WINDSOR
UTILITIES
COMMISSION

AGENDA SUBMISSION

To: Mayor and Members of City Council

2012 06 25

From: John Stuart

Subject: Fluoridation of the City of Windsor Water Supply

1. RECOMMENDATION:

That City Council pass a bylaw DIRECTING the Windsor Utilities Commission *to cease the fluoridation of the City of Windsor water supply while ensuring continued regulatory compliance and that the savings from this action be DIRECTED to oral health and nutrition education in Windsor and Essex County for a period of 5 years.*

2. EXECUTIVE SUMMARY:

Over the past several years the Windsor Utilities Commission (WUC) has received correspondence requesting the cessation of fluoridation of the City of Windsor water supply. At a public meeting held on September 1, 2011, the Commission passed a resolution indicating that they wished to take a proactive approach regarding the ongoing fluoride debate and instructed administration to contact the surrounding communities with respect to their stance on fluoridation and to prepare a report outlining the issues for the Commission.

Acting upon these instructions, on February 29, 2012, WUC held a special meeting to offer the public an opportunity to provide input with regard to the ongoing fluoridation of the City of Windsor water supply. At this meeting eleven delegations, both for and against fluoridation, provided presentations on the practice of fluoridation. The Commission was provided with an opportunity to ask questions related to the practice of fluoridation, both of the delegates as well as administration.

As an outcome of that meeting the Commission passed the following resolution, requiring:

"... WUC administration to bring a report to City Council requesting the REMOVAL of Fluoride from the City of Windsor water supply and that the savings be DIRECTED to oral health and nutrition education in Windsor and Essex County for a period of 5 years."

3. BACKGROUND:

Fluoride was first contemplated for the Windsor water supply at the request of the Public Health Unit in 1953. However, prior to 1957 the Province of Ontario had no legislation that dealt with the fluoridation of water. The

Supreme Court of Canada held that a municipality was not authorized to pass a by-law authorizing fluoridation of the water supply since there was no enabling Provincial legislation in effect at that time. In 1957, the Ontario *Public Health Act* was amended and allowed for fluoridation of the water supply for specific municipalities; at that time Windsor was not included within this select group.

In 1961, the Province of Ontario enacted the *Fluoridation Act,* which specifically provided for the establishment, maintenance and discontinuance of fluoridation of drinking water within the Ontario waterworks system. Under the Fluoridation Act, municipalities were given the discretionary authority, by way of the passing of a by-law, "*...to establish, maintain and operate, or require that the local board establish, maintain and operate, a fluoridation system in connection with the waterworks system.*"

On October 16, 1961 subsequent to the passage of the *Fluoridation Act,* the City of Windsor passed By-law number 2327, a by-law to require the establishment of a fluoridation system in connection with the water works system, thereby directing the Windsor Utilities Commission (a local board of the City of Windsor) to "*...establish a fluoridation system in connection with the waterworks system for the City of Windsor, and thereafter, to maintain and operate such fluoridation system in accordance with the provision of the Fluoridation Act...*"

While there have been significant regulatory changes over the intervening years, *The Fluoridation Act* as amended and *By-law Number 2327*, enacted there under, are still in effect and hence WUC continues to fluoridate the Windsor municipal water supply.

From a governance perspective, as it relates to the actions of Commission members with respect to the fluoridation of a municipal drinking water system, the *Municipal Act 2001* imposes a statutory duty of care on those who oversee drinking water systems requiring them to act in good faith. However, as of December 31, 2012 an additional enhanced standard of care will come into effect under the aegis of the *Safe Drinking Water Act (2002).* This enhanced standard of care similarly applies to those who have oversight of municipal drinking water systems. Under this standard, each person must exercise the level of care, diligence and skill in respect of a municipal drinking-water system that a reasonably prudent person would be expected to exercise in a similar situation. The standard of care also extends to the owner of the municipal drinking water system, and to those people who, on behalf of the municipality, oversee the accredited operating authority or who exercise decision making authority over the system. Said individuals may rely in good faith on a report of an engineer, lawyer, accountant or other person whose professional qualifications lend credibility to the report.

From an operating perspective, in Ontario the act of fluoridating the water supply is ostensibly covered by the *Safe Drinking Water Act (2002)* and its companion regulations, in particular, O.Reg. 170/03 and O.Reg. 169/03. With respect to the *Safe Drinking Water Act,* Section 11 is of particular note and requires that:

- All water provided by the drinking water system meets prescribed drinking water quality standards
- The drinking water system is operated in accordance with the Act and regulations and is kept in a good state of repair
- All sampling, testing and monitoring requirements are complied with; and
- All reporting requirements are complied with

Thus WUC, in order to comply with its license to operate the Windsor water system as issued by the Ontario Ministry of the Environment (MOE) and in compliance with the underlying Provincial Regulation, the *Ontario Drinking Water Quality Standards*, (O.Reg. 169/03), continues to fluoridate the water supply utilizing chemicals that meet NSF/ANSI 60 standards while not exceeding a maximum acceptable concentration (MAC) of 1.5 milligrams/litre measured as fluoride anion.

With respect to the discontinuance of fluoridating the City of Windsor water supply, this is a policy decision that is borne by the City of Windsor. Simply put, WUC cannot unilaterally discontinue fluoridation of the water supply. Much as the 1961 decision to fluoridate the water supply was enacted through a City by-law under the *Fluoridation Act*, so too the decision to cease fluoridation is similarly covered by the *Fluoridation Act* and would require City Council to pass a by-law requiring WUC (as a local board of the City) under Section 3 of the Act, to do so.

4. DISCUSSION:

Fluoride is the anionic, or reduced, form of fluorine which is the thirteenth most abundant element in the Earth's crust. Given that fluorine is so abundant, it is not surprising that fluoride compounds are components of minerals in rocks and soils. Due to these components, and the action of groundwater acting upon them, fluoride is released into the groundwater and is the major contributor to the small amounts of fluoride present in most water sources. In general most groundwater contains low concentrations of fluoride, typically less than 0.5ppm.

Fluoridation is the controlled addition of fluoride ions to water that has a low fluoride concentration. In the early part of the 1900's significant work was done in understanding the root cause of mottling of teeth in individuals who were also less prone to dental cavities. This mottling, and improved dental health, was ultimately attributed to the high fluoride concentrations in the ground water that was ingested by these individuals. Over time, additional studies were undertaken establishing a relationship between fluoride and substantially fewer cavities ultimately leading to four community wide studies that were established circa 1945. These studies were conducted in Grand Rapids, MI; Newburgh, NY; Brantford, ONT and Evanston, Ill and, at that time, concluded that community wide fluoridation was a practical and safe public health measure to prevent tooth decay.

Over the past 65 years, additional investigation has examined everything from the health effects of the various fluoride compounds used in the fluoridation process to the dosage levels that provide adequate dental health protection. Over this time-frame, fluoride dosage levels have on average dropped from 1.0 to 1.2ppm to between 0.6 and 0.8ppm (as fluoride ion in finished water) while the maximum acceptable concentration (MAC) has been established at 1.5ppm.

In 2007, Health Canada convened a panel of experts to provide advice and to make recommendations to both Health Canada and the Federal-Provincial-Territorial Committee on Drinking Water (CDW) regarding the addition of fluoride to drinking water. This panel reached consensus on all key issues identified and made several recommendations including:

a. The current MAC of 1.5 mg/L (milligrams per litre) of fluoride in drinking water is unlikely to cause adverse health effects, including cancer, bone fracture, immunotoxicity, reproductive/developmental toxicity, genotoxicity and/or neurotoxicity.
b. That the current MAC of 1.5 mg/L for fluoride is unlikely to be a cause of moderate dental fluorosis in the Canadian population.
c. That an optimal target concentration for fluoride in the drinking water, which would prevent excessive intake of fluoride through multiple sources of exposure (including air and through food) be set at 0.7 mg/L.

It is of interest that on January 7, 2011, the U.S. Department of Health and Human Services (HHS) and the U.S. Environmental Protection Agency (EPA) recommended dropping the fluoride concentration from their current recommended range of 0.7 to 1.2 milligrams per litre to 0.7 milligrams of fluoride per litre. This updated recommendation was based on recent EPA and HHS scientific assessments to balance the benefits of preventing tooth decay while limiting any unwanted health effects. These scientific assessments will also guide the EPA in

making a determination of whether to lower the maximum amount of fluoride allowed in drinking water, which is set to prevent adverse health effects.

The new EPA assessments of fluoride were undertaken in response to findings of the U.S. National Academies of Science (NAS). At EPA's request, NAS reviewed new data on fluoride in 2006 and issued a report recommending that EPA update its health and exposure assessments to take into account bone and dental effects and to consider all sources of fluoride. In addition to the EPA's new assessments and the NAS report, HHS also considered current levels of tooth decay, dental fluorosis and fluid consumption across the United States.

As a point of reference, the average monthly fluoride concentration in Windsor drinking water for the period 2007 through 2011 varied between 0.62 and 0.67 mg/L all within the guidelines as set out by Health Canada and as proposed by the US EPA.

Advocates for Fluoridation

In addition to support for fluoridation of drinking water by water industry associations, there is broad based endorsement from national and international organizations such as:

Canada	International
Health Canada	World Health Organization (WHO)
Canadian Medical Association	Centers for Disease Control and Prevention, USA
The Canadian Dental Association	Pan American Health Organization
The Canadian Association of Public Health Dentistry	European Organization for Caries Research
Canadian Public Health Association	American Dental Association
Canadian Pediatric Society	Australian Dental Association
Canadian Dental Hygienists Association	British Dental Association
Association of Local Public Health Agencies, Ontario	British Medical Association
Ontario Dental Association	
Ontario Medical Association	

Detractors of Fluoridation

Just as there are supporters of fluoridation, so are there those that oppose the practice of fluoridation of municipal water-supply systems. There is wide based opposition from the following advocacy and political groups, namely:

Canada	International
Green Party of Canada	International Chiropractic Association
UNICEF	International Society of Doctors for the Environment
Council of Canadians	Sierra Club
Canadian Association of Physicians for the Environment	Center for Health, Environment and Justice
Great Lakes United	Science and Environmental Health Network
Windsor Essex County Environmental Committee	Members of the National Research Council
Green Peace Canada	Environmental Working Group

In addition to the groups noted above, there is a groundswell of opposition from locally organized groups with affiliations to the Fluoride Action Network and Fluoridation-Free Canada

Issues

While the proponents of fluoridation typically base their argument on the reduction of dental caries in receiving populations and represent it as a low cost solution that crosses socio-economic barriers, detractors arguments are much broader based. Those opposed to the fluoridation of municipal water supplies specifically allege that fluoridation:

1. Results in negative health impacts including various cancers, high lead blood levels, dental fluorosis and lowering of IQ
2. Is harmful to the environment
3. Is the use of a toxic substance without the requisite toxicology reports
4. Results in an increase in lead and arsenic levels as a result of fluoridation
5. Is mass medication without informed consent of the affected population
6. Is not an effective means of delivering medication to combat dental caries
7. Proponents do insufficient consultation with local residents regarding the decision to fluoridate and furthermore do not provide sufficient information to parents of infants as to the use of fluoridated water as an adjunct to baby formula

Appendix 1, attached hereto provides an overview of these broader issues.

Adjoining Communities

The Windsor drinking water system currently provides water, on a bulk basis, to the Towns of LaSalle and Tecumseh. These two municipalities have had their administrative review the fluoride issue and have passed the following council resolutions, namely:

> ***THAT*** *the Town of LaSalle* ***SUPPORT*** *the resolution passed by the Region of Peel*
>
> *"That the Region of Peel request that Health Canada regulate the fluorosilicates hexaflurosilicic acid (H2SiF6) and sodium silicofluoride (Na2SiF6), used as a treatment for dental cavities in drinking water, as drugs under the Food and Drugs Act;*
>
> *And further, that all chemicals, especially fluorosilicates, added to drinking water for the purpose of treating dental decay undergo new drug applications and be assigned drug numbers by Health Canada;*
>
> *And further, that at least one properly conducted, double blinded, randomized placebo controlled clinical trial be used to provide effectiveness as the basis for a new drug classification;*
>
> *And further, that the Region of Peel make the above recommendations to Health Canada to reassure the citizens of Peel that the use of fluorosilicates added to drinking water for the purpose of treating dental decay is safe and what the health effects are;*
>
> *And further, that a copy of this resolution be sent to the Federal and Provincial Minister of Health, and Peel area MPs and MPPs;*
>
> *And further, that Peel MPs and MPPs be requested to follow up on this issue with the Ministers of Health and report back to Regional Council with response."*

THAT *the Town of Tecumseh advise the Windsor Utilities Commission (WUC) to cease fluoridation of drinking water supplied to the Town of Tecumseh, as recommended by the WUC at their February 29, 2012 meeting.*

5. RISK ANALYSIS:

With respect to the legal obligations by WUC, its' Commissioners and the City of Windsor (as owner of the drinking water system) regarding fluoridation we refer you to the Municipal Act, the Safe Drinking Water Act, the Fluoridation Act and their supporting regulations.

The impetus to discontinue fluoridation can originate in one of three ways, namely:

1. By the municipality without prior public consultation
2. By the municipality having had public consultation; or
3. By public petition

Where a municipal water system fluoridates its water-supply, and whether with or without public consultation, in order to discontinue the use of the fluoridation system, the council must pass a by-law requiring the discontinuance of the fluoridation practice

With respect to input from the citizens of the community, The Fluoridation Act states that where petitions signed by at least 10 per cent of the electors in the serviced municipality, are presented to the Chief Electoral Officer requesting that a question under this Act be submitted to the municipality, for which the waterworks system is operated, the question will be placed to its electors on a date to be fixed by the Chief Electoral Officer. The clerk of the municipality shall certify the result of the vote in the municipality to the Chief Electoral Officer and, if a majority of the votes cast in the municipality on the question is in the affirmative, then the municipality shall pass a by-law calling for the discontinuance of fluoridation. However, if a majority of the votes cast is in the negative, then no by-law shall be passed until the question has again been submitted to the electors and has received the affirmative vote of a majority of the electors who vote on it.

Once a bylaw has been passed in the serviced municipality, then the operating authority must apply to the Ministry of the Environment to modify the operating license for the facility, requesting discontinuance of fluoridation of the water systems.

With respect to the determination to add fluoride to the drinking water, based on the current science and regulatory environment in place in Ontario, it is unlikely that a lawsuit against either WUC or its Commissioners would prove to be successful. None of the lawsuits to date in Canada initiated by persons opposed to fluoridation have succeeded. Similarly, any action brought about against WUC or its Commissioners, with respect to the removal of fluoride from the drinking water would also be unlikely to succeed as long as the removal was conducted in accordance with the current regulatory framework.

6. CONSULTATION

To date, administration has met with individuals associated with the following organizations in order to solicit their input:

Town of LaSalle Administration
Town of Tecumseh Administration
City of Windsor Administration
Windsor Essex County Health Unit
Windsor Essex Dental Association
Fluoride Action Network (Windsor)
Royal College of Dental Surgeons of Ontario
National Sanitation Foundation (NSF)
Detroit Water and Sewerage Department

In addition, administration has received correspondence (both in support and against the practice of fluoridation) from interested third parties. To date we have received 26 letters in support and 22 email submissions against.

7. CONCLUSION

On balance, the fluoride debate is a public health issue, rather than a water treatment or operational issue, and much of what has been cited within the body of this report speaks to that point. As such, from an operability standpoint, administration sees no risk with respect to the removal of fluoride from the City of Windsor water supply and will act in a timely fashion to comply with the wishes of Council.

Appendix 1 – Fluoridation Issues

While the proponents of fluoridation typically base their argument on the reduction of dental caries in receiving populations and represent it as a low cost solution that crosses socio-economic barriers, detractors arguments are much broader based. Those opposed to the fluoridation of municipal water supplies specifically allege that fluoridation:

1. Results in negative health impacts including various cancers, high lead blood levels, dental fluorosis and lowering of IQ
2. Is harmful to the environment
3. Is the use of a toxic substance without the requisite toxicology reports
4. Is mass medication without informed consent of the affected population

1. Negative Health Impacts

Cancer:

A literature search identified one systematic review that examined the effect of water fluoridation on cancer incidence and mortality. This review by McDonagh et.al, undertaken in 2000, examined a total of 26 previous studies. For the cancer outcome, the McDonagh review included studies that compared a non-fluoridated control area with an area (or areas) with fluoridation of any level, be they natural or artificial. Therefore, in many cases the included studies related to fluoridation levels many times the optimal level for intentional water fluoridation. The review included 10 before and after studies, 11 ecological studies and 3 case control studies. A further two studies were not included in the analyses because of issues with mixed control groups. The studies were generally categorized as being of poor quality since none of the included studies involved prospective follow-up or reported any form of blinding.

McDonagh concluded that there is no clear association between water fluoridation and overall cancer incidence or mortality. When considering all of the analyses, 11 of the studies found the direction of the association to be positive (fewer cancers with fluoridation), 2 found no association, and 9 found the direction to be negative (more cancers with fluoridation). Only two studies reported statistically significant associations – one study reporting a decrease in cancer mortality (Smith et.al. 1980) while another reported an increase in cancer incidence in two of the eight sub-groups that they investigated (Lynch et.al. 1985). The McDonagh review also discussed in more detail the controversy surrounding various published analyses of data from the same set of US cities (10 fluoridated and 10 non-fluoridated) by four sets of different authors. McDonagh noted that all of the studies used a before and after study design, simply comparing cancer incidence or mortality before and after the introduction of water fluoridation in half of the cities. McDonagh also noted that the original US study (Yiamouyiannis, 1977) which found an association between fluoridation and cancer incidence and that was suggestive of additional cancers, did not take into account demographic differences between the cities at baseline and across the time period of interest. For example, the proportion of the population who were non-white and over 65 years of age increased more rapidly in the fluoridated areas, which may have contributed to the increased cancer incidence. When the later studies normalized for age, gender and ethnic group, there was no correlation between fluoride and cancer mortality. The study with the highest validity and corrected data (Smith et.al. 1980) was included by McDonagh in the review, the results of which indicated a statistically significant protective effect.

With respect to bone cancer generally, McDonagh's review showed the direction of the association to be positive (fewer cancers) in three analyses, no association in one analyses, and negative (more cancers) in four analyses. None of the studies reported statistically significant relationships. With respect to osteosarcoma, the direction of the association was positive (fewer cancers) in seven analyses, there was no association in two analyses and negative (more cancers) in three of the analyses. One study (Cohn et.al. 1992) reported a statistically significant increased prevalence of osteosarcoma in males, however McDonagh indicated that this study had the lowest validity score of those reviewed, since it utilised census data compared crude osteosarcoma rates form areas where greater than 85% or less than 10% of the population received fluoridated water; yet there was no correction for confounding factors even though Cohn presented results by age and gender categories.

McDonagh also included two studies that investigated the impact of water fluoridation upon thyroid cancer. Both of these studies indicated a lack of association between thyroid cancer and fluoridation.

In summary the McDonagh review concluded that the evidence related to fluoridation and cancer incidence or mortality is at best mixed, with small variations on either side of the effect. The takeaway from the McDonagh review is that investigators must take steps to control for potentially confounding factors when using similar datasets or when setting up new studies.

In 2010 in order to obtain updated advice on the health issues surrounding fluoridation of water, the European Commission undertook to seek the advice of its Scientific Committee on Health and Environmental Risks (SCHER). The SCHER jointly collaborated with the Scientific Committee on Consumer Products (SCCP), the European Food Safety Authority's (EFSA) panel on dietetic products, nutrition and allergies (EFSA NDA) and EFSA's panel on contaminants in the food chain (EFSA CONTAM) who had previously delivered opinions on fluoride.

In the report arising from the work of the Committee (A critical review of any new evidence on the hazard profile, health effects, and human exposure to fluoride and the fluoridating agents of drinking water) it was concluded that:

"...SCHER agrees that some epidemiological studies seem to indicate a possible link between fluoride in drinking water and osteosarcoma, but the studies are equivocal. There is no evidence from animal studies to support the link, and thus fluoride cannot be classified as to its carcinogenicity."

With respect to the linkage between fluoride and cancer in humans, the Canadian Cancer Society has stated:

"...The Canadian Cancer Society recognizes the importance of weighing the possible risks and the benefits for complex issues. On the basis of current evidence, it appears unlikely that water fluoridation increased the risk of osteosarcoma in humans. At the same time, the health benefits of water fluoridation have been proven, especially for people who have less access to dental care. As new research on the health impacts of water fluoridation becomes available, the Canadian Cancer Society will evaluate it and keep Canadians informed..."

High Blood Lead Levels

A 2000 study (Masters, Coplan et.al.) reported on a statistical study of over 150,000 venous blood level (VBL) tests, taken from children between the ages of birth and 6 years of age inclusive, residing in 105 different communities having populations ranging between 15,000 and 75,000. These tests were part of a study undertaken by the New York State Department of Children's Health and were generally collected between 1994 and 1998. The study indicated that for every age/group, there was a significantly association of silicofluoride treated community water and elevated blood level. Masters and Coplan went on to say that this data contradicts the null hypothesis that there is no difference between the toxic effects of silicofluoride and sodium fluoride and thus raises the need for

follow on chemical studies and comprehensive animal testing of water treated with commercial grade silicofluorides.

The 2010 SCHER report commented on both the Masters and Coplan study as well as that of Urbansky and Schock (2000) with respect to an increase in lead and arsenic levels in those systems that fluoridated their water supply: In that report SCHER stated that:

"...It has been claimed that fluoridated drinking water increases human exposure to lead due to solubilisation of lead from drinking water pipes by formation of highly soluble lead complexes. The claim was based on relationships of drinking water fluoridation and blood lead concentrations observed in a case study (Coplan et al, 2007).

Based on the available chemistry of fluoride in solution, the chemistry of lead and lead ions, and the concentrations of fluoride in tap water, it is highly unlikely that there would be an increased release of lead from pipes due to hexafluorosilicic acid. The added concentrations of hexafluorosilicic acid do not influence the pH of the tap water, and do not form soluble lead complexes at the low concentrations of hexafluorosilicic acid present in the gastrointestinal tract after consumption of fluoridated drinking water (Urbansky and Schock, 2000)."

As a point of reference the following table outlines the raw and finished lead and arsenic levels for the City of Windsor water supply

Windsor - Arsenic and Lead Comparison				
Year	2009	2010	2011	2012
Raw Water Arsenic (µg/L)	1.2	0.6	0.6	1.0
Treated Water Arsenic (µg/L)	0.6	0.4	0.5	0.6
Raw Water Lead (µg/L)	0.22	0.16	0.39	1.79
Treated Water Lead (µg/L)	<0.02	0.02	0.14	0.07

Dental Fluorosis

One of the aims of the McDonagh (2000) review was to examine whether water fluoridation had any negative effects including that of dental fluorosis. McDonagh included studies in the review if they considered fluoride within the water supply up to 5 parts per million (ppm) and involved at least two groups that had different fluoride concentrations. McDonagh included those studies that had been undertaken up until the time of their study (2000) for which a total of 88 studies were considered relevant to the review and included 4 before and after studies, a single case control study and 83 single time-point cross-sectional studies. Two levels of dental fluorosis were assessed in this review: (i) 'any fluorosis' as defined by the fluorosis scale; and (ii) 'fluorosis of aesthetic concern' which was defined as a score of ≥3 on the TF index, a Dean's score of mild or worse, or a TSIF score of ≥2.

The McDonagh review was considered to be of good methodological quality with the results being divided into the two previously noted sections, namely 'any fluorosis' and 'fluorosis of aesthetic concern.' McDonagh noted that the results of 'any fluorosis' indicated a significant relationship between level of water fluoride and fluorosis prevalence, with prevalence increasing with increasing fluoride concentration. Multivariate and univariate analysis of these results were consistent with these observations.

The results of the 'fluorosis of aesthetic concern' also indicated a significant relationship between level of water fluoride and fluorosis prevalence. Again multivariate and univariate analysis were consistent with these observations. Four variables were found to be significantly associated with fluoride prevalence namely fluoride

level, method of assessment (clinical or photographic), method of fluoridation (natural or artificial), as well as the interaction between fluoride level and the method of fluoridation.

In summary McDonagh showed that there is an increased risk in developing 'any fluorosis' with water fluoridation albeit that this included questionable or very mild fluorosis which may not be considered to be an issue.

Similarly, with respect to dental fluorosis, the 2010 SCHER report concluded that:

"...SCHER acknowledges that there is a risk for mild forms of dental fluorosis in children in EU countries with systemic fluoride exposure in a dose-dependent manner and a threshold cannot be detected. The occurrence of endemic skeletal fluorosis has not been reported in EU. SCHER agrees that there are insufficient data to evaluate the risk of bone fracture at the fluoride level seen in areas with fluoridated water."

IQ Levels

In a 2000 study (Lu et.al.) the Intelligence Quotient (IQ) was measured in 118 children between the ages of 10 and 12 who were life-long residents in two Chinese villages of similar population size, social, educational and economic background but differing in the level of fluoride in the drinking water. The IQ of the 60 children in the high-fluoride area was significantly lower than that of the 58 children in the low-fluoride area. Lu hypothesized that the exposure of children to high levels of fluoride may therefore carry the risk of impaired development of intelligence.

In a 2003 study (Xiang et.al.) found a significant inverse concentration-response relationship between the fluoride level of drinking water and the IQ of children. This study indicated that as the fluoride level in drinking water increased that IQ fell and it was hypothesized that in endemic fluorosis areas, where drinking water fluoride levels were greater than 1.0 ppm, there may be an adverse affect on the development of children's intelligence.

Two earlier studies also showed statistically significant results with respect to fluoride and its impact on IQ. In 1997, Forbes found a significant negative effect of water fluoride on Alzheimer's disease (increased incidence) but a significant positive effect on impaired mental functioning (decreased incidence). Lin (1991) found a significant negative association of combined low iodine and high fluoride with goiter and mental retardation.

Again drawing from the 2010 SCHER report, SCHER stated that:

"...Available human studies do not allow concluding firmly that fluoride intake hampers children's neurodevelopment.... Limited animal data cannot support the link between fluoride exposure and neurotoxicity, noted in the epidemiological studies, at relevant non-toxic doses. SCHER agrees that there is not enough evidence to conclude that fluoride in drinking water may impair IQ."

2. Environment

Since it is inevitable that water, treated with fluoride, finds its way back to a receiving stream via sewage treatment and/or the stormwater infrastructure, there are those who would argue that the fluoridation of the water supply can have a negative environmental impact on the flora and fauna, albeit that the concentration of fluoride is at low concentrations. This would seem to be borne out by several studies and is seemingly covered in the Canadian National Water Guidelines that speak to the protection of aquatic life.

In a 2003 review (Camargo et.al.) published in the journal *Chemosphere* it is stated that:

"...because in soft waters with low ionic content, a fluoride concentration as low as 0.5 mg/l can adversely affect invertebrates and fishes, safe levels below this fluoride concentration are recommended in order to protect freshwater animals from fluoride pollution."

Similarly in a 1989 salmon passage study on the Columbia River, undertaken by Damkaer and Dey they state that:

"...The results of our behavioral experiments suggest that fluoride concentrations of about 0.5 mg/l adversely affect the migration of adult salmon and that 0.2 mg/l may be near or below the threshold for fluoride sensitivity in Chinook and Coho salmon..."

In the 2001 edition of the *Canadian Water Quality Guidelines for the Protection of Aquatic Life: Inorganic Fluorides*, as published by the National Guidelines and Standards Office, Environmental Quality Branch, Environment Canada states that:

"...Inorganic fluorides at low concentrations in the aquatic environment can elicit slight effects that are statistically and ecologically relevant. Sensitive characteristics for fish include survival, growth, reproductions and behavioral endpoints. ... An interim water quality guideline of 0.12 mg/L is recommended for the protection of all stages of freshwater life against the adverse effects of total inorganic fluorides."

Countering this view, the 2010 EU SCHER report assessed the impact that adding fluoride to drinking water would have on the environment. In their final report SCHER noted:

"...Based on three lines of evidence, a simplistic risk assessment, mass balance modeling and a modified EUSES analysis SCHER is of the opinion that adding fluoride to drinking water at concentrations between 0.8 mg F^-/L and the reference dose level of WHO (1.5 mg F^-/L) does not result in unacceptable risk to water organisms. Due to the electronegativity of the F ion SCHER is of the view that there will be little partition to solids in the sewage treatment process. It follows that sewage sludge is unlikely to become contaminated and, in turn, this means that the contamination of soils and terrestrial systems is unlikely. Similarly atmospheric releases from the incineration of sewage sludge are unlikely. Hence SCHER concludes that the risks from fluoridation to soils and atmospheric compartments do not give any cause for concern."

3. Toxicology

Detractors of water fluoridation indicate that the chemicals used for fluoridation are not high purity, pharmaceutical quality products. Rather they are byproducts of aluminum and fertilizer manufacturing and contain a high concentration of toxins and heavy metals such as arsenic, lead and chromium. This brings in to question the safety of using fluoridating compounds such as hexafluosilicic acid (HFS) in municipal water supply as well as whether or not the National Sanitation Federation (NSF) Standard 60 adequately protects the public.

The National Sanitation Foundation (NSF) is the internationally recognized expert agency on certifying products and writing standards for food, water and consumer goods. To date, they have certified that the three available fluoride-containing water treatment additives (hexafluosilicic acid, sodium fluorosilicate, and sodium fluoride) meet NSF/ANSI Standard 60, which deals with the Health Effects of Drinking Water Treatment Chemicals. Although all three have been certified as safe, the Windsor Drinking Water License specifically lists the use of hexafluosilicic acid for fluoridation purposes.

Standard 60 was developed to establish minimum requirements for the control of potential human health effects from products added directly to water during its treatment, storage and distribution. The standard requires a full information disclosure of each chemical ingredient in a product. It also requires a toxicology review to determine that the product is safe at its maximum use level and to evaluate potential contaminants in the product. The standard requires testing of the treatment chemical products, typically by dosing in water at 10 times the maximum use level, so that trace levels of contaminants can be detected. A toxicology evaluation of test results is required to determine if any contaminant concentrations have the potential to cause adverse health effects. The standard sets criteria for the establishment of single product allowable concentrations (SPAC) of each respective contaminant. For contaminants regulated by the U.S. EPA, this SPAC has a default level not to exceed ten percent of the regulatory level to provide protection for the consumer in the unlikely event of multiple sources of the contaminant, unless a higher or lower number of sources can be specifically identified.

Fluoride treatment products including hexafluosilicic acid are allowed to be used up to concentrations that result in a maximum use level of 1.2 mg/L fluoride ion in water. The standard also requires that the US EPA regulated maximum contaminant level (MCL), be used to determine the acceptable level for a contaminant. The US EPA MCL for fluoride in water is 4 mg/L. The NSF SPAC for fluoride ion in drinking water is 1.2 mg/L, hence the allowable maximum use level (MUL) for NSF certified hexafluosilicic acid is 6 mg/L.

Hexafluosilicic acid has the generally accepted molecular formula H_2SiF_6 which, when added to water, hydrolyses according to the following set of equations, namely:

i. $H_2SiF_6 \leftrightarrows 2HF + SiF_4\uparrow$

ii. $SiF_4\uparrow + 2H_2O \leftrightarrows 4HF + SiO_2\downarrow$

iii. $SiF_4 + 3H2O \leftrightarrows 4HF + H_2SiO_3$

iv. $HF \leftrightarrows H^+ + F^-$

Silicon tetrafluoride (SiF_4) is a gas that evaporates out of solution in high enough concentration, while silica (SiO_2) is generally insoluble in water and hence will precipitate out of solution. Hydrofluoric acid (HF) is a volatile acid that will also evaporate out of solution at high concentrations. Thus, in practical terms, and at neutral pH (circa 7.0), HFS dissociates to form both Hydrogen (H^+) and Fluoride (F^-) ions.

The United States Environmental Protection Agency (USEPA) states that studies have shown that silicofluorides achieve virtually complete dissolution and ionic disassociation at the concentrations they are added to drinking water. The equilibrium reached at the pH, temperature, and fluoride concentration used in water fluoridation account for this. One study reported that no intermediates or other products were observed at pH levels as low as 3.5. (Finney WF, Wilson E, Callender A, Morris MD, Beck LW. Reexamination of hexafluorosilicate hydrolysis by fluoride NMR and pH measurement. Environ Sci Technol 2006; 40:8:2572).

In its 2010 report SCHER similarly stated that:

"...Hexafluorosilicic acid and hexafluorosilicates are the most commonly used agents in drinking water fluoridation and it has been claimed that incomplete dissociation of these agents in drinking water may result in human exposure to these chemicals. The toxicology of these compounds is incompletely investigated. Recent studies have addressed the equilibrium of free fluoride ion and fluorosilicate species in aqueous solutions over a wide concentration and pH range. In the pH-range and at the concentrations of hexafluorosilicates/fluoride relevant for

drinking water, hydrolysis of hexafluorosilicates to fluoride was rapid and the release of fluoride ion was essentially complete, and residual fluorosilicate intermediates were not observed by sensitive ^{19}F NMR. Other hydrolysis products of hexafluorosilicate such as $Si(OH)_4$ are rapidly transformed to colloidal silica (Finney et al, 2008). $Si(OH)_4$ is present naturally in drinking water in large quantities and is not considered a risk. In summary, these observations suggest that human exposure to fluorosilicates due to the use of hexafluorosilicic acid or hexafluorosilicate for drinking water fluoridation, if any, is very low as fluorosilicates in water are rapidly hydrolyzed to fluoride..."

Within the City of Windsor drinking water system, raw water is drawn from the Detroit River, treated at the Wyandotte Street campus and then pumped into the distribution system. In 2011 the source water had an average incoming pH of 8.15 and, post treatment, the water was pumped into the distribution system at an average pH of 7.02. Given the nature of the treatment process and the physical chemical properties of the drinking water, and based on the study findings as outlined above, on balance the HFS added to the City of Windsor drinking water system is rapidly hydrolyzed to its constituent ions.

It has been purported that the National Sanitation Foundation (NSF), has not carried out the necessary toxicology studies for the three available fluoride-containing water treatment additives (hexafluosilicic acid, sodium fluorosilicate, and sodium fluoride) that meet NSF/ANSI Standard 60. It should be noted that where toxicology results have previously been undertaken for a specific substance and have been accepted by Health Canada or the USEPA, then the NSF/ANSI Standard 60 can rely upon these results in the assessment of the treatment chemical.

Since hexafluosilicic acid is rapidly hydrolyzed within typical water treatment operations, there are no fluorosilicate species present and hence, under the Standard, no toxicology studies are required for these species.

Analyses conducted by the NSF have shown that arsenic is the most common impurity found in HFS. Arsenic was found in 43% of product samples though at extremely low levels, far below the Single Product Allowable Concentration (SPAC). The current Maximum Concentration Level for arsenic is 10 ppb, and the highest levels found in their research was 0.6 ppb, with an average of around 0.12 ppb.

The second most common contaminant found, and on a much less frequent basis, was copper, with 97% of all samples being tested having no detectable levels of copper. The average concentration of copper in those samples where it was detected was 0.02 ppb with 2.6 ppb being the highest concentration detected. These results were also well below the 130 ppb SPAC requirement of NSF 60.

Lead was the third most commonly detected impurity found in hydrofluosilicic acid. The NSF studies indicated that it was found at the NDL (non detectible level) 98% of the time. The Single Product Allowable Concentration (SPAC) for lead is 1.5 ppb, and in the 2% of samples where it was found, the average concentration was 0.006 ppb.

With respect to the toxicology results for fluoride as well as the aforementioned contaminants, specifically arsenic, copper and lead a significant volume of data can be found at the Health Canada website, namely at the following url:

http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/water-eau/2011-fluoride-fluorure/2011-fluoride-fluorure-eng.pdf

http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/water-eau/arsenic/arsenic-eng.pdf

http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/water-eau/copper-cuivre/copper-cuivre-eng.pdf

http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/contaminants/dhhssrl-rpecscepsh/dhhssrl-rpecscepsh-eng.pdf

With respect to silicates, the second most prevalent substance in HFS, Health Canada and the USEPA have not established a maximum contaminant level (MCL) for silicates because there are no recognized health concerns.

Since the EPA does not have a MCL for silicate in drinking water thus, where a MCL does not exist for a contaminant, the Standard provides criteria to conduct a toxicological risk assessment of the contaminant and the development of a SPAC. NSF has established a SPAC for silicate at 16mg/L, therefore a fluorosilicate product applied at its MUL, results in silicate drinking water levels that are substantially lower than 16 mg/L.

As noted above, Windsor currently utilizes hexafluosilicic acid (HFS) as its source of fluoride.

NSF studies indicate that *"the majority of fluoridation products as a class, based on NSF test results, do not add measurable amounts of arsenic, lead, other heavy metals, or radionuclide contamination to drinking water."*

Substances such as arsenic and lead can, when present at concentrations in excess of recognized standards, expose consumers to a "drinking water health hazard" as defined by the Safe Drinking Water Act. In Windsor, samples are taken quarterly for lead and arsenic in the drinking water. The arsenic level for Windsor is consistently found far below the Maximum Allowable Concentration (MAC) of 25 µg/L (or 0.025 mg/L) and has averaged 0.48 µg/L over the past 6 quarters. With respect to lead, that is also found to be well below the MAC of 10 µg/L averaging just 0.045 µg/L over the past 6 quarters. Where elevated lead levels were found, it was associated with localized pipes and plumbing fixtures within private dwellings and buildings.

It should also be noted that both arsenic and lead are found in the raw water entering the treatment facility, albeit at low levels. For the period 2009 through the end of September 2012, treated arsenic and lead levels were lower than that found in the raw source water, despite the addition of treatment chemicals.

It has been suggested that operating authorities ought to consider the use of "pharmaceutical grade" fluoride for the fluoridation process. With regard to the use of "pharmaceutical grade" fluoride versus the currently approved NSF fluoride materials, the USEPA indicates that United States Pharmacopeia (USP) grading standards used in formulating prescription drugs are not appropriate for water fluoridation additives. If applied, those standards could actually increase the amount of impurities as allowed by AWWA and NSF/ANSI in drinking water.

The USP National Formulary (USP-NF) presents monographs on tests and acceptance criteria for substances and ingredients by manufacturers for pharmaceuticals. The USP 29 NF–24 monograph on sodium fluoride provides no independent monitoring or quality assurance testing. That leaves the manufacturer with the responsibility of quality assurance and reporting. Some potential impurities have no restrictions by the USP including arsenic, some heavy metals regulated by the U.S. EPA, and radionuclides.

The USP does not provide specific protection levels for individual contaminants, but tries to establish a relative maximum exposure level of a group of related contaminants. The USP does not include acceptance criteria for hexafluosilicic acid or sodium fluorosilicate.

Given the volumes of chemicals used in water fluoridation, a pharmaceutical grade of sodium fluoride for fluoridation could potentially contain much higher levels of arsenic, radionuclide's, and regulated heavy metals than a NSF/ANSI Standard 60-certified product.

4. Mass Medication

Detractors of fluoridation of municipal water supplies often claim that this practice is tantamount to mass medication of the general population without their informed consent and hence is unethical. Furthermore, it is stated that the fluoride used for water fluoridation does not have FDA approval and is considered by the FDA as an "unapproved drug." As such, the proper use of any drug requires a fuller understanding of how much is too much, and since fluoride is already present in many other foods and beverages, an estimated total intake of existing fluoride is therefore imperative.

Those opposed to water fluoridation often cite constitutional and civil liberty issues, specifically as it pertains to "mass medication" of the populations. Despite there being alternative means of reducing caries that would provide exemptions for those to opt out of fluoridation, akin to the exemptions for parents who wish not to participate in mandatory school immunization programs.

The Center for Children's Health and the Environment, a part of the Mount Sinai School of Medicine, indicates that there would seem to be a relationship between exposure to toxic chemicals and childhood illness *"...Of the thousands of synthetic chemicals on the market, relatively few have been tested for safety. And even fewer have been tested in conjunction with other chemicals. For our health, for our children's health, such testing should be in place for all chemicals."* This would tend to lend credence to the argument that since neither the estimated total intake of fluoride, nor the combination testing of fluoride and other chemicals has been undertaken, then by extension the general population is being mass medicated, utilising unapproved drugs.

It is interesting to note the Province of Quebec is now actively contemplating fluoridation of the public water supplies in municipalities having populations in excess of 5,000 individuals. Of particular note is that fluoridation of the Quebec water supply currently reaches only 3% of the population and hence the ethical aspects of drinking water fluoridation have become a cause for concern by the Quebec government. With this in mind, the Public Health Ethics Committee (CESP) of the Nation Public Health Institute of Quebec was asked to study and comment on the morality of public fluoridation practices. In their report issued in March 2012, the CESP noted:

"...The fluoridation of drinking water is presented in the literature as one of the safest, most effective, economical and equitable ways of reducing tooth decay. It has a greater impact on disadvantaged populations, and thus helps reduce health inequalities. The negative effects of fluoridation on health and the environment are not significant enough to outweigh the benefits.

However, the fluoridation of a population's water supply system will inevitably run counter to the wishes of part of that population. To force people to live more healthily against their will is certainly not a trivial matter. It is therefore important to explore ways to mitigate the consequences of such a measure on the free choice of individuals.

In conclusion, the CESP takes the view that the benefits of fluoridation outweigh its potential negative impacts on health and the environment and that such benefits justify the impinging on the freedom of choice of people who do not wish to have their water fluoridated. This opinion offers ways to mitigate these negative consequences on target populations; these include informing and consulting the public and inviting it to participate in the process leading to the change in regulations on the quality of drinking water..."

Notwithstanding the information provided herein, in May of 2009, Ontario's Chief Medical Officer of Health, Dr. David Williams MD, MHSc. FRCP, issued a memorandum to Ontario's Medical and Associate Medical Officers of Health, in which he stated:

"...I find no reason for Ontarians to avoid drinking fluoridated water at the recommended levels in Ontario's drinking water. Through Ontario's Child Health Program, public health units across the province are required to review drinking water quality reports for their municipal drinking water where fluoride is added, and to take action in accordance with provincial legislation and guidelines.

As you know, the decision to fluoridate drinking water is made by each municipality in consultation with local residents. It is an effective public measure that reduces social inequalities in health. It helps to contain costs of health care in Ontario. It benefits all residents in a community, and for these reasons we fully expect that this important practice will continue for many years to come so that Ontarians can enjoy lasting health benefits..."