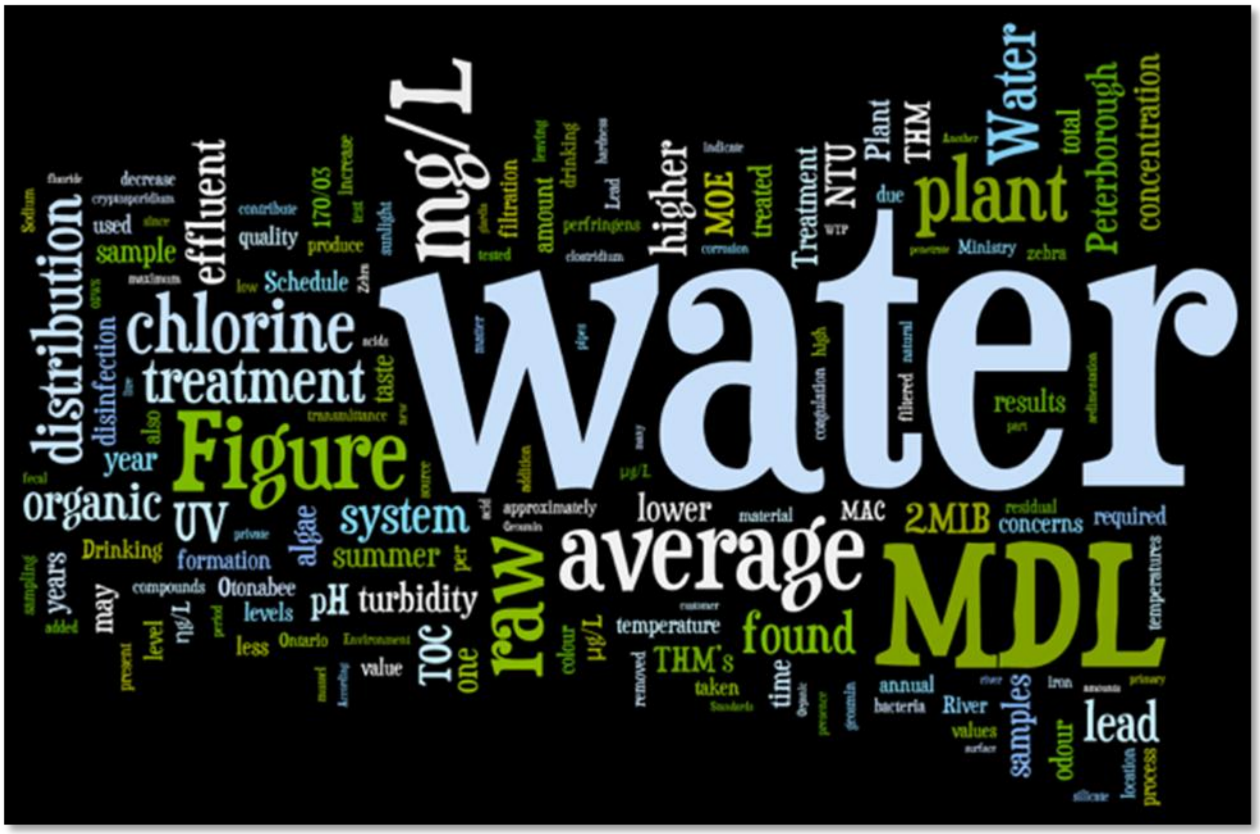
Peterborough
Utilities
Commission




# 2010 WATER QUALITY REPORT

**On the Cover** The "word cloud" was generated using the text of the annual water quality report. The clouds give greater prominence to words that appear more frequently in the report

Source: www.wordle.net

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## EXECUTIVE SUMMARY

With minimal disruptions to the plant process for construction or maintenance, the Peterborough Water Treatment Plant continued to produce an excellent quality of drinking water for the consumers in Peterborough during 2010.

The weather in 2010 had an influence on the water flow and water quality for the Otonabee River (source water). For example, higher summer raw water temperatures resulted in more chlorine being used to achieve the same disinfection results. According to Environment Canada, it was one of the mildest winters with lower than normal accumulation of snowfall, receiving approximately half the snow of a normal winter. It was also one of warmest summers on record; in 2010 we had 5 days in July with extreme UV readings of +11, a very rare occurrence in Canada. The summer‘s many isolated thunderstorms contributed to wide fluctuations of flow in the Otonabee River. Rainfall totals for the three summer months of June, July and August was 286.0mm, 26% above normal values of 226.6mm.

The Otonabee River water temperature varied over the year from 0.0°C to 26.9°C. The 2010 annual average water temperature of 11.7°C was higher than the last five year average of 10.8°C.

Higher summer raw water temperatures also contribute to increased growth of algae in the Otonabee River, which historically has lead to a higher level of taste and odour causing compounds (geosmin and 2MIB). A higher amount of sunlight reaching down into the water column will increase the algae activity – including taste and odour causing algae – this would be one of the few disadvantages of having a hot sunny summer.

During the 4$^{th}$ quarter of 2010, preventative maintenance and inspection was performed on the chlorine contact tank. During this time, the primary disinfection chlorine was added into the raw water prior to coagulation and filtration in order to ensure that the water received the required contact time. Adding the chlorine at this point in the treatment process, prior to the removal of most organic material, would cause an elevated trihalomethane (THM) result leaving the water treatment plant and also a higher result in the distribution system during this period (see page 18).

Reviewing data over the last sixteen year period, 2010 had the second lowest pumping volume of plant raw water. During the summer we had variable and timely rainfall, which seemed to contribute to a lower water demand. Customers used less water (including less lawn watering), resulting in the water staying in to distribution system longer. Longer retention times means a higher value of THM's.

The highest pumpage day was on May 31$^{st}$, 2010 at 61,963$m^3$ (cubic metres). This was only 61.1% of the historical daily high of 91,008$m^3$, recorded in 2005. A water volume of 13,817,865$m^3$ was treated during 2010 compared to an annual total of 13,710,950$m^3$ for 2009 – a 0.8% increase from 2009.

2010 was the fourth year that the Ministry of Environment (MOE) lead sampling regulations was in place. In Peterborough, 99% of the sample results were below MOE lead standards. These results demonstrate that the corrosion control program (addition of sodium silicate) has been effectively maintaining the integrity of the infrastructure (see page 6). The Peterborough Utilities Commission replaced the remaining municipal lead services in early 1990. There are however a few remaining homes in Peterborough with private lead pipes. As per the MOE regulations, starting December 2009, the number of required volunteers needed for the lead sampling program has been reduced from 80 customers down to 40 customers since our results have been very favourable.

The new maximum acceptable concentration (MAC) for filtered water is now 0.30 Nephelometric Turbidity Units (NTU) for 95% of the time and never greater than 1.0 NTU. This value was previously set at 1.0 NTU for 100% of the time. The average filtered water level in the Peterborough's drinking water was 0.06 NTU for 2010 and filters are taken off-line when the turbidity exceeds 0.15 NTU.

In conclusion, the Peterborough Water Treatment Plant continued to produce an excellent quality of water for its consumers and once again exceeded the quality required in the Ontario Drinking Water Standards (ODWS). This is largely due to the optimization of the facilities and the continuing expertise and dedication of the staff to produce and maintain excellent quality drinking water.

## Source Water

### Zebra Mussel

During 2010, zebra mussel populations appeared to be stable with virtually no change in raw water turbidity. Since the introduction of zebra mussels (an invasive species) into Ontario and later into the Otonabee River system in 1997, the effects continue to cause slight changes in raw water turbidity. The Ontario Federation of Anglers and Hunters had their first confirmed sighting of zebra mussels in this area at Lock 19 in 1997. According to literature, one zebra mussel can clear 1 litre of water per day. Large numbers of zebra mussels can actually clear a water body. Sunlight (when available) is then able to penetrate further down into the water column allowing other species of algae to flourish.

### Turbidity

The 2010 average raw water turbidity was 0.67 NTU; this is a decrease of 0.10 NTU from 2009. The variable summer rainfall gave us normal Otonabee river flows, giving us close to average turbidities. . A 20-year trend of Otonabee River (raw water) and finished treated water (plant effluent) turbidity is shown in Figure 1. The past 20 year average raw water turbidity was 0.73 NTU.

The zebra mussel population in the river could also be a contributing factor for the cyclical increase and decreases in raw water turbidity. Since zebra mussels feed on organic matter in the water, less zebra mussels feeding could show an increase in raw water turbidity.

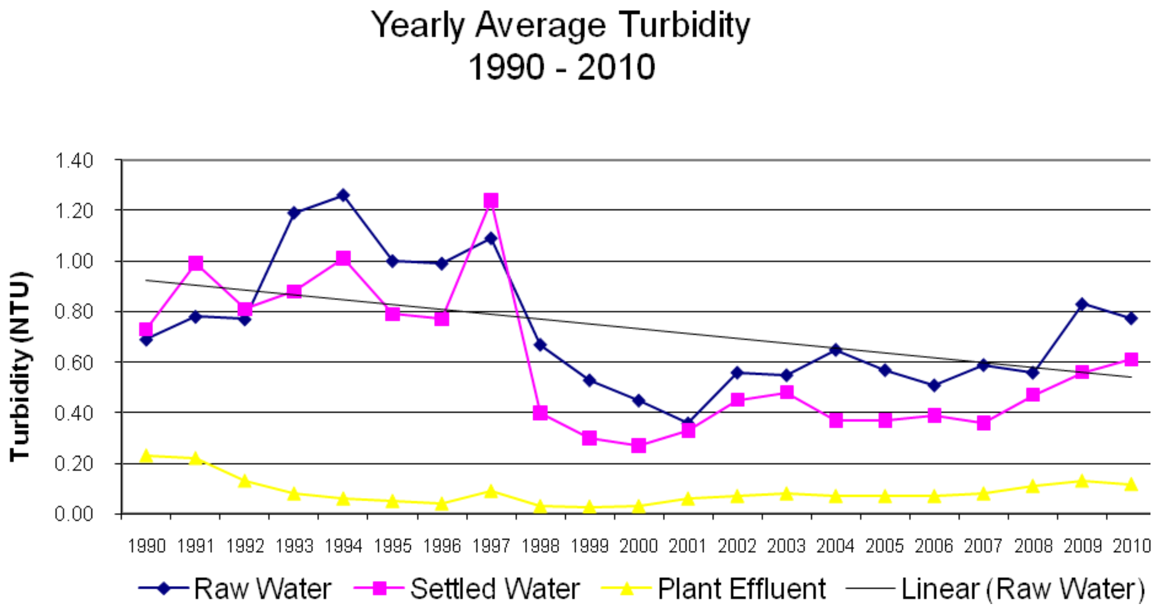


*Figure 1*

The annual raw water turbidity peak occurred July 18th at 1.79 NTU due to a large thunderstorm event coupled with 11.5mm of precipitation (average July monthly turbidity at 0.67 NTU) with normal water temperatures (average July temperature at 25.0°C) and high sunlight - good conditions for algae growth (Figure 2).

The MAC for filtered water is 0.3 NTU for 95% of the time, and never exceeding 1.0 NTU. The average filtered water turbidity was 0.07 NTU for 2010 and filters are taken off-line when the turbidity exceeds 0.15 NTU (half the MAC).

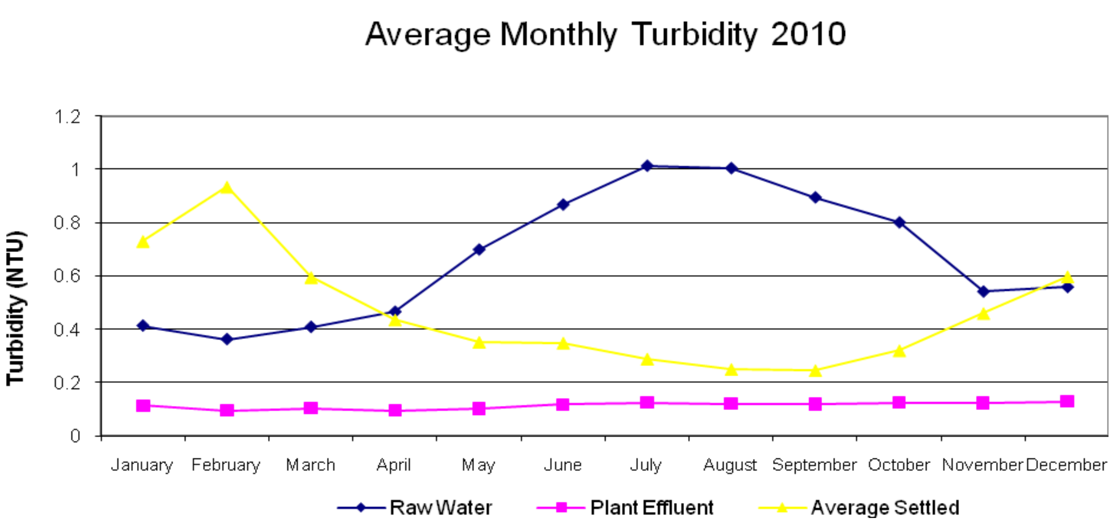

*Figure 2*

## Taste and Odour

During 2010, the primary source of taste and odour in our raw water was from the naturally occurring compounds geosmin and 2MIB. These compounds are monitored as a precursor to taste and odour complaints of the water and are not a health concern. They can be detected by humans at very low levels (less than 10ηg/L). A ηg/L is equal to one billionth of a gram per litre. The bacteria actinomycetes, zebra mussels and some species of blue-green algae can produce geosmin and 2MIB, though the exact organisms are not known.

Previous annual data indicates that geosmin and 2MIB would hit peaks at the same time during the summer months. There is usually a large peak near the end of the summer when the water temperature is the highest. During 2010, 2MIB appeared in the raw water much earlier than other years. The water warmed up earlier contributing to this occurence (Figure 3 & 4).

Geosmin is thought to originate higher in the water column and produce an earthy odour. The average raw water value during 2010 was 7.8ηg/L and the average plant effluent was 4.0ηg/L (Figure 3). During the year 31% of samples taken came back as too low to measure (3<MDL) for geosmin in the raw water.

2MIB is produced in the sediment or benthic layer and gives off a musty odour. 2MIB can reproduce well when sunlight can penetrate down to the bottom of lakes and streams. Zebra mussels may be clearing the water to allow sunlight to penetrate further down to these benthic layers.

A summer with plenty of sunlight (high water column algae) would contribute to higher amounts of this geosmin & 2MIB. During 2010 one geosmin peak occurred July 6th with a value of 18ηg/L and another peak occurred in September again with a value of 18ηg/L (Figure 4).

The reduction of geosmin and 2MIB due to water treatment processes (coagulation, sedimentation, filtration and chlorination) was 48% and 26%, respectively. Both geosmin and 2MIB compounds resist oxidation (disinfection) and are difficult to remove by conventional water treatment processes.

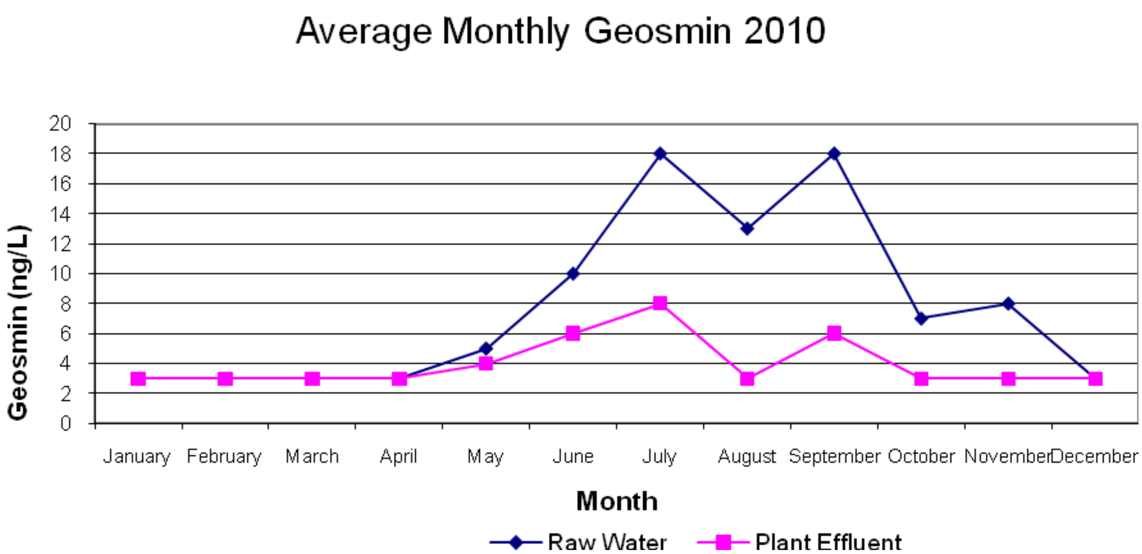


*Figure 3*

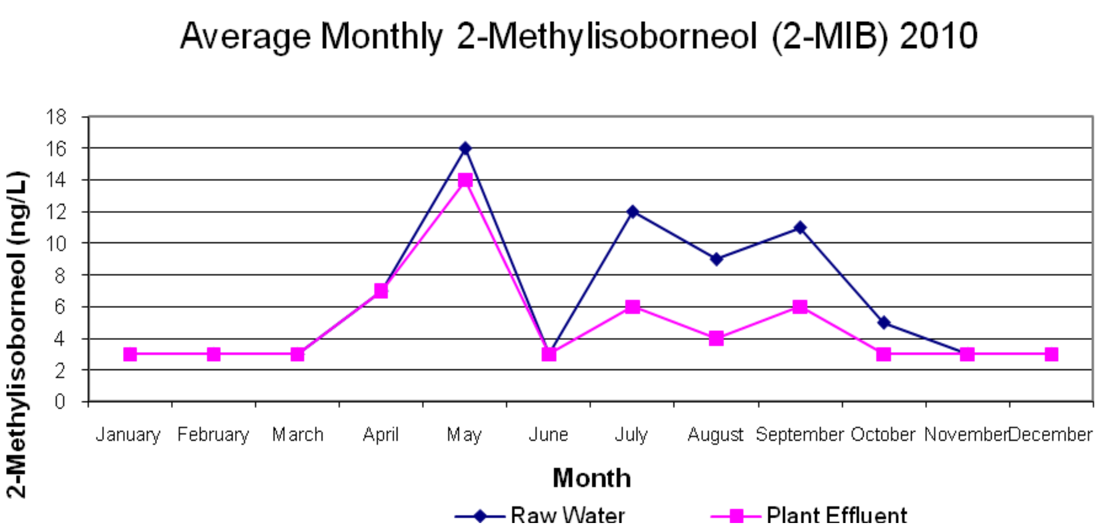


*Figure 4*

### Blue Green Algae

Blue-green algae are technically known as cyanobacteria**,** a microscopic organism which is naturally present in our lakes and streams. Usually present in low numbers, however blue-green algae can become very abundant in warm, shallow, undisturbed surface water that receives a lot of sunlight. In 2010, the raw water temperatures were higher but the higher water flows from increased precipitation prevented algae blooms from forming.

## Operational Parameters

### Sodium Silicate (BW46)

Sodium silicate (BW46) is added to the plant effluent for corrosion control within the distribution system as well as plant effluent pH adjustment. The average sodium silicate dosage for 2010 was 15.4mg/L (as $SiO_2$) compared to 14.3mg/L in 2009. The use of chlorine and alum during the water treatment process lowers the pH level causing the water to be slightly acidic (corrosive). The addition of BW46 increases the pH to a more acceptable value of 7.1. The addition of BW46 may contribute to the total silica level found in the water. The level of silica in the distribution system is monitored annually. Silica levels throughout the distribution system generally ranged between 6.6mg/L and 21.4mg/L with an annual average of 14.5mg/L. The 2010 annual average silica level found leaving the water treatment plant was 13.6mg/L.

### Aluminum

Aluminium residual found in the plant effluent can be a by-product of the addition of aluminium sulphate (alum). Alum is used as our primary coagulant causing particles (silt, sand, algae, bacteria, etc.) to coagulate or ‘clump’ to form a floc, which can settle in the sedimentation basins. The water is further treated by filtration. Alum was added to the water during 2010 at an average of 43.8mg/L. The average alum dosage during 2009 was 45.9mg/L.

A properly balanced/optimized treatment with coagulation, sedimentation and filtration resulted in reduced aluminium residuals in the plant effluent sample. The Province of Ontario’s operational guideline for aluminium residual is 100μg/L. The average concentration of aluminium leaving the water treatment plant was found to be 46μg/L (Figure 5).

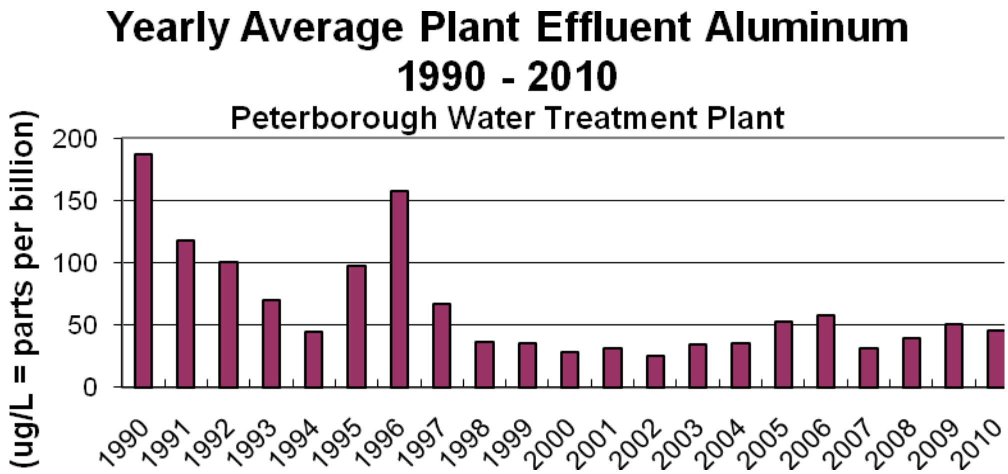


*Figure 5*

## Chlorine

The Peterborough Water Treatment Plant uses chlorine for disinfection against virus and bacteria in accordance with O. Reg. 170/03. The primary disinfection dose of chlorine for 2010 ranged between 2.4mg/L and 3.5mg/L. During the summer months the primary chlorine dose could be as high as 2.8mg/L due to warmer water temperatures and also to maintain the chlorine residual throughout the distribution system to comply with the Ontario Drinking Water Standards (ODWS).

Zebra mussel chlorine dose modulator

Zebra mussel control for the water treatment plant included adding approximately 0.5mg/L of chlorine into the water treatment plant intakes from January to October. The addition of zebra mussel chlorine is dosed only during the months when we experience warmer water temperatures (usually when water temperature is above 12°C). This is when the zebra mussels will colonize on surfaces such as the intake pipe walls.

Post chlorine (or secondary chlorination) is dosed at approximately 0.1 to 0.3mg/L to the finished water (plant effluent) in order to maintain a proper disinfection leaving the water treatment plant and to ensure that free chlorine residuals in the distribution system are maintained within MOE guidelines (target of 0.20mg/L free chlorine).

## Hardness

According to the MOE, the recommended operational guideline for hardness is 80 to 100mg/L expressed as calcium carbonate (CaCO3). Levels between 80 and 100mg/L as CaCO3 are considered to provide an acceptable balance between corrosion and incrustation.

Hardness is caused by the presence of certain dissolved chemical compounds, with calcium and magnesium being the primary elements. The amount of hardness varies significantly depending on the source. Source water in areas where there are higher amounts of limestone and dolomite will have higher amounts of hardness. Calcium is dissolved as water passes over limestone deposits. Magnesium is dissolved as water passes over dolomite and other magnesium bearing minerals.

Groundwater usually has higher amounts of hardness due to the fact that groundwater will be in contact with these geologic formations for a longer period of time than surface waters. Average hardness values for Peterborough's raw water in 2010, was 89.2mg/L as $CaCO_3$ and 90.3mg/L in the treated water. Hardness at this level is considered to be moderately hard. Hardness does not appear to change from year to year substantially and treatment has little effect on it.

## Alkalinity

Alkalinity is a measure of the capacity of water to neutralize acids and is also known as the buffering capacity. It is due primarily to the presence of naturally available bicarbonate, carbonate and hydroxide ions. According to the MOE, the recommended operational range for alkalinity in coagulant-treated drinking water is 30 to 500mg/L as $CaCO_3$. Alkalinity over 30mg/L assists flocculation formation during the coagulation process. Levels of 20 to 200mg/L are typical for fresh water.

Average alkalinity values in 2010 for our raw water were 84.3mg/L and 75mg/L in the plant effluent (Figure 6). Alkalinity generally decreases when water is treated with alum (aluminium sulphate)

A total alkalinity level of 100 to 200mg/L will stabilize the pH level in a stream. Levels below 10mg/L indicate that the system is poorly buffered and is very susceptible to changes in pH from natural and human-caused sources.

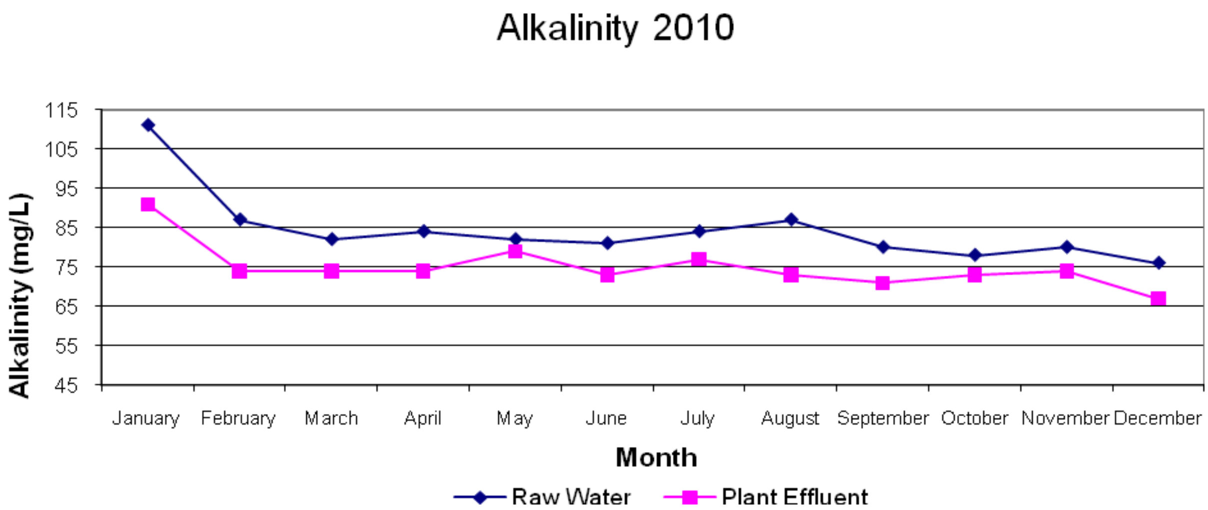


*Figure 6*

### Hydrofluosilic Acid

Hydrofluosilicic acid (fluoride) was added to the treated water to attain a combined average concentration of 0.65mg/L (natural fluoride plus added fluoride). The fluoride feed system was off for a total of 92 days during 2010 due to preventative maintenance of the fluoridation feed and test equipment. Hydrofluosilicic acid was also off during the period of time that the chlorine contact tank out of service (by-passed).

The MOE recommends that the fluoride residual be between 0.5mg/L and 0.8mg/L with a MAC of 1.5mg/L. Approximately 1,300 samples taken at the water treatment plant, raw water and the distribution system and were tested for fluoride concentration during 2010. The average fluoride concentration found in the treated water was 0.53mg/L. The average fluoride concentration found in the raw water was 0.18mg/L.

### Iron

Although not generally considered a health issue, excessive levels of iron in drinking water supplies may impart a brownish colour to laundered goods, plumbing fixtures and the water itself; it may produce a bitter, astringent taste in water and beverages. The precipitation of iron can also promote the growth of bacteria in water mains and pipes.

During 2010, 22 distribution locations were sampled each month and tested for iron. The 2010 average distribution iron levels were 0.025mg/L (Figure 7). The average iron residual in 2009 was found to be 0.022mg/L. The MOE aesthetic objective (for appearance effects only) is 0.30mg/L.

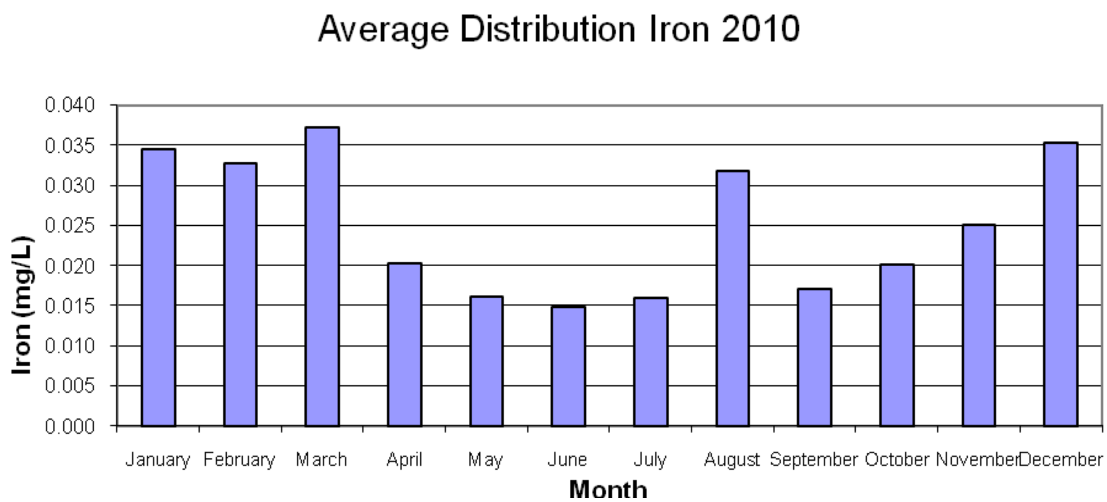


*Figure 7*

**pH**

The MOE operational guideline recommended in drinking water is to maintain a pH between 6.5 and 8.5. The principal objective in controlling pH is to produce a water that is neither corrosive nor produces incrustations. In 2010, the average raw water pH was 7.53 (Figure 8). With the addition of alum the pH is lowered to 6.77 (in the settled basins). With the addition of chlorine, pH is lowered further to 6.44 (in the chlorine contact tank). A pH of 6.44 is considered slightly corrosive so sodium silicate is added to increase pH.

Sodium silicate (BW46) is added to the plant effluent water in order to raise the pH to an annual average of 7.1 and to deposit a thin silicate coating to the distribution piping for corrosion protection.

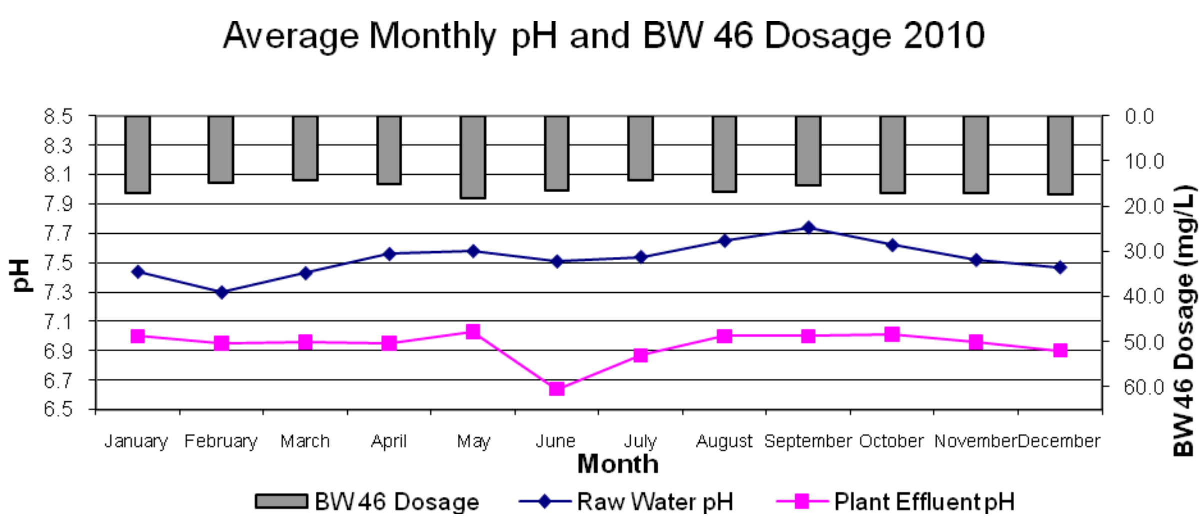


*Figure 8*

## Regulatory Sampling

### Lead Sampling

A total of 127 lead samples were taken in 2010, during 2 rounds of sampling. Over 99% of the sample results were below the Ministry's standard for lead (less than 10µg/L). There were 2 residential samples that were above 10µg/L. It was determined that one residential location had internal lead piping in their home (circa 1880). This would cause the level of lead in the water to be above 10µg/L. The second residential location was built in approximately 1948 – not a prime time for lead plumbing installations. During the two rounds adverse lead was found in less than 2.5% of residential samples.

### Bacteria

### Clostridium Perfringens

The MOE guidelines for clostridium perfringens is to have all samples collected from the plant effluent to be zero CFU (colony forming units) per litre of water sampled. While the MOE do not require this parameter to be tested, the bacteria clostridium perfringens is analyzed as an indicator of treatment efficiency for protection from parasitic protozoan giardia and cryptosporidium. Clostridium perfringens frequent the intestines of humans and many domestic and feral animals. Spores of the organism persist in soil, sediments and areas subject to human or animal fecal pollution. Since this organism is spore forming it can be used to mimic other organisms that can be found in an oocyst stage such as giardia and cryptosporidium.

Giardia and cryptosporidium which are resistant to disinfection treatment and only through optimum coagulation, flocculation, sedimentation and filtration can these organisms be removed. If clostridium perfringens can be effectively removed from the water treatment train then there is a very low probability that giardia and cryptosporidium are present in the plant effluent. The relative sizes are as follows: Clostridium perfringens 1–2µm, cryptosporidium 4–5µm, and giardia 8–14µm.

The raw water, settled water and plant effluent were all monitored for clostridium perfringens during 2010. The raw water contained on average of 10.3 CFU/L of clostridium perfringens. During 2009, the average was 11 CFU/L. All treated water samples for 2010 returned results of 0 CFU for clostridium perfringens (Figure 9), indicating an effective treatment process.

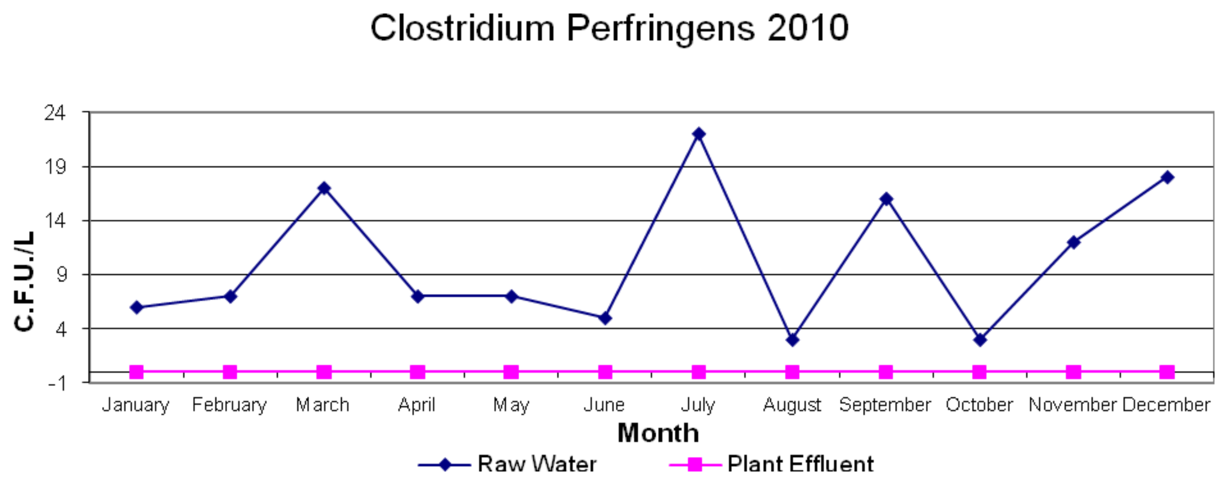


*Figure 9*

**Fecal Streptococci & E. Coli Ratios**

During 2010, a total of 12 fecal streptococci and E. coli samples were analyzed from the Otonabee River (at the WTP intake) to assist in determining the source of fecal contamination within our source water (Figure 10). Fecal streptococci are another species of bacteria (similar to E. coli) from warm-blooded animals.

A ratio between fecal streptococci and E. coli can assist in determining the species source of contamination. The ratio between 2010 average E. coli to fecal strep bacteria populations in the WTP raw water were found to be 1:0.60 CFU. This would indicate that the majority of fecal contamination in the Otonabee River found at the WTP was from ducks or geese.

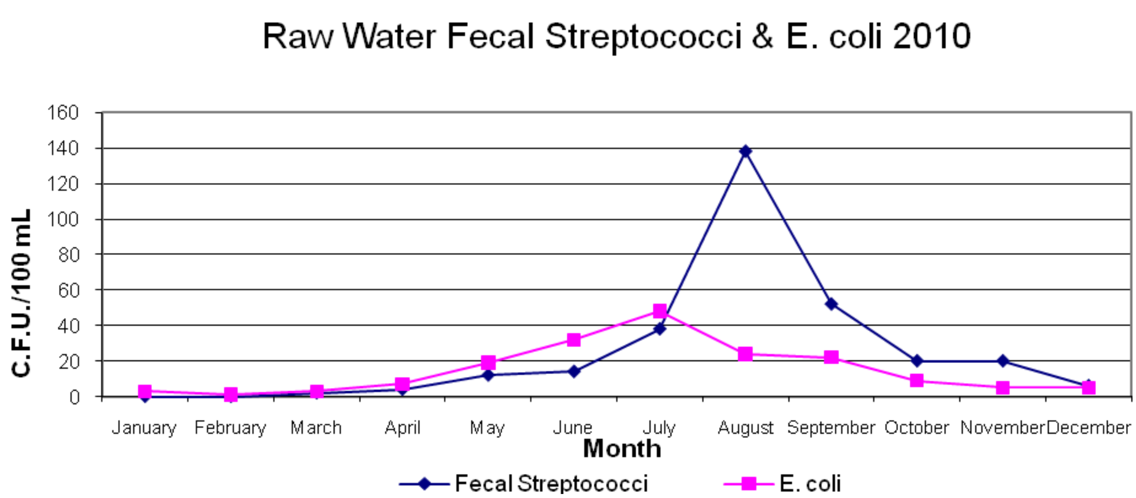


*Figure 10*

## Testing

The Peterborough Water Treatment Plant fully complied with the quarterly and annual testing and reports required under the Ministry of the Environment's Drinking Water Systems Regulations 170/03 made under the Safe Drinking Water Act, 2002. Schedule 23 & 24 list the annual parameters required under the Drinking Water Standards, Regulations 170/03.

During 2010, there was 1 adverse water quality reported to the MOE; a low free chlorine residual was tested (free chlorine lower than 0.05mg/L) in the distribution system. The low free chlorine sampling location was flushed and re-sampled. The re-sample test results were in compliance to the MOE standards.

During 2010, there were over 20,000 individual water quality tests performed on samples taken from the Peterborough Water Treatment Plant and the distribution system. Approximately 13,000 tests were performed at the Peterborough Water Treatment Plant laboratory. SGS Lakefield Research Analytical Laboratory performed approximately 6,000 microbiological and chemical tests. The MOE laboratories performed approximately 1,000 tests including inorganic and organic parameters taken as part of the Drinking Water Surveillance Program (DWSP).

The Peterborough Water Treatment Plant effluent and distribution sample test results for inorganic and organic parameters in 2010 met present health-related Ministry of the Environment Drinking Water Standards: Schedule 23 and Schedule 24 as per the MOE O. Reg. 170/03.

Please note that the majority of results indicated "< MDL" meaning that the results were below the Method Detection Limit (i.e. test could not detect any concentration). All tested parameters were found to be below the ODWS, MAC.

Lead is not part of Schedule 23 or 24 but is required to be sampled and tested annually. This sample must be taken from a location in the city's distribution system that may have the oldest water mains. Sherbrooke Street Sampling Station was selected as this location since it was indicated that the water mains in this area are over 100 years old.

Sodium is not part of Schedule 23 or 24 but is required to be tested at least once every 5 years. It has been sampled every year and was found to be below the ODWS, aesthetic objective of 200mg/L. The local MOH must be notified when the sodium concentration exceeds 20mg/L, so that this information may be passed on to local physicians.

Records of individual test results are kept on file at the Peterborough Water Treatment Plant laboratory. An updated copy of the Peterborough Water Treatment Plant annual report can be found on the Peterborough Utilities web site at www.peterboroughutilities.ca.

## Ontario Drinking Water Standards Summary

Required under regulation 170/03

Note: All units are µg/L unless otherwise stated.
<MDL is less than laboratory Method Detection Level
MAC is the Maximum Acceptable Concentration

### Schedule 23 – Inorganic Parameters

| Inorganic | Jan 19 | | MAC |
|---|---|---|---|
| Antimony | **0.2** | | 6 |
| Arsenic | **0.4** | | 25 |
| Barium | **25.2** | | 1000 |
| Boron | **23.4** | | 5000 |
| Cadmium | **0.003** | <MDL | 5 |
| Chromium | **0.5** | <MDL | 50 |
| Mercury | **0.02** | <MDL | 1 |
| Selenium | **1** | <MDL | 10 |
| Uranium | **0.047** | | 20 |
| | | | |
| | | | |
| Lead* (Sampled at Sherbrooke Sampling Station ) | **1.05** | | 10 |
| Lead * (Treated Water) | **0.05** | | 10 |
| Sodium** mg/L | **12.2** | | 20 |

Note: Copper, Iron, and Manganese are not required with the new regulations (after June, 2003). Lead must be sampled in the distribution system (reg. 170/03).

### Schedule 24 – Organic Parameters

| Organic | Jan 19 | | MAC |
|---|---|---|---|
| Alachlor | **0.11** | <MDL | 5 |
| Aldicarb | **0.30** | <MDL | 9 |
| Aldrin + Dieldrin | **0.067** | <MDL | 0.7 |
| Aldrin | **0.060** | <MDL | |
| Atrazine + N-dealkylated metabolites | **0.12** | <MDL | 5 |
| Atrazine | **0.11** | <MDL | |
| Desethyl atrazine | **0.12** | <MDL | |
| Azinphos-methyl | **0.21** | <MDL | 20 |
| Bendiocarb | **0.13** | <MDL | 40 |
| Benzene | **0.32** | <MDL | 5 |
| Benzo(a)pyrene | **0.004** | <MDL | 0.01 |
| Bromoxynil | **0.33** | <MDL | 5 |
| Carbaryl | **0.16** | <MDL | 90 |
| Carbofuran | **0.37** | <MDL | 90 |
| Carbon Tetrachloride | **0.16** | <MDL | 5 |
| Chlordane (total) | **0.11** | <MDL | 7 |
| a-chlordane | **0.069** | <MDL | |

| **Organic** | **Jan 19** | | **MAC** |
|---|---|---|---|
| g-chlordane | **0.063** | <MDL | |
| Chlorpyrifos | **0.18** | <MDL | 90 |
| Cyanazine | **0.18** | <MDL | 10 |
| Diazinon | **0.081** | <MDL | 20 |
| Dicamba | **0.20** | <MDL | 120 |
| 1,2-Dichlorobenzene | **0.41** | <MDL | 200 |
| 1,4-Dichlorobenzene | **0.36** | <MDL | 5 |
| Dichlorodiphenyltrichloroethane (DDT) & Metabolites | **0.14** | <MDL | 30 |
| op-DDT | **0.095** | <MDL | |
| pp-DDD | **0.098** | <MDL | |
| pp-DDE | **0.075** | <MDL | |
| pp-DDT | **0.14** | <MDL | |
| 1,2-dichloroethane | **0.35** | <MDL | 5 |
| 1,1-Dichloroethylene (vinylidene chloride) | **0.33** | <MDL | 14 |
| Dichloromethane | **0.35** | <MDL | 50 |
| 2-4-Dichlorophenol | **0.15** | <MDL | 900 |
| 2,4-Dichlorophenoxy acetic acid ( 2,4-D) | **0.19** | <MDL | 100 |
| Diclofop-methyl | **0.40** | <MDL | 9 |
| Dimethoate | **0.12** | <MDL | 20 |
| Dinoseb | **0.36** | <MDL | 10 |
| Diquat | **1** | <MDL | 70 |
| Diuron | **0.087** | <MDL | 150 |
| Glyphosate | **6** | <MDL | 280 |
| Heptachlor + Heptachlor Epoxide | **0.11** | <MDL | 3 |
| Heptachlor | **0.061** | <MDL | |
| Heptachlor epoxide | **0.11** | <MDL | |
| Lindane (total) | **0.056** | <MDL | 4 |
| Malathion | **0.091** | <MDL | 190 |
| Methoxychlor | **0.14** | <MDL | 900 |
| Metolachlor | **0.092** | <MDL | 50 |
| Metribuzin | **0.12** | <MDL | 80 |
| Monochlorobenzene | **0.3** | <MDL | 80 |
| Oxychlordane | **0.11** | <MDL | |
| Paraquat | **1** | <MDL | 10 |
| Parathion | **0.18** | <MDL | 50 |
| Pentachlorophenol | **0.15** | <MDL | 60 |
| Phorate | **0.11** | <MDL | 2 |
| Picloram | **0.25** | <MDL | 190 |
| Polychlorinated Biphenyls (PCB) | **0.04** | <MDL | 3 |
| Prometryne | **0.23** | <MDL | 1 |
| Simazine | **0.15** | <MDL | 10 |
| Temephos | **0.31** | <MDL | 280 |
| Terbufos | **0.12** | <MDL | 1 |
| Tetrachloroethylene (perchloroethylene) | **0.35** | <MDL | 30 |
| 2,3,4,6 - Tetrachlorophenol | **0.14** | <MDL | 100 |
| Triallate | **0.10** | <MDL | 230 |
| Trichloroethylene | **0.43** | <MDL | 5 |

| Organic | Jan 19 | | MAC |
|---|---|---|---|
| 2,4,6 - Trichlorophenol | **0.25** | <MDL | 5 |
| 2,4,5 - Trichlorophenoxy acetic acid (2,4,5-T) | **0.22** | <MDL | 280 |
| Trifluralin | **0.12** | <MDL | 45 |
| Vinyl Chloride | **0.17** | <MDL | 2 |
| Dieldrin | **0.067** | <MDL | |

Note: If any parameter from Schedules 23 and 24 were found to exceed half of the prescribed standard for the parameter, the frequency of sampling and testing for that parameter shall be increased so that at least one water sample is taken and tested every three months.

## Disinfection By-Products

### Halogenic Acetic Acid (HAA)

Since 2009 testing has been conducted on the raw and treated water for halogenic acetic acid (HAA), in anticipation that this will be introduced into the O. Reg. 170/03 or O. Reg 169/03 sampling amendments. The 2010 average treated water HAA was 21.8µg/L and the average distribution sample was found to be 58.8µg/L (Figure 11).

HAA's are another group of chemicals that are formed as disinfection by-products similar to trihalomethanes (THM). HAA's are formed when chlorine is used to disinfect drinking water, which reacts with naturally occurring organic matter (NOM) in water. Also called haloacetic acids, they are a relatively new disinfection by-product being studied.

The reported HAA value refer to the sum of the concentration of six haloacetic acid compounds which include monochloroacetic acids, dichloroacetic acids, trichloroacetic acids, monobromoacetic acids, dibromoacetic acids and bromochloroacetic acid.

Presently there are no provincial guidelines or standards for HAA's in the Ontario Drinking Water Systems Regulation. The Guidelines for Canadian Drinking Water Quality recommend a MAC of 80 micrograms per litre (µg/L) for HAA's in drinking water, based on a locational running annual average of a minimum of quarterly samples taken in the distribution system.

Water facilities that derive their water from surface water (lakes, rivers, reservoirs) are likely to produce water with higher levels of disinfection by-products than facilities that draws from groundwater. The natural characteristics of a surface water source and the characteristics of the associated watershed greatly influence water quality, including the potential formation of HAA's.

The natural factors that are key parameters to influence water quality are hydrology, topography, geology, soil, vegetation and climate. The formation of HAA's has been reported to be a function of precursor concentration (NOM), chlorine dose, chlorination pH, temperature, contact time and bromide ion concentration.

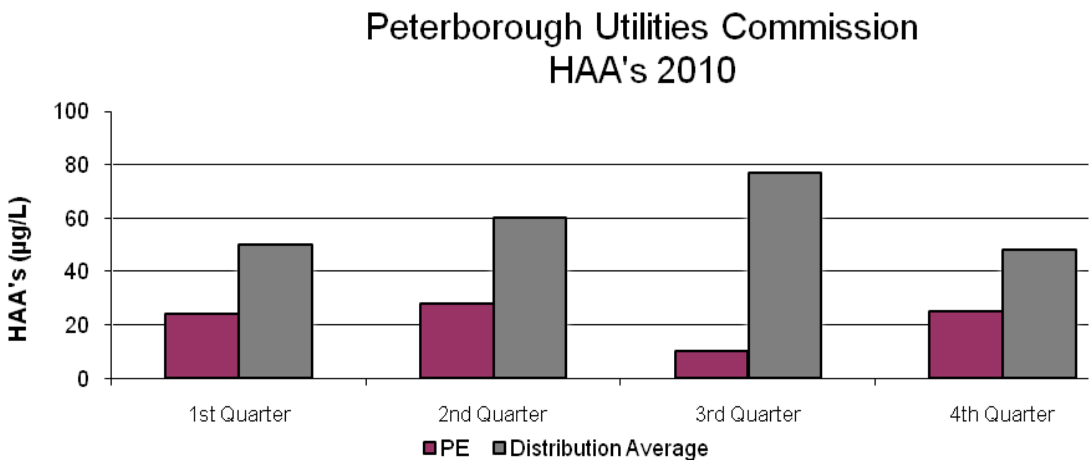


*Figure 11*

## Colour

The colour of the water can indicate the degree of organic matter that may be present. The Otonabee River has 'tea' coloured water that indicates the presence of humic substances. Humic substances are the end product of decaying organic matter and most likely contain tannin (complex organic compound found naturally in soil and in certain tree barks) and lignin (natural compound common in woody plants and trees). These compounds are part of a natural group of organic substances in soil, produced by decaying vegetation. The presence of organic materials along with the use of chlorine in the water treatment process can contribute to the formation of disinfection by-products.

According to the Ministry of Environment colour is classed as a physical aesthetic parameter. The aesthetic objective for colour in treated water is 5 True Colour Units (TCU's).

In 2010, the average raw water colour was 13 TCU and the average colour for our treated water was less than 1 TCU. The raw water colour tends to peak during the spring months when there is snow melt and/or high rainfall with a large amount of surface runoff. A large proportion of colour has been removed during our water treatment processes (Figure 12).

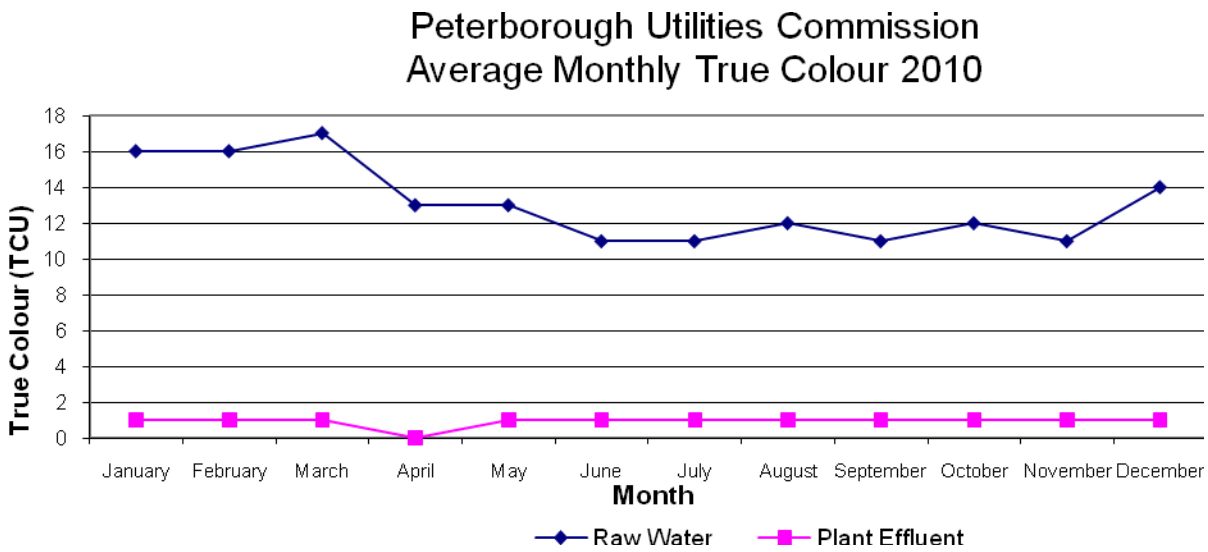


*Figure 12*

**Trihalomethanes**

Trihalomethanes (THM's) are formed as a by-product when chlorine is used to disinfect water for drinking. The reaction of chlorine with organic matter in the water produces THM's. The THM's may have adverse health effects at high concentrations and many governments set limits on the amount permissible in drinking water.

In Ontario, the Ministry of the Environment's MAC for total THM's (total concentration of chloroform, bromoform, bromodichloromethane and dibromochloromethane) are set to 100μg/L (sliding yearly average) for the distribution system. According to O. Reg. 170/03, THM samples must be collected and analyzed at least quarterly.

There are many factors which contribute to the formation of THM's with the more notable being water temperature, amount of organic material present (total organic carbon or TOC), chlorine residual present and time at which these chemicals are in contact with each other. The average water temperature was cooler which can lower the formation of THM's but the residency time (time that the water is in the water pipes) can be longer since the water is not being used as readily (for example lawn watering, etc.).

A lower TOC value in our finished water will help to lower the THM formation as the water travels through the distribution system. The water treatment plant processes (coagulation, sedimentation and filtration) reduced TOC by 35% during 2010 to a value of 3.4mg/L.

The THM average values found leaving the water treatment plant during 2010 was 55.0μg/L. The average plant effluent THM level for 2009 was 45.0μg/L. The past 10-year average plant effluent has been 48μg/L (Figure 14).

Distribution levels are always found to be higher than those leaving the water treatment plant since THM's continue to form as the water travels through the distribution piping system. During 2010, one distribution location was selected to assist in determining areas of the city where THM's may be highest. The average THM value in the distribution system was 87μg/L. The 10-year average of distribution THM concentration was found to be 70μg/L.

If our customers are using more water, the reaction time between organics and chlorine is reduced. The less time that chlorine and organics are in contact with each other means that a lower concentration of THM's are produced.

The raw water temperature during the summer hit a maximum of 26.9°C (26°C maximum in 2009). Since it is a chemical reaction, THM formation is higher when the water is warmer so it is logical reason as to why the THM levels were slightly higher in 2010 than other years.

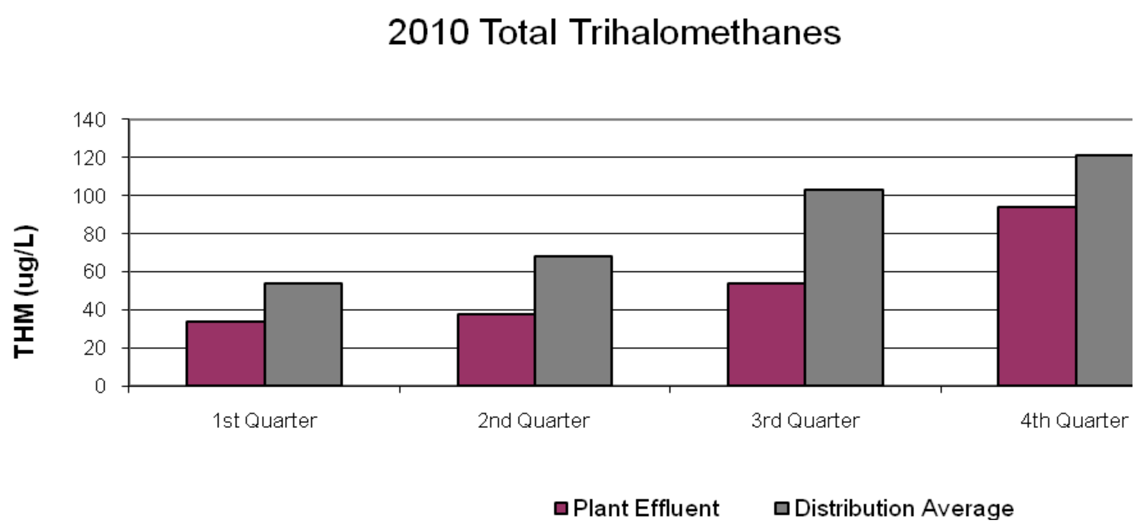


*Figure 13*

During 2010, 58% of the THM formation occurred in the water treatment plant and the remaining 42% was formed in the distribution system. In other years approximately 60% of the total THM formation took place at the Water Treatment Plant and the remaining 40% was formed in the distribution system (Figure 13).

The maximum amount of chlorine dosed during 2010 summer months was 3.1mg/L compared to 2.8mg/L in 2009. A higher amount of chlorine used will also increase the amount of THM formation.

The 4$^{th}$ quarter results of THM's in the distribution system were elevated since during a two week period we performed some preventative maintenance and inspection on our chlorine contact tank. During this time the primary disinfection chlorine was added into our raw water prior to coagulation and filtration in order to insure that the water received the required contact time. Primary disinfection chlorine added into the raw water prior to the removal of most organic material would cause an elevated THM result leaving the water treatment plant and also a higher result in the distribution system during this period.

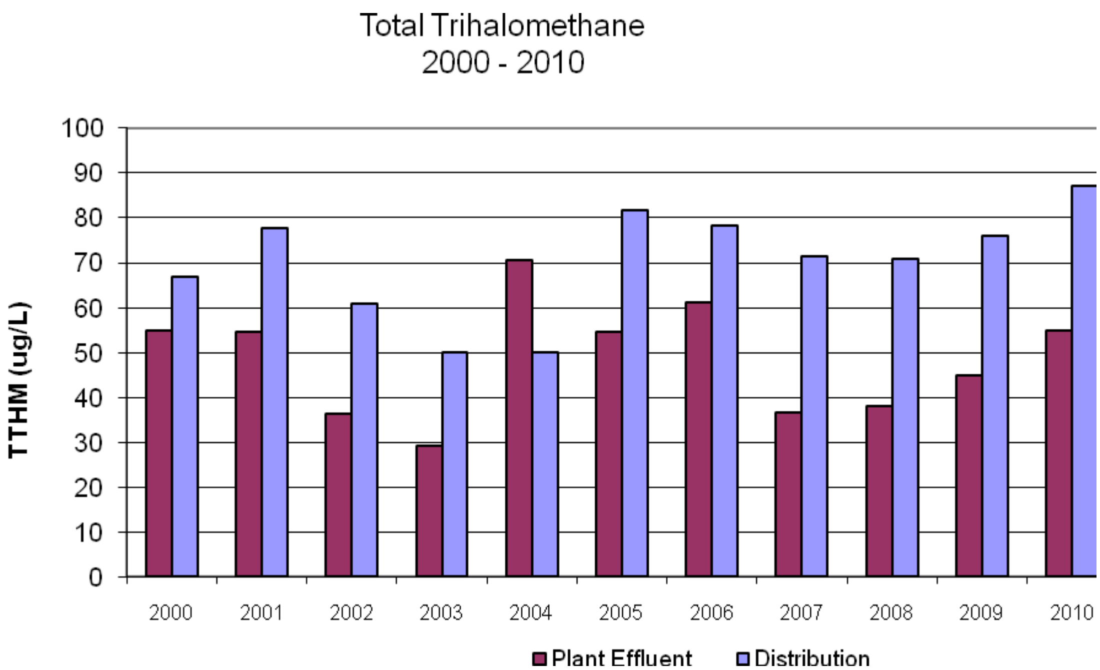


*Figure 14*

**Total Organic Carbon (TOC)**

Another test that indicates the amount of organic matter in the raw and treated water is TOC. The overall health of the natural river environment can be determined by TOC since these compounds can consume more oxygen. Sources for TOC are organic contaminants (natural organic substances, insecticides, herbicides and other agricultural chemicals) that enter waterways in rainfall runoff. Domestic and industrial wastewaters also contribute organic contaminants in various amounts. However, this is not an issue for Peterborough.

Some of the contaminants may not be completely removed by treatment processes; therefore, they could become a problem for drinking water sources. Higher amounts of TOC in the treated water can contribute to the formation of THM's in the distribution system.

The difference between TOC raw water and TOC treated water would indicate the amount of organic matter that has been removed through the water treatment process. The water treatment plant removed 35% of TOC from the raw water during 2010. During 2010, raw water TOC varied from 3.9 to 6.2mg/L. (Figure 15).

During the last 8 years the water treatment process has removed on average 40% of organic material as measured by TOC.

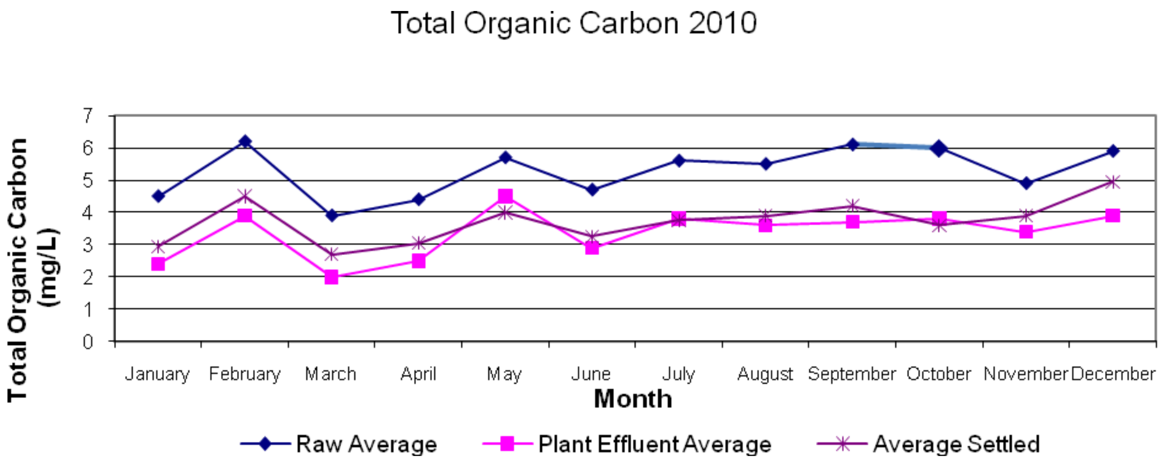


*Figure 15*

2010 has shown an increase in raw water TOC levels. Higher levels of TOC's when combined with chlorine (used for WTP disinfection) can form a higher concentration of THM's. TOC levels may have increased during 2010 due to a decrease in zebra mussels and also fluctuations in river flows during storm events (Figure 16).

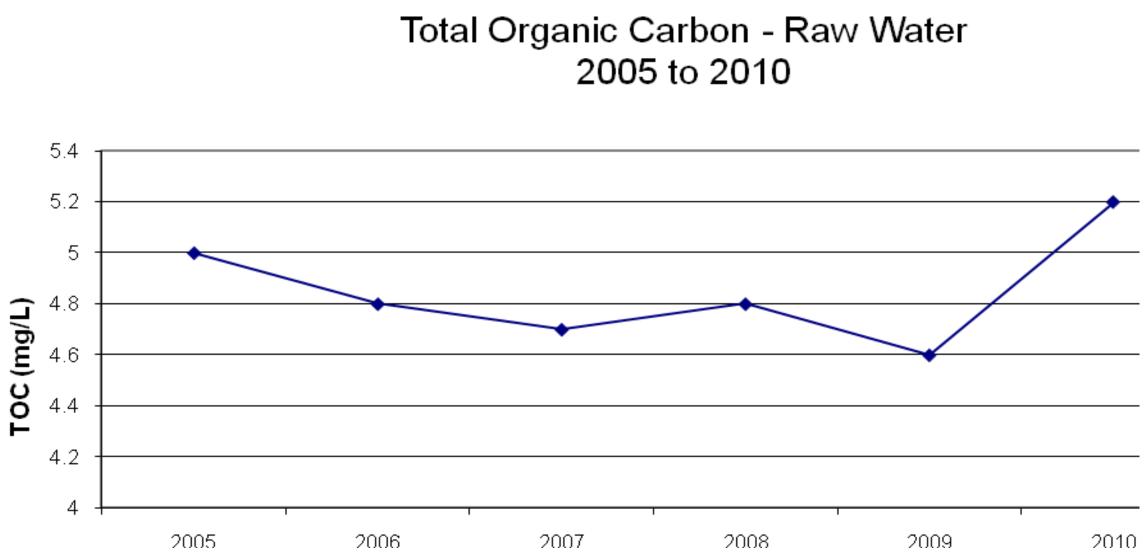


*Figure 16*

## Ultraviolet (UV) Absorption

An Ultraviolet Absorption or UV test was introduced in 2005. This test is carried out daily on raw, filter #1 and plant effluent samples to determine how well UV (at a wavelength of 253.7ηm) can penetrate our coloured waters, especially our filtered water. UV was studied since it may be a viable disinfection complement with chlorine.

The inability for UV to penetrate the water sample would indicate the presence of organic material. A higher UV transmittance would indicate that there is a lower amount of organic material present – less organic material to absorb the UV radiation. A higher UV transmittance in the plant effluent and filtered water indicates that most of the organic material has been removed during flocculation, sedimentation, and filtration.

During 2010, the average UV transmittance for raw water was 85.4%, the average for Filter #1 was 87.7% and the plant effluent average was 95.0%. The UV results would indicate that the Water Treatment Plant process of flocculation, coagulation, sedimentation and filtration removed enough organic material to possibly utilize UV as an alternative disinfectant, provided that this technology is used after filtration. A high UV transmittance in our filtered and finished waters shows great promise to this technology as an alternative or complimentary disinfectant.

## Customer Calls

A customer concern computer program was initiated during 2006 to track all questions and concerns relating to water. Some questions and concerns that were asked from our WTP staff were related to; taste and odour, colour, hardness, general water quality, information on water treatment, sampling, operations, ground water systems and questions to assist with school projects on water treatment.

In 2010 the staff at the Water Treatment Plant responded to a total of 69 inquiries (Figure 22). There were 4 requests for information, such as hardness results, water quality reports and how the water treatment plant operates. The remaining 65 inquiries were related to the following concerns; 34% of customer concern calls were related to taste and odours (earthy/musty or chlorine). Another 39% of customer concern calls were relating to colour concerns (usually rusty coloured water). Some of these concerns were mainly due to water main construction or rehabilitation and routine water main maintenance. 20% of the concerns were related to particulate matter that the customer indicated was present in their water. This may also be due to rusty coloured water. Another 7% were concerns from customers of bacteria in the water. In every case the water was tested for bacteria and none was found.

A further breakdown of the 18 taste and odour complaints revealed the following; 6 concerns were for an earthy musty odour, 4 concerns were for a chlorine taste and odour, and 8 concerns were for various other taste and odours, from metallic to medicinal.

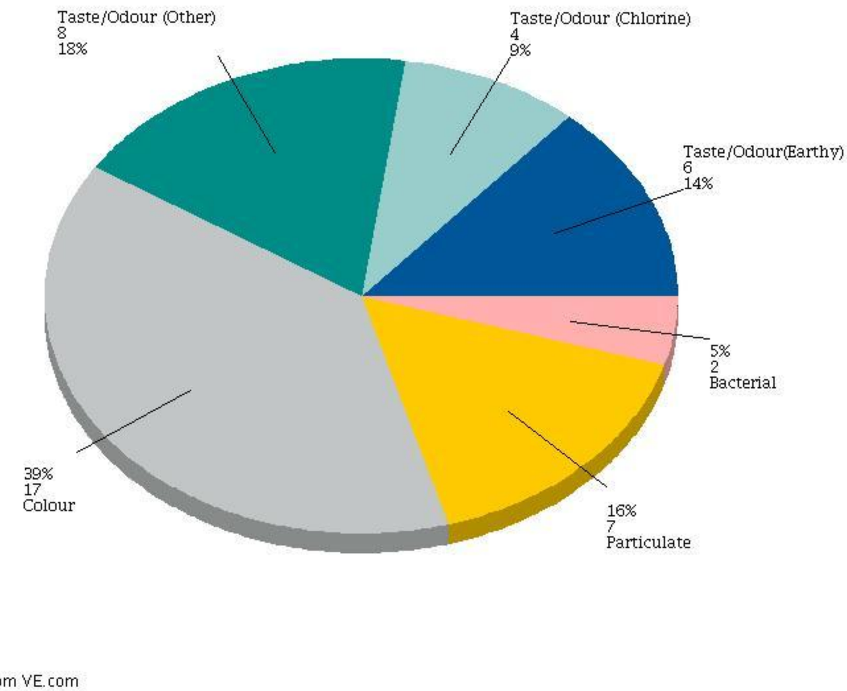


*Figure 17*

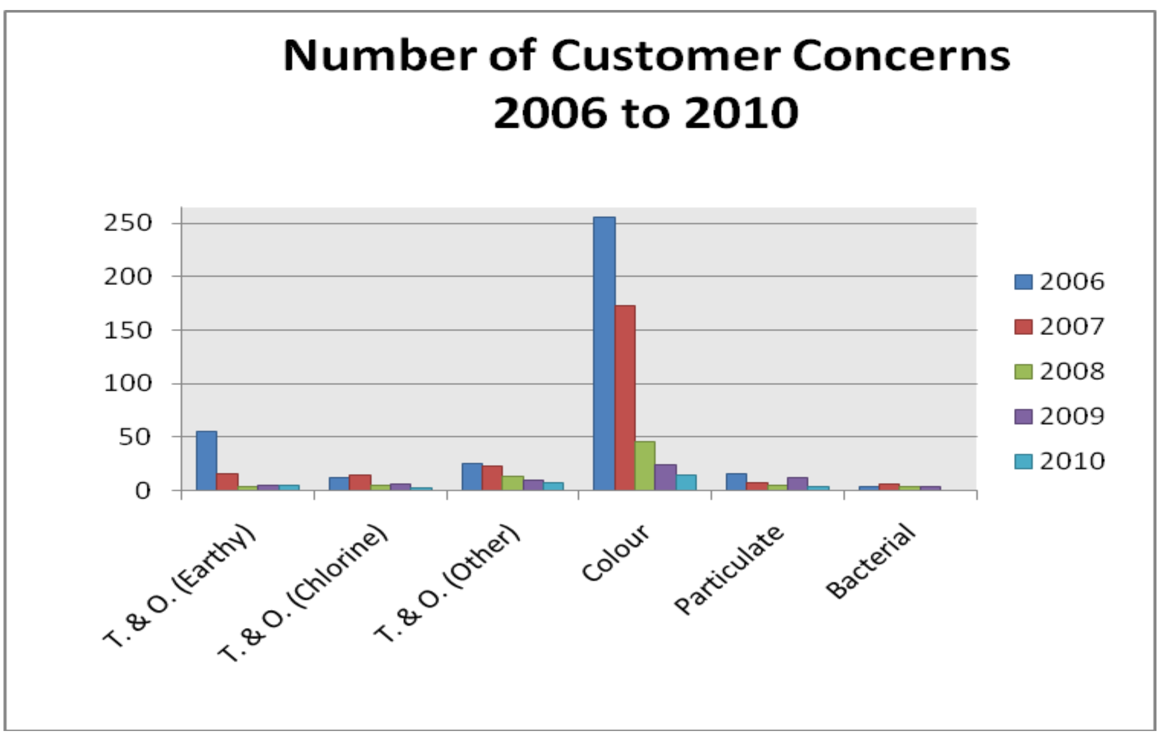


*Figure 18*

Since 2006 the number of customer concerns has decreased each year from a total of 367 concerns in 2006 down to a total of 44 concerns in 2010.

## Tours

Tours have been an important part of public education at the Peterborough Water Treatment Plant. Over 190 people have had a tour of the water plant process during 2010 (over 1,100 people in the last 6 years).

## Abbreviations

| | |
|---|---|
| <MDL | Less than Method Detection Limit |
| 2MIB | 2-Methylisoborneol |
| Alum | Aluminum Sulphate |
| $CaCo_3$ | Calcium Carbonate |
| CFU | Colony Forming Unit |
| DNA | Deoxyribonucleic Acid |
| DWSP | Drinking Water Surveillance Program |
| HPC | Heterotrophic Plate Count |
| $m^3$ | Cubic Meters |
| MAC | Maximum Acceptable Concentration |
| mg/L | Milligram (one in one thousand) per Litre |
| MOE | Ministry of Environment |
| MOH | Ministry of Health |
| ηg/L | Nanogram (one in one billion) per litre |
| ηm | Nanometer (one in one billion) per meter |
| NOM | Natural Organic Matter |
| NTU | Nephelometric Turbidity Units |
| $^{O}C$ | Degree Celsius |
| ODWS | Ontario Drinking Water Standards |
| TCU | True colour Units |
| THM | Trihalomethanes |
| TOC | Total Organic Carbon |
| μg/L | Microgram (one in one million) per litre |
| WTP | Water Treatment Plant |