Peterborough
Utilities
Commission

2012 WATER QUALITY REPORT

On the Cover

R. L. Dobbin Building on a frigid cold winter's morning, built in the spring of 1893, it was intended to satisfy the town's need for a public water system. The William Hamilton Manufacturing Company of Peterborough won the contract to supply the pumping machinery. By 1909, another pump house (water Street Pumphouse) had been constructed downstream and the machinery was moved into the new building. In 1935, Waterworks Superintendent Ross Dobbin brought two alligators back from Florida as a gift to the City and housed them in the 1893 pump house. This was the beginning of Riverview Park and Zoo. In 1946, the Old Pump House became the home of the monkey collection and used to be known as the "Monkey House". The design of the building is believed to have been inspired by the architecture of the 1893 Chicago World's Fair. Source: Heritage Designation Brief and Peterborough Bylaw 1983-51.

Table of Contents

EXECUTIVE SUMMARY

The Otonabee River water temperature varied over the year from 0.0°C to 27.0°C. The 2012 annual average water temperature of 11.7°C was warmer than the last five year average of 11.1°C. Higher summer raw water temperatures (max. 27.0°C on July 18th, and max. air temperature of 33.9 °C. on July 17$^{th)}$ contributed to the 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.

Reviewing data over the last fifteen year period, 2012 had the lowest pumping volume of raw water at 13,345.4 ML. The summer months saw average rainfall with occasional storm events. Customers used less water (including outdoor water use), resulting in the water remaining in the distribution system longer. Longer retention times in the distribution system can contribute to higher values of trihalomethanes (THM), but 2012 saw lower values than 2011. There are many contributing factors that affect the THM formation; during 2012 we saw total organic carbon (TOC) higher than other years but the normally corresponding turbidity and colour were lower. In addition in 2012 the treated water pH was lower which can be a major contributing factor for a lower THM value in our distribution system.

The highest pumpage day was on July 18th at 54,123 m^3 (cubic metres). This was 59.5% of the historical daily high of 91,008 m^3, recorded in 2005. A water volume of 11,200,735 m^3 was treated during 2012 compared to an annual total of 13,492,575 m^3 for 2011 – a 17% decrease from 2011.

2012 was the sixth 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). Peterborough obtained approval for the lead reduction program. In the future samples will only be collected for lead in the distribution system once every 3 years. 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.

The maximum acceptable concentration (MAC) for filtered water is 0.30 Nephelometric Turbidity Units (NTU) for 95% of the time and never greater than 1.0 NTU. The average filtered water level in the Peterborough's drinking water was 0.055 NTU for 2012 and filters are taken off-line when the turbidity exceeds 0.15 NTU.

In conclusion, 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 2012. 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 2012, zebra mussel populations appeared to be stable with virtually no change in raw water turbidity. There have been changes over many years showing fluctuations in populations. Visually, 2012 appears to be a peak in zebra mussel population. Since the introduction of zebra mussels (an invasive species) into Ontario (1988) and later into the Otonabee River system in 1997, the effects continue to cause slight changes in raw water turbidity. A large decrease in raw water turbidity occurred in 1997 the same year as the introduction of zebra mussels into the Otonabee River waterways. We have seen cyclic changes in zebra mussel populations and corresponding raw water turbidity – the greater number of zebra mussels, the lower the raw water turbidity. According to literature, one zebra mussel can clear 1 litre of water per day and 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 (some algae may be taste and odour causing).

Turbidity

The average raw water turbidity in 2012 was 0.59 NTU; average during 2011 was 0.69 NTU. The variable summer rainfall provided average Otonabee river flows, and lower raw water turbidity. 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. With higher populations of zebra mussels (that feed on organic matter in the water) we see lower raw water turbidity.

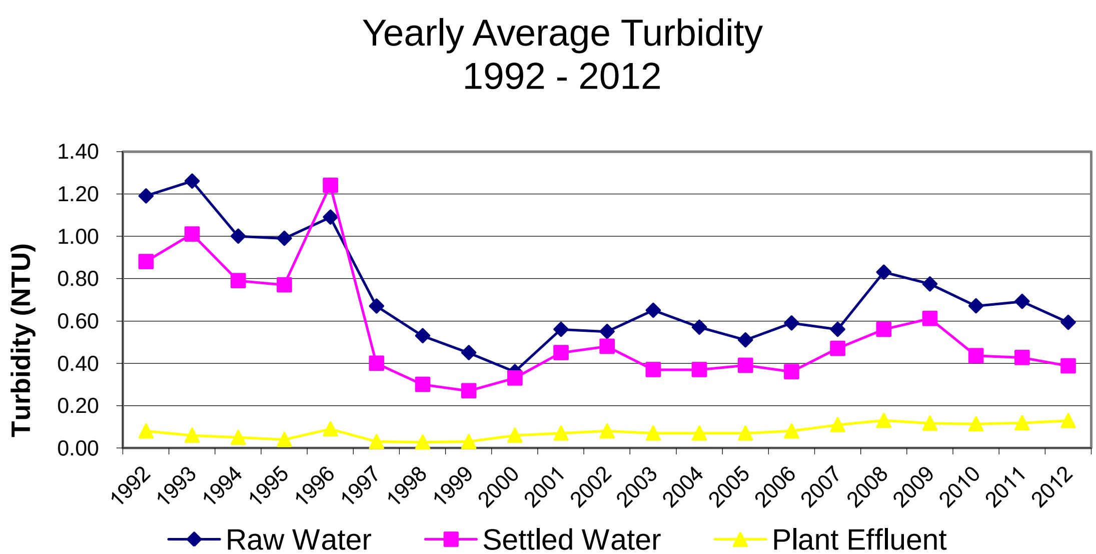

Figure 1

The annual raw water turbidity peak occurred January 17 at 2.2 NTU. It appears that because of a warm spell which caused snow melt and some surface run off causing higher turbidity in our raw water. The MAC for filtered water is 0.3 NTU for 95% of the time, without exceeding 1.0 NTU. The average filtered water turbidity was 0.055 NTU for 2012 and filters are taken off-line when the turbidity exceeds 0.15 NTU (half the MAC). The 2012 average treated water turbidity was 0.13 NTU.

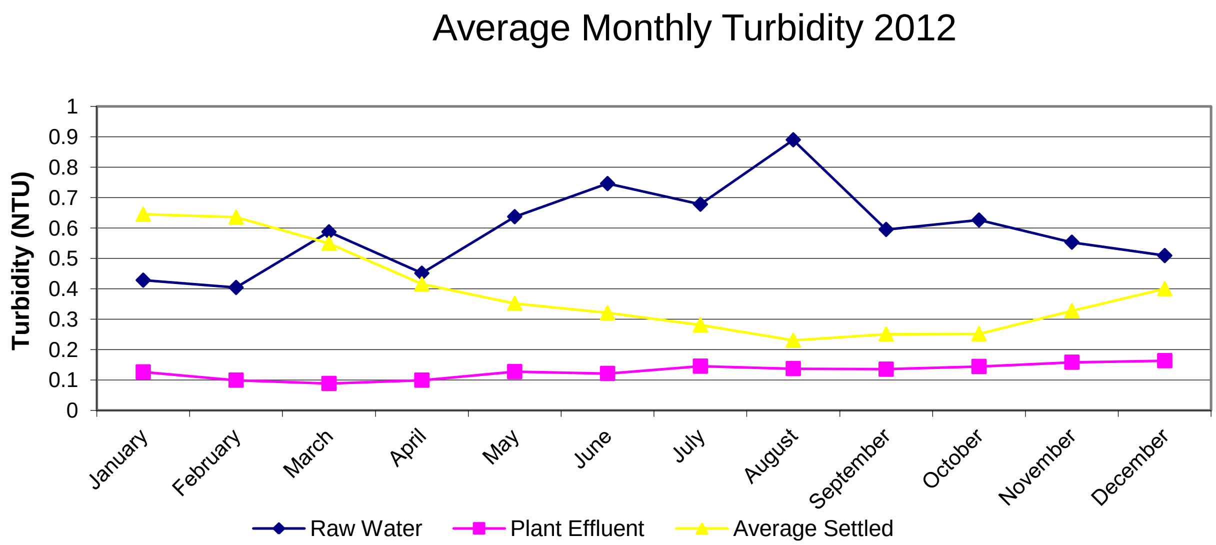

Figure 2

Taste and Odour

During 2012, the primary source of taste and odour in our raw water was from the naturally occurring compounds geosmin (name derived from the Greek ‘earth’ and ‘smell’) and 2MIB (2-methylisoborneol). These compounds are monitored as a precursor to taste and odour complaints (earthy/musty) 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. Observations have shown that when higher numbers of zebra mussel populations and/or algae populations we experience higher amounts of geosmin and 2MIB.

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. The concentration peaks for both taste and odour causing compounds occurred at approximately the same time; July to November (Figures 3 & 4).

Geosmin is thought to originate higher in the water column and produce an earthy odour. The average raw water value during 2012 was 7.5 ηg/L and the average plant effluent was 4.6 ηg/L (Figure 3). During the year, 50% of samples taken came back as too low to measure, 3 < MDL (Maximum Detectable Level) for geosmin in the raw and treated 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. The average raw water value during 2012 was 4.8 ηg/L and the average plant effluent was 4.3 ηg/L (Figure 3). During the year, 58% of samples taken came back as too low to measure (3<MDL) for geosmin in the raw and treated water.

A summer with plenty of sunlight (high raw water column algae) could contribute to higher amounts of geosmin and 2MIB. During 2012 one geosmin peak occurred in October 4th with a value of 21 ηg/L (Figure 3) and the 2MIB peak occurred August 28th with a value of 10 ηg/L.

The reduction of geosmin and 2MIB due to water treatment processes (coagulation, sedimentation, filtration and chlorination) was 39% and 10%, respectively. Both geosmin and 2MIB compounds resist oxidation (disinfection) and are difficult to remove by conventional water treatment processes.

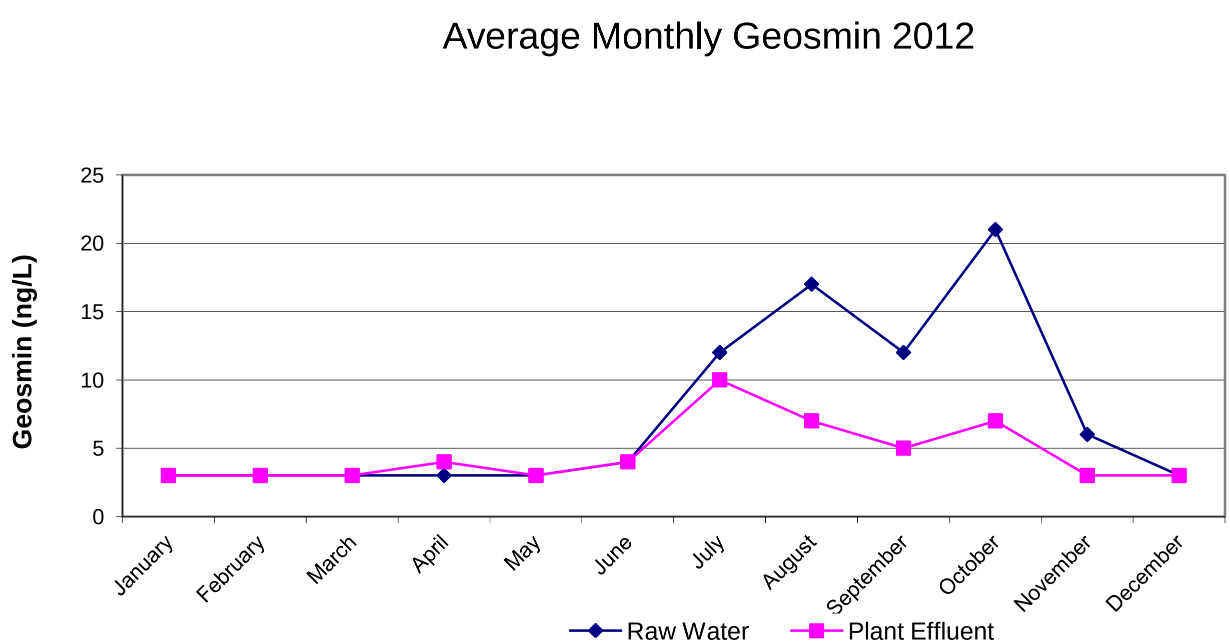

Figure 3

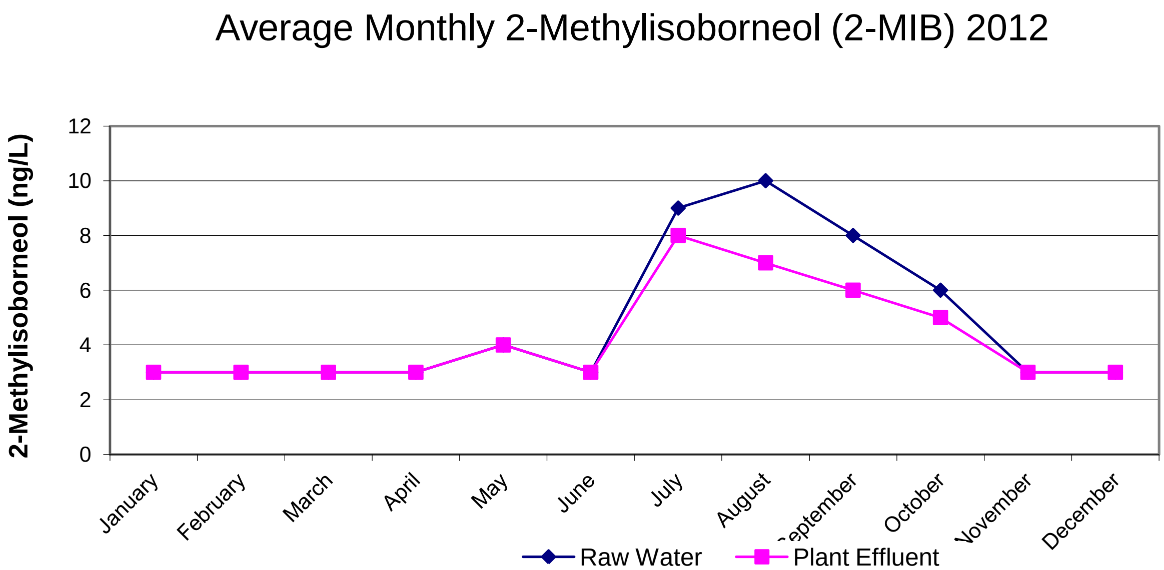

Figure 4

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 2012, there were an increase number of reported algae blooms, probably due to higher raw water temperatures (max. of 27.0^{0}C with more sunlight) combined with lower river water flows. The increase in algae blooms did not appear to have any significant impacts on the water treatment, however decaying algae can add to any taste and odours (see geosmin and 2MIB).

Operational Parameters

Sodium Silicate

Sodium silicate (BW46) is added to the plant effluent for corrosion control within the distribution system as well as plant effluent pH adjustment. 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 contributes 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 2.6 mg/L and 14.5 mg/L with an annual average of 8.0 mg/L (from 23 different locations). The 2012 annual average silica level found leaving the water treatment plant was 7.6 mg/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 2012 at an average rate of 47.9 mg/L. The average alum dosage during 2011 was 44.9 mg/L

A properly balanced/optimized treatment including, coagulation, sedimentation and filtration resulted in reduced aluminium residuals in the plant effluent sample. The MOE operational guideline for aluminium residual is 100 μg/L. The average concentration of aluminium leaving the water treatment plant was found to be 40 μg/L. The 2012 annual average aluminium found in the distribution was 38 μg/L. (from 137 samples) and the 2012 average value of aluminium found in the treated water was 44 μg/L. (46 μg/L in 2011).

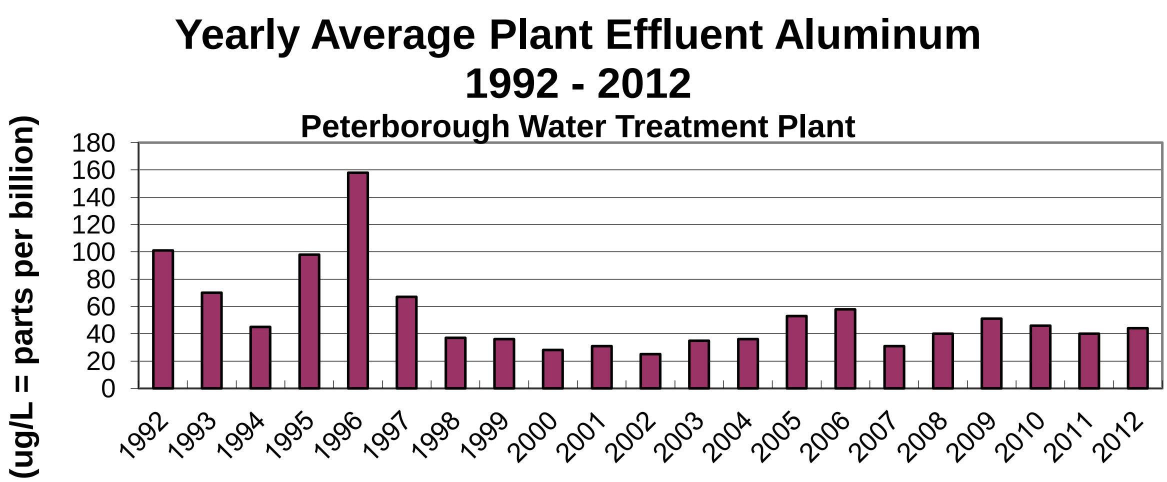

Figure 5

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 2012 ranged between 2.27 mg/L and 2.74 mg/L. Higher doses of primary chlorine are required during the summer months because it takes more chlorine to disinfect the water when the water is warmer. Chlorine is also added into the treated water before the water leaves the WTP. This extra chlorine is added to help maintain the chlorine residual throughout the distribution system to comply with the Ontario Drinking Water Standards (ODWS). The treated water chlorine dose averaged at 0.27 mg/L throughout 2012.

Zebra mussel control for the water treatment plant included adding approximately 0.5 mg/L of chlorine into the water treatment plant intakes from May 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.

Zebra mussel chlorine dose modulator

Post chlorine (or secondary chlorination) is dosed at approximately 0.1 mg/L to 0.3 mg/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 minimum of 0.20 mg/L free chlorine).

Hardness

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. According to the MOE, the recommended operational guideline for hardness is 80 mg/L to 100 mg/L expressed as calcium carbonate ($CaCO_3$). This provides an acceptable balance between corrosion and incrustation.

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 2012 was 97.4 mg/L as $CaCO_3$ and 98.2 mg/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 mg/L to 500 mg/L as $CaCO_3$. Alkalinity over 30 mg/L assists flocculation formation during the coagulation process. Levels of 20 mg/L to 200 mg/L are typical for fresh water. Levels below 1 mg/L indicate that the system is poorly buffered and is very susceptible to changes in pH from natural and human-caused sources.

Average alkalinity values in 2012 were 90.8 mg/L for our raw water and 72.2 mg/L in the plant effluent (Figure 6). Alkalinity generally decreases when water is treated with alum (aluminium sulphate).

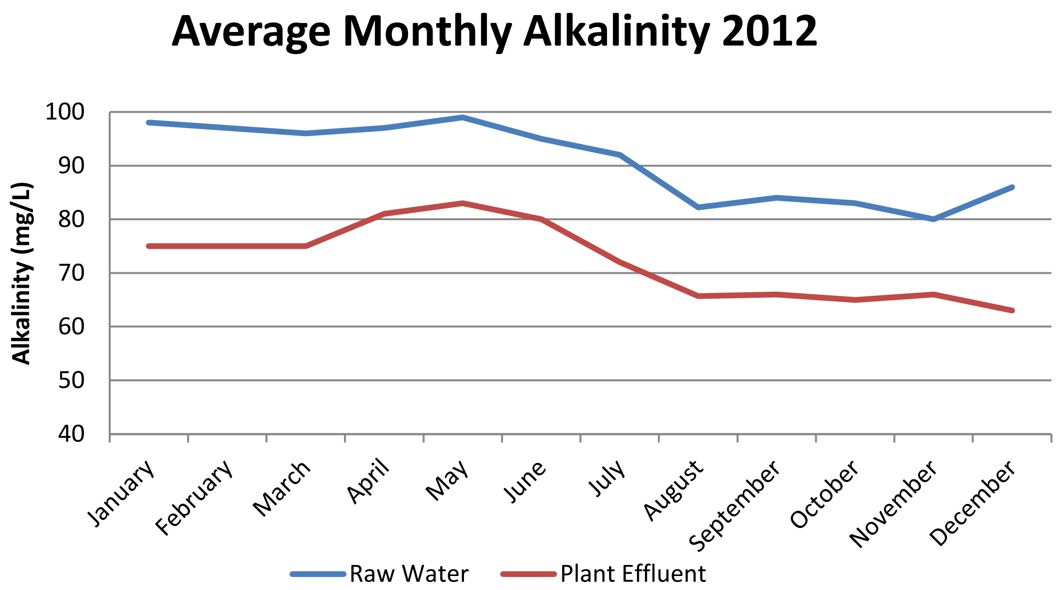

Figure 6

Hydrofluorosilicic Acid

Hydrofluorosilicic acid (fluoride) was added to the treated water to attain a combined average concentration of 0.60 mg/L (natural fluoride plus added fluoride). The fluoride feed system was off for a few days during 2012 for preventative maintenance on the fluoridation feed and test equipment.

The MOE recommends that the fluoride residual be between 0.5 mg/L and 0.8 mg/L with a MAC of 1.5 mg/L. Over 700 samples taken at the water treatment plant, raw water and the distribution system and were tested for fluoride concentration during 2012. The average fluoride concentration found in the treated water was 0.55 mg/L. The average fluoride concentration found in the raw water (natural fluoride) was 0.17 mg/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 2012, 24 distribution locations were sampled each month and tested for iron. The 2012 average distribution (from 363 samples) iron levels were 0.032 mg/L (Figure 7). The average iron residual in 2011 was found to be 0.029 mg/L. The MOE aesthetic objective is 0.30 mg/L.

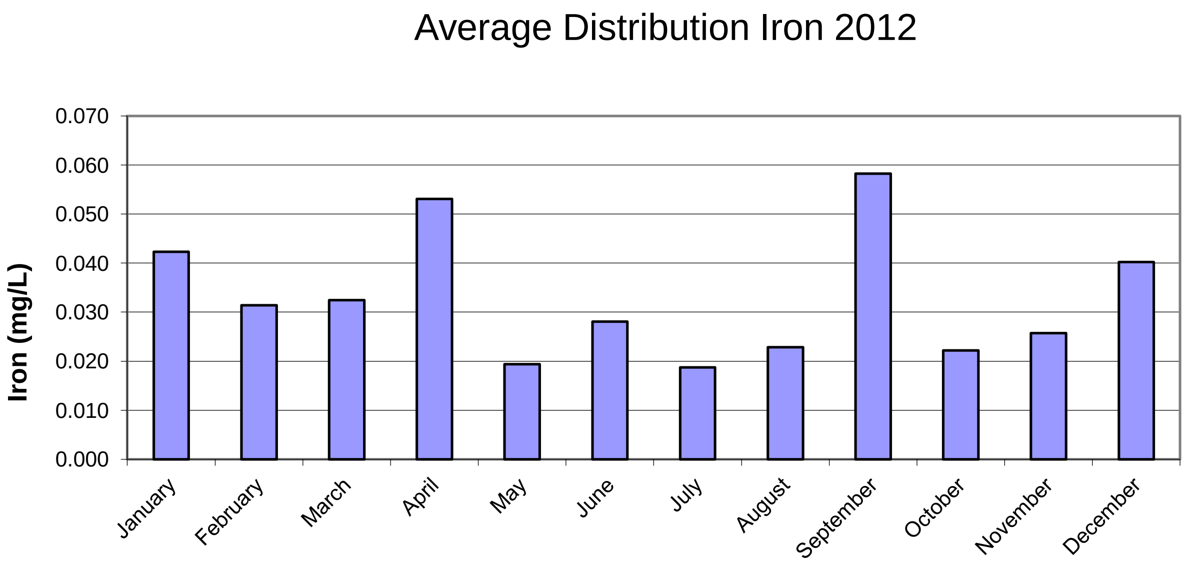

Figure 7

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 2012, the average raw water pH was 8.0 (Figure 8). With the addition of alum the pH is lowered to 7.0 (in the settled basins). With the addition of disinfection chlorine, pH is lowered further to 6.99 (in the chlorine contact tank). A pH of 6.99 is considered slightly corrosive so sodium silicate (BW46) 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. The average dose of Sodium Silicate (BW46) added to the treated water during 2012 was 7.3 mg/L (as SiO_2).

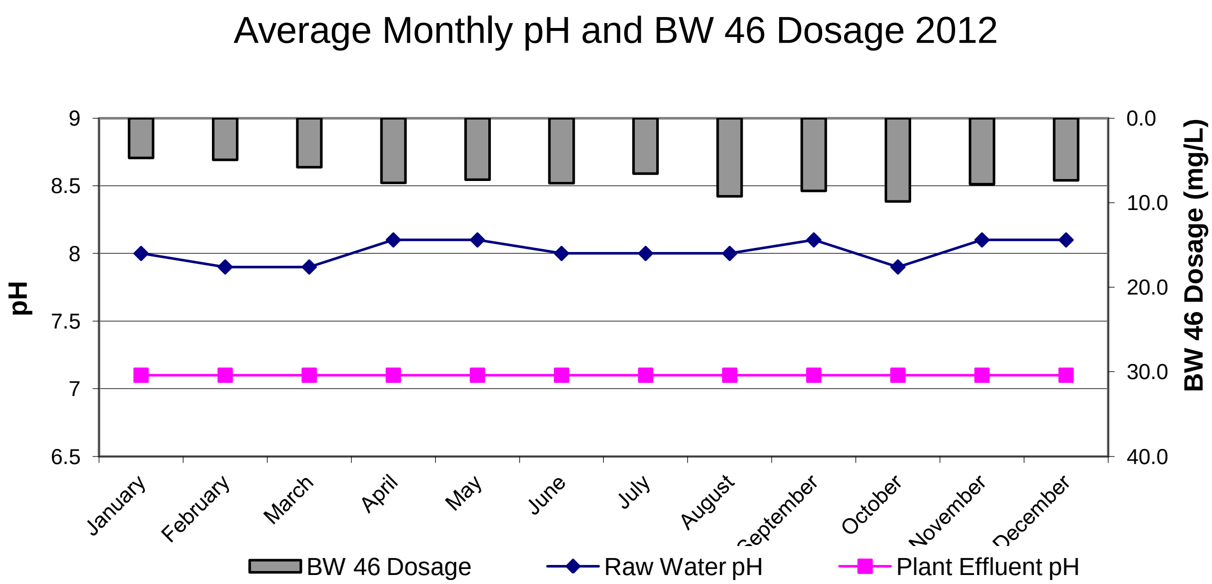

Figure 8

Regulatory Sampling

Lead Sampling

The lead sampling results have shown that over 99% of the sample results were below the Ministry's standard for lead (less than 10 μg/L). As a result of these low values, relief from full lead residential sampling was granted by the MOE in 2011. Through previous substantial lead sampling, it was determined that some residential locations (mostly built prior to 1920) might have internal lead piping and have lead in their drinking water. This may cause the level of lead in their tap water to be above 10 μg/L.

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 does 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 1–2 μm, cryptosporidium 4–5 μm and giardia 8–14 μm.

The raw water, settled water and plant effluent were all monitored for clostridium perfringens during 2012. The raw water contained an average of 11 CFU/L of clostridium perfringens. All treated water samples for 2012 returned results of 0 CFU for clostridium perfringens (Figure 9), indicating an effective treatment process. During 2011, the average was 10 CFU/L in the raw water.

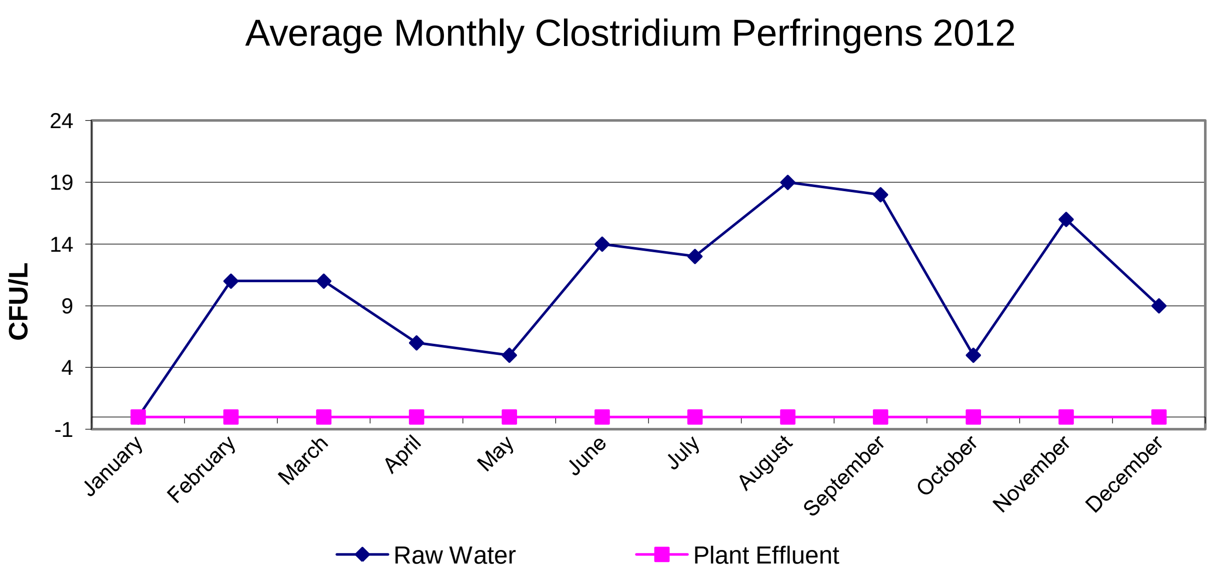

Figure 9

Fecal Streptococci & E. Coli Ratios

During 2012, 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 2012 average E. coli to fecal strep bacteria populations in the WTP raw water were found to be 1:0.86 CFU. A value close to 1:0.60 would indicate that the majority of fecal contamination in the Otonabee River found at the WTP was from ducks or geese.

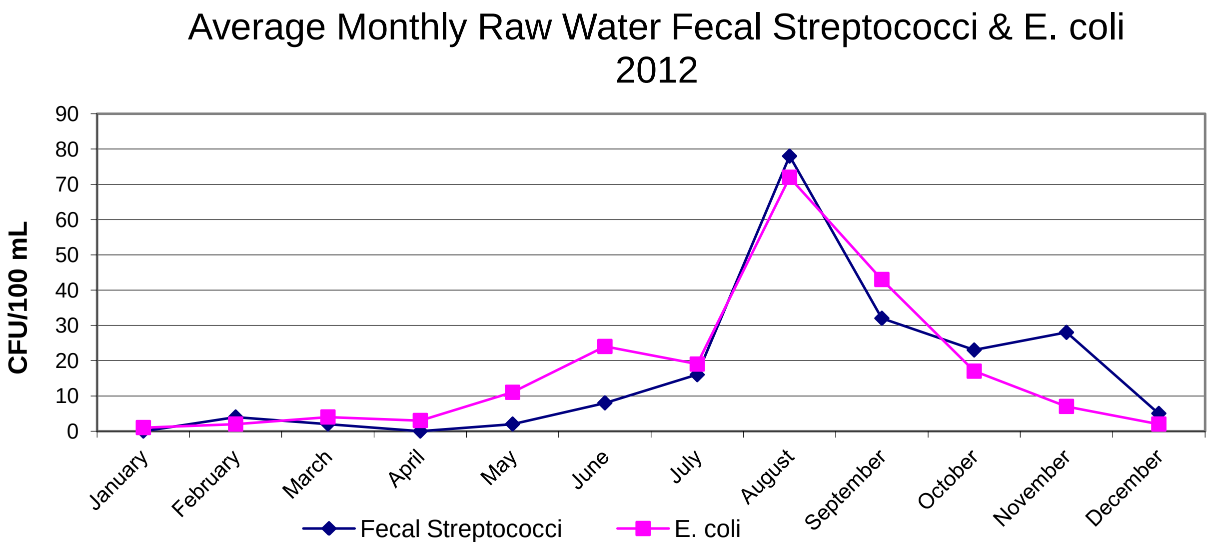

Figure 10

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 2012, there were ten adverse water quality incidents reported to the MOE; three low free chlorine residuals were detected (free chlorine lower than 0.05 mg/L) in the distribution system. The low free chlorine sampling locations were flushed and re-sampled. The re-sample test results were in compliance to the MOE standards. During 2012, a new laboratory was contracted to conduct our bacteriological analysis. During our initial start-up, the new lab reported 6 adverse total coliform (TC) results. All results were report to the MOE and the laboratory was inspected to ensure compliance to laboratory standards. Shortly after the inspection there were no more total coliform adverse results reported. All cases of adverse TC were re-sampled and new results were found to be '0'. A high fluoride result was reported to the MOE as adverse (ie greater than 1.5 mg/L) after a WTP Operator adjusted the carrier water flow for the fluoride feed. This adjustment inadvertently gave a temporary high result (lasting seconds). The total fluoride residual within seconds went back to normal readings.

During 2012, 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 and the City of Peterborough Environment Protection 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).

Lead is not part of Schedule 23 or 24 but is required to be sampled as per Schedule 15; Reduced Sampling, or if the distribution system has a very low number of positive results. There were no locations found in the distribution system that had an adverse result for lead. An annual lead 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 200 mg/L. The local MOH must be notified when the sodium concentration exceeds 20 mg/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

Parameter	Jan.10/12		MAC
Antimony	**0.03**		6
Arsenic	**0.4**		25
Barium	**27.9**		1000
Boron	**7.8**		5000
Cadmium	**0.074**		5
Chromium	**0.8**		50
Mercury	**0.02**	<MDL	1
Selenium	**1**	<MDL	10
Uranium	**0.056**		20

Lead* (Sampled at Sherbrooke Sampling Station) Jan. 11th, 2012	**0.2**		10
Lead * (Treated Water) Jan. 11th, 2012	**0.02**	<MDL	10
Sodium** mg/L	**9.64**		20

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.

Schedule 24 – Organic Parameters

Parameter	Jan.10/12		MAC
Alachlor	**0.02**	<MDL	5
Aldicarb	**0.01**	<MDL	9
Aldrin + Dieldrin	**0.01**	<MDL	0.7
Aldrin	**0.01**	<MDL	
Atrazine + N-dealkylated metabolites	**0.01**	<MDL	5
Atrazine	**0.01**	<MDL	
Desethyl atrazine	**0.01**	<MDL	
Azinphos-methyl	**0.02**	<MDL	20
Bendiocarb	**0.01**	<MDL	40
Benzene	**0.32**	<MDL	5
Benzo(a)pyrene	**0.004**	<MDL	0.01
Bromoxynil	**0.33**	<MDL	5
Carbaryl	**0.01**	<MDL	90
Carbofuran	**0.01**	<MDL	90
Carbon Tetrachloride	**0.16**	<MDL	5
Chlordane (total)	**0.01**	<MDL	7
a-chlordane	**0.01**	<MDL	

Parameter	Jan.10/12		MAC
g-chlordane	**0.01**	<MDL	
Chlorpyrifos	**0.02**	<MDL	90
Cyanazine	**0.03**	<MDL	10
Diazinon	**0.02**	<MDL	20
Dicamba	**0.20**	<MDL	120
1,2-Dichlorobenzene	**0.41**	<MDL	200
1,4-Dichlorobenzene	**0.36**	<MDL	5
Dichlorodiphenyltrichloroethane (DDT) & Metabolites	**0.01**	<MDL	30
op-DDT	**0.01**	<MDL	
pp-DDD	**0.01**	<MDL	
pp-DDE	**0.01**	<MDL	
pp-DDT	**0.01**	<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	**0.03**	<MDL	20
Dinoseb	**0.36**	<MDL	10
Diquat	**1**	<MDL	70
Diuron	**0.03**	<MDL	150
Glyphosate	**6**	<MDL	280
Heptachlor + Heptachlor Epoxide	**0.01**	<MDL	3
Heptachlor	**0.01**	<MDL	
Heptachlor epoxide	**0.01**	<MDL	
Lindane (total)	**0.01**	<MDL	4
Malathion	**0.02**	<MDL	190
Methoxychlor	**0.01**	<MDL	900
Metolachlor	**0.01**	<MDL	50
Metribuzin	**0.02**	<MDL	80
Monochlorobenzene	**0.30**	<MDL	80
Oxychlordane	**0.01**	<MDL	
Paraquat	**1**	<MDL	10
Parathion	**0.02**	<MDL	50
Pentachlorophenol	**0.15**	<MDL	60
Phorate	**0.01**	<MDL	2
Picloram	**0.25**	<MDL	190
Polychlorinated Biphenyls (PCB)	**0.04**	<MDL	3
Prometryne	**0.03**	<MDL	1
Simazine	**0.01**	<MDL	10
Temephos	**0.01**	<MDL	280
Terbufos	**0.01**	<MDL	1
Tetrachloroethylene (perchloroethylene)	**0.35**	<MDL	30
2,3,4,6 - Tetrachlorophenol	**0.14**	<MDL	100
Triallate	**0.01**	<MDL	230
Trichloroethylene	**0.44**	<MDL	5

Parameter	Jan.10/12		MAC
2,4,6 - Trichlorophenol	**0.25**	<MDL	5
2,4,5 - Trichlorophenoxy acetic acid (2,4,5-T)	**0.22**	<MDL	280
Trifluralin	**0.02**	<MDL	45
Vinyl Chloride	**0.17**	<MDL	2
Dieldrin	**0.01**	<MDL	

Disinfection By-Products

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. 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 2012, the average raw water colour was 11 TCU (was 13 TCU in 2011) and the average colour for our treated water was 1 TCU, this was the same value as 2011. During 2012, the Otonabee River colour peaked during January and February (15 TCU) where we experienced higher than normal river flows. A large proportion of colour was removed during our water treatment processes (Figure 11).

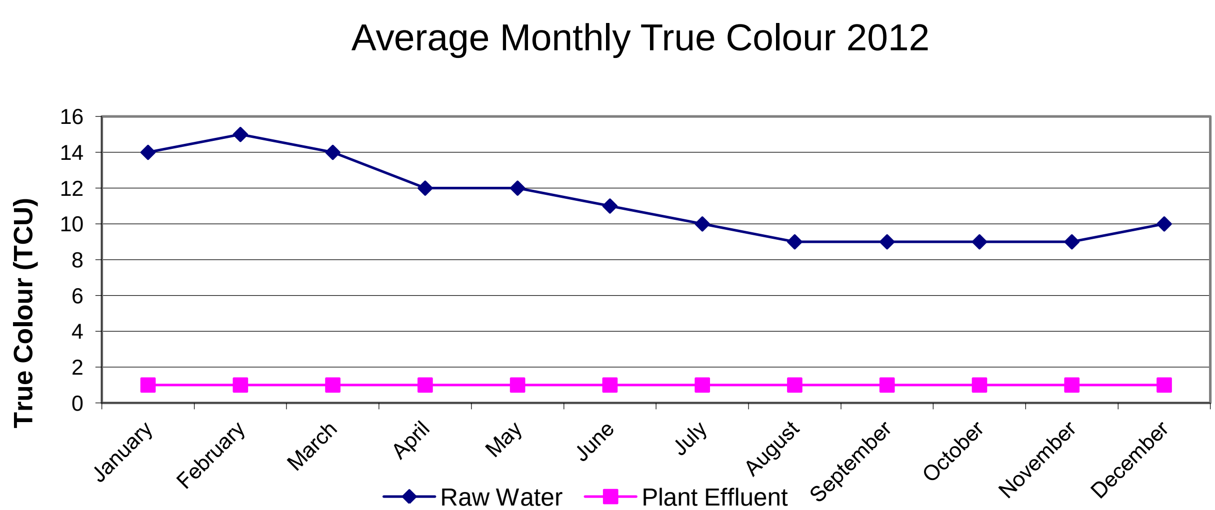

Figure 11

Trihalomethanes

Trihalomethanes (THM's) are formed as a by-product when chlorine is used to disinfect water for drinking. 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. 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 100 μg/L (sliding yearly average) for the distribution system. According to O. Reg. 170/03, distribution 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 warmer which can increase the formation of trihalomethanes (THM's) but the residency time (time that the water is in the water pipes) can be shorter since the water is being used more 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, filtration and disinfection) reduced TOC by 40% during 2012 to a value of 3.5 mg/L from a raw water value of 5.8 mg/L. The THM average values found leaving the water treatment plant during 2012 was 37 μg/L. The average plant effluent THM level for 2011 was 44.0 μg/L. The past 10-year average plant effluent has been 47.7 μg/L (Figure 12).

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 2012, one distribution location was selected to assist in determining areas of the city where THM's may be highest. The annual average THM value in the distribution system was 69.0 μg/L. The average THM value during 2011 was 80 μg/L. The 10-year average of distribution THM concentration was found to be 72.3 μg/L (Figure 13). The raw water temperature during the summer hit a maximum of 28.0°C (26.9°C maximum in 2011). The higher temperature would contribute to the higher third quarterly value for THM's for 2012.

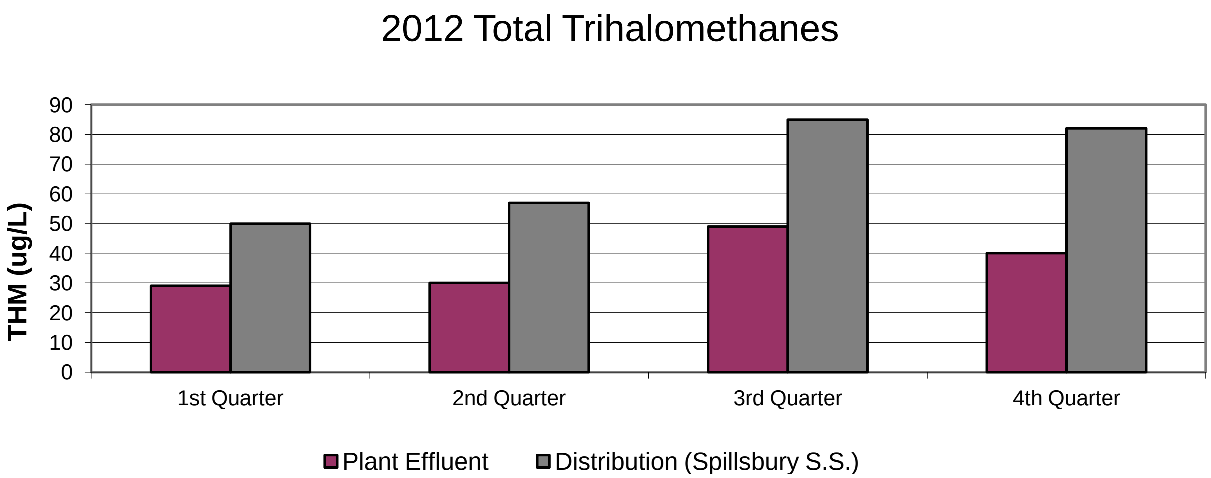

Figure 12

During 2012, 61% of the THM formation occurred in the water treatment plant and the remaining 39% was formed in the distribution system (Figure 13). The average daily total chlorine dosed was 3.1 mg/L (0.3 mg/L for zebra mussel protection, 2.5 mg/L for disinfection chlorine, and 0.3 mg/L for distribution maintenance chlorine). A higher amount of chlorine is dosed during the warmer months to help maintain a proper distribution free chlorine. A higher dosage can increase the amount of THM formation.

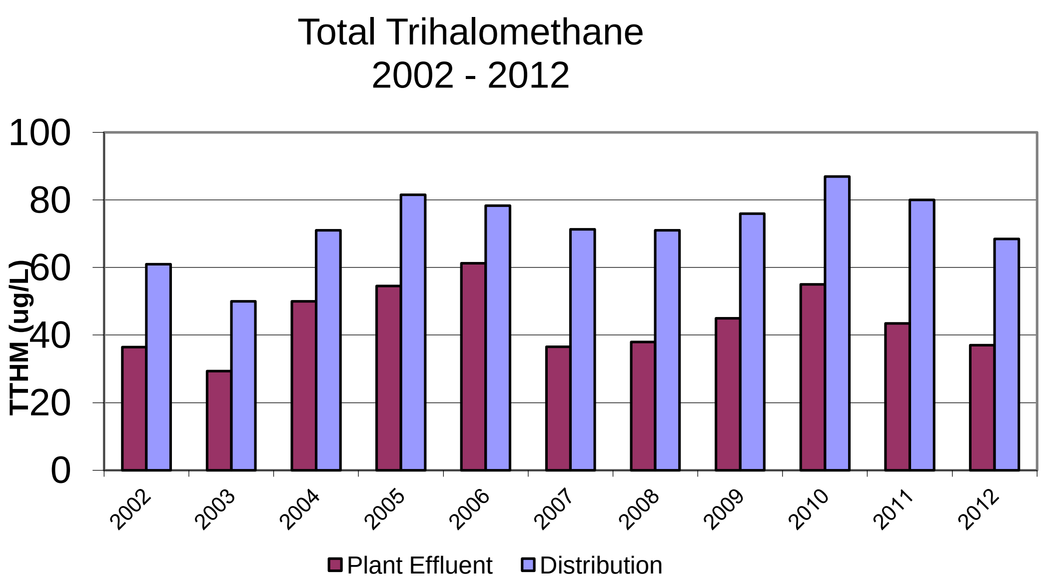

Figure 13

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 40% of TOC from the raw water during 2012. During 2012, raw water TOC varied from 4.7 mg/L to 7.4 mg/L and the Treated Water TOC varied from 2.5 mg/L to 4.8 mg/L. (Figure 14).

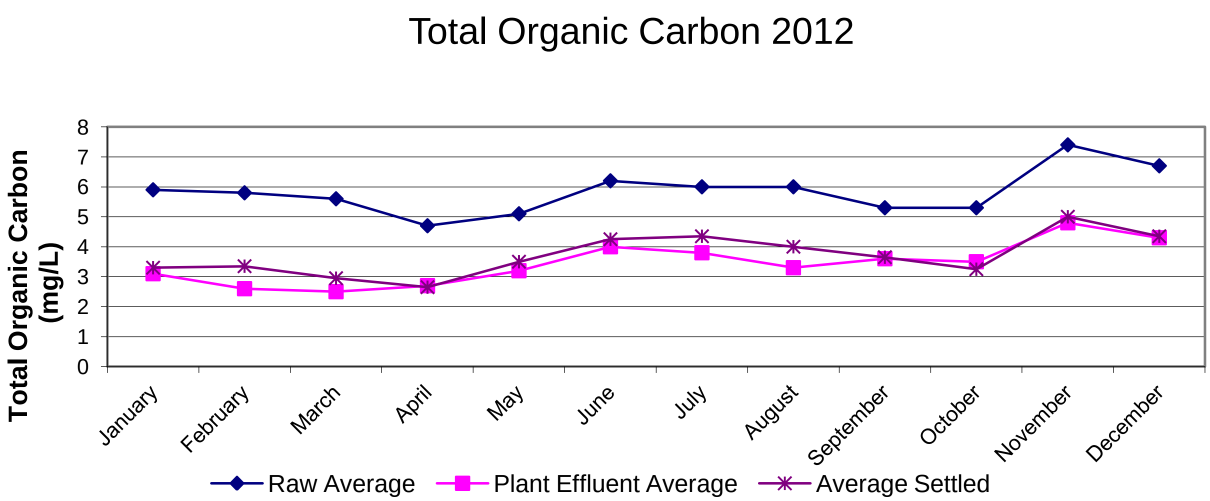

Figure 14

During the last 4 years the water treatment process has removed on average 40% of organic material as measured by TOC. Since 2009, the raw water natural TOC has steadily increased. 2012 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 2012 due to fluctuations in river flows during storm events (Figure 15).

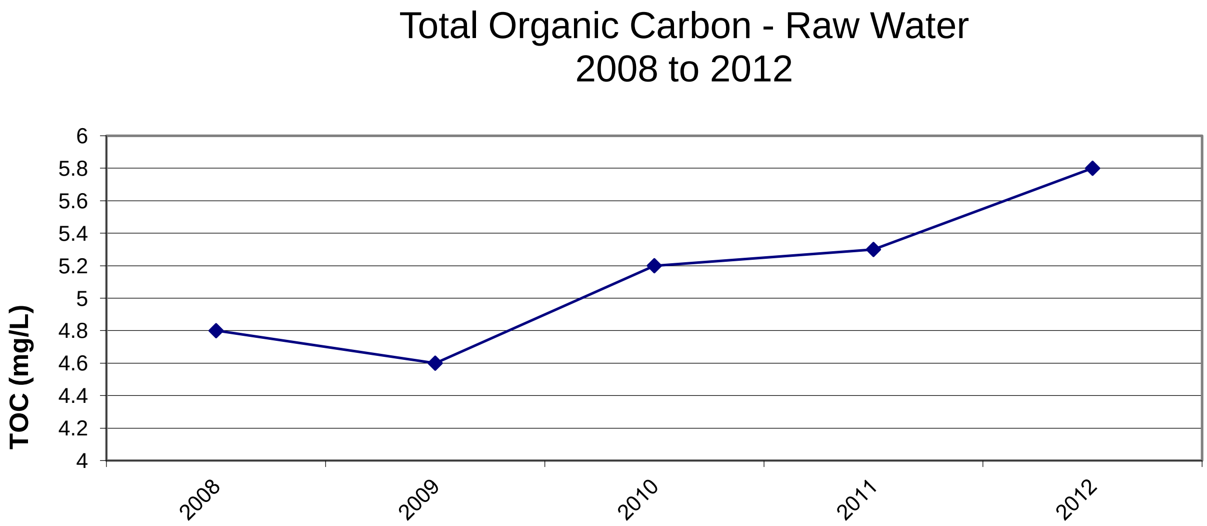

Figure 15

Haloacetic Acid

Since 2009 testing has been conducted on the raw and treated water for halogenic acetic acid (HAA) in anticipation that this will be introduced as a sampling amendment. The 2012 average treated water HAA was 30.3 μg/L and the average distribution sample was found to be 56.8 μg/L (Figure 16). 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.

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

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 μg/L for HAA's in drinking water, based on a running annual average of a minimum of quarterly samples taken in the distribution system.

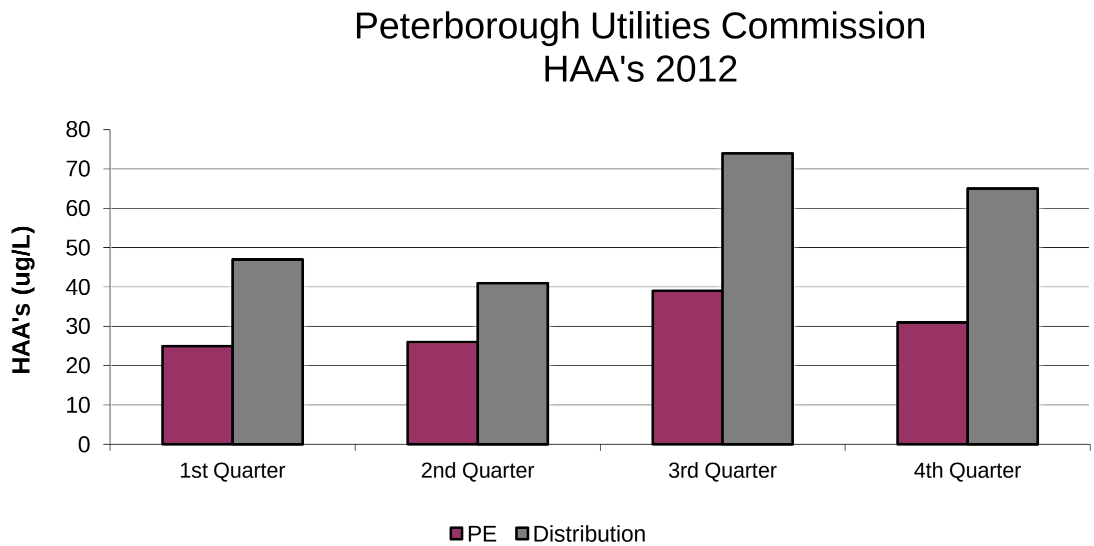

Figure 16

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 253.7 ηm) 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.

The laboratory instruments measure UV 253.7 ηm absorbance. This value is converted to transmittance by the formula;

$$A = 2 - \log_{10} \%T$$

During 2012, the average UV transmittance for raw water was 72.9%, the average for filter #1 was 87.9% and the plant effluent average was 89.5%. 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 complementary 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 2012 the staff responded to a total of 63 inquiries (Figure 17). There were 9 requests for information such as hardness results, water quality reports and how the water treatment plant operates. There was also 1 request for lead sampling. The remaining 53 inquiries were related to the following concerns; 48% of customer concern calls were related to taste and odours (earthy/musty or chlorine). 45% of concerns were relating to colour (usually rusty coloured water). Some of these concerns were mainly due to water main construction or rehabilitation and routine water main maintenance. 18% 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. Customers concerned about bacteria in the water accounted for about 6% of the overall complaints. In every case the water was tested for bacteria and none was found.

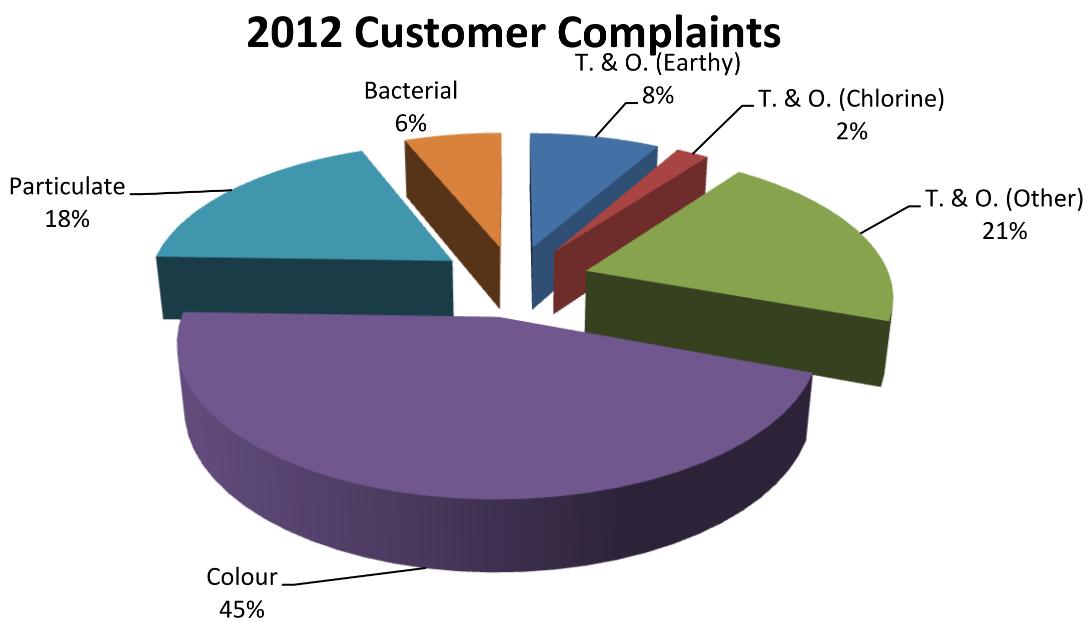

Figure 17

A further breakdown of the 15 taste and odour complaints revealed the following; 4 concerns were for an earthy musty odour, 1 concern were for a chlorine taste and odour, and 10 concerns were for various other taste and odours, from metallic to medicinal. Since 2006 the number of customer concerns has decreased each year from a total of 367 concerns in 2006 down to a total of 63 concerns in 2012.

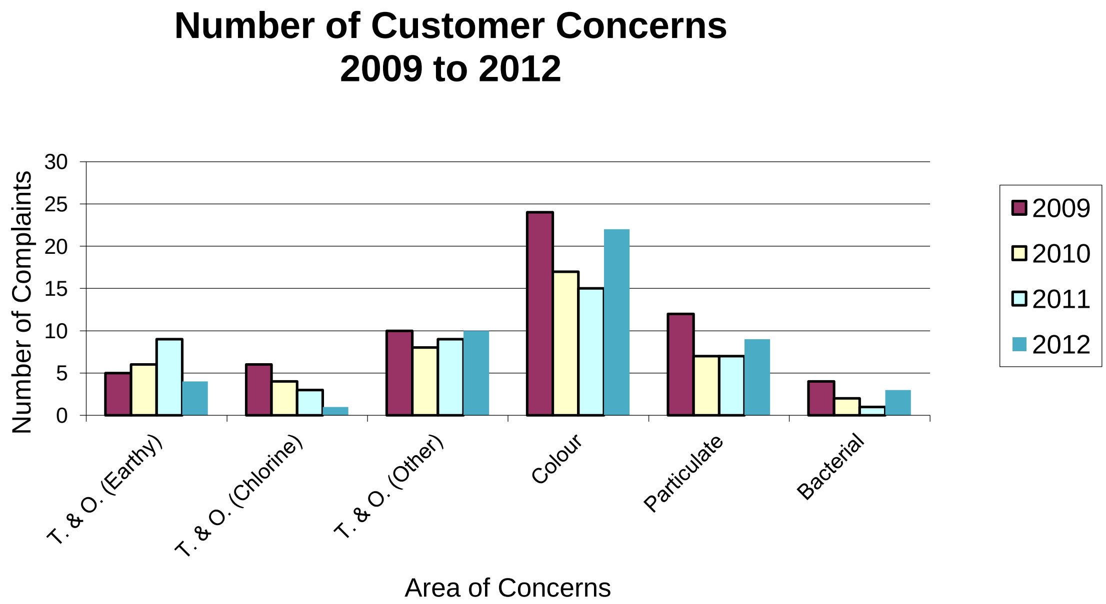

Figure 18

Tours

Tours have been an important part of public education at the Peterborough Water Treatment Plant. Over 131 people have had a tour of the water plant process during 2012 (over 1,431 people in the last 8 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