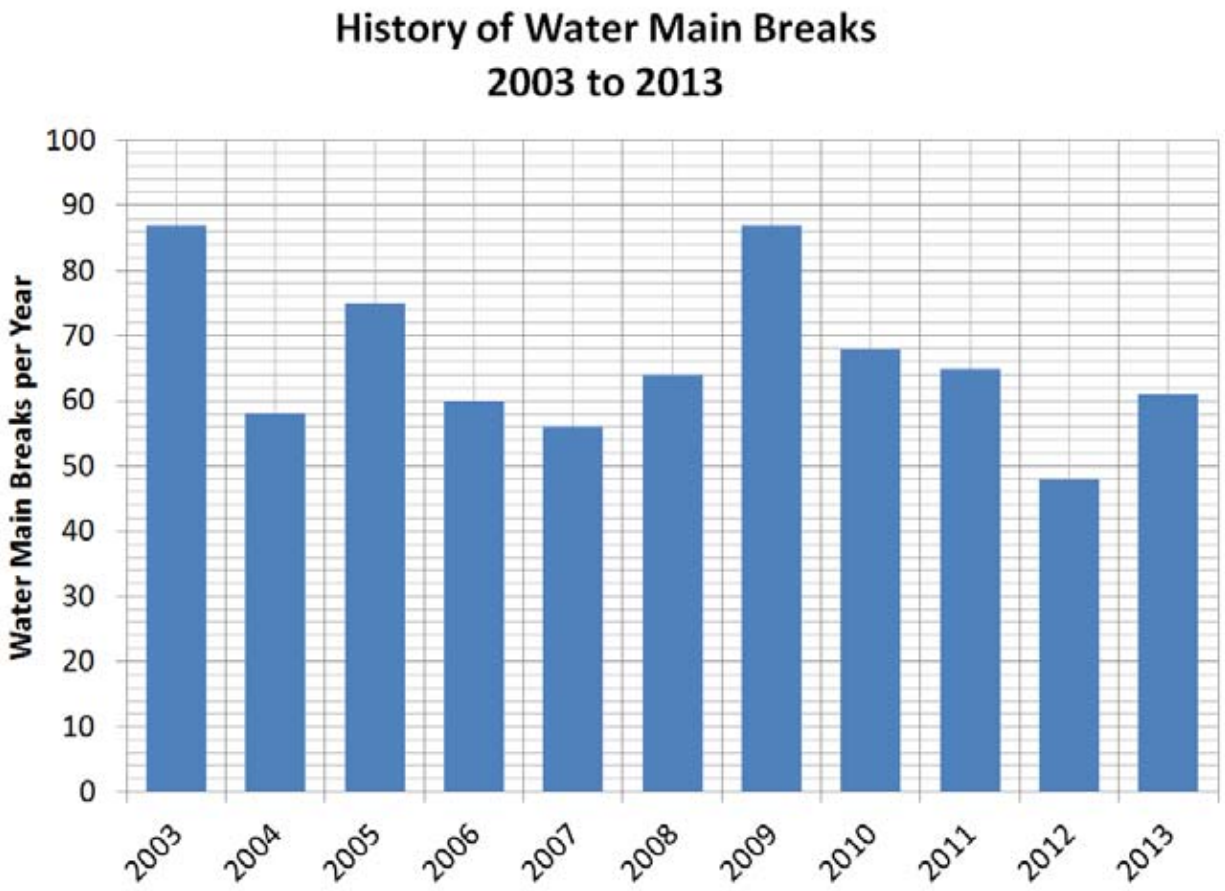
4.2.1 Main Breaks

The Water Utility participated in the 2013 National Benchmarking Program that compares municipalities across a number of indexes.

Of the metrics compared, the "number of main breaks" is typically used as a proxy of the overall condition of a distribution system. In 2012, the City ranked well relative to similar municipal water systems. When compared to other Canadian municipalities of a similar scale, Vancouver's experienced fewer breaks while maintaining one of the older water systems. As such, it can be inferred that water mains chosen to be replaced over the years as part of the Distribution Main Replacement Program have reduced the system's overall risk of failure.

In 2013 crews repaired 61 main breaks. Approximately 70% of water main breaks occur during the winter months between October and February. Figure 8 shows the history of water main breaks from 2003 to 2013.

Figure 8: Water Main Break History (2003 to 2013)



4.2.2 Service Leak Repairs

Many of the residential copper services in Vancouver were installed between the late 1950s and late 1960s. These copper services are now reaching the end of their normal life expectancy of approximately 50 years and the number of leaking services is expected to increase.

In 2012, the maintenance budget for leaking services was overspent because of the large number of service repairs required. In 2013 this budget was increased to $1.05M and the City spent only 88% of this new budget as the number of service leaks unexpectedly dropped by about 15% from the previous years. Waterworks will continue to closely monitor the number of leaking services in the coming years to see how to best allocate resources and funding of this maintenance program.

4.2.3 Meters

In 2013 crews completed 1,133 new water meter installations and 682 water meter replacements.

The utility has been able to replace many of the older small meters and some of the large industrial fire meters while many mid-sized meters for larger commercial and higher zoned residential properties are reaching the end of their lifespan. The ability to repair and calibrate these meters is becoming much more difficult and costly. In many cases the meter manufacturers are no longer producing parts because meters are usually replaced once they start to fail.

While the Water Utility has funding to test, service and replace meters, the amount needs to be reviewed to ensure that it is adequate to support ongoing maintenance needs to allow meters to read accurately and to fund their replacement when they cannot perform their intended function.

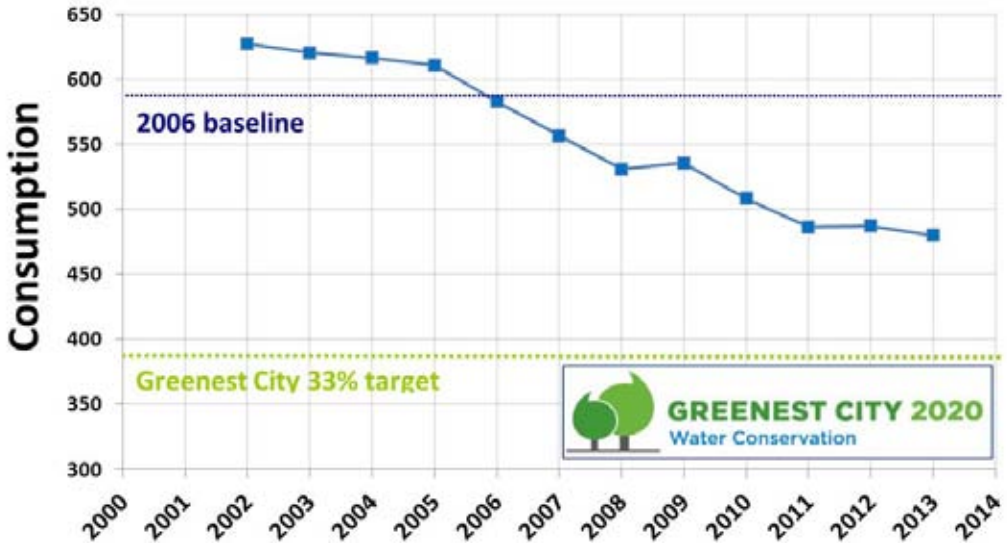
A sustainable long term funding strategy is being developed in response to the new metering policy that requires all new single and two-family residences to install a water meter.

5.0 Greenest City Goals for Clean Water

Vancouver City Council has approved the work and budget for implementing the water consumption goals as part of the Greenest City Action Plan. The majority of this work has focused on water conservation in order to reduce per capita water consumption by 33% from 2006 levels. To date, the City has achieved a 17.6% reduction; more than halfway towards the 2020 goal.

A summary of the progress to date is provided below:

Figure 9: Greenest City Water Consumption Goal (Liters per Capita)



While the City generally continues to show year over year declines in consumption, the rate of decline is slowing. In order to meet the Greenest City target by 2020, water consumption will continue to be monitored closely and new programs will be developed should the trend continue to slow.

As part of the Greenest City Action Plan, the City has also adopted a water quality target "to meet or beat the strongest British Columbian, Canadian and appropriate international drinking water quality standards and guidelines". In 2013 and as comprehensively discussed in an earlier section of this report, water quality met all standards and guidelines set by the three agency levels.

5.1 Water Conservation & System Leakage

Over the last three years, considerable effort has been spent reviewing the City's strategy to limit water losses in the system. In 2013, total water losses were estimated to be 12 billion litres, or 11% of total billed water purchased, a value of $7.2M. While this leakage rate is typical of water systems of comparable size and age, there remains an opportunity to reduce system leakage to realize operational savings and better the stewardship of this valuable resource. The current water loss reduction strategy consists of the following programs:

Table 10: Water Loss Reduction Programs

Program	Description
Proactive Leak Detection Survey	Distribution mains, services, other appurtenances
Hydrant Leak Detection Survey	Each Hydrant in the City is checked twice annually
Reactive Leak Detection Survey	Based on resident or corporate feedback
Pressure Management	Pressures in certain parts of the City are lowered to reduce system leakage

Furthermore, a number of water conservation programs were undertaken in 2013 to assist in further reducing water consumption. These are shown in the following table.

Table 11: Water Conservation Programs

Program	Description
Small Business Water Efficiency Audits	Pilot scale for commercial properties
Water efficiency fixture retrofit	Pilot scale for older building stock (rentals, condominiums)
Lawn Sprinkling Education and Enforcement	Educating and enforcing the sprinkling bylaw
Greenest City garden workshops	Neighbourhood scale engagement on outdoor water efficiency
Water efficiency in Parks and City Facilities	Fixture retrofits
Garden rain barrel program	Subsidized rain barrels for residents
Indoor and outdoor water saving kits	Subsidized water efficient fixtures for homes
Water conservation school plays, "H2 Whoa!"	Education for elementary school students
Seasonal water rates	Seasonal water rates for all metered customers (residential & commercial)

6.0 Financial Summary

In 2013, the City purchased and delivered approximately 109,600,000 cubic metres of water from Metro Vancouver at a total cost of $66.4 million; bulk water purchases make up approximately 64% of all Waterworks expenditures. The revenues collected from water users cover the cost of water purchases and the remaining expenditures are made-up of financing for capital projects, water billing costs, and operation and maintenance expenses.

The total of 2013 actual expenditures and revenues were within 1% of the forecasted budget. This is a good indication that estimates for water consumption are in line with current trends and that both operating and capital programs are well managed.

Waterworks also carries a "Water Rate Stabilization Reserve" to provide a funding buffer for year-over-year variations in demand and increases of bulk water rates from Metro Vancouver. While approximately $1.5M was transferred out of the Stabilization Reserve due to lower than anticipated revenues, it is $1M less than budgeted.

The following table displays the 2013 Waterworks Operating Budget alongside the actual year-end expenditures and revenues.

Table 12: 2013 Waterworks Expenditures and Revenues

Expenditures	Budget	Actual
City Debt Charges	$ 26,922,730	$ 26,922,730
Water Purchases (Metro Vancouver)	65,988,600	66,412,060
Water Rates Billing	691,864	621,006
Operating & Maintenance	11,401,951	10,403,406
Total Expenditures	**$ 105,005,145**	**$ 104,359,202**
Revenue	Budget	Actual
Flat Rate	$ 44,605,630	$ 44,019,537
Metered Rate	52,117,330	52,675,590
Meter Service Charge	2,498,550	3,548,975
Fire Line Flat Rate	3,434,830	2,601,503
Other Revenues	3,140	6,487
Total Revenues	**$ 102,659,480**	**$ 102,852,092**
Transfer from Stabilization Reserve	$ 2,345,665	$ 1,507,111
Total Revenues (incld. Transfer)	**$ 105,005,145**	**$ 104,359,202**

Even though the cost of bulk water purchases have been increasing, water consumption in Vancouver has been generally decreasing over the last several years, offsetting the overall impact.

7.0 Summary

In 2013, there were many accomplishments in terms of policy, maintenance, and construction. A number of initiatives were undertaken in order to reduce overall water use by the target of 33% from 2006 levels by the year 2020. These initiatives consisted mostly of the water conservation and leak detection programs.

Construction crews constructed distribution mains, transmission mains, and the neighbourhood energy utility (NEU) infrastructure. About 8.8km of distribution main and 230m of the Pender Transmission main was constructed. In addition waterworks operations staff installed branch and service connections for the NEU.

Operations and maintenance programs continued in 2014. These programs are necessary to ensure the operation and reliability of the water system.

Water quality also continued to meet provincial, federal and international standards and guidelines.

In 2014, there will be a continued effort to monitor performance across the utility to fine tune expenditures and target water system investments in order to meet three goals:

1) Ensuring that the drinking water quality delivered to customers meets all relevant health and quality guidelines,
2) Ensuring that water system assets are well managed and resilient, and
3) Making progress on the City's water consumption and water quality targets adopted as part of the Greenest City Action Plan's Clean Water goal, effectively offsetting population growth through efficient water use.

Appendix A - Source Water Quality

Physical and Chemical Analysis of Water Supply

Greater Vancouver Water District

2013 - Capilano Water System

Parameter	Untreated Average	Treated Average	Treated Range	Days Guideline Exceeded	Canadian Guideline Limit	Reason Guideline Established
Alkalinity as $CaCO_3$ (mg/L)	2.6	3.0	2.9 - 3.2		none	
Aluminium Dissolved (µg/L)	75	75	68 - 82		none	
Aluminium Total (µg/L)	101	91	83 - 99		none	
Antimony Total (µg/L)	<0.5	<0.5	<0.5	0	6	health
Arsenic Total (µg/L)	<0.5	<0.5	<0.5	0	10	health
Barium Total (µg/L)	2.8	2.1	2.1	0	1000	health
Boron Total (mg/L)	<0.01	<0.01	<0.01	0	5	health
Bromate (mg/L)		<0.01	<0.01	0	0.01	health
Bromide (mg/L)		<0.01	<0.01		none	
Cadmium Total (µg/L)	<0.2	<0.2	<0.2	0	5	health
Calcium Total (mg/L)	1.26	1.07	1.04 - 1.12		none	
Carbon Organic Dissolved (mg/L)	1.8		1.3 - 1.7		none	
Carbon Organic Total (mg/L)	1.78	1.59	1.30 - 1.77		none	
Chlorate (mg/L)	<0.01	0.05	0.05	0	1.0	health
Chloride Total (mg/L)	0.6	1.9	1.7 - 2.2	0	≤ 250	aesthetic
Chromium Total (µg/L)	0.08	0.07	0.07	0	50	health
Color Apparent (ACU)	14	6	2 - 9		none	
Color True (TCU)	12	4	2 - 7	0	≤ 15	aesthetic
Conductivity (umhos/cm)	11	15	13 - 17		none	
Copper Total (µg/L)	2.9	1.4	1.4		≤ 1000	aesthetic
Cyanide Total (mg/L)	<0.02	<0.02	<0.02	0	0.2	health
Fluoride (mg/L)	<0.05	<0.05	<0.05	0	1.5	health
Hardness as $CaCO_3$ (mg/L)	3.65	3.24	3.14 - 3.42		none	
Iron Dissolved (µg/L)	37	25	14 - 51		none	
Iron Total (µg/L)	126	51	29 - 109	0	≤ 300	aesthetic
Lead Total (µg/L)	<0.5	<0.5	<0.5		10	health
Magnesium Total (µg/L)	171	137	131 - 152		none	
Manganese Dissolved (µg/L)	11	1.7	1.3 - 2.6		none	
Manganese Total (µg/L)	6.9	2.0	1.5 - 3.0	0	≤50	aesthetic
Mercury Total (µg/L)	<0.05	<0.05	<0.05	0	1.0	health
Nickel Total (µg/L)	<0.5	<0.5	<0.5		none	
Nitrogen - Ammonia as N (mg/L)	<0.02	<0.02	<0.02		none	
Nitrogen - Nitrate as N (mg/L)	0.09	0.06	0.03 - 0.08	0	10	health
Nitrogen - Nitrite as N (mg/L)	<0.01	<0.01	<0.01	0	1.0	health
pH	6.5	6.6	6.5 - 6.7	0	6.5 to 8.5	aesthetic
Phenols (µg/L)	<5	<5	<5		none	
Phosphorus Total (µg/L)	<5	<5	<5		none	
Potassium Total (µg/L)	162	125	125		none	
Residue Total (mg/L)	14	16	16		none	
Residue Total Dissolved (mg/L)	13	15	13 - 16	0	≤ 500	aesthetic
Residue Total Fixed (mg/L)	9	10	10		none	
Residue Total Volatile (mg/L)	6	6	6		none	
Selenium Total (µg/L)	<0.5	<0.5	<0.5	0	10	health
Silica as SiO_2 (mg/L)	3.4	2.8	2.7 - 2.8		none	
Silver Total (µg/L)	<0.5	<0.5	<0.5		none	
Sodium Total (mg/L)	0.58	1.7	1.69 - 1.71	0	≤200	aesthetic
Sulphate (mg/L)	0.8	0.7	0.6 - 0.8	0	≤500	aesthetic
Turbidity (NTU)	0.49	0.30	0.20 - 0.56			
Uranium Total (µg/L)	0.036			0	<20	health
UV254 (Abs/cm)	0.074	0.051	0.041 - 0.056		none	
Zinc Total (µg/L)	<3	<3	<3	0	≤ 5000	aesthetic

These figures are average values from a number of laboratory analyses done throughout the year. Where the range is a single value no variation was measured for the samples analysed. Methods and terms are based on those of "Standard Methods of Water and Waste Water" 22nd Edition 2012. Less than (<) denotes not detectable with the technique used for determination. Untreated water is from the intake prior to chlorination, treated water is from a sample line after 10 minutes chlorine contact time. Guidelines are taken from "Guidelines for Canadian Drinking Water Quality - Sixth Edition" Health and Welfare Canada 1996, updated to Aug 2012. Capilano source water is treated with sodium hypochlorite for disinfection. Capilano source was out of service from January 1- May 3, and August 30 -December 31. It was operational for only 117 days in 2013.

Physical and Chemical Analysis of Water Supply

Greater Vancouver Water District

2013 - Seymour Water System

Parameter	Untreated		Treated		Days Guideline Exceeded	Canadian Guideline Limit	Reason Guideline Established
	Average	Range	Average	Range			
Alkalinity as $CaCO_3$ (mg/L)	3.5	2.6-4.2	7	5.0-9.5		none	
Aluminium Dissolved (µg/L)	61	36-98	38	15-80		none	
Aluminium Total (µg/L)	90	57-169	35	14-87	0	200	aesthetic
Antimony Total (µg/L)	<0.5	<0.5	<0.5	<0.5	0	6	health
~~Arsenic Total (µg/L)~~	~~<0.5~~	~~<0.5~~	~~<0.5~~	~~<0.5~~	~~0~~	~~10~~	~~health~~
Barium Total (µg/L)	3.5	3-5	3.8	3.0 - 4.4	0	1000	health
Boron Total (mg/L)	<10	<10	<10	<10		5	
Bromate (mg/L)	<0.01	<0.01	<0.01	<0.01	0	0.01	health
Bromide (mg/L)	<0.01	<0.01	<0.01	<0.01	0	none	health
Cadmium Total (µg/L)	<0.2	<0.2	<0.2	<0.2	0	5	health
Calcium Total (mg/L)	1.72	1.48-2.05	3.51	2.69-4.31		none	
Carbon Organic Dissolved (mg/L)	1.5	0.9-2.6	0.7	0.5-0.9		none	
Carbon Organic Total (mg/L)	1.77	1.14-3.2	0.70	0.5 - 1.15		none	
Chlorate (mg/L)	<0.01	<0.01	<0.01	<0.01	0	1.0	health
Chloride Total (mg/L)	<0.5	<0.5	<0.5	<0.5	0	≤ 250	aesthetic
Chromium Total (µg/L)	<0.05	<0.05	<0.05	<0.05 - 0.07	0	50	health
Color Apparent (ACU)	17	12-48	<2	<2		none	
Color True (TCU)	12	6-22	<2	<2	0	≤ 15	aesthetic
Conductivity (umhos/cm)	13	10-16	13	10 - 16		none	
Copper Total (µg/L)	11.2	5.8-22.1	0.8	<0.5-0.8	0	≤1000	aesthetic
Cyanide Total (mg/L)	<0.02	<0.02	<0.02	<0.02	0	0.2	health
Fluoride (mg/L)	<0.05	<0.05	<0.05	<0.05	0	1.5	health
Hardness as $CaCO_3$ (mg/L)	4.88	4.25-6.03	9.42	7.38-11.6		none	
Iron Dissolved (µg/L)	88	26-176	<5	<5-9		none	
Iron Total (µg/L)	211	63-481	5	<5-10	0	≤ 300	aesthetic
Lead Total (µg/L)	<0.5	<0.5	<0.5	<0.5	0	10	health
Magnesium Total (µg/L)	160	135-218	165	144-190		none	
Manganese Dissolved (µg/L)	6.6	2.3-15.5	6.3	1.9-14.0		none	
Manganese Total (µg/L)	9.2	2.9-27.0	6.8	2.1-15.3	0	≤ 50	aesthetic
Mercury Total (µg/L)	<0.05	<0.05	<0.05	<0.05	0	1.0	health
Nickel Total (µg/L)	<0.5	<0.5	<0.5	<0.5		none	
Nitrogen - Ammonia as N (mg/L)	<0.02	<0.02	<0.02	<0.02		none	
Nitrogen - Nitrate as N (mg/L)	0.07	0.01-0.11	0.07	0.01 - 0.11	0	10	health
Nitrogen - Nitrite as N (mg/L)	<0.01	<0.01	<0.01	<0.01	0	1.0	health
pH	6.5	6.2-6.8	7.4	7.2 - 7.7	0	6.5 to 8.5	aesthetic
Phenols (µg/L)	<5	<5	<5	<5		none	
Phosphorus Total (µg/L)	<5	<5	<5	<5		none	
Potassium Total (µg/L)	166	137-194	165	139-191		none	
Residue Total (mg/L)	16	15-18	17	15 - 18		none	
Residue Total Dissolved (mg/L)	15	11-16	14	11 - 16	0	≤ 500	aesthetic
Residue Total Fixed (mg/L)	11	9-14	11	9 - 14		none	
Residue Total Volatile (mg/L)	6	4-8	6	4 - 8		none	
Selenium Total (µg/L)	<0.5	<0.5	<0.5	<0.5	0	10	health
Silica as SiO_2 (mg/L)	3.3	2.7-3.9	3.3	2.7 - 3.9		none	
Silver Total (µg/L)	<0.5	<0.5	<0.5	<0.5		none	
Sodium Total (mg/L)	0.55	0.45-0.64	0.56	0.45 - 0.69	0	≤ 200	aesthetic
Sulphate (mg/L)	1.3	1.0-1.7	2.9	2.5-3.6	0	≤ 500	aesthetic
Turbidity (NTU)	0.50	0.21-4.70	0.055	0.041 - 0.090		≤0.3	
Uranium Total (µg/L)	0.033					<20	health
UV254 {cm^{-1} (% Transmittance)} Apparent	0.079 (83.4)	0.062-0.128 (74.5-86.7)	0.012 (97.3)	0.006 - 0.019 (95.7-98.6)		none	
UV254 (cm^{-1}) True	0.067	0.041-0.111	0.012	0.006 - 0.019		none	
Zinc Total (µg/L)	<3	<3	<3	<3	0	≤ 5000	aesthetic

These figures are average values from a number of laboratory analyses done throughout the year. Where the range is a single value no variation was measured for the samples analysed. Methods and terms are based on those of "Standard Methods of Water and Waste Water" 22nd Edition 2012. Less than (<) denotes not detectable with the technique used for determination. Untreated water is from the intake or a sample site prior to coagulation, treated water is from a sample site downstream of SCFP clearwell. Guidelines are taken from "Guidelines for Canadian Drinking Water Quality - Sixth Edition" Health and Welfare Canada 1996, updated to Aug 2012. Seymour source water is filtered, disinfected with UV light and sodium hypochlorite for primary and secondary disinfections, respectively; lime is added to increase pH and alkalinity while CO_2 is added to adjust pH. Turbidity and pH for raw and treated waters were taken from SCADA. TOC and UV254 (cm^{-1} and % Transmittance) were taken from SCFP WQC Lab data. Seymour Source was operational for 365 days in 2013.

Physical and Chemical Analysis of Water Supply

Greater Vancouver Water District

2013 - Coquitlam Water System

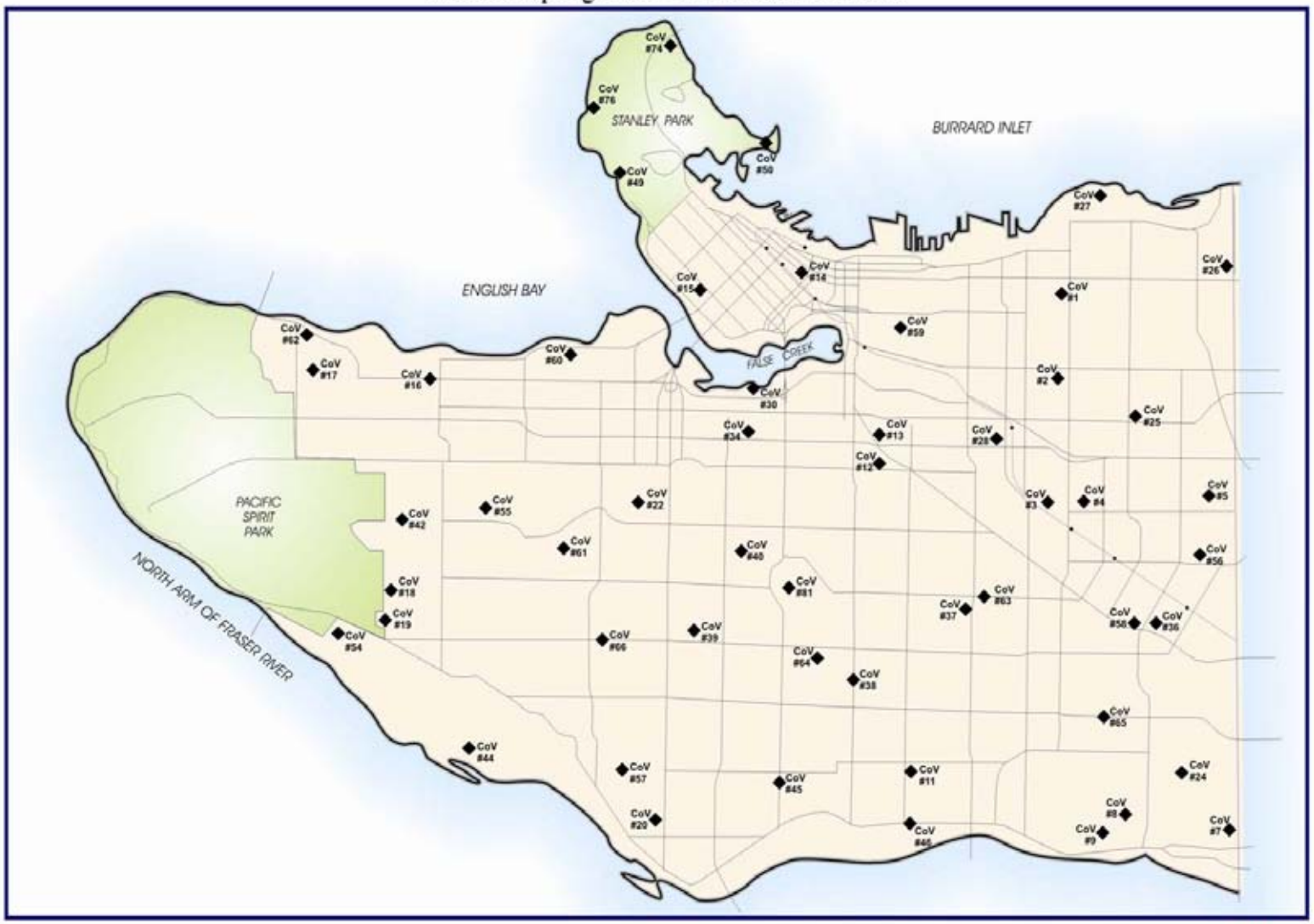
Parameter	Untreated	Treated			Canadian Guideline Limit	Reason Guideline Established
	Average	Average	Range	Days Guideline Exceeded		
Alkalinity as $CaCO_3$ (mg/L)	1.5	8.6	7.6 - 10.0		none	
Aluminium Dissolved (µg/L)	65	62	52 - 68		none	
Aluminium Total (µg/L)	83	80	72 - 87		none	
Antimony Total (µg/L)	<0.5	<0.5	<0.5	0	6	health
Arsenic Total (µg/L)	<0.5	<0.5	<0.5	0	10	health
Barium Total (µg/L)	2.3	2.6	2.3-2.9	0	1000	health
Boron Total (mg/L)	<0.01	<0.01	<0.01		5	
Bromate (mg/L)		<0.01	<0.01	0	0.01	health
Bromide (mg/L)		<0.01	<0.01	0	none	health
Cadmium Total (µg/L)	<0.2	<0.2	<0.2	0	5	health
Calcium Total (mg/L)	0.86	0.85	0.75-0.91		none	
Carbon Organic Dissolved (mg/L)	1.5	1.5	1.1-1.9		none	
Carbon Organic Total (mg/L)	1.5	1.5	1.1-1.8		none	
Chlorate (mg/L)		0.06	<0.01-0.16	0	1.0	health
Chloride Total (mg/L)	<0.5	1.5	1.6-2.2	0	≤ 250	aesthetic
Chromium Total (µg/L)	<0.05	<0.05	<0.05	0	50	health
Color Apparent (ACU)	12	2	<1-7		none	
Color True (TCU)	10	2	<1-6	0	≤ 15	aesthetic
Conductivity (umhos/cm)	8	25	16-31		none	
Copper Total (µg/L)	7	0.6	0.5-0.6	0	≤ 1000	aesthetic
Cyanide Total (mg/L)	<0.02	<0.02	<0.02	0	0.2	health
Fluoride (mg/L)	<0.05	<0.05	<0.05	0	1.5	health
Hardness as $CaCO_3$ (mg/L)	2.54	2.52	2.32-2.70		none	
Iron Dissolved (µg/L)	18	19	15-26		none	
Iron Total (µg/L)	45	46	31-73	0	≤ 300	aesthetic
Lead Total (µg/L)	<0.5	<0.5	<0.5	0	10	health
Magnesium Total (µg/L)	98	99	87-110		none	
Manganese Dissolved (µg/L)	3.5	2.4	1.8-2.9		none	
Manganese Total (µg/L)	3.9	2.9	2.1-3.6	0	≤ 50	aesthetic
Mercury Total (µg/L)	<0.05	<0.05	<0.05	0	1.0	health
Nickel Total (µg/L)	<0.5	<0.5	<0.5		none	
Nitrogen - Ammonia as N (mg/L)	<0.02	<0.02	<0.02		none	
Nitrogen - Nitrate as N (mg/L)	0.11	0.09	0.05-0.11	0	10	health
Nitrogen - Nitrite as N (mg/L)	<0.01	<0.01	<0.01	0	1.0	health
pH	6.2	7.4	6.6-8.4	0	6.5 to 8.5	aesthetic
Phenols (µg/L)	<5	<5	<5		none	
Phosphorus Total (µg/L)	<5	<5	<5		none	
Potassium Total (mg/L)	0.11	0.11	0.11-0.12		none	
Residue Total (mg/L)	12	24	21-27		none	
Residue Total Dissolved (mg/L)	10	19	16-22	0	≤ 500	aesthetic
Residue Total Fixed (mg/L)	7	17	15-20		none	
Residue Total Volatile (mg/L)	5	6	4-8		none	
Selenium Total (µg/L)	<0.5	<0.5	<0.5	0	10	health
Silica as SiO_2 (mg/L)	2.8	2.4	2.1-2.6		none	
Silver Total (µg/L)	<0.5	<0.5	<0.5		none	
Sodium Total (mg/L)	0.5	4.6	2.2-5.8	0	≤ 200	aesthetic
Sulphate (mg/L)	0.7	0.7	0.6-0.8	0	≤ 500	aesthetic
Turbidity (NTU)	0.35	0.31	0.16-1.20			
Uranium Total (µg/L)	0.048			0	<20	health
UV254 (Abs/cm)	0.062	0.023	0.008-0.050		none	
UV254 App. (Abs/cm)	0.070	0.028	0.015-0.068		none	
Zinc Total (µg/L)	<3	<3	<3	0	≤ 5000	aesthetic

These figures are average values from a number of laboratory analyses done throughout the year. Where the range is a single value no variation was measured for the samples analysed. Methods and terms are based on those of "Standard Methods of Water and Waste Water" 22nd Edition 2012. Less than (<) denotes not detectable with the technique used for determination. Untreated water is from the intake prior to chlorination, treated water is from a single site in the GVWD distribution system downstream of chlorination. Guidelines are taken from "Guidelines for Canadian Drinking Water Quality - Sixth Edition" Health and Welfare Canada 1996, updated to Aug 2012. Coquitlam water is treated with ozone for primary disinfection, chlorine for secondary disinfection, soda ash to increase pH and alkalinity, and CO_2 to adjust the pH. Coquitlam was operational for 365 days in 2013.

Appendix B - Water Sampling Stations (Map)

CITY OF VANCOUVER

Water Sampling Sites - 53 Dedicated Stations



N.T.S.

Appendix C - Metals Analysis

Metals Analysis of CoV Distribution System – 2013 (Metals analysis performed by Metro Vancouver laboratory)

		COV-09		COV-19		COV-26		COV-34		COV-39		Canadian Guideline
		14-May-2013	27-Nov-2013	14-May-2013	27-Nov-2013	14-May-2013	27-Nov-2013	14-May-2013	27-Nov-2013	14-May-2013	27-Nov-2013	
Aluminum Total	mg/L	0.032	0.038	0.100	0.029	0.040	0.031	0.134	0.027	0.076	0.032	<0.2 (A/O)
Antimony Total	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.006
Arsenic Total	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.010
Barium Total	mg/L	0.0028	0.0038	0.0025	0.0033	0.0029	0.0037	0.0024	0.0037	0.0030	0.0037	1.0
Boron	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	5
Cadmium Total	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.005
Calcium Total	mg/L	2.730	3.540	1.200	3.660	2.910	3.610	1.100	3.630	2.680	3.510	none req'd
Chromium Total	mg/L	<0.00005	0.00009	0.00006	0.00005	<0.00005	<0.00005	0.00007	0.00006	<0.00005	0.00005	0.05
Cobalt Total	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	none
Copper Total	mg/L	<0.0005	0.0007	0.0094	0.0030	0.0012	0.0009	0.0028	0.0010	0.0010	0.0006	≤1.0 (A/O)
Iron Total	mg/L	0.009	0.023	0.050	0.022	0.017	0.019	0.072	0.011	0.059	<0.005	≤0.3 (A/O)
Lead Total	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.010
Magnesium Total	mg/L	0.138	0.164	0.136	0.160	0.139	0.163	0.139	0.163	0.144	0.162	none req'd
Manganese Total	mg/L	0.0012	0.0091	0.0014	0.0011	0.0014	0.0017	0.0031	0.0009	0.0159	0.0013	≤0.05 (A/O)
Mercury Total	mg/L	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.001
Molybdenum Total	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	None
Nickel Total	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	None
Potassium Total	mg/L	0.132	0.187	0.129	0.192	0.138	0.192	0.128	0.192	0.132	0.192	None
Selenium Total	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.01
Silver Total	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	none req'd
Sodium Total	mg/L	1.310	1.680	1.840	1.670	1.310	1.470	1.850	1.640	1.300	1.640	≤200 (A/O)
Zinc Total	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	≤5.0 (A/O)

1. A/O - Aesthetic Objective
2. Copper, iron, lead and zinc require semi-annual testing as per the Water Quality Monitoring and Reporting Plan for the GVRD and Member Municipalities, Since the method for metals analysis produces other metal results, these values are also provided.

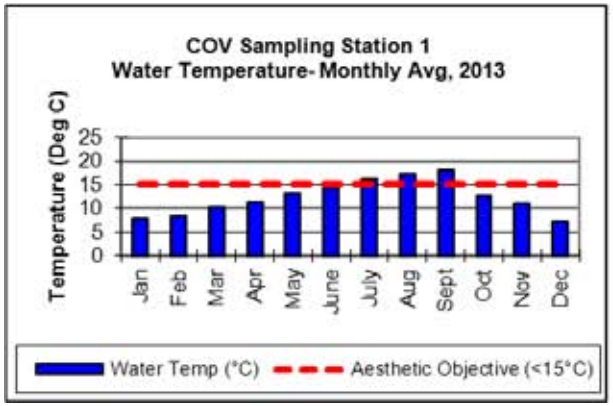
Appendix D - Disinfection By-products

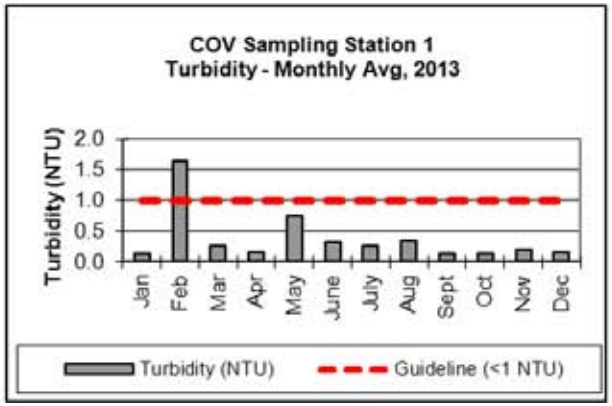
Sample	Date Sampled	THM (ppb)							HAA (ppb)						
		Bromodichloromethane	Bromoform	Chlorodibromomethane	Chloroform	Total Trihalomethanes	**Total THM Quarterly Average (MAC = 100 ppb)**		Dibromoacetic Acid	Dichloroacetic Acid	Monobromoacetic Acid	Monochloroacetic Acid	Trichloroacetic Acid	Total Haloacetic Acid	**Total HAA Quarterly Average (MAC = 80 ppb)**
COV-03	5/10/2012	<1	<1	<1	26	26			<0.5	17	<1	7	18	43	
COV-03	8/30/2012	<1	<1	<1	39	39			<0.5	13	<1	<2	19	33	
COV-03	11/29/2012	<1	<1	<1	23	23			<0.5	10	<1	<2	11	20	
COV-03	2/21/2013	<1	<1	<1	27	28	**29**		<0.5	11	1	2	16	31	**32**
COV-03	5/16/2013	<1	<1	<1	61	61	**38**		<0.5	21	<1	2	23	48	**33**
COV-03	9/19/2013	1	<1	<1	31	32	**36**		<0.5	3	<1	4	19.7	27	**32**
COV-03	11/28/2013	<1	<1	<1	24	25	**36**		<0.5	8	<1	8	10.7	28	**34**
COV-07	5/10/2012	<1	<1	<1	23	23			<0.5	20	<1	13	16	49	
COV-07	8/30/2012	<1	<1	<1	24	24			<0.5	8	<1	2	7	17	
COV-07	11/29/2012	<1	<1	<1	21	21			<0.5	8	<1	2	10	21	
COV-07	2/21/2013	<1	<1	<1	23	24	**23**		<0.5	10	<1	2	11	24	**27**
COV-07	5/16/2013	<1	<1	<1	23	23	**23**		<0.5	7	<1	<2	13	21	**21**
COV-07	9/19/2013	<1	<1	<1	27	28	**24**		<0.5	14	<1	6	13.4	35	**25**
COV-07	11/28/2013	<1	<1	<1	22	23	**24**		<0.5	7	<1	6	5.1	19	**25**
COV-24	5/10/2012	<1	<1	<1	22	22			<0.5	16	<1	10	13	39	
COV-24	8/30/2012	<1	<1	<1	25	25			<0.5	8	<1	3	6	17	
COV-24	11/29/2012	<1	<1	<1	22	22			<0.5	9	<1	<2	9	18	
COV-24	2/21/2013	<1	<1	<1	15	16	**21**		<0.5	6	<1	<2	5	13	**22**
COV-24	5/16/2013	<1	<1	<1	24	24	**22**		<0.5	8	<1	2	12	23	**18**
COV-24	9/19/2013	<1	<1	<1	25	26	**22**		<0.5	9	<1	5	10.9	27	**20**
COV-24	11/28/2013	<1	<1	<1	22	23	**22**		<0.5	7	<1	6	7.5	22	**21**
COV-28	5/10/2012	<1	<1	<1	24	24			<0.5	14	<1	7	17	38	
COV-28	8/30/2012	<1	<1	<1	51	51			<0.5	17	<1	<2	29	47	
COV-28	11/29/2012	<1	<1	<1	26	26			<0.5	9	<1	2	12	23	
COV-28	2/21/2013	<1	<1	<1	16	17	**29**		<0.5	6	<1	4	5	16	**31**
COV-28	5/16/2013	<1	<1	<1	75	75	**42**		<0.5	31	<1	2	43	76	**40**
COV-28	9/19/2013	1	<1	<1	31	32	**38**		<0.5	7	<1	5	12	25	**35**
COV-28	11/28/2013	<1	<1	<1	26	26	**38**		<0.5	8	<1	7	11.2	28	**36**

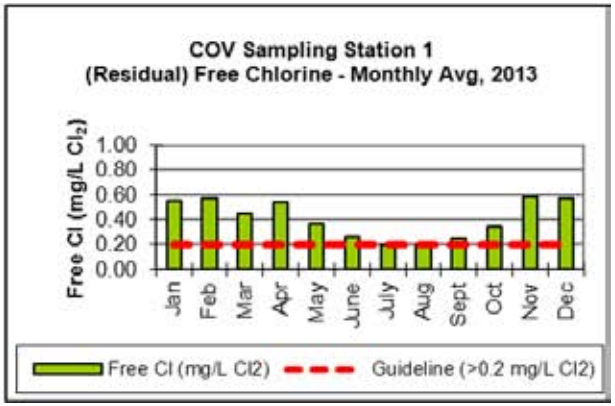
Sample	Date Sampled	THM (ppb)							HAA (ppb)						
		Bromodichloromethane	Bromoform	Chlorodibromomethane	Chloroform	Total Trihalomethanes	**Total THM Quarterly Average (MAC = 100 ppb)**		Dibromoacetic Acid	Dichloroacetic Acid	Monobromoacetic Acid	Monochloroacetic Acid	Trichloroacetic Acid	Total Haloacetic Acid	**Total HAA Quarterly Average (MAC = 80 ppb)**
COV-30	8/30/2012	<1	<1	<1	27	27			<0.5	19	<1	<2	14	33	
COV-30	11/29/2012	<1	<1	<1	20	20			<0.5	9	<1	<2	9	18	
COV-30	2/21/2013	<1	<1	<1	14	15	**20**		<0.5	5	<1	<2	4	11	**23**
COV-30	5/16/2013	<1	<1	<1	40	40	**26**		<0.5	25	<1	2	23	51	**28**
COV-30	9/19/2013	<1	<1	<1	24	25	**25**		<0.5	9	<1	6	9.9	26	**26**
COV-30	11/28/2013	<1	<1	<1	21	22	**25**		<0.5	8	<1	7	8.9	24	**28**
COV-46	5/10/2012	<1	<1	<1	20	20									
COV-46	8/30/2012	<1	<1	<1	23	23									
COV-46	11/29/2012	<1	<1	<1	20	20									
COV-46	2/21/2013	<1	<1	<1	19	19	**21**								
COV-46	5/16/2013	<1	<1	<1	19	19	**20**								
COV-46	9/19/2013	1	<1	<1	26	27	**21**								
COV-46	11/28/2013	<1	<1	<1	21	21	**22**								
COV-54	5/10/2012	<1	<1	<1	28	28			<0.5	19	<1	9	20	48	
COV-54	8/30/2012	<1	<1	<1	36	36			<0.5	17	<1	<2	18	36	
COV-54	11/29/2012	<1	<1	<1	26	26			<0.5	8	<1	<2	10	18	
COV-54	2/21/2013	<1	<1	<1	32	32	**30**		<0.5	13	<1	<2	16	30	**33**
COV-54	5/16/2013	<1	<1	<1	68	68	**40**		<0.5	28	<1	2	38	69	**38**
COV-54	9/19/2013	<1	<1	<1	30	31	**39**		<0.5	7	<1	6	19.1	33	**38**
COV-54	11/28/2013	<1	<1	<1	28	29	**40**		<0.5	6	<1	6	10.8	25	**39**
COV-55	5/10/2012	<1	<1	<1	25	25			<0.5	19	<1	35	14	68	
COV-55	8/30/2012	<1	<1	<1	25	25			<0.5	10	<1	5	6	21	
COV-55	11/29/2012	<1	<1	<1	21	21			<0.5	8	<1	<2	9	17	
COV-55	2/21/2013	<1	<1	<1	25	25	**24**		<0.5	10	<1	3	10	24	**32**
COV-55	5/16/2013	<1	<1	<1	24	24	**24**		<0.5	7	<1	<2	11	20	**20**
COV-55	9/19/2013	<1	<1	<1	28	29	**25**		<0.5	11	<1	6	15.5	33	**24**
COV-55	11/28/2013	<1	<1	<1	21	22	**25**		<0.5	6	<1	6	6.3	20	**24**

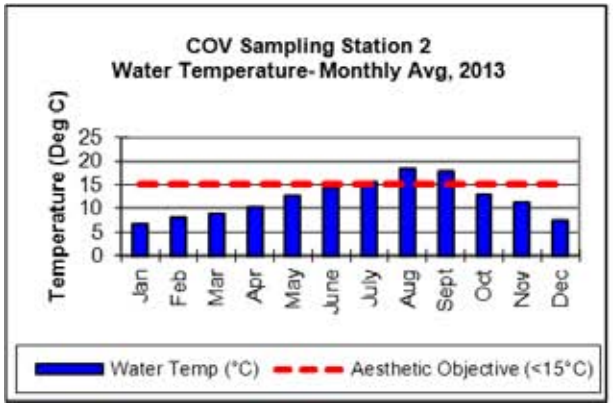
Sample	Date Sampled	THM (ppb)							HAA (ppb)						
		Bromodichloromethane	Bromoform	Chlorodibromomethane	Chloroform	Total Trihalomethanes	**Total THM Quarterly Average (MAC = 100 ppb)**		Dibromoacetic Acid	Dichloroacetic Acid	Monobromoacetic Acid	Monochloroacetic Acid	Trichloroacetic Acid	Total Haloacetic Acid	**Total HAA Quarterly Average (MAC = 80 ppb)**
COV-58	8/30/2012	<1	<1	<1	24	24			<0.5	9	<1	<2	5	14	
COV-58	11/29/2012	<1	<1	<1	20	20			<0.5	8	<1	2	8	19	
COV-58	2/21/2013	<1	<1	<1	21	21	**22**		<0.5	9	<1	<2	8	18	**22**
COV-58	5/16/2013	<1	<1	<1	22	22	**22**		<0.5	7	<1	<2	11	21	**18**
COV-58	9/19/2013	<1	<1	<1	27	28	**23**		<0.5	14	<1	7	12.4	34	**23**
COV-58	11/28/2013	<1	<1	<1	22	23	**23**		<0.5	8	<1	7	5.4	22	**24**
COV-62	5/10/2012	<1	<1	<1	26	26									
COV-62	8/30/2012	<1	<1	<1	34	34									
COV-62	11/29/2012	<1	<1	<1	25	25									
COV-62	2/21/2013	<1	<1	<1	26	27	**28**								
COV-62	5/16/2013	<1	<1	<1	26	26	**28**								
COV-62	9/19/2013	1	<1	<1	36	38	**29**								
COV-62	11/28/2013	<1	<1	<1	28	29	**30**								

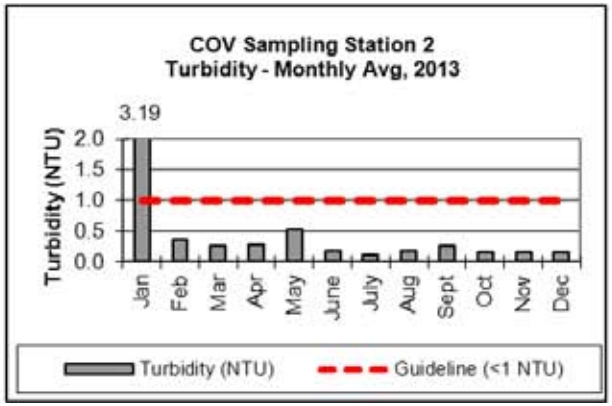
Appendix E - Sampling Site Characterization

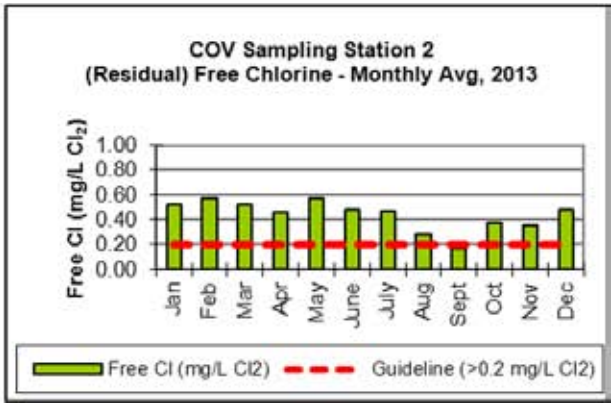

COV Sampling Station 1
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

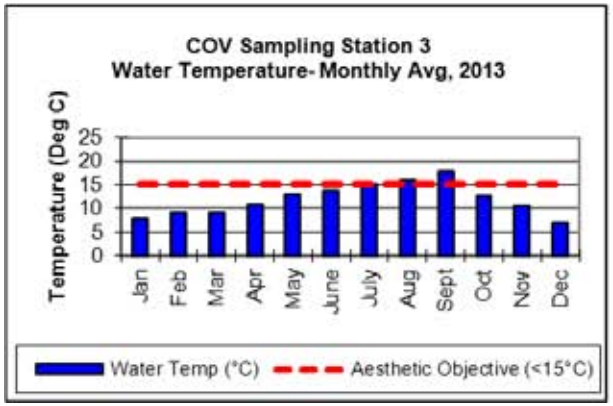

COV Sampling Station 1
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

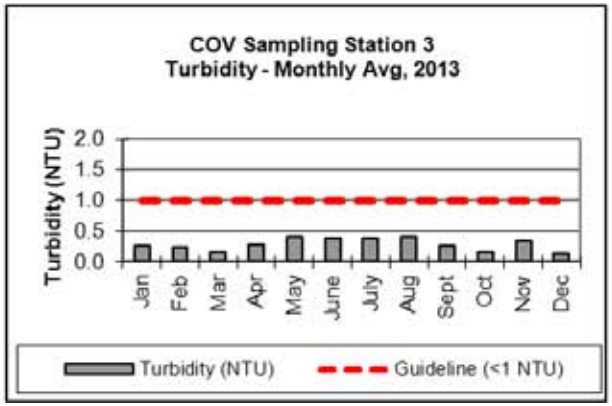

COV Sampling Station 1
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

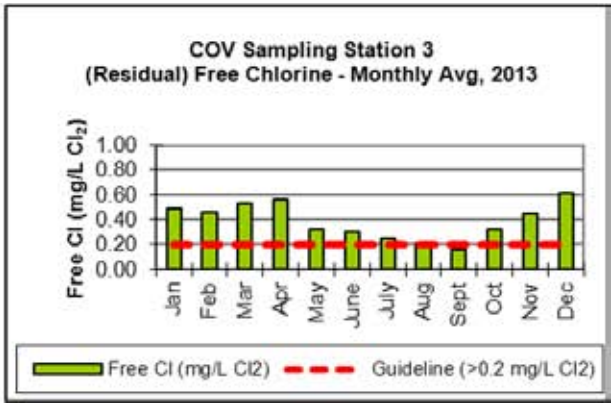

COV Sampling Station 2
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

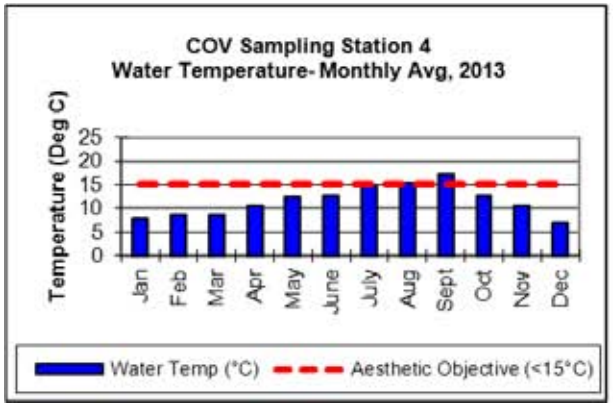

COV Sampling Station 2
Turbidity - Monthly Avg, 2013
3.19
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

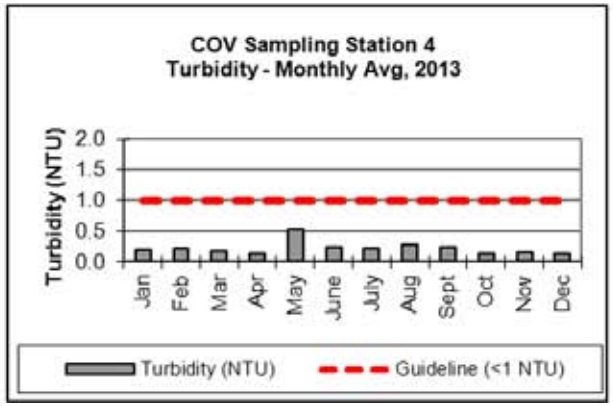

COV Sampling Station 2
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

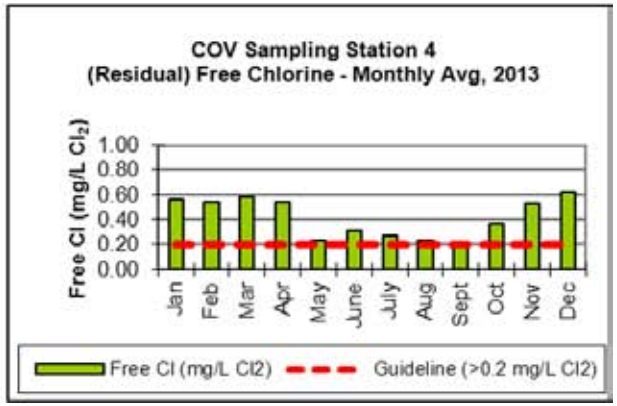

COV Sampling Station 3
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

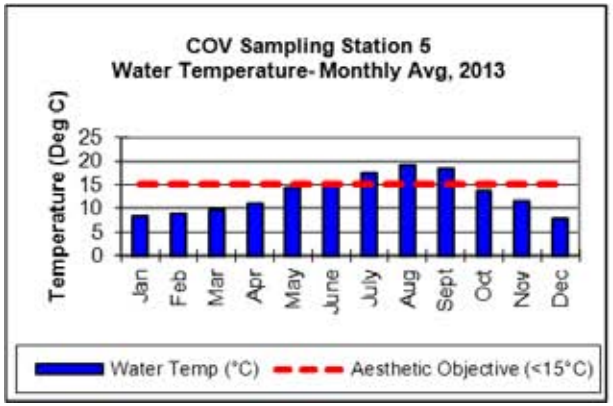

COV Sampling Station 3
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

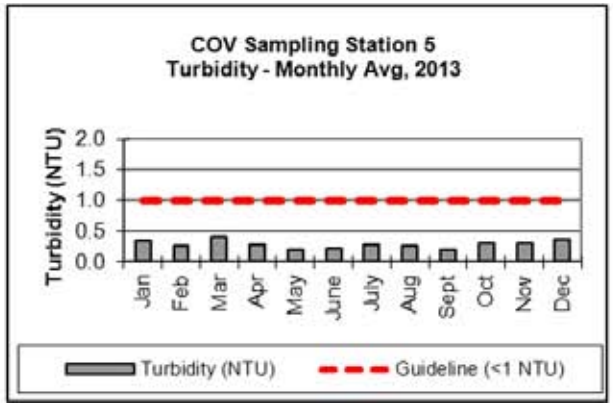

COV Sampling Station 3
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

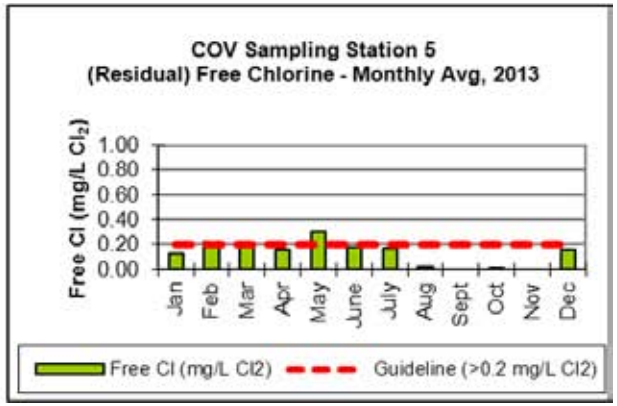

COV Sampling Station 4
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

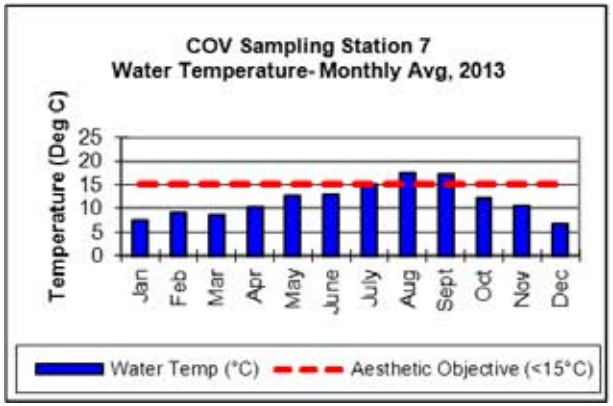

COV Sampling Station 4
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

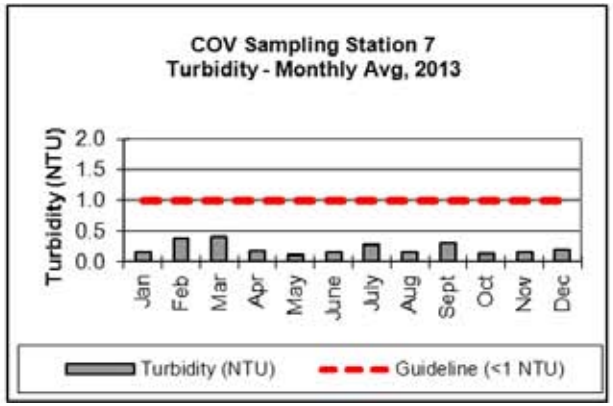

COV Sampling Station 4
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

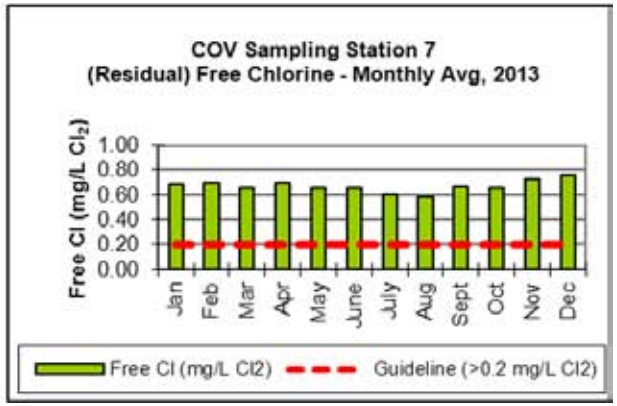

COV Sampling Station 5
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

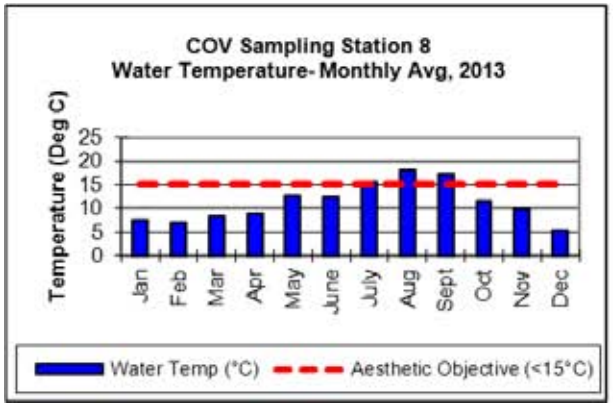

COV Sampling Station 5
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

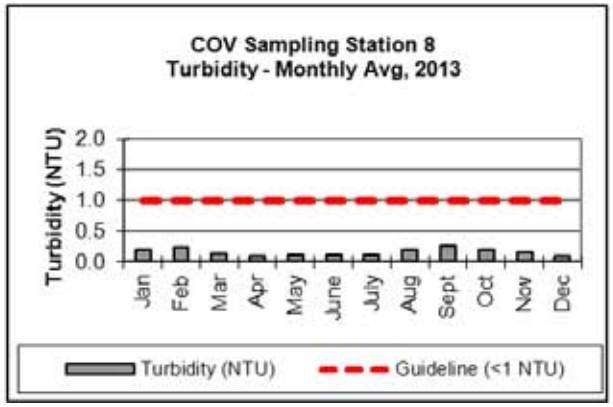

COV Sampling Station 5
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

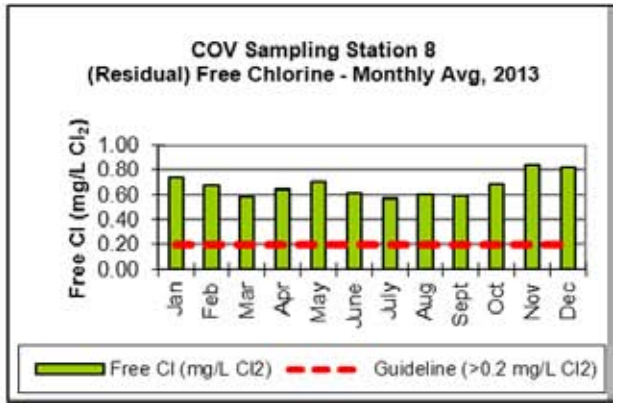

COV Sampling Station 7
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

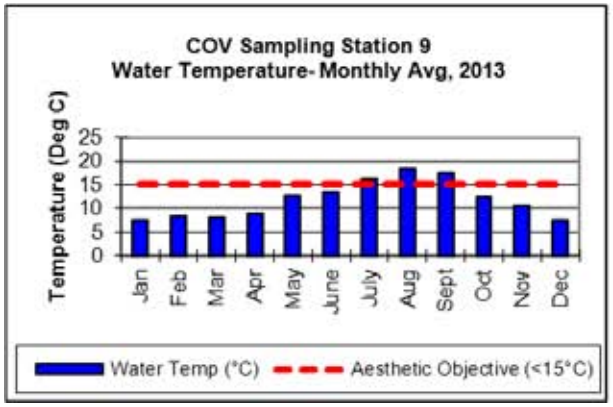

COV Sampling Station 7
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

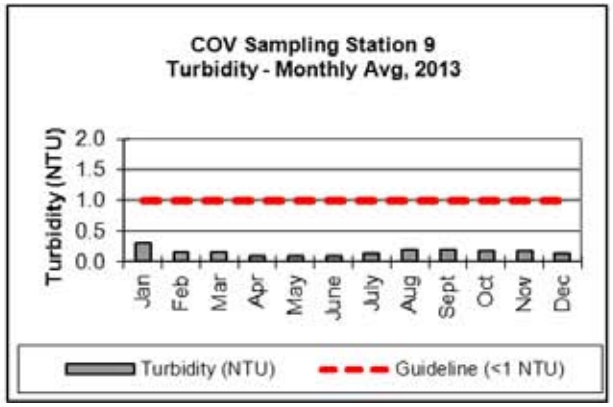

COV Sampling Station 7
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

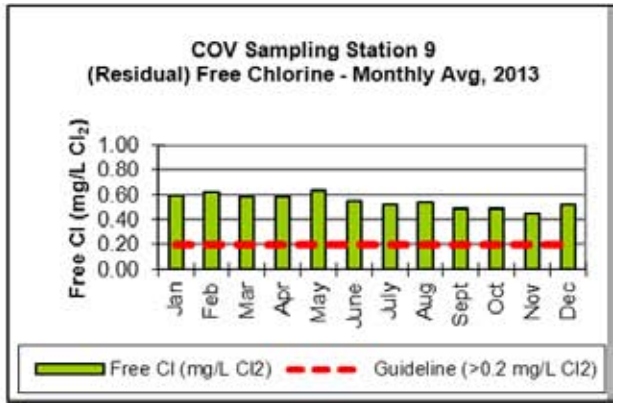

COV Sampling Station 8
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

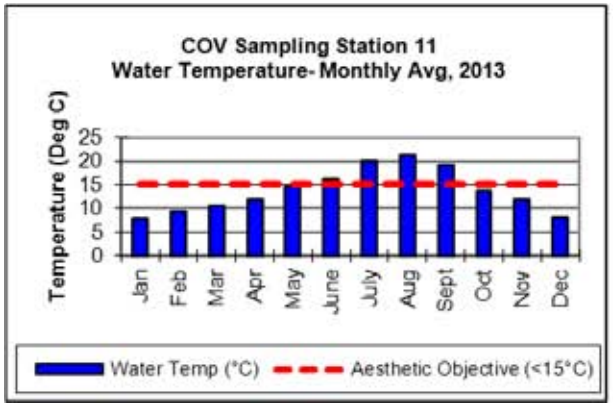

COV Sampling Station 8
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

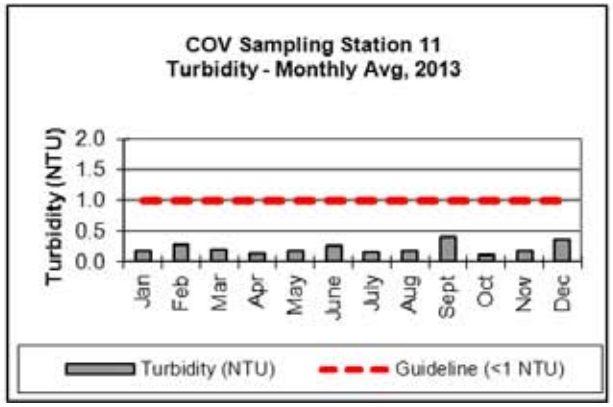

COV Sampling Station 8
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

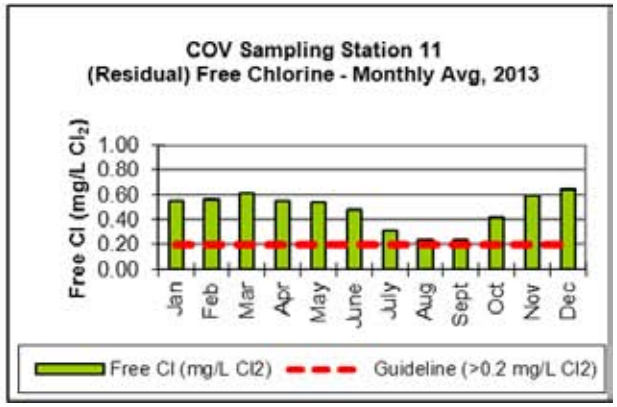

COV Sampling Station 9
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

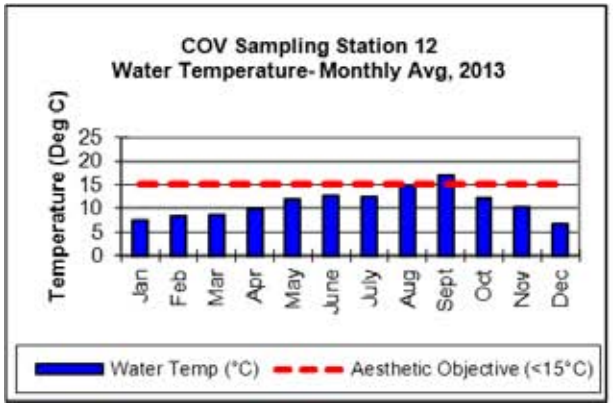

COV Sampling Station 9
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

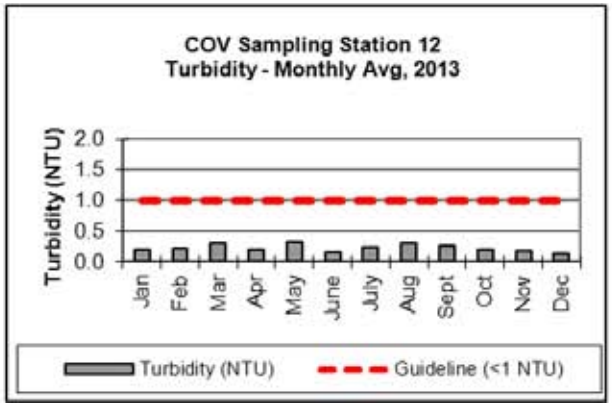

COV Sampling Station 9
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

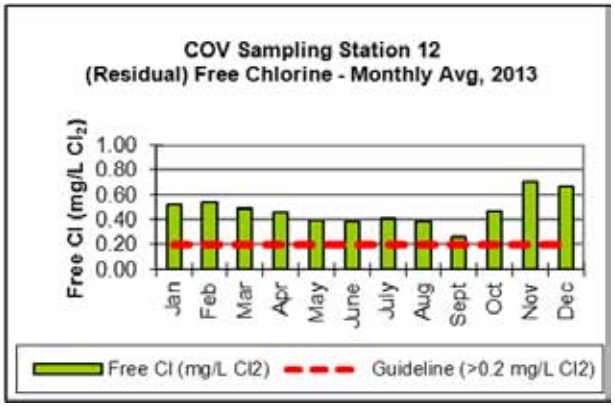

COV Sampling Station 11
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

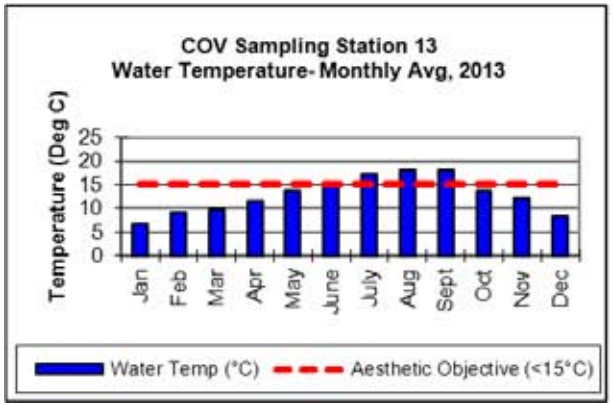

COV Sampling Station 11
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

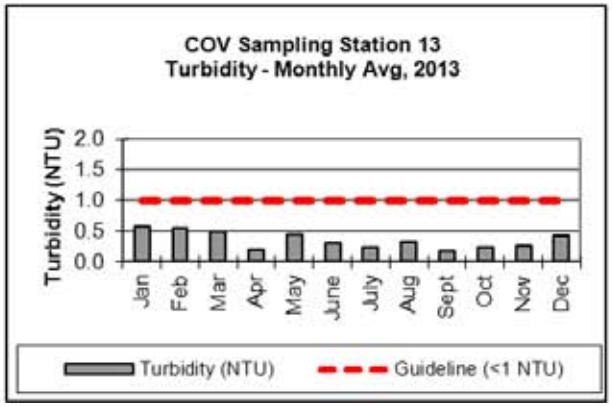

COV Sampling Station 11
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

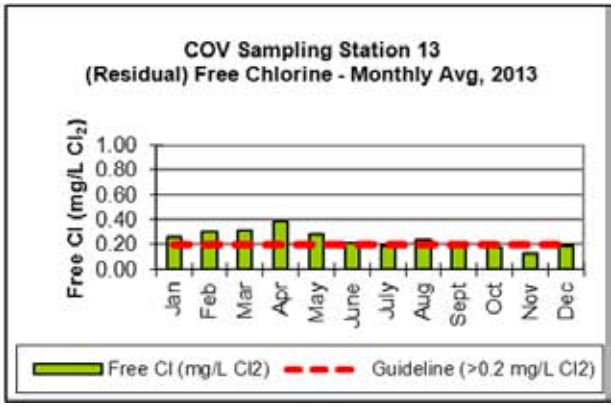

COV Sampling Station 12
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

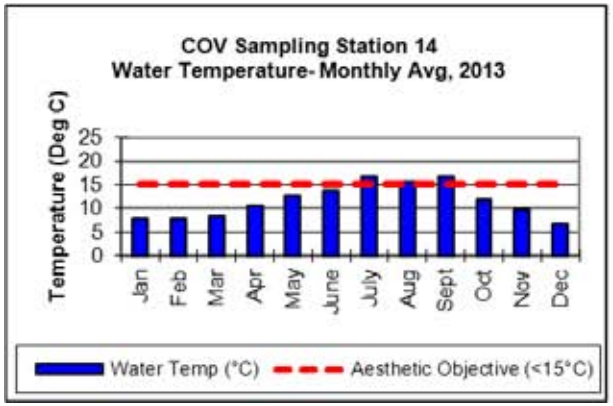

COV Sampling Station 12
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

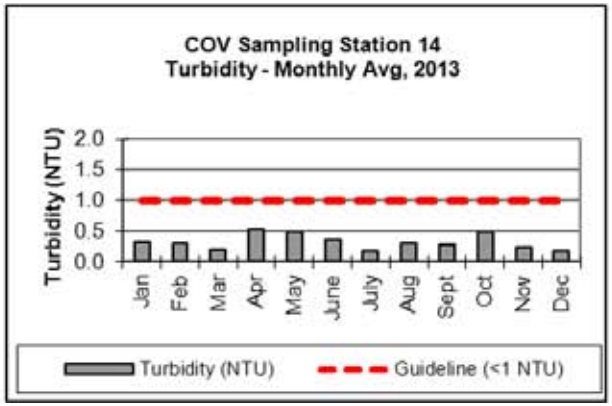

COV Sampling Station 12
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

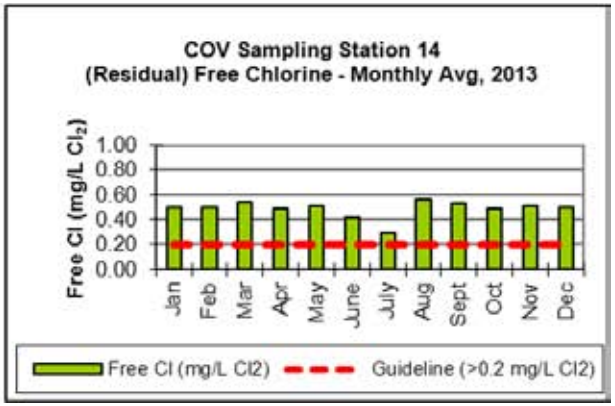

COV Sampling Station 13
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

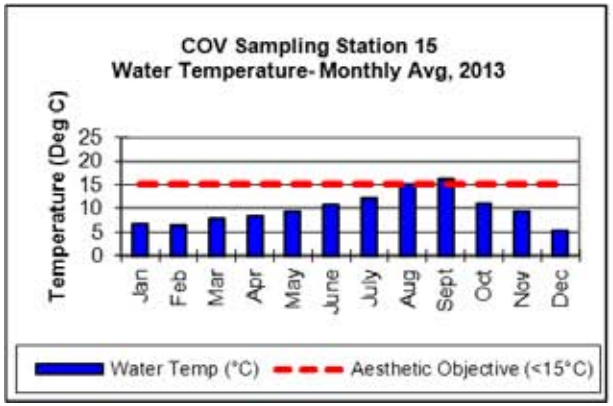

COV Sampling Station 13
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

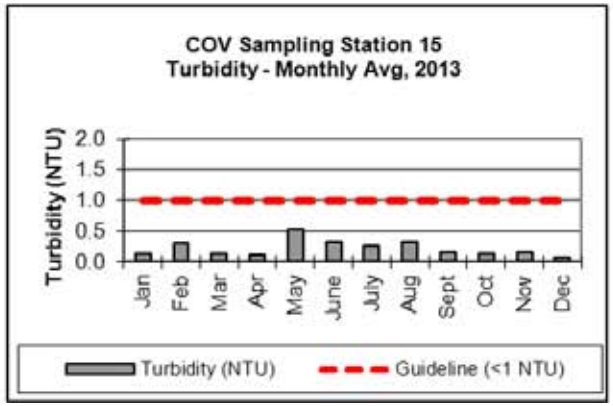

COV Sampling Station 13
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

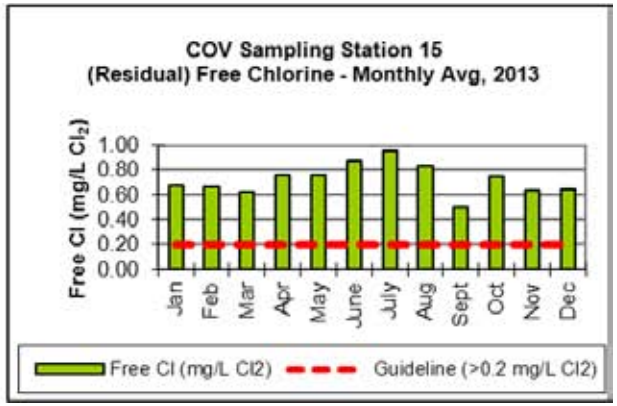

COV Sampling Station 14
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

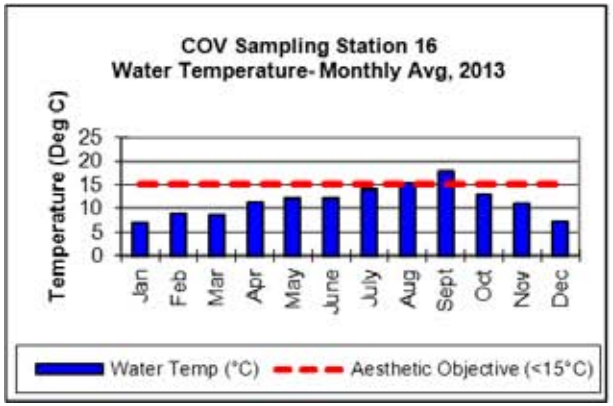

COV Sampling Station 14
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

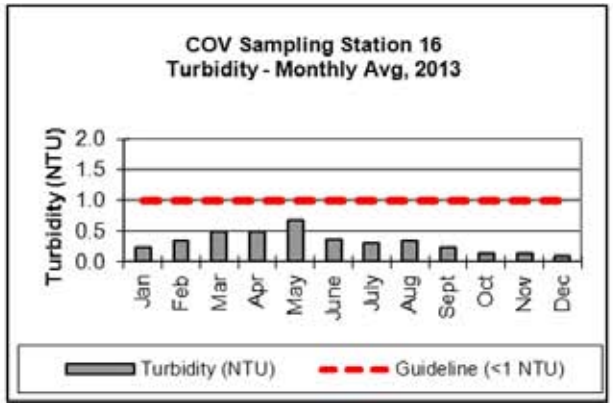

COV Sampling Station 14
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

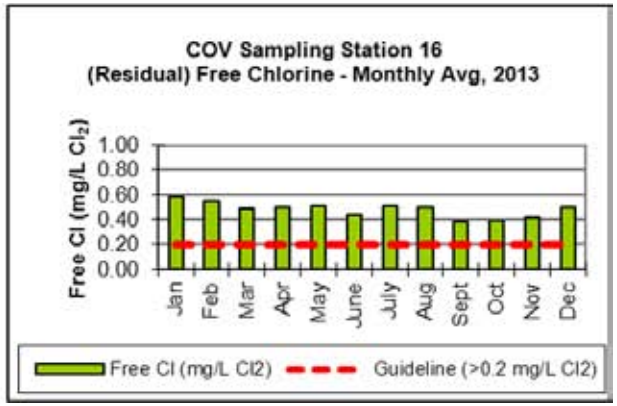

COV Sampling Station 15
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

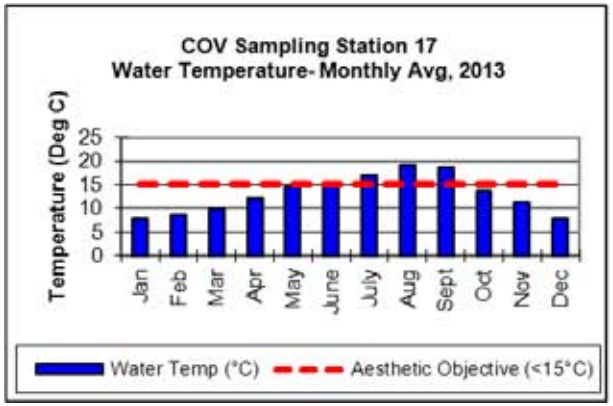

COV Sampling Station 15
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

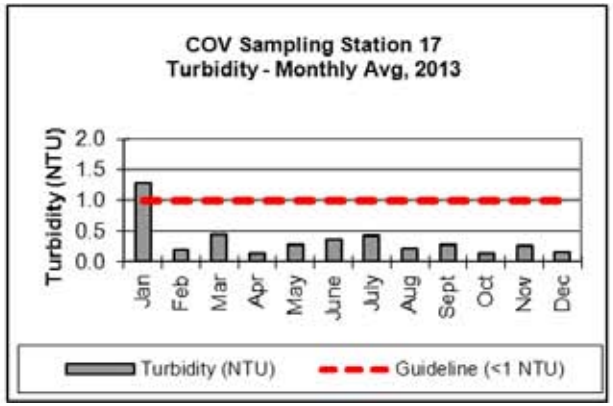

COV Sampling Station 15
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

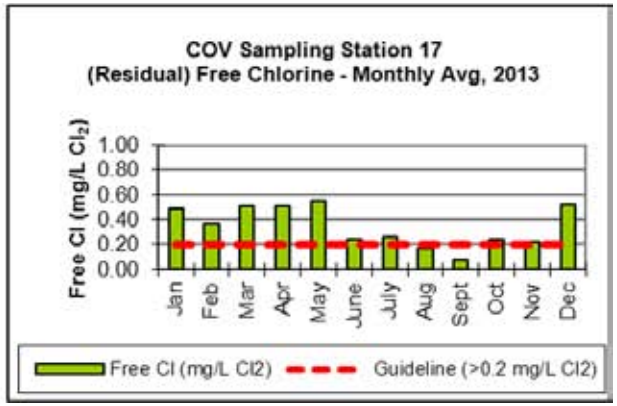

COV Sampling Station 16
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

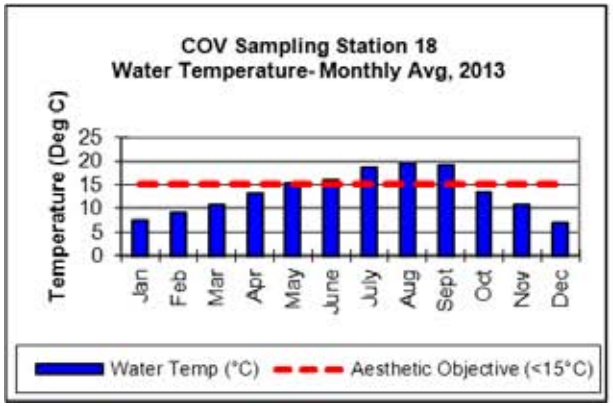

COV Sampling Station 16
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

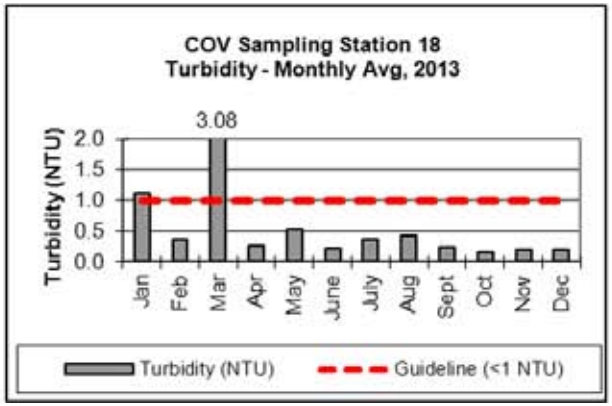

COV Sampling Station 16
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

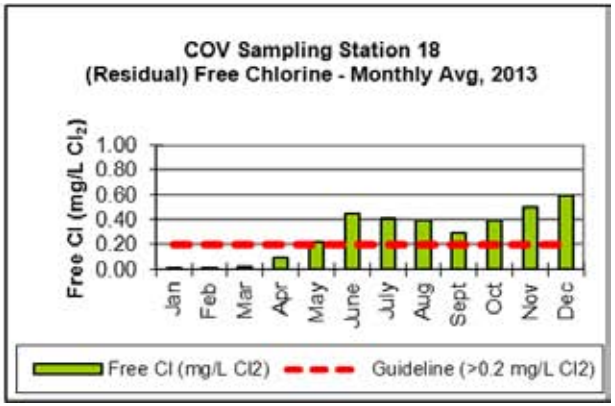

COV Sampling Station 17
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

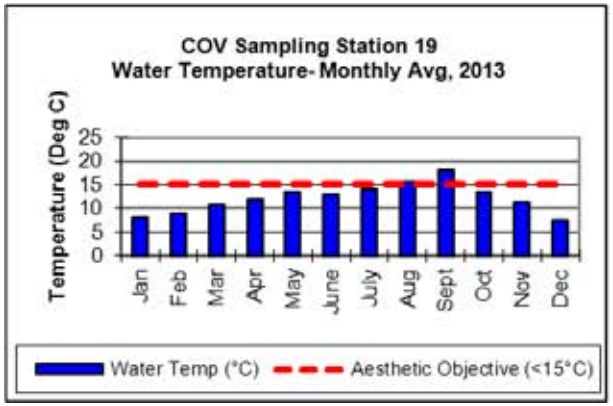

COV Sampling Station 17
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

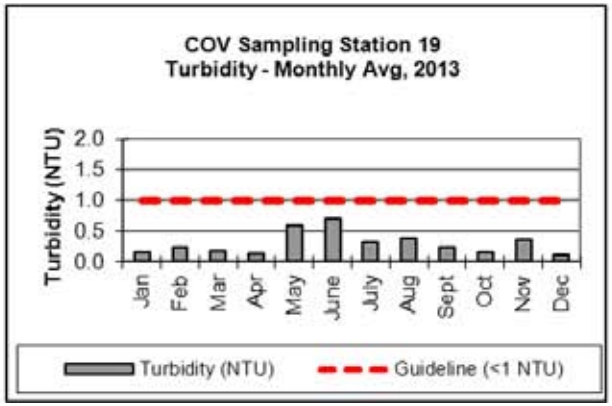

COV Sampling Station 17
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

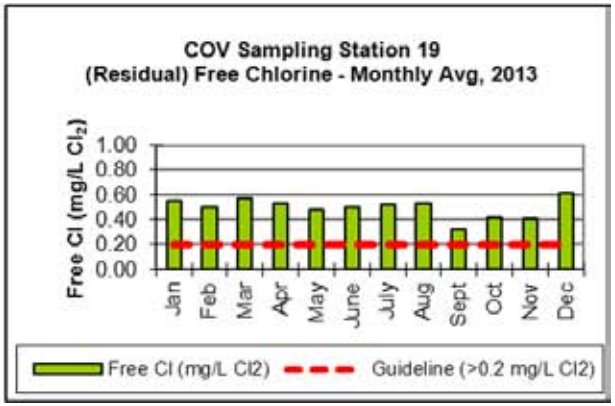

COV Sampling Station 18
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

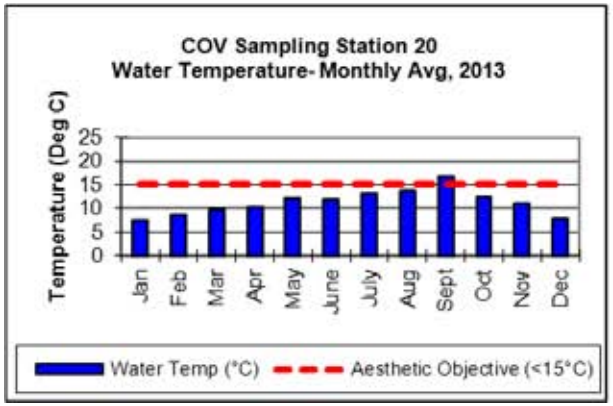

COV Sampling Station 18
Turbidity - Monthly Avg, 2013
3.08
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

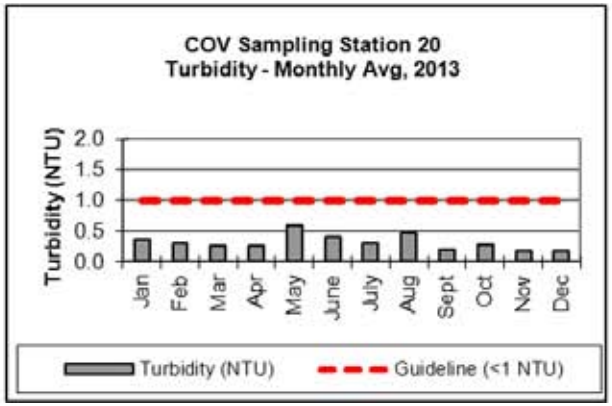

COV Sampling Station 18
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

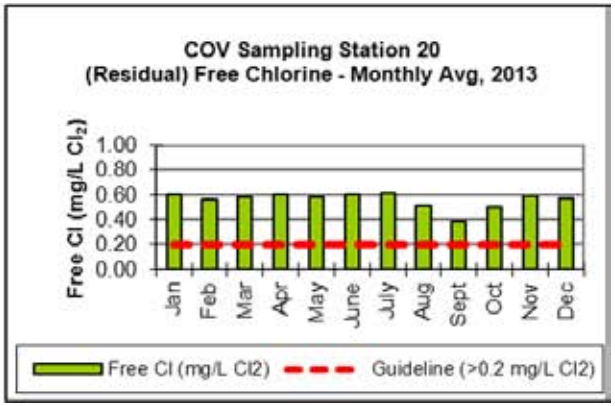

COV Sampling Station 19
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

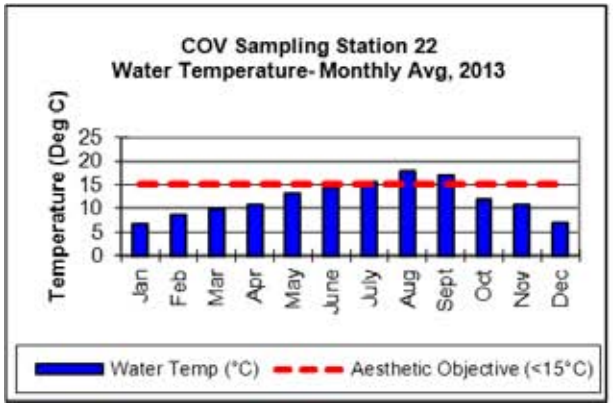

COV Sampling Station 19
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

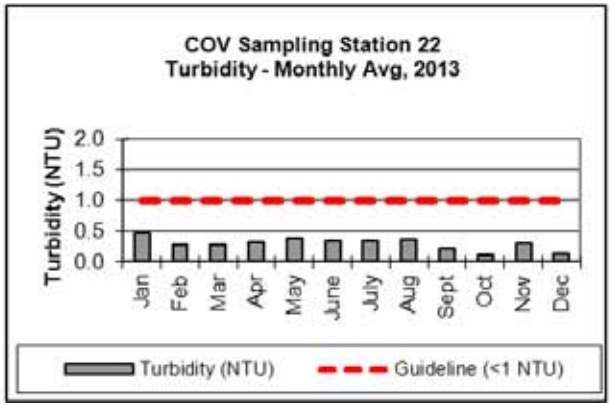

COV Sampling Station 19
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

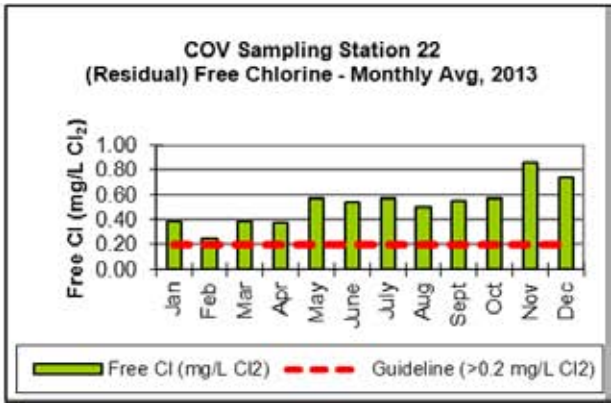

COV Sampling Station 20
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

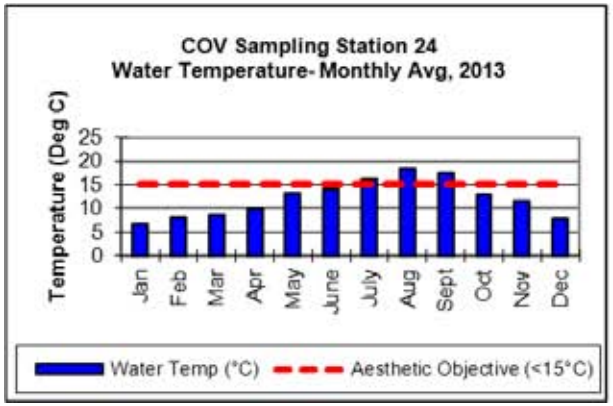

COV Sampling Station 20
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

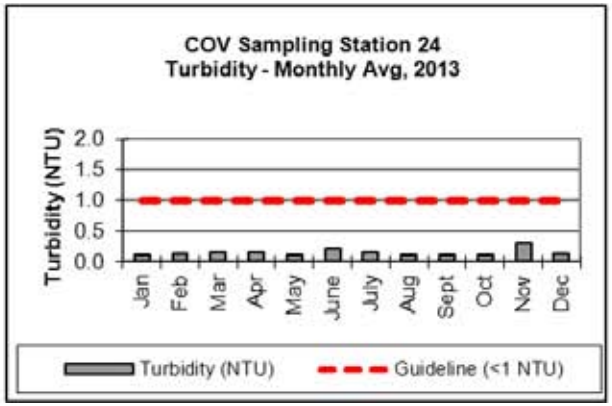

COV Sampling Station 20
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

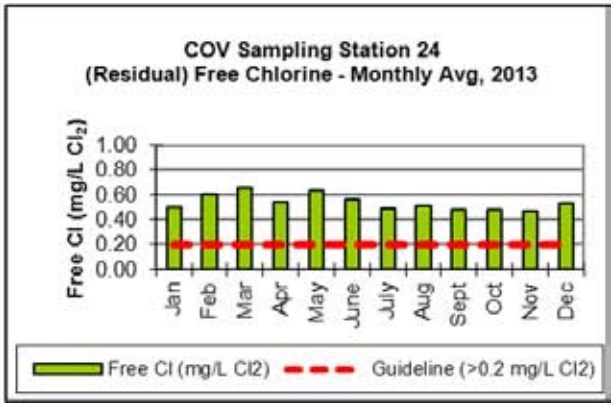

COV Sampling Station 22
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

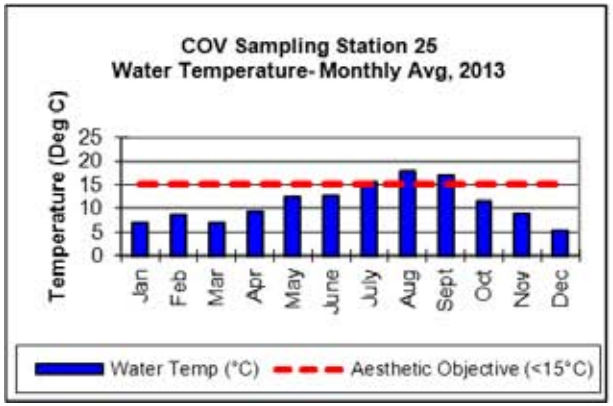

COV Sampling Station 22
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec
Turbidity (NTU)
Guideline (<1 NTU)

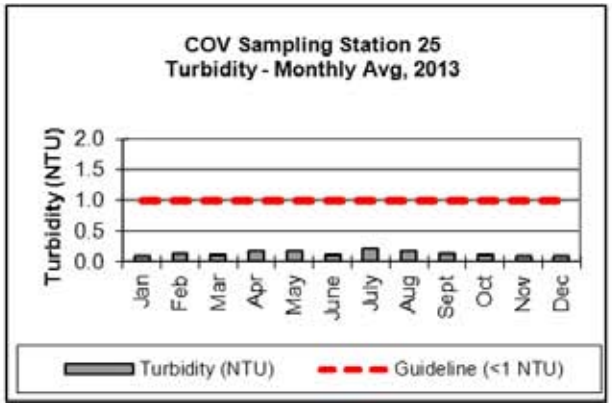

COV Sampling Station 22
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

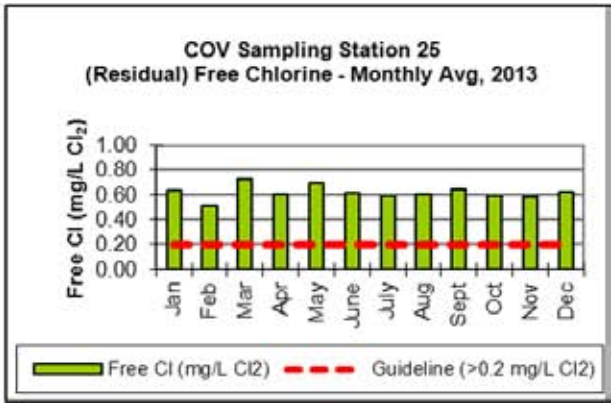

COV Sampling Station 24
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

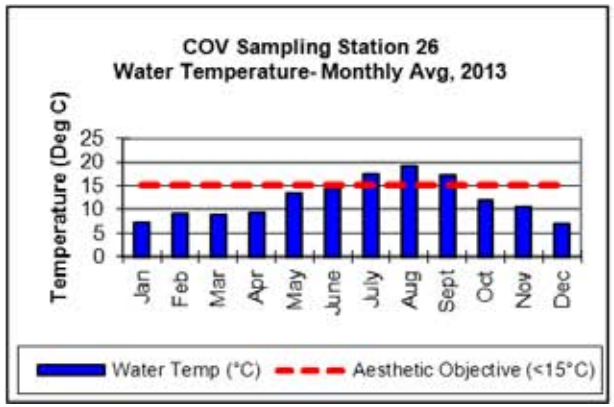

COV Sampling Station 24
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec
Turbidity (NTU)
Guideline (<1 NTU)

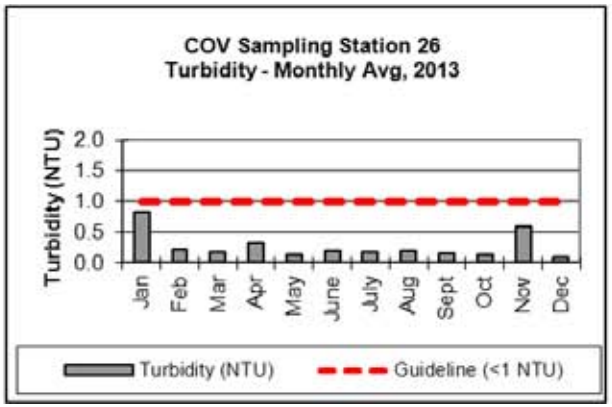

COV Sampling Station 24
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

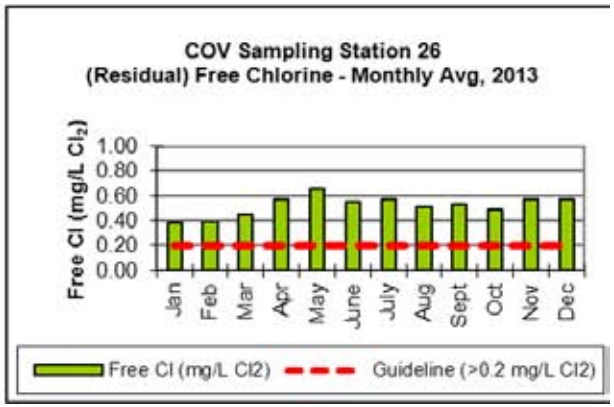

COV Sampling Station 25
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

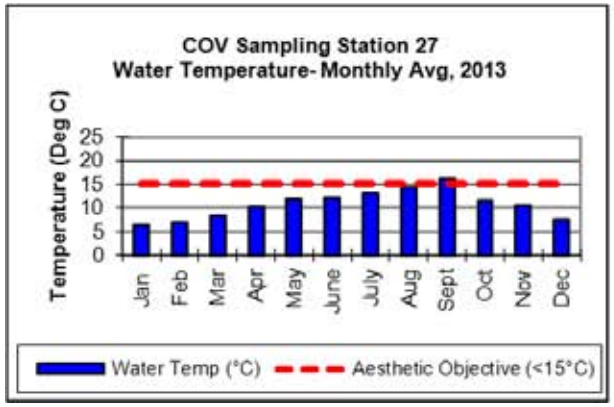

COV Sampling Station 25
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec
Turbidity (NTU)
Guideline (<1 NTU)

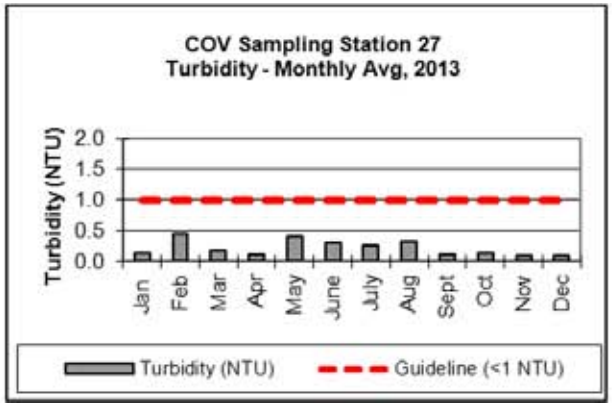

COV Sampling Station 25
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

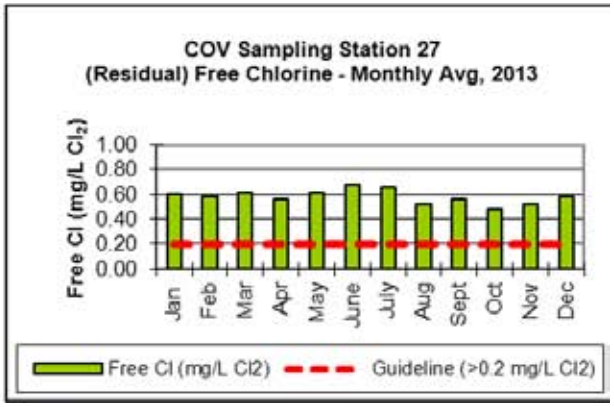

COV Sampling Station 26
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

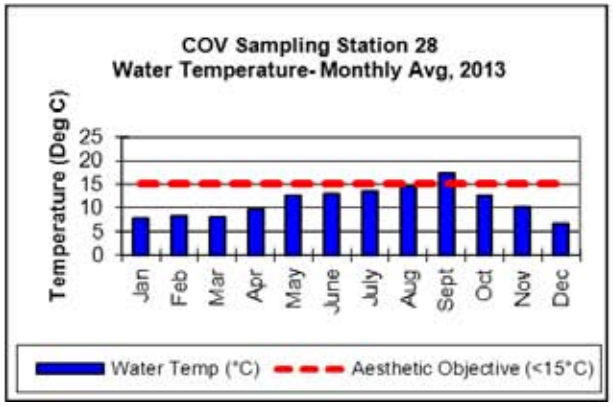

COV Sampling Station 26
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

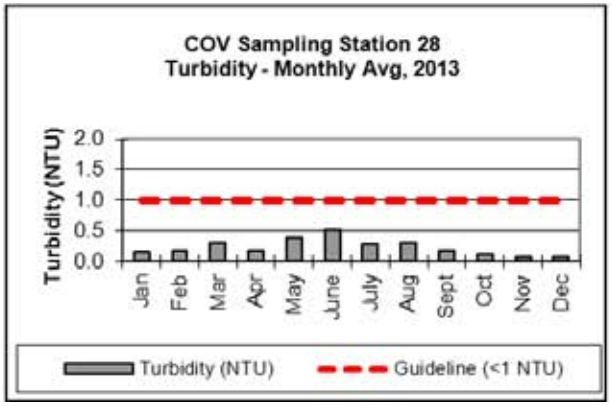

COV Sampling Station 26
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

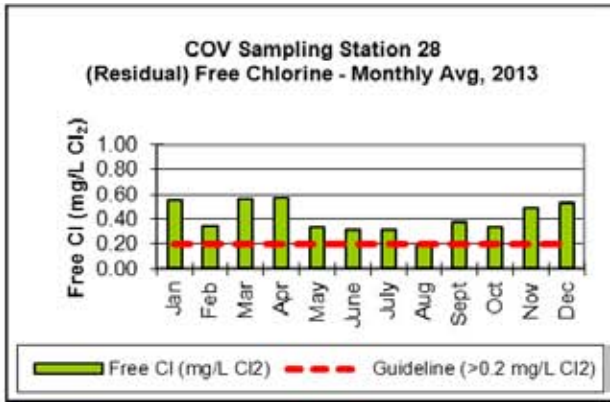

COV Sampling Station 27
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

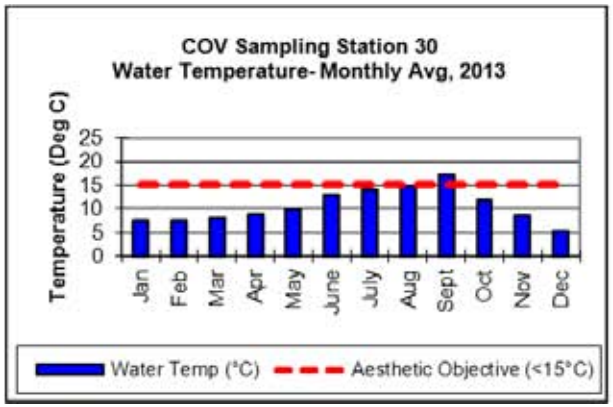

COV Sampling Station 27
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

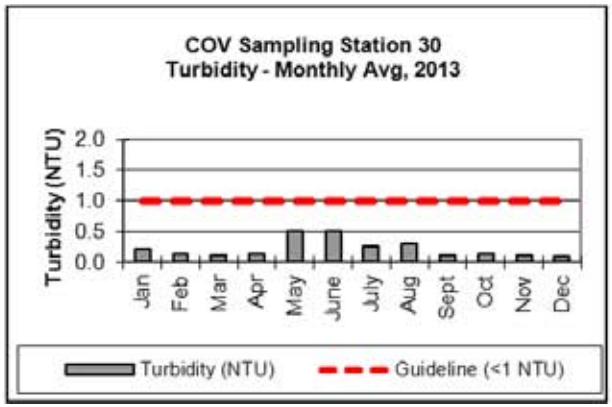

COV Sampling Station 27
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

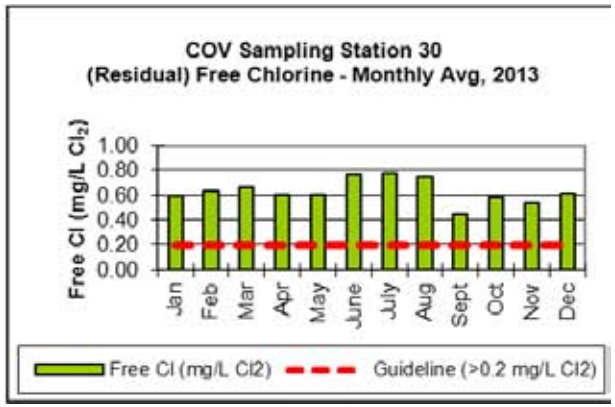

COV Sampling Station 28
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

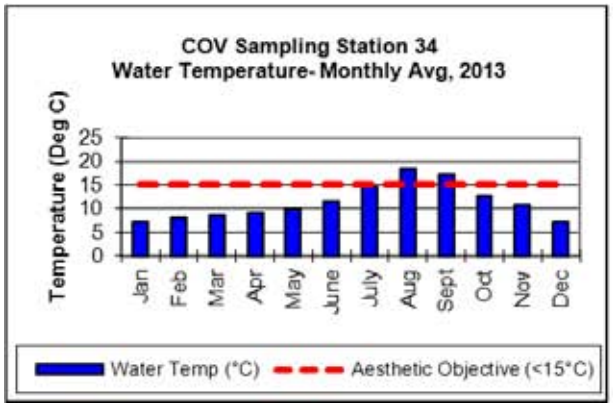

COV Sampling Station 28
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

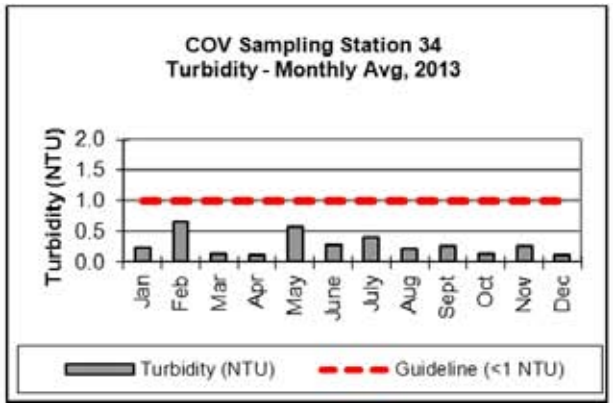

COV Sampling Station 28
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

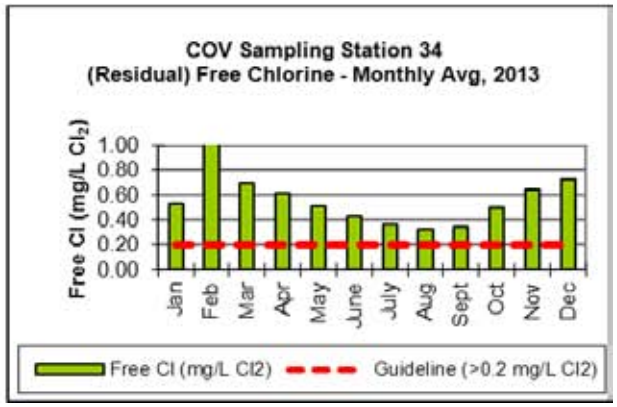

COV Sampling Station 30
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

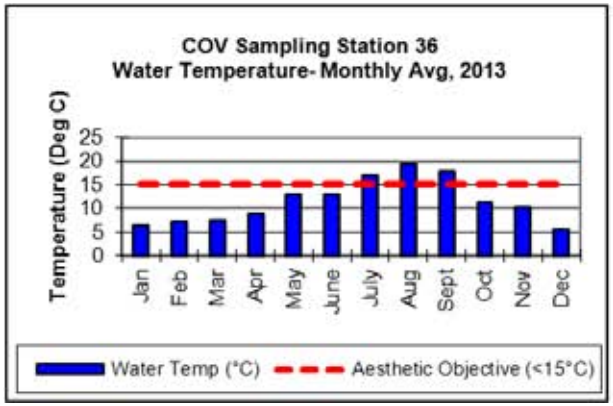

COV Sampling Station 30
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

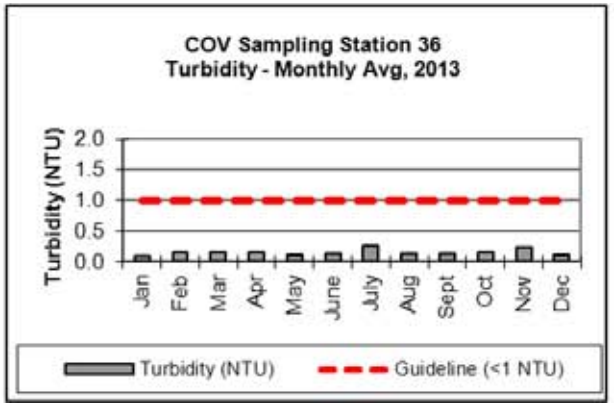

COV Sampling Station 30
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

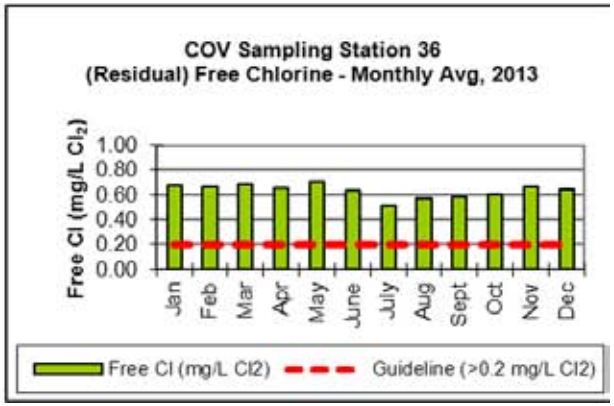

COV Sampling Station 34
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

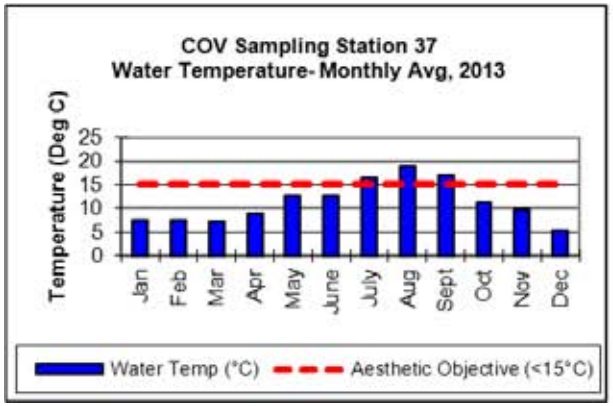

COV Sampling Station 34
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

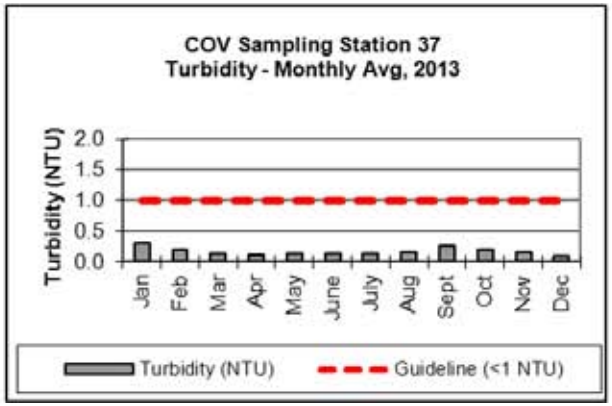

COV Sampling Station 34
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

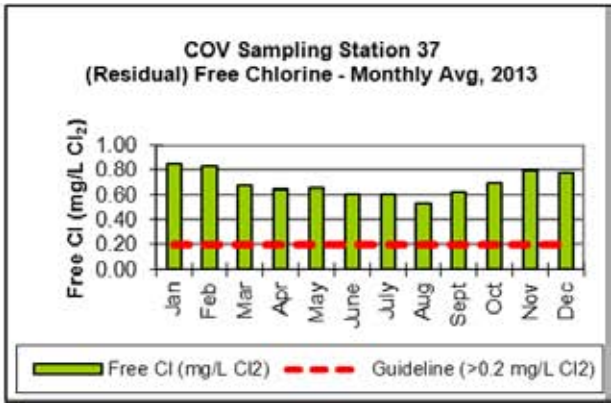

COV Sampling Station 36
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

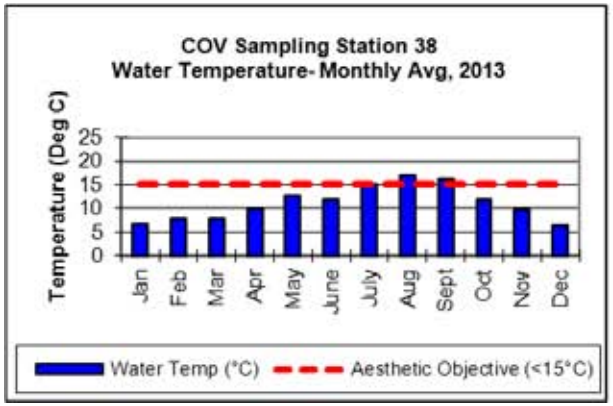

COV Sampling Station 36
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

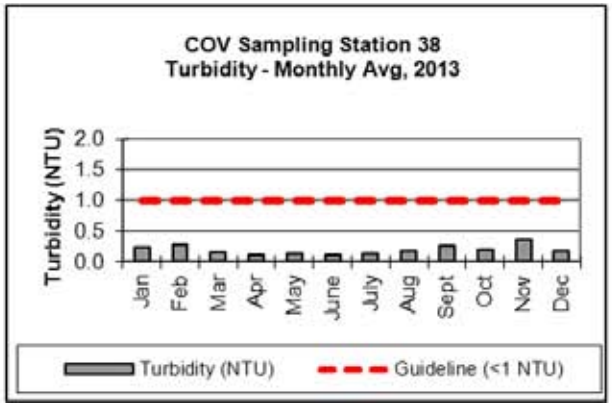

COV Sampling Station 36
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

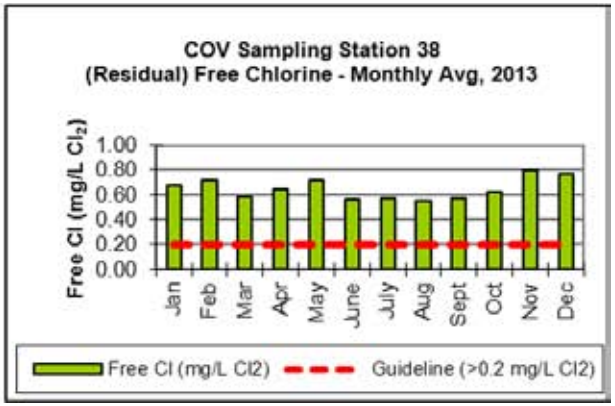

COV Sampling Station 37
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

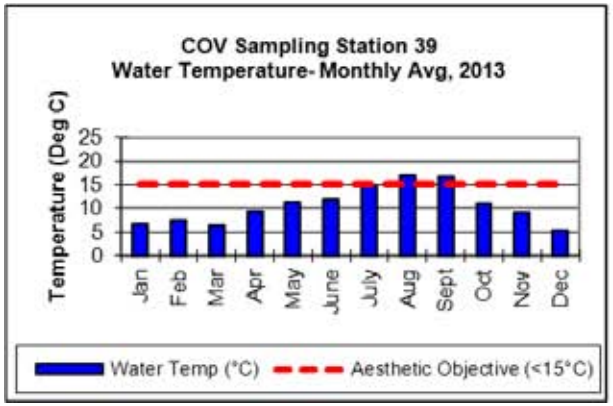

COV Sampling Station 37
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

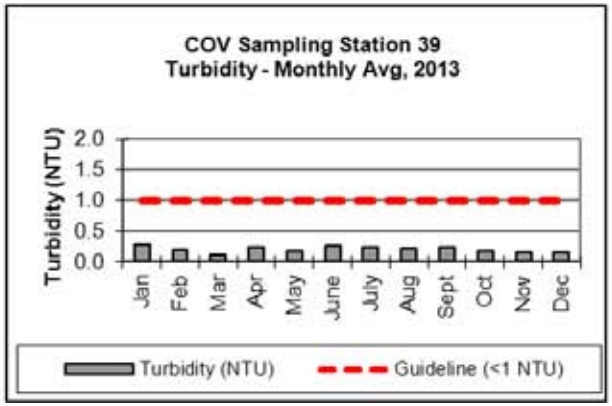

COV Sampling Station 37
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

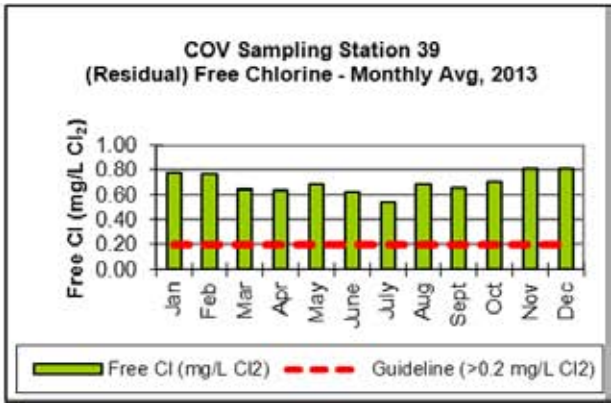

COV Sampling Station 38
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

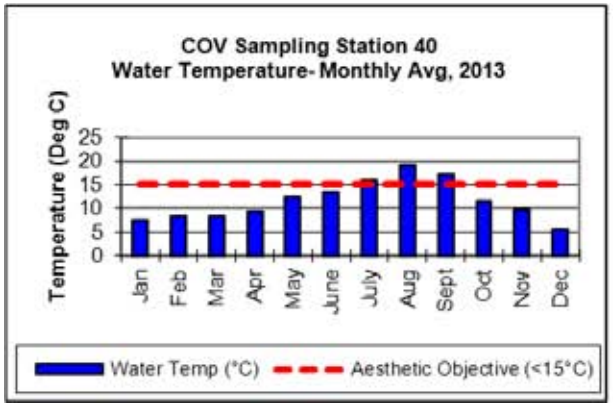

COV Sampling Station 38
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

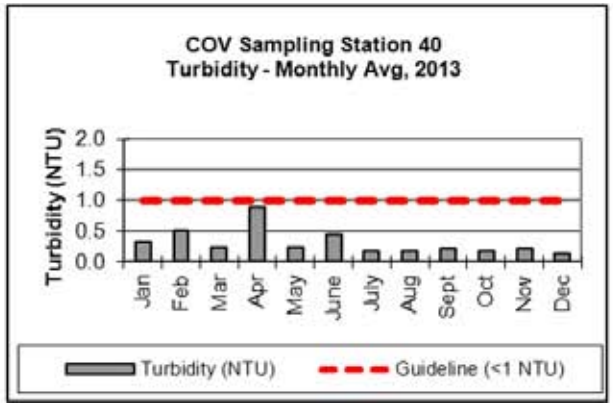

COV Sampling Station 38
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

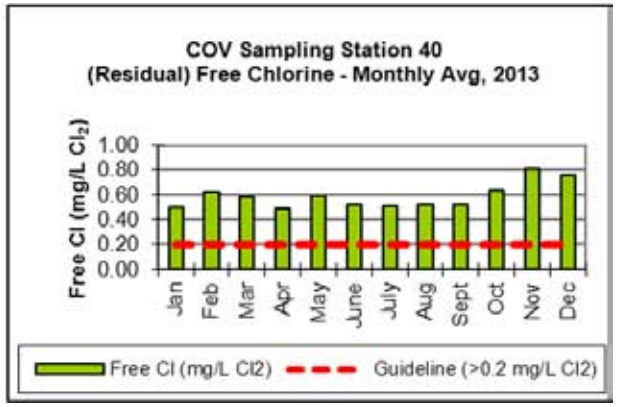

COV Sampling Station 39
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

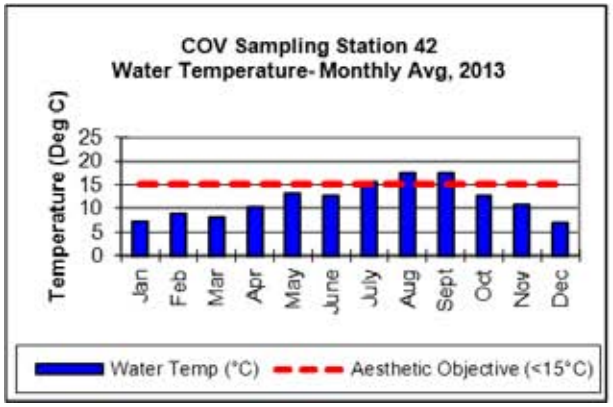

COV Sampling Station 39
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

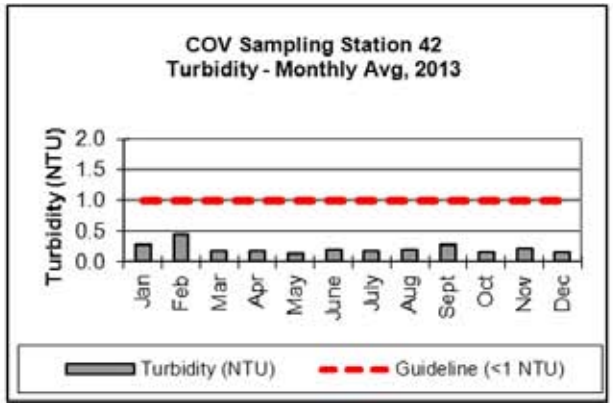

COV Sampling Station 39
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

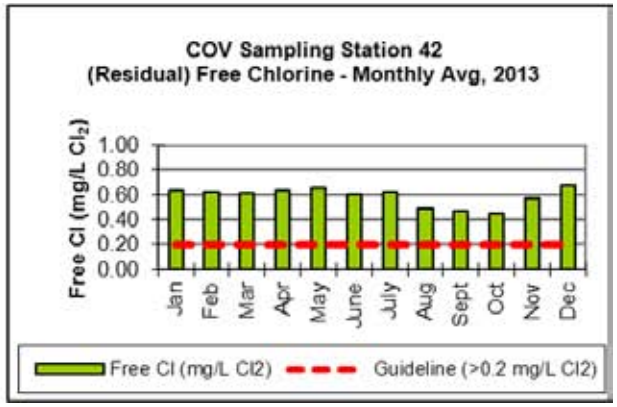

COV Sampling Station 40
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

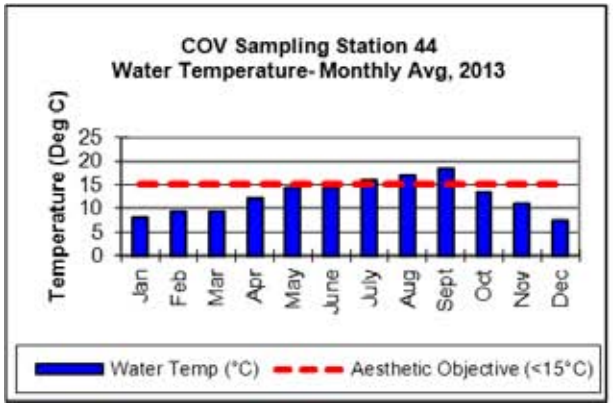

COV Sampling Station 40
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

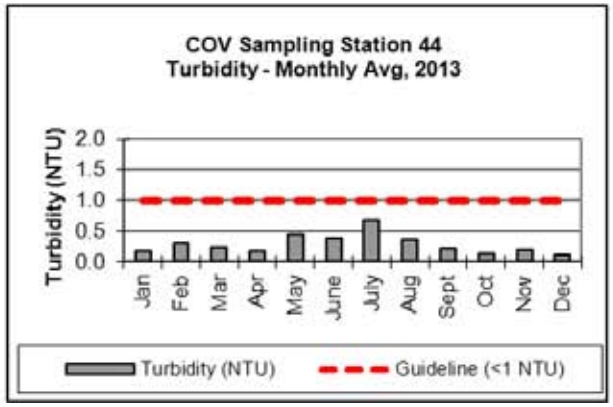

COV Sampling Station 40
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

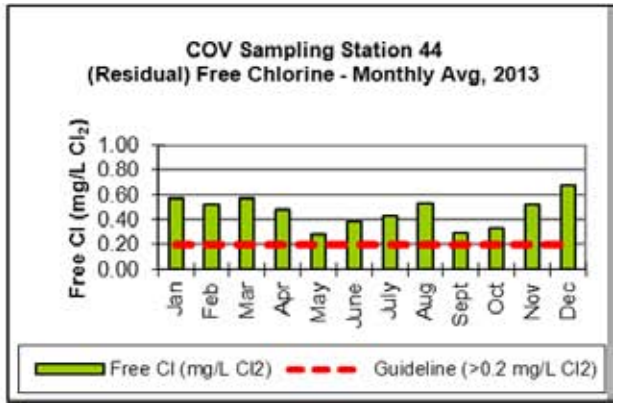

COV Sampling Station 42
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

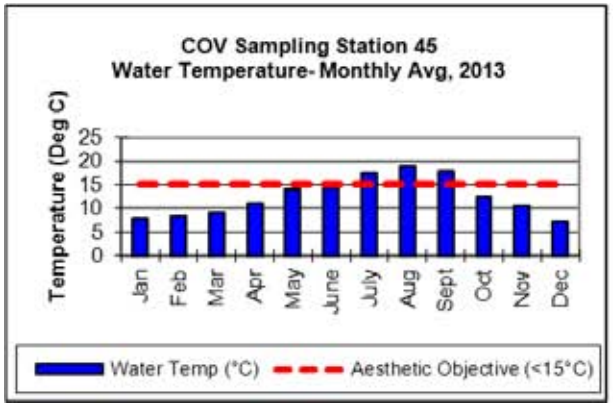

COV Sampling Station 42
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

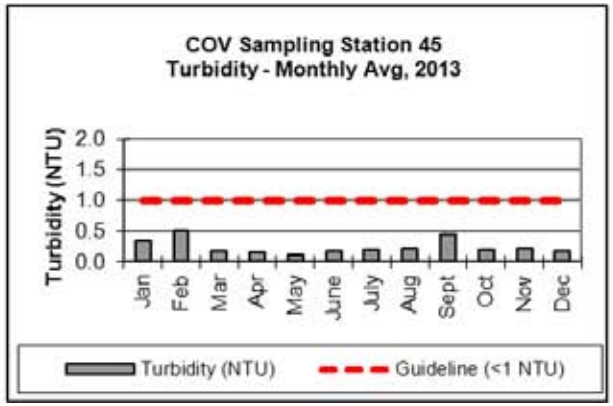

COV Sampling Station 42
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

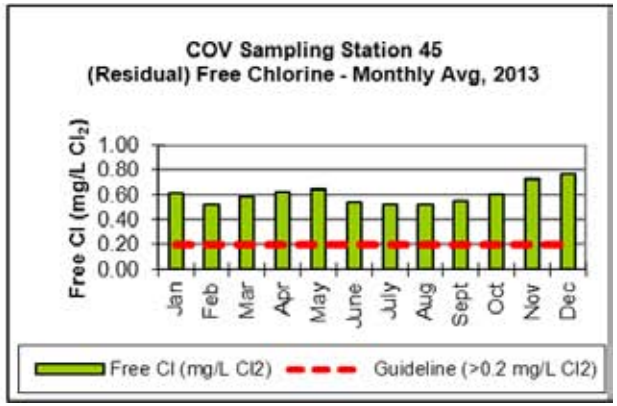

COV Sampling Station 44
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

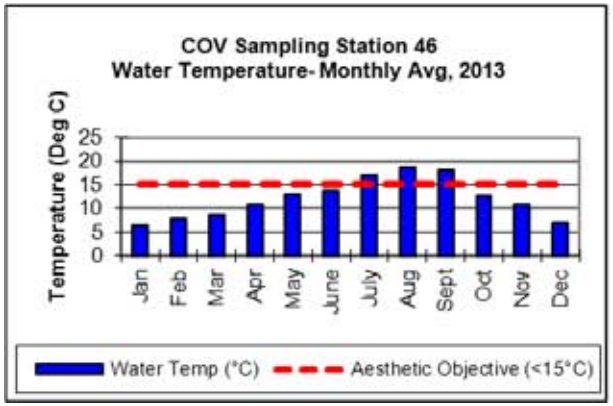

COV Sampling Station 44
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

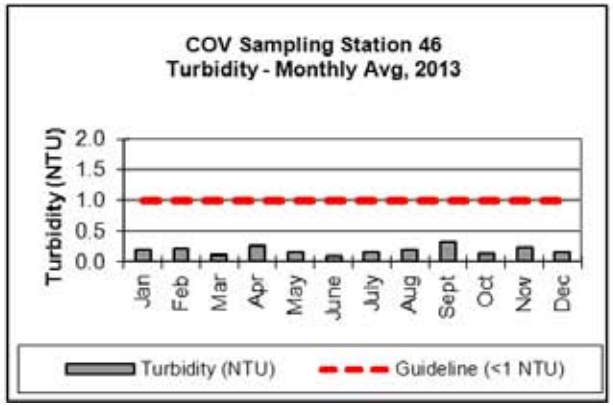

COV Sampling Station 44
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

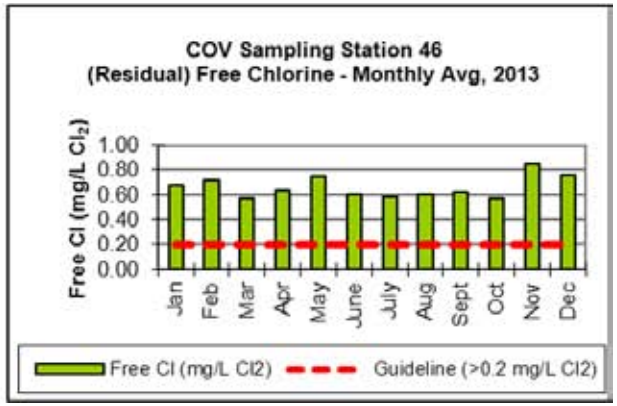

COV Sampling Station 45
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

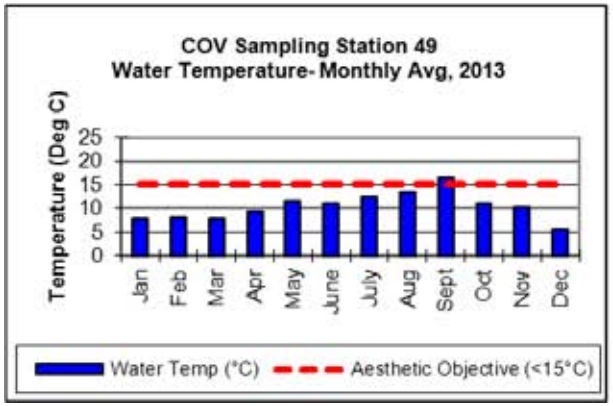

COV Sampling Station 45
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

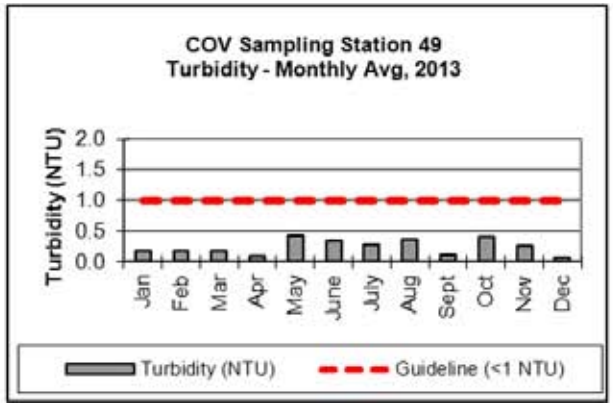

COV Sampling Station 45
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

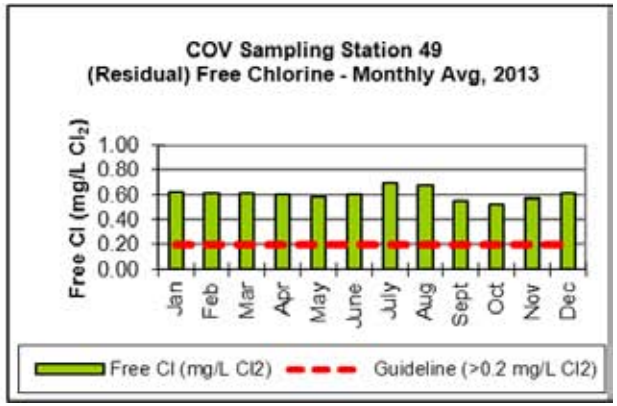

COV Sampling Station 46
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

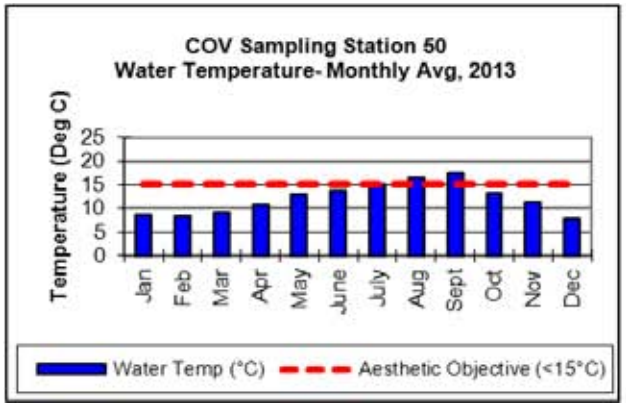

COV Sampling Station 46
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

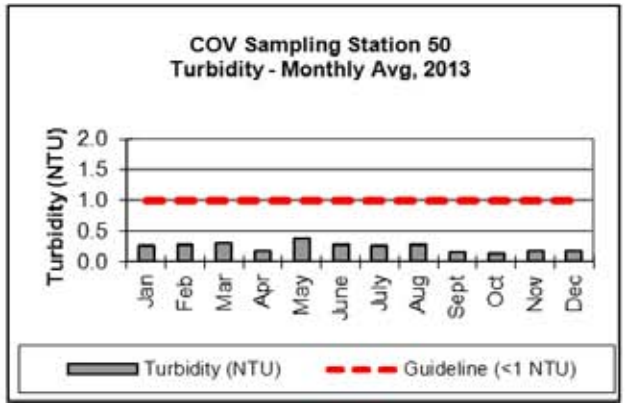

COV Sampling Station 46
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

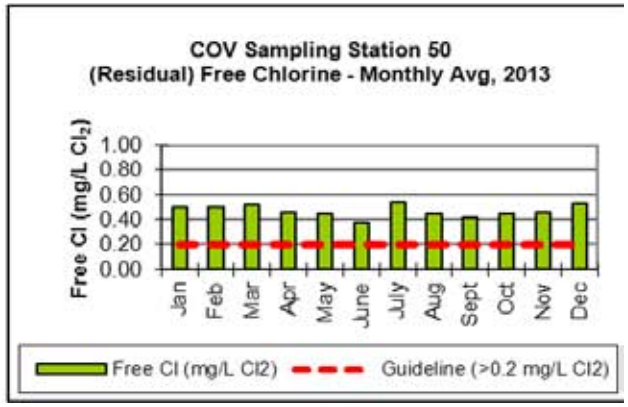

COV Sampling Station 49
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

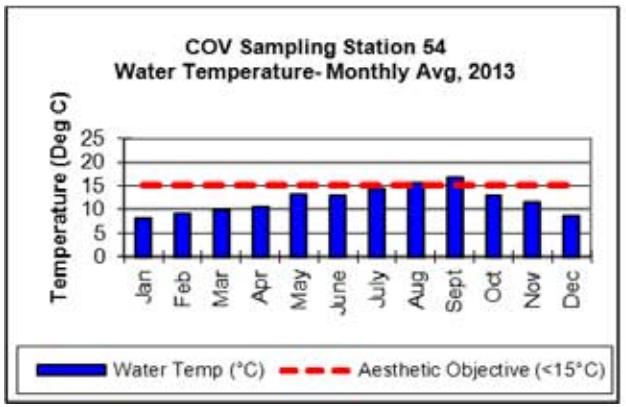

COV Sampling Station 49
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

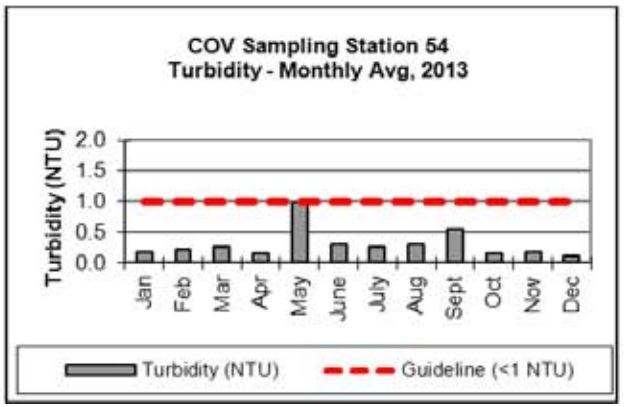

COV Sampling Station 49
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

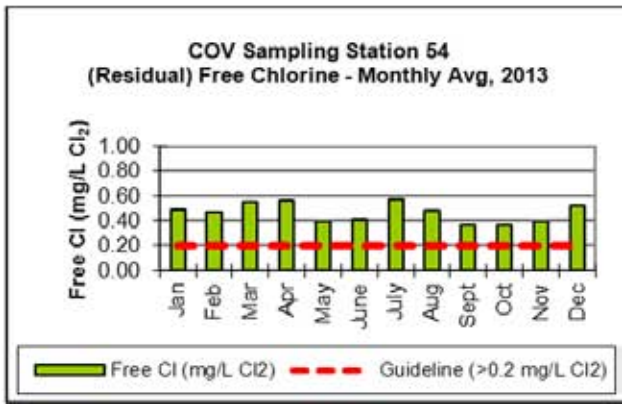

COV Sampling Station 50
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

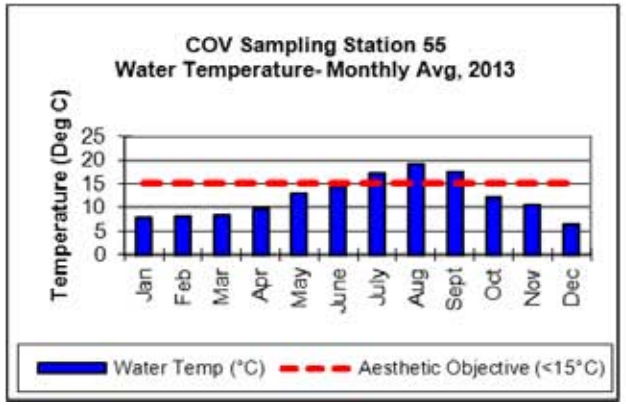

COV Sampling Station 50
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

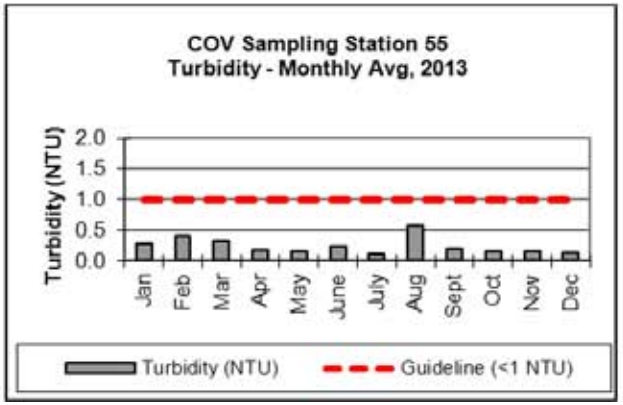

COV Sampling Station 50
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

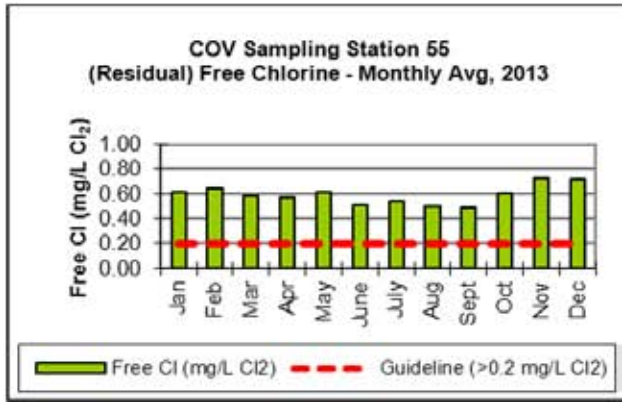

COV Sampling Station 54
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

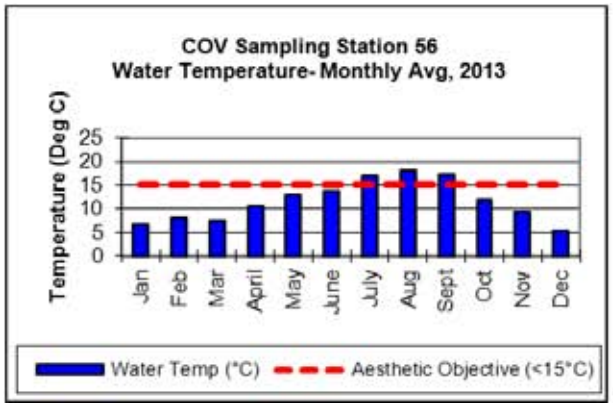

COV Sampling Station 54
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

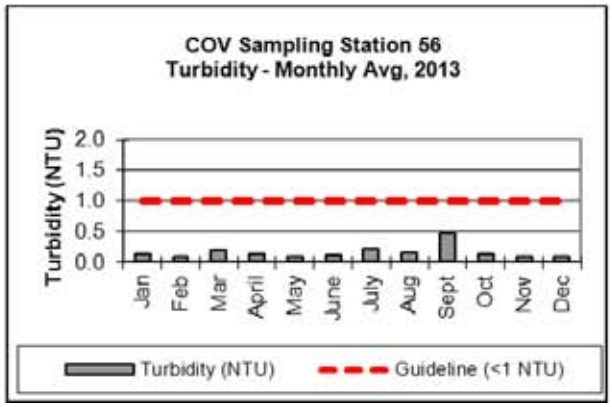

COV Sampling Station 54
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

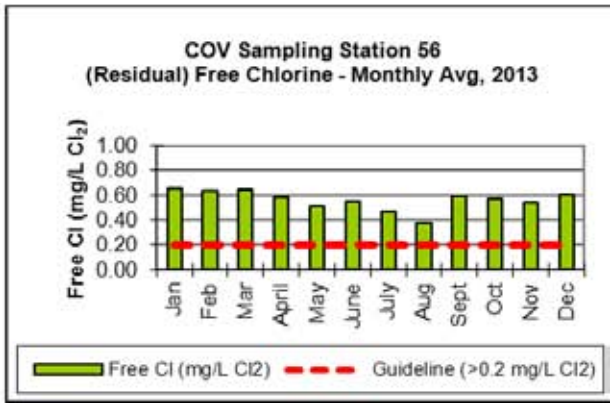

COV Sampling Station 55
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

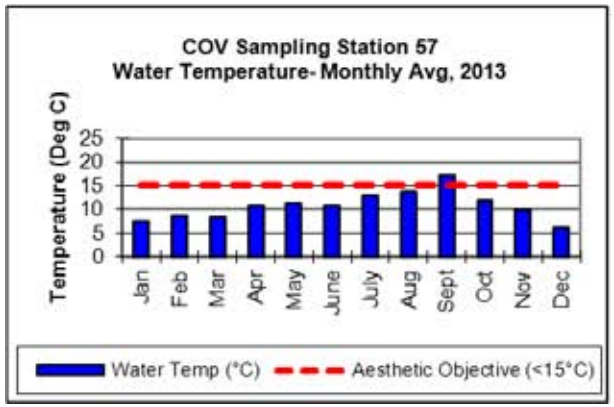

COV Sampling Station 55
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

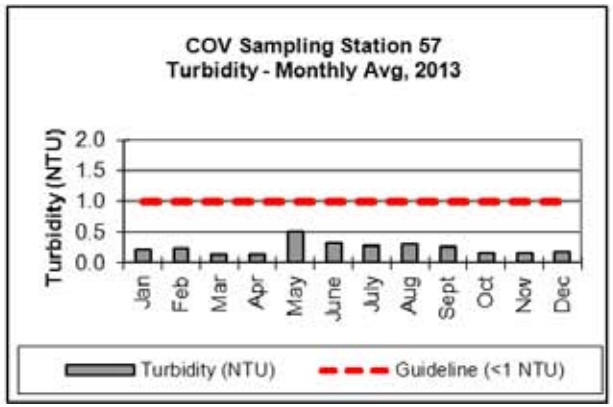

COV Sampling Station 55
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

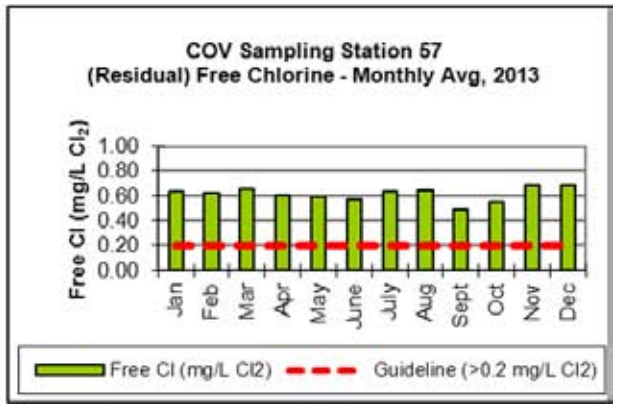

COV Sampling Station 56
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
April
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

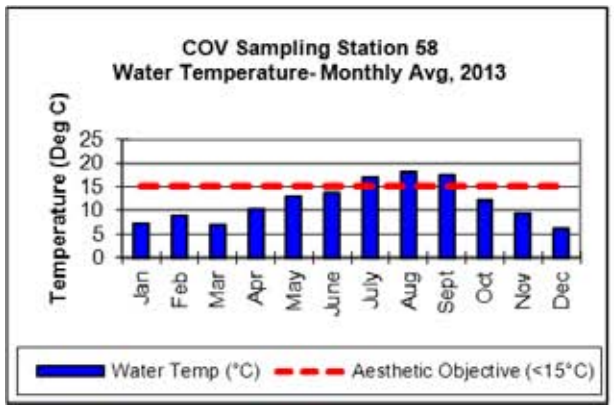

COV Sampling Station 56
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
April
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

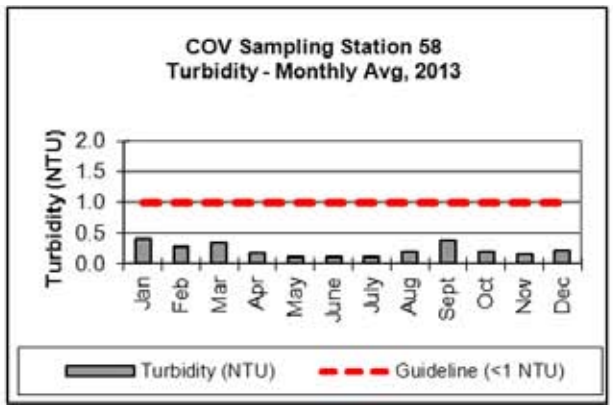

COV Sampling Station 56
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
April
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

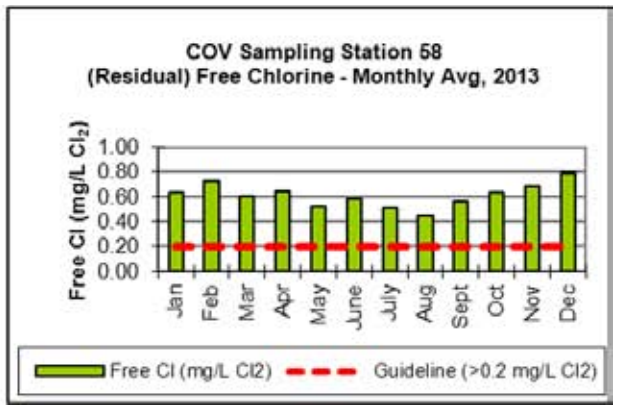

COV Sampling Station 57
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

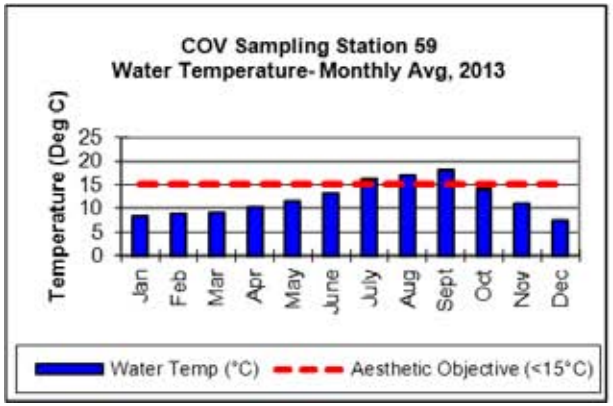

COV Sampling Station 57
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

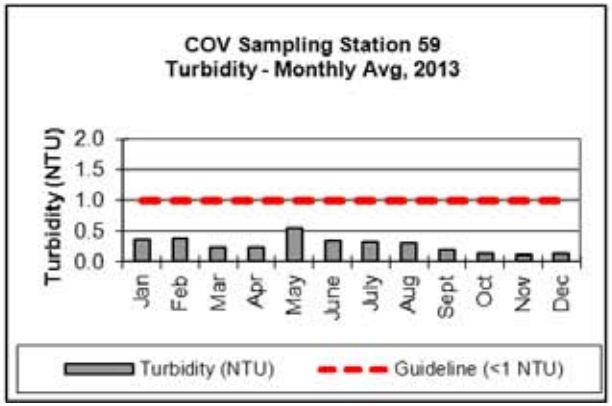

COV Sampling Station 57
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

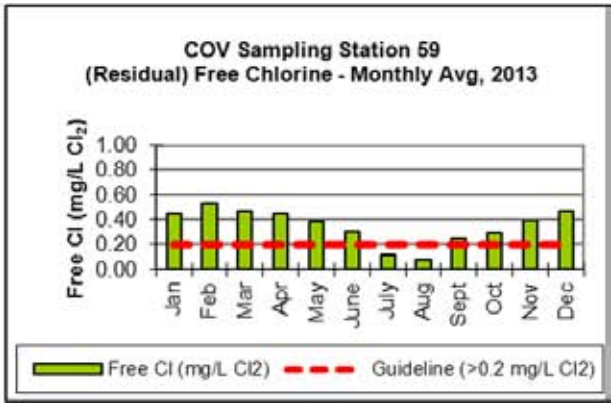

COV Sampling Station 58
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

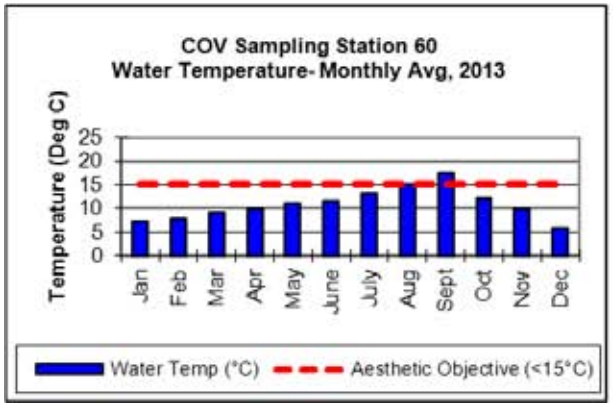

COV Sampling Station 58
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

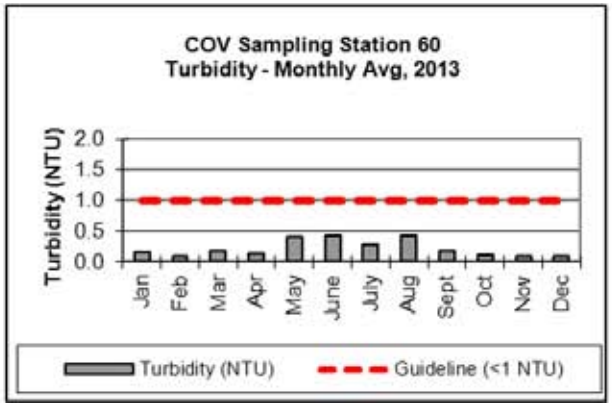

COV Sampling Station 58
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

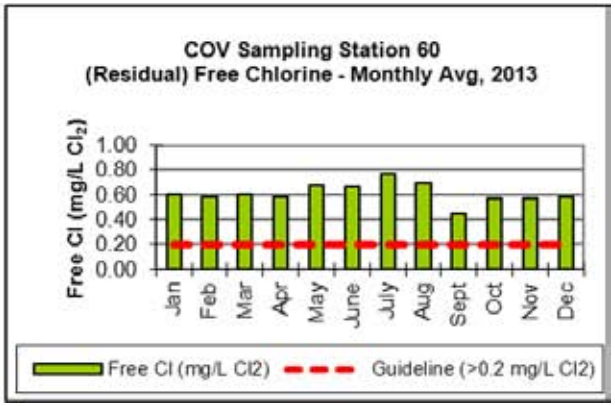

COV Sampling Station 59
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

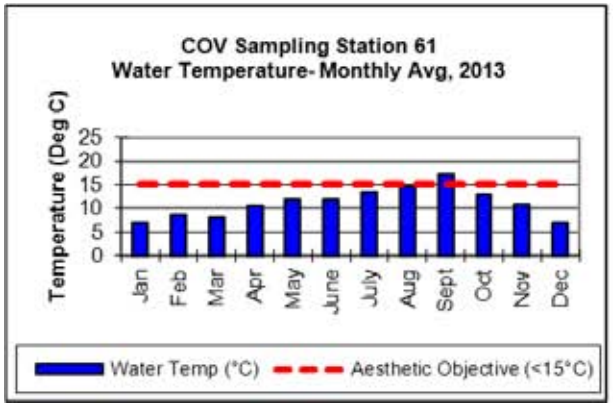

COV Sampling Station 59
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

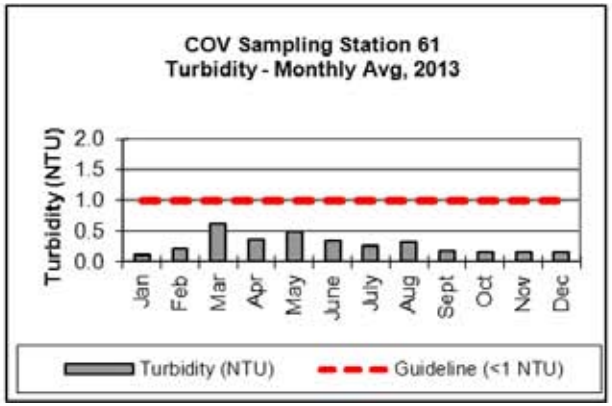

COV Sampling Station 59
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

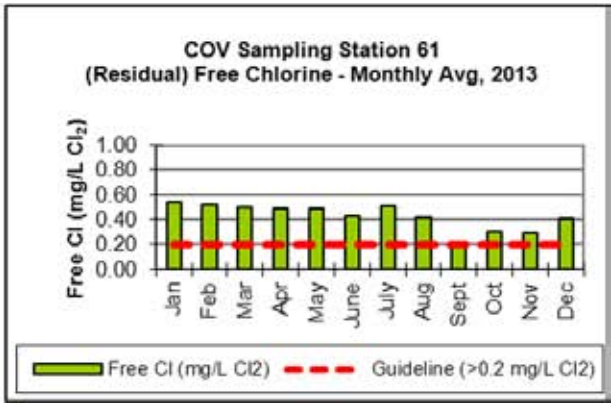

COV Sampling Station 60
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

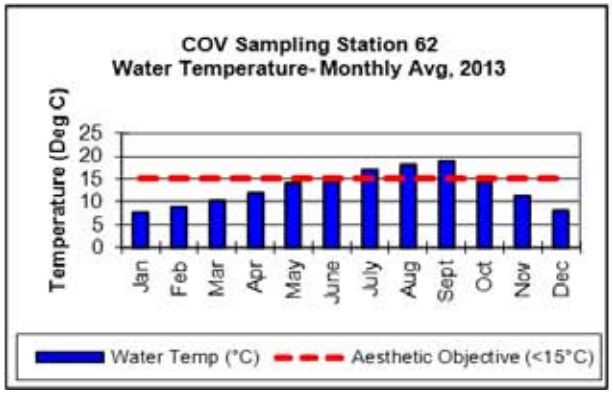

COV Sampling Station 60
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

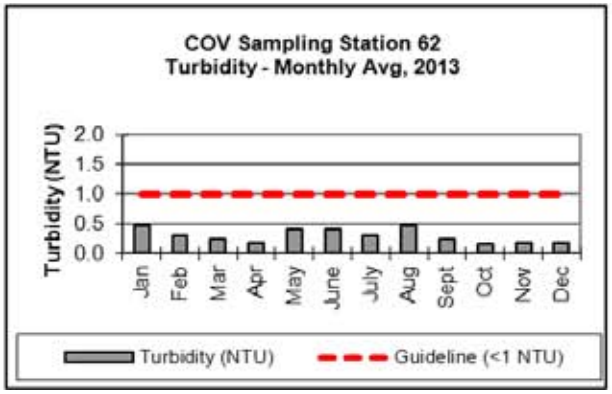

COV Sampling Station 60
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

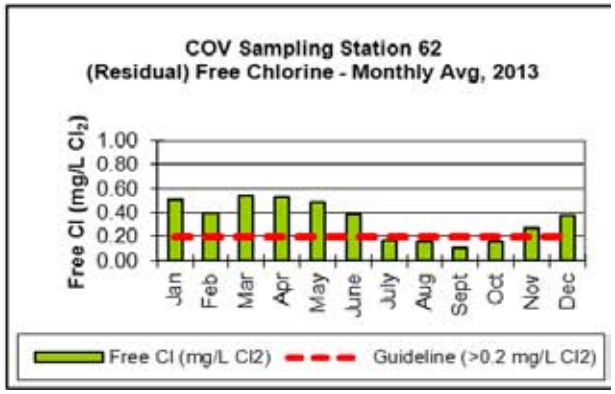

COV Sampling Station 61
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

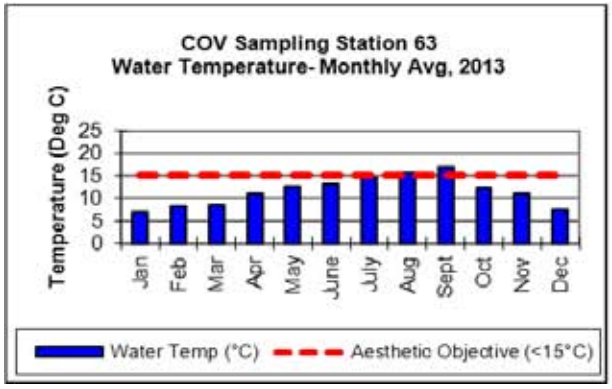

COV Sampling Station 61
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

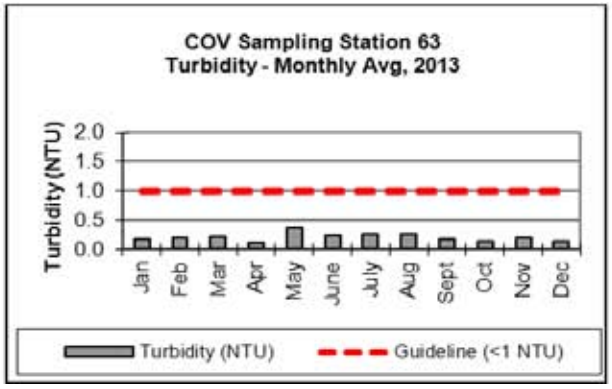

COV Sampling Station 61
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

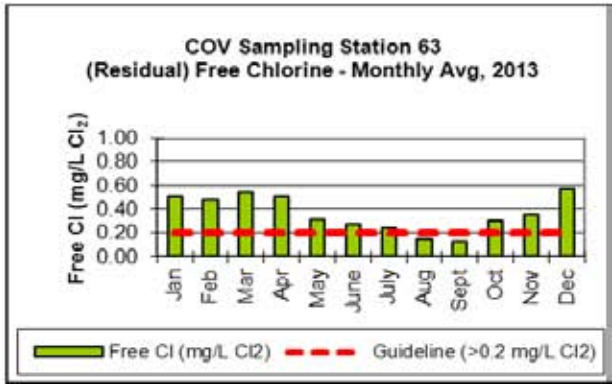

COV Sampling Station 62
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

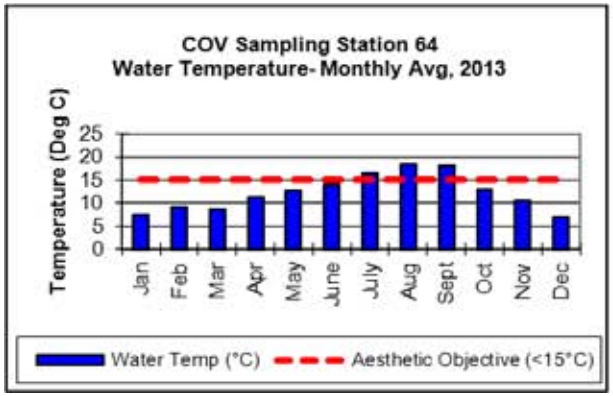

COV Sampling Station 62
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

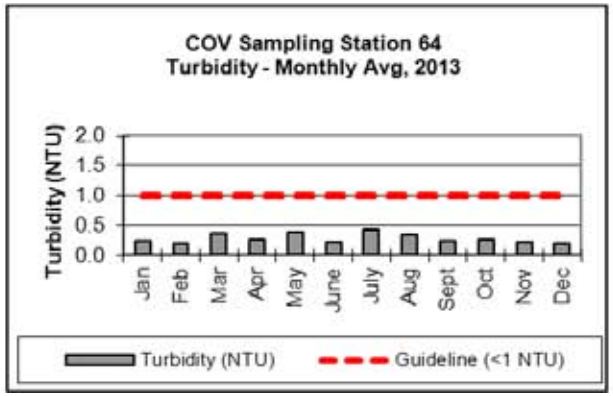

COV Sampling Station 62
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

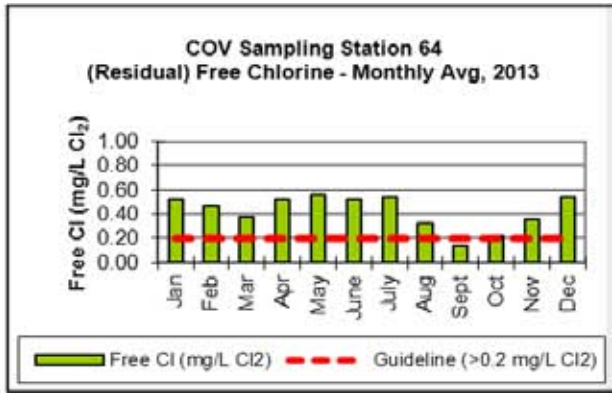

COV Sampling Station 63
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

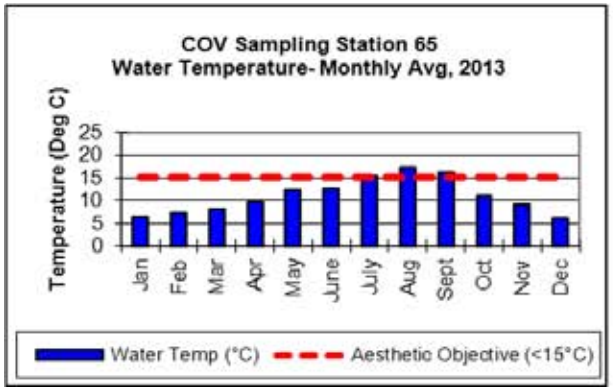

COV Sampling Station 63
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

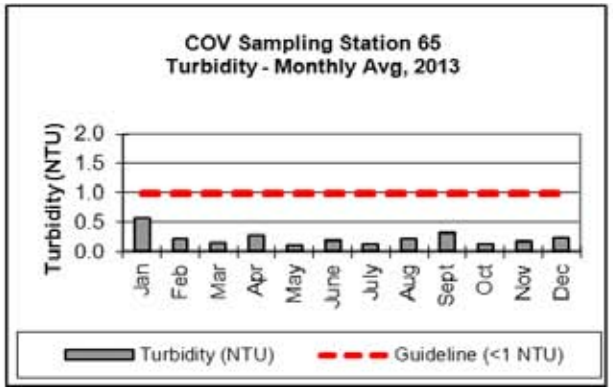

COV Sampling Station 63
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

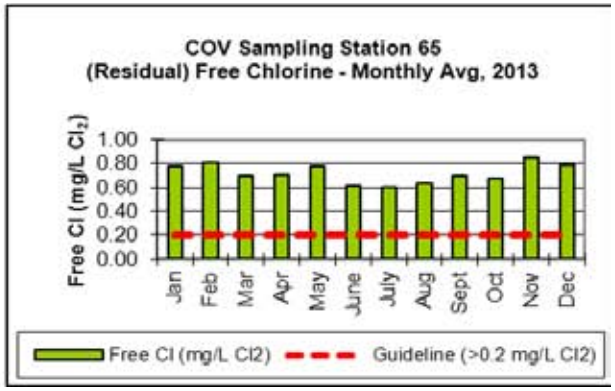

COV Sampling Station 64
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

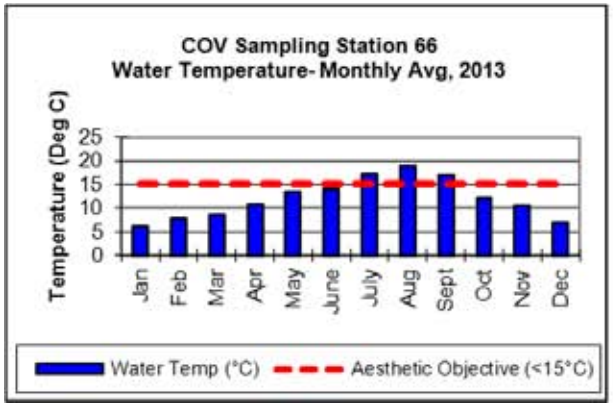

COV Sampling Station 64
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

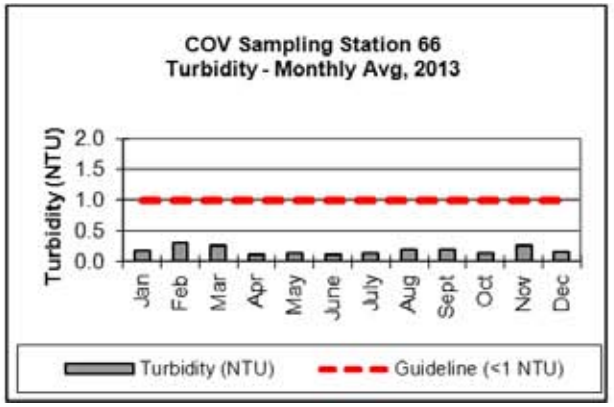

COV Sampling Station 64
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

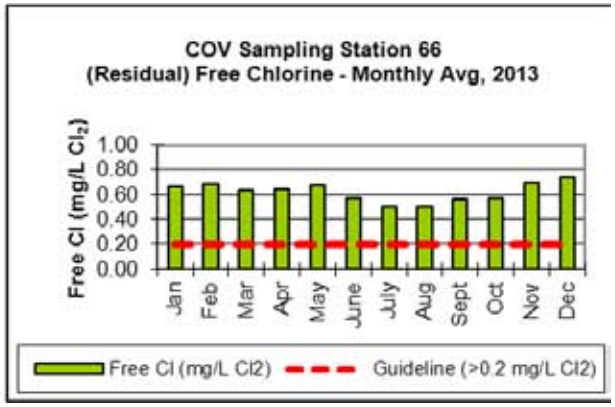

COV Sampling Station 65
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

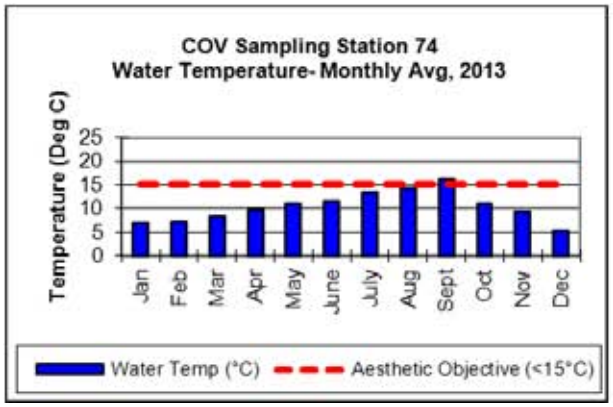

COV Sampling Station 65
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

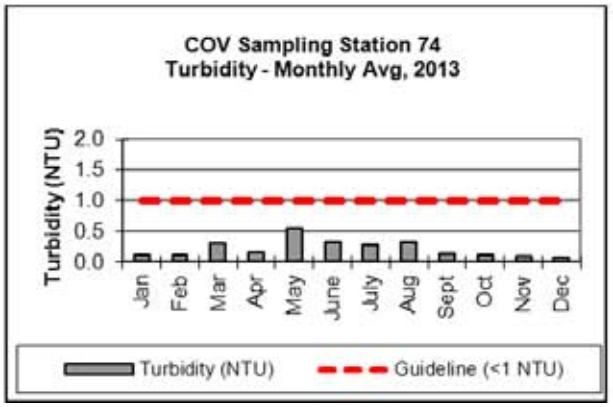

COV Sampling Station 65
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

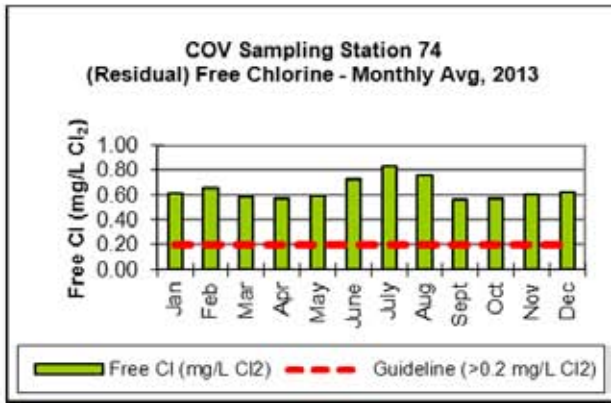

COV Sampling Station 66
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

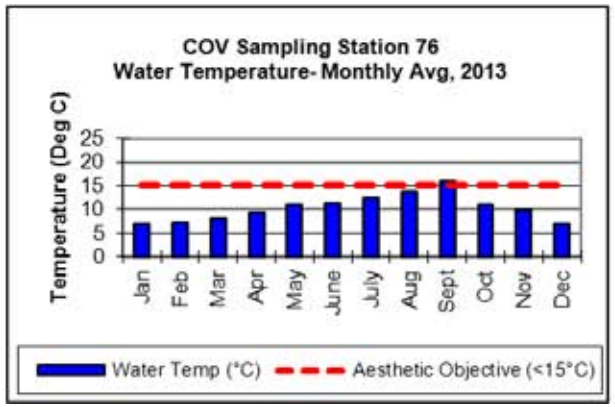

COV Sampling Station 66
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

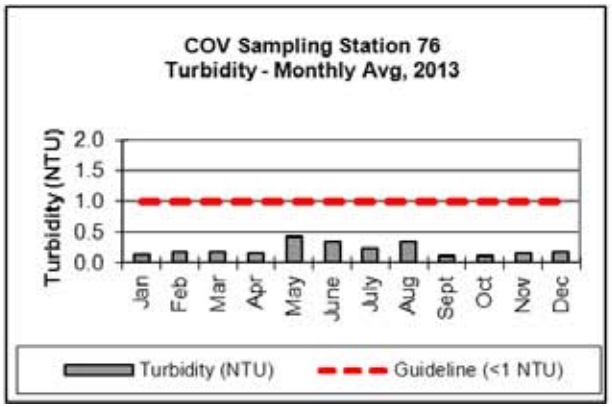

COV Sampling Station 66
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

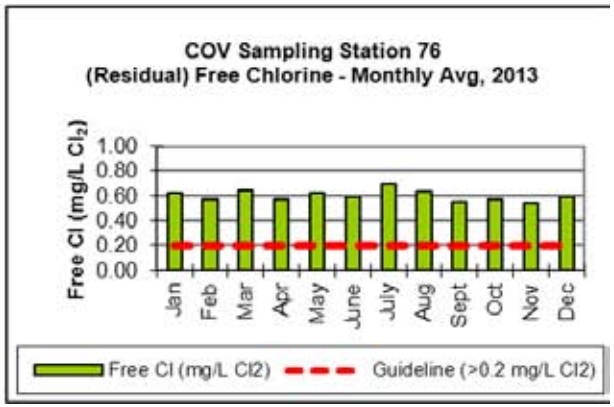

COV Sampling Station 74
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)

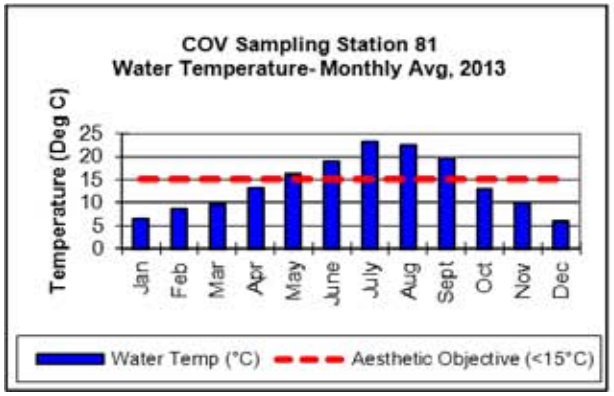

COV Sampling Station 74
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)

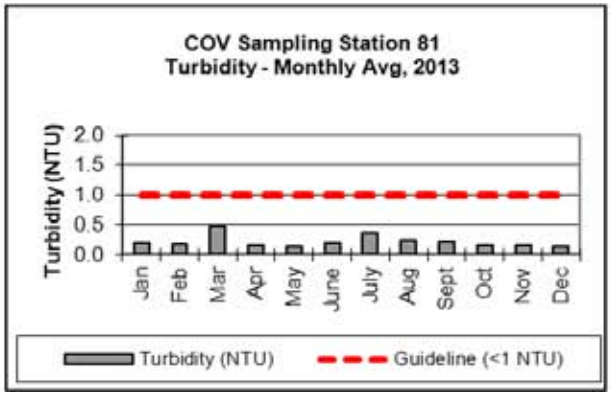

COV Sampling Station 74
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)

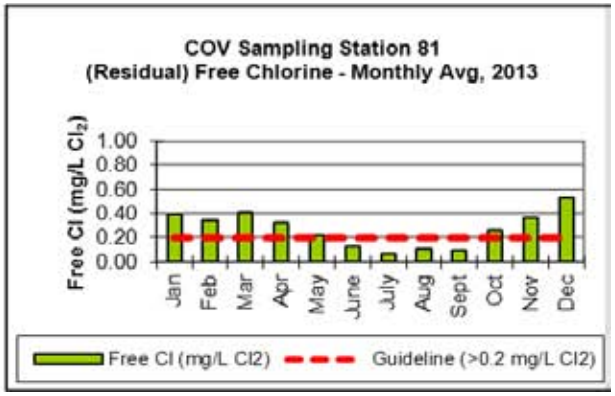

COV Sampling Station 76
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)


COV Sampling Station 76
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)


COV Sampling Station 76
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)


COV Sampling Station 81
Water Temperature- Monthly Avg, 2013
Temperature (Deg C)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Water Temp (°C)
Aesthetic Objective (<15°C)


COV Sampling Station 81
Turbidity - Monthly Avg, 2013
Turbidity (NTU)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Turbidity (NTU)
Guideline (<1 NTU)


COV Sampling Station 81
(Residual) Free Chlorine - Monthly Avg, 2013
Free Cl (mg/L Cl2)
1.00
0.80
0.60
0.40
0.20
0.00
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Free Cl (mg/L Cl2)
Guideline (>0.2 mg/L Cl2)