Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines

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APPENDIX A – DESCRIPTION OF INDIVIDUAL PARAMETERS

Detailed supporting documentation for most of the parameters listed can be obtained through Health Canada at
https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table-health-canada-2012.html

Alachlor (herbicide)

The interim maximum acceptable concentration (IMAC) for alachlor in drinking water is 0.005 mg/L. This IMAC was developed in February 1985 by Health Canada, at the request of the Ontario government, in response to detection of this herbicide in municipal and private drinking water. Alachlor is a chloroacetanilide herbicide used mainly on corn and soybeans to control the growth of weeds. It is applied to cornfields prior to corn emergence to kill annual grasses. Alachlor is a proven animal carcinogen and a possible human carcinogen. In November of 1985, the use of alachlor was banned in Canada.

Aldicarb (insecticide)

The maximum acceptable concentration for aldicarb in drinking water is 0.009 mg/L. Aldicarb is a carbamate insecticide used in relatively low quantities for the control of specified insects. It was used on potatoes as well as on sugar beets and greenhouse ornamentals for aphid and root maggot control. Since aldicarb is highly soluble in water, persistent and mobile in soils, it has a high potential to enter ground water supplies. Available evidence suggests that aldicarb is not carcinogenic. The use of aldicarb was withdrawn by the manufacturer in the late 1980s.

Aldrin + Dieldrin (insecticide)

The maximum acceptable concentration for aldrin+dieldrin in drinking water is 0.0007 mg/L. Aldrin and dieldrin are organochlorine pesticides used to control soil insects. Aldrin is not often found in aquatic systems because it quickly oxidizes to dieldrin, which is very persistent. Most uses of aldrin and dieldrin were banned in Ontario in 1969 except for termite control under appropriate circumstances. This remaining use was banned in Ontario in April 1994.

Alkalinity (inorganic)

Alkalinity is a measure of the resistance of the water to the effects of acids added to water. The recommended operational range for alkalinity in coagulant-treated drinking water is 30 to 500 mg/L expressed as calcium carbonate. Alkalinity over 30 mg/L assists floc formation during the coagulation process. In some circumstances chemicals must be added to boost alkalinity before addition of a coagulant. Water with low alkalinity may tend to accelerate natural corrosion leading to "red water" problems whereas high alkalinity waters may produce scale incrustations on utensils, service pipes and water heaters. Water treatment processes, which do not use a coagulant generally, do not require alkalinity measurement or adjustment.

Aluminum (inorganic)

Aluminum in untreated water is present in the form of very fine particles of alumino-silicate clay. These clay particles are effectively removed in coagulation/filtration. Aluminum found in coagulant treated water is due to the presence of aluminum left over from use of the coagulant. Optimization of treatment should be applied to reduce this "residual" aluminum to under the operational guideline of 0.1 mg/L. High residual aluminum can cause coating of the pipes in the distribution system resulting in increased energy requirements for pumping, interferences with certain industrial processes and flocculation in the distribution system.

Medical studies have not provided clear evidence that residual aluminum has any effect on health.

Antimony (inorganic)

The interim maximum acceptable concentration for antimony in drinking water is 0.006 mg/L. The standard is set to protect against increased blood cholesterol and decreased blood glucose, as well as prevention of nausea, vomiting and diarrhea upon short-term exposure. Antimony is rarely detected in Ontario drinking water.

Arsenic (inorganic)

The interim maximum acceptable concentration for arsenic in drinking water is 0.025 mg/L. Arsenic is a known carcinogen and must therefore be removed by treatment where present at levels over this concentration.
Arsenic is sometimes found at higher levels in ground water in hard rock areas (e.g. Canadian Shield) in Ontario through the natural dissolution of arsenic containing minerals, in some mine drainage waters and in some mine leachates. Arsenic is present at very low concentrations in most surface waters.

Atrazine (herbicide)

The interim maximum acceptable concentration for atrazine plus N-dealkylated metabolites in drinking water is 0.005 mg/L. Atrazine, a triazine pesticide, is used mainly as a pre-emergent herbicide on corn for annual grass control. Atrazine is highly persistent and moderately mobile in soil.

Azinphos-methyl (insecticide)

The maximum acceptable concentration for azinphos-methyl in drinking water is 0.02 mg/L. Azinphos-methyl, an organophosphorus insecticide, is a broad spectrum insecticide used against foliage-feeding insects.

Barium (inorganic)

The maximum acceptable concentration for barium in drinking water is 1.0 mg/L. Barium is a common constituent in sedimentary rocks such as limestone and dolomite where it is

accompanied by strontium and much larger amounts of calcium. As a result, hard water contains small amounts of barium but seldom at concentrations greater than 1 mg/L. Most treatment methods used for water softening are effective for barium removal.

Bendiocarb (insecticide)

The maximum acceptable concentration for bendiocarb in drinking water is 0.04 mg/L. Bendiocarb is a carbamate insecticide used to control specific insects in buildings and greenhouses.

Benzene (organic)

The maximum acceptable concentration of benzene in drinking water is 0.005 mg/L. Benzene is present in small amounts in gasoline and other refined petroleum products. Long term exposure to high levels of benzene has been shown to increase cancer risk. Benzene is reported to occur in vehicle emissions and cigarette smoke. Drinking water is not considered a significant source of benzene because objectionable taste and odour discourages consumption.

Benzo(a)pyrene (organic)

The maximum acceptable concentration for benzo(a)pyrene in drinking water is 0.00001 mg/L. Benzo(a)pyrene is formed during the incomplete burning of organic matter and is found in poorly adjusted diesel exhaust and in coal/coking tar. Benzo(a)pyrene is classed as a PAH (polycyclic aromatic hydrocarbon) and has strong carcinogenic properties.

Boron (inorganic)

The interim maximum acceptable concentration for boron in drinking water is 5.0 mg/L. Boron in water is most commonly found as borate. Acute boron poisonings have resulted from the use of borates as antiseptic agents and from accidental ingestion, however, the amount consumed was much higher than would be encountered through drinking water. Infants, the elderly and individuals with kidney diseases are most susceptible to the toxic effects of boron compounds.

Bromate (inorganic)

The interim maximum acceptable concentration for bromate in drinking water is 0.010 mg/L. Bromate is not a natural component of water, but may be formed during the disinfection of drinking water using ozone or a combination of ozone and hydrogen peroxide. The concentration of bromide in raw water is a major factor in the formation of bromate. The major natural sources of bromide in groundwater are salt intrusion and bromide dissolution from sedimentary rocks. Sewage and industrial effluent as well as road and agricultural runoff may also contribute to elevated bromide levels in surface waters.

Bromoxynil (herbicide)

The interim maximum acceptable concentration for bromoxynil in drinking water is 0.005 mg/L. Bromoxynil is a hydroxybenzonitrile herbicide used in Ontario for the control of specific weed seedlings in grain crops.

Cadmium (inorganic)

The maximum acceptable concentration for cadmium in drinking water is 0.005 mg/L. Cadmium is a relatively rare element that is extremely unlikely to be present as a significant natural contaminant in drinking water. Cadmium compounds used in electroplated materials and electroplating wastes may be a significant source of drinking water contamination. Other than occupational exposure and inhalation from cigarette smoke, food is the main source of cadmium intake.

Carbaryl (insecticide)

The maximum acceptable concentration for carbaryl in drinking water is 0.09 mg/L. Carbaryl is a commonly used broad spectrum carbamate insecticide used in agriculture and forestry for control of foliar pests and as a home and garden product for specific garden and lawn pests. It is also used for ectoparasite control on livestock and pets. Available evidence suggests that carbaryl is not carcinogenic.

Carbofuran (insecticide)

The maximum acceptable concentration for carbofuran in drinking water is 0.09 mg/L. Carbofuran, trade-name Furadan, is a broad spectrum carbamate insecticide used in agriculture for control of foliar pests. It may also be used to treat soil at planting time to control root maggot, wireworm and some species of nematodes.

Carbon tetrachloride (organic)

The maximum acceptable concentration for carbon tetrachloride in drinking water is 0.005 mg/L. Carbon tetrachloride is likely to be found only in ground water from old industrial sites where chlorinated solvents were made or used. It is a well-known liver toxin and is classified as probably carcinogenic to humans.

Chloramines

The maximum acceptable concentration for chloramines in drinking water is 3.0 mg/L. Chloramines are produced when ammonia is added to chlorinated water during the disinfection process. Chloramine is a very weak disinfectant that is most suited for use as a stable distribution system disinfectant. Chloramination usually results in the production of lower levels of trihalomethanes and other chlorination by-products in the drinking water.

Chlordane (insecticide)

The maximum acceptable concentration for chordane in drinking water is 0.007 mg/L. Chlordane is an organochlorine insecticide that was once used extensively in agriculture as a soil insecticide and for domestic control of cockroaches, ants and termites. Chlordane is very persistent in soil. The use of chlordane in Ontario was banned in 1994.

Chloride (inorganic)

Chloride is a common non-toxic material present in small amounts in drinking water and produces a detectable salty taste at the aesthetic objective level of 250 mg/L. Chloride is widely distributed in nature, generally as the sodium (NaCl), potassium (KCl) and calcium ($CaCl_2$) salts.

Chlorpyrifos (insecticide)

The maximum acceptable concentration for chlorpyrifos in drinking water is 0.09 mg/L. Chlorpyrifos is a commonly used organophosphorus insecticide used for the control of insects on agricultural crops, for domestic use and for flea and tick control. Available evidence suggests that chlorpyrifos is not carcinogenic.

Chromium (inorganic)

The maximum acceptable concentration for chromium in drinking water is 0.05 mg/L. Trivalent chromium, the most common and naturally occurring state of chromium, is not considered to be toxic. However, if chromium is present in raw water, it may be oxidized to a more harmful hexavalent form during chlorination. Chromium in the more highly oxidized form may be present in older yellow paints and in residues from plating operations and around old recirculating water cooling systems.

Colour (physical)

The aesthetic objective for colour in drinking water is 5 TCU (True Colour Units). Water can have a faint yellow/brown colour which is often caused by organic materials created by the decay of vegetation. Sometimes colour may be contributed to by iron and manganese compounds produced by processes occurring in natural sediments or in aquifers. The presence of organic materials is the main cause of disinfection by-products when water is treated with chlorine.

Copper (inorganic)

The aesthetic objective for copper in drinking water is 1.0 mg/L. Copper occurs naturally in the environment but is rarely present in raw water. Copper is used extensively in domestic plumbing in tubing and fittings and is an essential trace component in food. Drinking water has the potential to be corrosive and to cause copper to dissolve in water. At levels above 1.0 mg/L, copper may impart an objectionable taste to the water. Although the intake of large doses of

copper has resulted in adverse health effects such as stomach upsets, the levels at which this occurs are much higher than the aesthetic objective.

Cyanazine (herbicide)

The interim maximum acceptable concentration for cyanazine in drinking water is 0.01 mg/L. Cyanazine is a triazine herbicide registered for control of weeds in crop and non-crop areas.

Cyanide (inorganic)

The maximum acceptable concentration for cyanide in drinking water is 0.2 mg/L measured as free cyanide. Cyanide is widely used in the metal plating and refining industry, and industrial effluents are the major potential sources of cyanide contamination. Cyanide at levels less than 10 mg/L is readily detoxified in the body to thiocyanate. Lethal toxic effects of cyanide usually occur only when this detoxification mechanism is overwhelmed. The maximum acceptable concentration for free cyanide provides a safety factor of approximately 25. Adequate chlorination will oxidize cyanide and reduce it to a level below this limit.

Diazinon (insecticide)

The maximum acceptable concentration for diazinon in drinking water is 0.02 mg/L. Diazinon is an organophosphorus insecticide that is used to control foliar and soil dwelling pests. It is also used for control of flies in barns and for ant and cockroach control.

Dicamba (herbicide)

The maximum acceptable concentration for dicamba in drinking water is 0.12 mg/L. Dicamba is a benzoic acid herbicide that is used for control of broadleaf weeds in grains, corn, flax, sorghum, pastures and weed control in lawns.

1,2-Dichlorobenzene (organic)

The maximum acceptable concentration for 1,2-dichlorobenzene in drinking water is 0.2 mg/L and the aesthetic objective is 0.003 mg/L. Although health effects from 1,2-dichlorobenzene are negligible below 0.2 mg/L, it does impart an unpleasant taste to water if present above 0.003 mg/L. It is used in a variety of specialty chemical blends (degreasing agents, imported dye carriers). There is sufficient evidence to suggest that 1,2-dichlorobenzene is probably non-carcinogenic.

1,4-Dichlorobenzene (organic)

Dichlorobenzene is a persistent synthetic material with a strong “medicinal” smell. It has been used widely in toilet pucks and mothballs. The maximum acceptable concentration for 1,4-dichlorobenzene in drinking water is 0.005 mg/L. At levels above the aesthetic objective of 0.001 mg/L, 1,4-dichlorobenzene imparts an unpleasant taste to the water.
DDT (Dichlorodiphenyltrichloroethane) and Metabolites (insecticides)

The maximum acceptable concentration of DDT and its metabolites in drinking water is 0.03 mg/L. Its persistence in the environment and concerns with potential bio-magnification resulting in potential widespread damage to the environment resulted in use restrictions in North America by the late 1960's. DDT was banned in Ontario in 1988.

1,2-Dichloroethane (organic)

An interim maximum acceptable concentration for 1,2-dichloroethane in drinking water is 0.005 mg/L. It is principally used as a starting material in the production of vinyl chloride, as a solvent and a fumigant. It is released into the environment via atmospheric emissions and the discharge of industrial waste waters. There is some information which suggests that 1,2-dichloroethane is an animal carcinogen, but inadequate data to determine human carcinogenicity.

1,1-Dichloroethylene (vinylidene chloride) (organic)

The maximum acceptable concentration for 1,1-dichloroethylene (1,1-dichloroethene, vinylidene chloride, 1,1-DCE) in drinking water is 0.014 mg/L. This chemical is not produced in Canada, however it is imported for use in the food packaging industry and the textile industry for furniture and automotive upholstery, drapery fabric and outdoor furniture.

Dichloromethane (organic)

The maximum acceptable concentration for dichloromethane in drinking water is 0.05 mg/L. Methylene chloride is an alternative name for dichloromethane. It is used extensively as an industrial solvent for paint-stripping and as a degreasing agent. There is sufficient data to show that dichloromethane is an animal carcinogen, but inadequate data to determine human carcinogenicity.

2,4-Dichlorophenol (organic)

Chlorophenols are highly odorous synthetic materials which are most often present in drinking water due to the action of chlorine on phenolic precursors. Lighter phenols are found in water only as a result of industrial contamination. The maximum acceptable concentration for 2,4-dichlorophenol in drinking water is 0.9 mg/L and the aesthetic objective is 0.0003 mg/L. At levels above 0.0003 ug/L, 2,4-dichlorophenol will impart an unpleasant taste to the water.

2,4-D (2,4-Dichlorophenoxy acetic acid) (herbicide)

The interim maximum acceptable concentration for 2,4-D in drinking water is 0.1 mg/L. 2,4-D is a commonly used chlorophenoxy herbicide used for control of broadleaf weeds in cereal crops and lawns.

Diclofop-methyl (herbicide)

The maximum acceptable concentration for diclofop-methyl in drinking water is 0.009 mg/L. Diclofop-methyl is a chlorophenoxy derivative that is used for control of annual grasses in grain and vegetable crops. It is relatively soluble in water.

Dieldrin + Aldrin (insecticide)

Refer to Aldrin + Dieldrin

Dimethoate (insecticide)

The interim maximum acceptable concentration for dimethoate in drinking water is 0.02 mg/L. Dimethoate is an organophosphorus miticide and insecticide used on a wide range of plants for control of mites and both sucking and leaf-feeding insects. It is also used for fly control in livestock pens. Concentrated preparations can be painted on the trunk and main limbs of large trees to control leaf miner.

Dinoseb (herbicide)

The maximum acceptable concentration for dinoseb in drinking water is 0.01 mg/L. Dinoseb is a contact herbicide and desiccant. Dinoseb is no longer used in Ontario.

Dioxins (organic)

The interim maximum acceptable concentration for dioxin, the commonly used name for any chlorinated dibenzodioxin or dibenzofuran, in drinking water is 0.000000015 mg/L (expressed as 2,3,7,8-TCDD toxicity equivalents (TEQ)/L). Dioxins are formed in very small amounts in combustion processes, particularly combustion of chlorine containing materials such as scrap tires and, potentially, in some poorly controlled industrial processes such as bleached paper manufacturing.

Diquat (herbicide)

The maximum acceptable concentration for diquat in drinking water is 0.07 mg/L. Diquat is a bipyridilium herbicide used primarily as a crop desiccant in seed crops and as an aquatic herbicide.

Dissolved Organic Carbon (DOC) (Organic)

The aesthetic objective for dissolved organic carbon (DOC) in drinking water is 5 mg/L. High DOC is an indicator of possible water quality deterioration during storage and distribution due to the carbon being a growth nutrient for biofilm dwelling bacteria. High DOC is also an indicator of potential chlorination by-product problems. Coagulant treatment or high pressure membrane treatment can be used to reduce DOC.

Diuron (herbicide)

The maximum acceptable concentration for diuron in drinking water is 0.15 mg/L. Diuron is a substituted urea-based herbicide used for the control of vegetation in crop and non-crop areas, including industrial sites and rights-of-way. It is moderately soluble in water.

Escherichia coli (microbiological)

Escherichia coli should not be detected/present in any drinking water sample. Escherichia coli is a fecal coliform and can be detected using methods such as membrane filtration, presence/absence and MPN. Since Escherichia coli is present in fecal matter and prevalent in sewage, but is rapidly destroyed by chlorine, it is a strong indicator of recent fecal pollution. Contamination with sewage as shown by positive E-coli tests would strongly suggest presence of pathogenic bacteria and viruses, as well as more chlorine resistant pathogens such as Giardia and Cryptosporidium, which are much more difficult to detect.

Ethylbenzene (organic)

The taste/odour related aesthetic objective for ethylbenzene in drinking water is 0.0024 mg/L. Ethylbenzene is a component of the BTEX gasoline additive used for octane rating boosting. It is also used in solvent based paint formulations.

Fluoride (inorganic)

Where fluoride is added to drinking water, it is recommended that the concentration be adjusted to 0.5 - 0.8 mg/L, the optimum level for control of tooth decay. Where supplies contain naturally occurring fluoride at levels higher than 1.5 mg/L mg/L but less than 2.4 mg/L the Ministry of Health and Long-Term Care recommends an approach through local boards of health to raise public and professional awareness to control excessive exposure to fluoride from other sources. Levels above the MAC must be reported to the local Medical Officer of Health.

Glyphosate (herbicide)

The interim maximum acceptable concentration for glyphosate in drinking water is 0.28 mg/L. Glyphosate is a broad-spectrum, non-selective herbicide used for weed control on rights-of-way, forestry plantations and in-site preparations for planting of crops, as well as for domestic control of plants. It is very soluble in water.

Hardness (inorganic)

The operational guideline for hardness in drinking water is set at between 80 and 100 mg/L as calcium carbonate. This value is set to aid in water source selection where a choice exists. Hardness is caused by dissolved calcium and magnesium, and is expressed as the equivalent quantity of calcium carbonate. On heating, hard water has a tendency to form scale deposits and can form excessive scum with regular soaps. However, certain detergents are largely unaffected by hardness. Conversely, soft water may result in accelerated corrosion of water pipes. Hardness levels between 80 and 100 mg/L as calcium carbonate ($CaCO_3$) are considered to provide an acceptable balance between corrosion and incrustation. Water supplies with a hardness greater than 200 mg/L are considered poor but tolerable. Hardness in excess of 500 mg/L in drinking water is unacceptable for most domestic purposes (see the entry below for sodium).

Heptachlor + Heptachlor epoxide (insecticide)

The maximum acceptable concentration of heptachlor + heptachlor epoxide in drinking water is 0.003 mg/L. Heptachlor is an organochlorine insecticide once used in agriculture for control of soil insects. Heptachlor use has been banned in Canada since 1969.

Heterotrophic Plate Count (microbiological)

Heterotrophic plate count (HPC) results give an indication of overall water quality in drinking-water systems. HPC results should be used as a tool for monitoring the overall quality of the water, both immediately post-treatment and in the distribution system. HPC results are not an indicator of water safety and, as such, should not be used as an indicator of potential adverse human health effects.

Sudden increases in HPC above normal baseline levels can indicate a change in raw water quality or a problem such as bacterial regrowth in the distribution system or plumbing. Steady increases in HPC over time indicate a gradual decline in raw water quality or in the condition of the system. Additionally, increases in disinfected systems can indicate a problem with drinking water treatment.

Iron (inorganic)

Iron may be present in ground water as a result of mineral deposits and chemically reducing underground conditions. It may also be present in surface waters as a result of anaerobic decay in sediments and complex formation. The aesthetic objective for iron, set by appearance effects, in drinking water is 0.3 mg/L. 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; and the precipitation of iron can also promote the growth of iron bacteria in water mains and service pipes. Iron based coagulants such as ferric sulfate can be highly effective in treatment processes at removing particles from water and leave very little residual iron in the treated water.

Lead (inorganic)

The maximum acceptable concentration for lead in drinking water is 0.01 mg/L. This applies to water at the point of consumption since lead is only present as a result of corrosion of lead solder, lead containing brass fittings or lead pipes which are found close to or in domestic plumbing and the service connection to buildings. Lead ingestion should be avoided particularly by pregnant women and young children, who are most susceptible.
It is recommended that only the cold water supply be used for drinking/consumption and only after five minutes of flushing to rid the system of standing water. Corrosion inhibitor addition or other water chemistry adjustments may be made at the treatment plant to reduce lead corrosion rates where necessary.

Lindane (insecticide)

The maximum acceptable concentration for lindane in drinking water is 0.004 mg/L. Lindane is an organochlorine insecticide used for seed treatment. It may also be used in pharmaceutical preparations of human lice and mite shampoos. The chemical name for lindane is gamma-BHC (an isomer of hexachlorocyclohexane).

Malathion (insecticide)

The maximum acceptable concentration for malathion in drinking water is 0.19 mg/L. Malathion is a wide spectrum organophosphorus insecticide used on fruits and vegetables, as well as for mosquito, fly, flea and tick control. It has low mammalian toxicity.

Manganese (inorganic)

The colour related aesthetic objective for manganese in drinking water is 0.05 mg/L. Like iron, manganese is objectionable in water supplies because it stains laundry and fixtures black, and at excessive concentrations causes undesirable tastes in beverages. Manganese is present in some ground waters because of chemically reducing underground conditions coupled with presence of manganese mineral deposits. Manganese is also occasionally present, seasonally, in surface waters when anaerobic decay processes in sediments is occurring.

Mercury (inorganic)

The maximum acceptable concentration for mercury in drinking water is 0.001 mg/L. Possible sources of mercury in drinking water include air pollution from coal combustion, waste incineration and from metal refining operations and from natural mineral deposits in some hard rock areas. Food is the major source of human exposure to mercury, with freshwater fish being the most significant local source.

Methane (organic)

The aesthetic objective due to gas bubble release and violent spurting from taps for methane is 3 L/m^3. Methane may be a problem in ground water since it can cause mechanical damage by causing water hammer. Methane occurs naturally in some ground water and acts as a stimulant for microbiological fouling in the distribution system. Methane is not detected in dissolved organic carbon (DOC) analysis and its carbonaceous content is, therefore, additional to any DOC result. If methane is allowed to accumulate in confined areas, the potential for explosive combustion exists.

Methoxychlor (insecticide)

The maximum acceptable concentration for methoxychlor in drinking water is 0.9 mg/L. Methoxychlor is an organochlorine insecticide. It is non-persistent and non-accumulative in biological tissues, making it an attractive insecticide for use on products nearing harvest, in dairy barns for housefly control and as either a larvicide or adulticide against black flies and mosquitoes.

Metolachlor (herbicide)

The interim maximum acceptable concentration for metolachlor in drinking water is 0.05 mg/L. Metolachlor is a selective herbicide used for pre-emergence and pre-plant broad leaf weed control in corn, soybeans, peanuts, grain sorghum, pod crops, woody ornamentals and sunflowers.

Metribuzin (herbicide)

The maximum acceptable concentration for metribuzin in drinking water is 0.08 mg/L. Metribuzin is a triazine herbicide used for control of broad leaf weeds and grasses infesting agricultural crops. It is used selectively on soybeans, tomatoes and potatoes, all crops that are highly sensitive to most other triazine herbicides.

Microcystin-LR

The maximum acceptable concentration (MAC) for the cyanobacterial toxin microcystin-LR in drinking water is 0.0015 mg/L. This guideline is believed to be protective of human health against exposure to other microcystins (total microcystins) that may also be present. Cyanobacterial toxins are toxins produced by cyanobacteria or blue-green algae. Water bodies that have historically exhibited algal blooms should be visually monitored for bloom formation and hence toxin production during the peak season (usually late May to early October) and follow the steps outlined in Annex A.

Monochlorobenzene or Chlorobenzene (organic)

The maximum acceptable concentration for chlorobenzene in drinking water is 0.08 mg/L and the taste related aesthetic objective is 0.03 mg/L. Chlorobenzene is used in the production of chloronitrobenzene and diphenyl ether, as a rubber intermediate, and as a solvent in adhesives, paints, waxes, polishes and inert solvents. It is also used in metal cleaning operations and may be present in industrial discharges.

Nitrate (inorganic)

The maximum acceptable concentration of nitrates in drinking water is 10 mg/L as nitrogen. Nitrates are present in water (particularly ground water) as a result of decay of plant or animal material, the use of agricultural fertilizers, domestic sewage or treated wastewater contamination, or geological formations containing soluble nitrogen compounds. There is a risk that babies and small children may suffer blood related problems (methaemoglobinaemia) with excess nitrate intake. The nitrate ion is not directly responsible for this condition, but must first be reduced to the nitrite ion by intestinal bacteria. The nitrite reacts with the iron of haemoglobin in red blood cells which are then prevented from carrying oxygen to the body tissues.

Nitrate poisoning, in terms of methaemoglobinaemia, from drinking water appears to be restricted to susceptible infants. Older children and adults drinking the same water are unaffected. Most water-related cases of methaemoglobinaemia have been associated with the

use of water containing more than 10 mg/L nitrate as nitrogen. In Canada, no cases of the condition have been reported where the nitrate concentration was consistently less than the maximum acceptable concentration. Where both nitrate and nitrite are present, the total nitrate plus nitrite-nitrogen concentration should not exceed 10 mg/L. In areas where the nitrate content of water is known to exceed the maximum acceptable concentration the public should be informed by the appropriate health authority of the potential dangers of using the water for infants.

Nitrite (inorganic)

The maximum acceptable concentration of nitrite in drinking water, 1.0 mg/L as nitrogen, is based, as with nitrate, primarily on the relationship between nitrite in water and the incidence of infantile methaemoglobinaemia. Nitrite is fairly rapidly oxidized to nitrate and is therefore seldom present in surface waters in significant concentrations. Nitrite may occur in ground water, however if chlorination is practiced the nitrite will usually be oxidized to nitrate.

NTA (Nitrilotriacetic Acid) (organic)

The maximum acceptable concentration for NTA in drinking water is 0.40 mg/L. NTA is mainly used in laundry detergents, most of which is eventually disposed of in domestic wastewater. In general, the toxicity of NTA is very low, however, an increased incidence of urinary tract tumours was found in rats and mice that had been fed very large doses of NTA. Risk assessment, together with the relatively poor absorption of ingested NTA by humans, suggests that the risk associated with a NTA level in drinking water of below 0.40 mg/L is negligible.

NDMA (N-Nitrosodimethylamine) (organic)

The interim maximum acceptable concentration for NDMA is 0.000009 mg/L. NDMA is rarely used industrially but has been used as an antioxidant, as an additive for lubricants and as a softener of copolymers. It has been detected in some foods particularly smoked foods and very occasionally in treated river/lake water in heavily farmed locations. NDMA is an animal carcinogen.

Odour (physical/chemical)

The contamination of drinking water with offensively odorous substances may have an easily identified cause such as paint solvent odour or odour from diesel fuel or gasoline. In these cases, systems must be flushed to clear the contaminants and contaminating surfaces stripped and repainted. Another common source of musty odours is from harmless, but very smelly substances produced by certain algae. These materials from algae are present in some surface waters from late summer into fall and can sometimes be partly removed using activated carbon treatment. Another common source of odours is sulfide (see below) which is found in some ground waters but not in surface waters. Numerous other substances could cause odour and these are sometimes very hard to identify and correct. The odour of drinking water should be inoffensive.

Organic Nitrogen (organic)

The operational guideline for organic nitrogen in drinking water is 0.15 mg/L. Organic nitrogen is calculated by the difference between the total Kjeldahl nitrogen and the ammonia nitrogen. High levels may be caused by septic tank or sewage effluent contamination. This form of contamination is often associated with some types of chlorine- worsened taste problems. Organic nitrogen at levels above 0.15 mg/L would be typically associated with DOC contribution of 0.6 mg/L. Organic nitrogen compounds frequently contain amine groups which can react with chlorine and severely reduce its disinfectant power. Certain chlorinated organic nitrogen compounds may be responsible for flavour problems that are associated with chlorophenol. Taste and odour problems are common with organic nitrogen levels greater than 0.15 mg/L.

Paraquat (herbicide)

The interim maximum acceptable concentration for paraquat in drinking water is 0.01 mg/L. Paraquat is a highly toxic, bipyridil herbicide used as a contact herbicide and for desiccation of seed crops. It is also used for non-crop and industrial weed control. It is a pre-emergent herbicide used in "no-till" situations or before planting or crop emergence. It is also registered for aquatic use to control cattails, bulrushes and grasses.

Parathion (insecticide)

The maximum acceptable concentration for parathion in drinking water is 0.05 mg/L. Parathion is an extremely toxic, organophosphorous broad spectrum insecticide used in agriculture against foliar pests and the adult stage of root maggots. In some instances, resistance to parathion has developed and parathion is no longer effective.

Pentachlorophenol (organic)

The maximum acceptable concentration for pentachlorophenol in drinking water is 0.06 mg/L and the taste/odour based aesthetic objective is 0.03 mg/L. Pentachlorophenol is rarely found in commercial use today but was used extensively as a pesticide and wood preservative. It is the most environmentally persistent of the chlorophenols.

Pesticides

Pesticides can be grouped by chemical composition. Pesticides which contain chlorine tend to persist in the environment and may become concentrated in food chains causing health effects in animals such as predators at the top of the chains. Some chlorophenoxy herbicides and cholinesterase-inhibiting compounds, including organo-phosphorus chemicals and carbamates, have a high acute toxicity to mammals. Many of these, however, hydrolyse rapidly in water to form harmless or less harmful products.

Additional information on pesticides can be found on the World Wide Web at:

The EXtension TOXicology NETwork (http://ace.orst.edu/info/extoxnet/)

Pest Management Regulatory Agency (http://www.hc-sc.gc.ca/pmra-arla/)
Ontario Pesticides Advisory Committee (http://www.opac.gov.on.ca/)

pH (physical-chemical)

pH is a parameter that indicates the acidity of a water sample. The 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 incrustation. At pH levels above 8.5, mineral incrustations and bitter tastes can occur. Corrosion is commonly associated with pH levels below 6.5 and elevated levels of certain undesirable chemical parameters may result from corrosion of specific types of pipe. With pH levels above 8.5, there is also a progressive decrease in the efficiency of chlorine disinfection and alum coagulation.

Phorate (insecticide)

The interim maximum acceptable concentration for phorate in drinking water is 0.002 mg/L. Phorate is an organophosphorus insecticide used for control of sucking insects, larvae of the corn rootworm and leaf-eating beetles.

Picloram (herbicide)

The interim maximum acceptable concentration for picloram in drinking water is 0.19 mg/L. Picloram is a phenoxy alkanoic acid herbicide used for broadleaf weed and brush control on right-of-ways and roadsides. Picloram can be persistent in soil for up to a year after application.

PCBs (Polychlorinated Biphenyls) (organic)

The interim maximum acceptable concentration for PCBs in drinking water is 0.003 mg/L. PCBs are among the most ubiquitous and persistent pollutants in the global ecosystem. In the past, PCBs have been marketed extensively for a wide variety of purposes but are no longer manufactured or used. The available information suggests that drinking water containing PCB, at a concentration of 0.003 mg/L or less, does not pose a health risk.

Prometryne (herbicide)

The interim maximum acceptable concentration for prometryne in drinking water is 0.001 mg/L. Prometryne is a methylthiotriazine herbicide which is used to selectively control annual grasses and broadleaf weeds in crops and non-crops. It can be applied both as a pre-emergent and post-emergent herbicide.

Radionuclides (radiological)

There are 78 new and revised standards (see Table 3) for both natural and artificial radionuclides. They are derived from a 50-year committed effective dose of 0.1 millisievert (mSv) from one year's consumption of water and are expressed in activity concentration units of becquerels per litre (Bq/L). The derivation of radiological guidelines conforms to

international radiation protection methodologies. The approach accounts for the total lifetime exposure that will result from any radionuclide ingested in one year, based on its retention in human tissue. The limits are designed to protect human health from the carcinogenic effects of exposure to radionuclides via drinking water.

Selenium (inorganic)

The maximum acceptable concentration for selenium in drinking water is 0.01 mg/L. Selenium occurs naturally in waters at trace levels as a result of geochemical processes such as weathering of rocks. It is difficult to establish levels of selenium that can be considered toxic because of the complex inter-relationships between selenium and dietary constituents such as protein, vitamin E and other trace elements. Food is the main source of selenium intake other than occupational exposure. Selenium is an essential trace element in the human diet. Drinking water containing selenium at the maximum acceptable concentration of 0.01 mg/L would be the source of only 10 per cent of total selenium intake. The maximum acceptable concentration, therefore, is considered to provide a satisfactory factor of safety against known adverse effects.

Simazine (herbicide)

The interim maximum acceptable concentration for simazine in drinking water is 0.01 mg/L. Simazine is a triazine herbicide which is used for pre-emergence weed control in annual row crops. Simazine is the least soluble of all the triazine herbicides and is easily leached to ground water where it may persist for years.

Sodium (inorganic)

The aesthetic objective for sodium in drinking water is 200 mg/L at which it can be detected by a salty taste. Sodium is not toxic. Consumption of sodium in excess of 10 grams per day by normal adults does not result in any apparent adverse health effects. In addition, the average intake of sodium from water is only a small fraction of that consumed in a normal diet. A maximum acceptable concentration for sodium in drinking water has, therefore, not been specified. Persons suffering from hypertension or congestive heart disease may require a sodium-restricted diet, in which case, the intake of sodium from drinking water could become significant. It is therefore recommended that the measurement of sodium levels be included in routine monitoring programs of water supplies. The local Medical Officer of Health should be notified when the sodium concentration exceeds 20 mg/L, so that this information may be passed on to local physicians.

Softening using a domestic water softener increases the sodium level in drinking water and may contribute a significant percentage to the daily sodium intake for a consumer on a sodium restricted diet. It is recommended that a separate unsoftened supply be retained for cooking and drinking purposes.

Sulfate (inorganic)

The aesthetic objective for sulfate in drinking water is 500 mg/L. At levels above this concentration, sulfate can have a laxative effect, however, regular users adapt to high levels of

sulfate in drinking water and problems are usually only experienced by visitors and new consumers. The presence of sulfate in drinking water above 150 mg/L may result in noticeable taste. The taste threshold concentration, however, depends on the associated metals present in the water. High levels of sulfate may be associated with calcium, which is a major component of scale in boilers and heat exchangers. In addition, sulfate can be converted into sulfide by some anaerobic bacteria creating odour problems and potentially greatly accelerating corrosion.

Sulfide (inorganic)

The odour related aesthetic objective for sulfide in drinking water is 0.05 mg/L as H2S (hydrogen sulphide). Although ingestion of large quantities of hydrogen sulfide gas can produce toxic effects on humans, it is unlikely that an individual would consume a harmful dose in drinking water because of the associated unpleasant taste and odour. Sulfide is also undesirable in water supplies because, in association with iron, it produces black stains on laundered items and black deposits on pipes and fixtures. Lower levels of sulfide can be removed effectively from most well water by aeration. Sulfide is oxidized to sulfate in well-aerated waters over a period of hours and consequently sulfide levels in surface supplies are usually very low.

Taste

Taste and odour are intimately interrelated, and consumers frequently mistake odours for tastes. In general, the sense of taste is most useful in detecting the ionic inorganic constituents of drinking water, whereas the sense of smell is most useful in detecting volatile organic constituents. Taste and odour problems constitute the largest category of consumer complaints. Changes in the taste of drinking water may indicate possible contamination of the raw water supply, treatment inadequacies, excessive biological activity due to sediment accumulation, encrustations and/or loss of chlorine residual in the distribution system. A numerical limit for taste has not been specified because there is no accepted method for the quantitative measurement of taste and there is considerable variation among consumers as to which tastes are acceptable. Water provided for public consumption should have an inoffensive taste.

Temephos (insecticide)

The interim maximum acceptable concentration of temephos in drinking water is 0.28 mg/L. Temephos is an organophosphorus insecticide used to control mosquito and blackfly larvae. It is only slightly soluble in water.

Temperature (physical)

An aesthetic objective is set for maximum water temperature to aid in selection of the best water source or the best placement for a water intake. It is desirable that the temperature of drinking water should not exceed 15°C because the palatability of water is enhanced by its coolness. Low water temperatures offer a number of other benefits. A temperature below 15°C will tend to reduce the growth of nuisance organisms and hence minimize associated taste, colour, odour and corrosion problems. In summer and fall, water temperatures may increase in the distributed water due to the warming of the soil and/or as a result of higher temperatures in the source water. Low temperature facilitates maintenance of a free chlorine residual by reducing the rates

of decay of the chlorine. Low water temperature is not necessary to produce water of an acceptable quality.

Terbufos (insecticide)

The interim maximum acceptable concentration of terbufos in drinking water is 0.001 mg/L. Terbufos is an organophosphorus insecticide used for insect control in corn.

Tetrachloroethylene (perchloroethylene)(organic)

The recommended maximum acceptable concentration for tetrachloroethylene in drinking water is 0.03 mg/L. Tetrachloroethylene is no longer produced in Canada but continues to be imported primarily as a solvent for the dry cleaning and metal cleaning industries. It has been found in ground water, primarily after improper disposal or dumping of cleaning solvents.

2,3,4,6-Tetrachlorophenol (organic)

The maximum acceptable concentration of 2,3,4,6-tetrachlorophenol in drinking water is 0.1 mg/L and the aesthetic objective is 0.001 mg/L. At levels above the aesthetic objective, it will impart an unpleasant taste to the water. 2,3,4,6-tetrachlorophenol was used extensively, along with pentachlorophenol, to preserve wood.

Toluene (organic)

The taste/odour related aesthetic objective for toluene in drinking water is 0.024 mg/L. Toluene is used in gasoline and other petroleum products and in the manufacture of benzene derived medicines, dyes, paints, coating gums, resins and rubber. It may be found in industrial effluents.

Total Coliforms (microbiological)

The total coliform group consists of:

- all facultative anaerobic, Gram-negative, non-spore forming, rod-shaped bacteria that ferment lactose with gas formation within 48 hours at 35°C;
- many facultative anaerobic, Gram-negative, non-spore forming, rod-shaped bacteria that develop red colonies with a metallic (golden) sheen within 24 hours at 35°C on an Endo-type medium contain lactose; or,
- all bacteria possessing the enzyme β-galactosidase, which cleaves a chromogenic substrate (e.g. *ortho*-nitrophenyl- β-galactopyranoside), resulting in a release of a chromogen (*ortho*-nitrophenol).

These definitions are not identical but refer to three groups that are roughly equivalent. All three groups contain various species of the genera *Escherichia, Klebsiella, Enterobacte, Citrobacter, Serratia,* and many others.

The presence of any total coliform bacteria in water leaving a treatment plant or in any treated water immediately post treatment signifies inadequate treatment and is unacceptable. Corrective action needs to be taken.

Total Dissolved Solids (inorganic)

The aesthetic objective for total dissolved solids in drinking water is 500 mg/L. The term "total dissolved solids" (TDS) refers mainly to the inorganic substances dissolved in water. The principal constituents of TDS are chloride, sulphates, calcium, magnesium and bicarbonates. The effects of TDS on drinking water quality depend on the levels of the individual components. Excessive hardness, taste, mineral deposition or corrosion are common properties of highly mineralized water. The palatability of drinking water with a TDS level less than 500 mg/L is generally considered to be good.

Triallate (herbicide)

The maximum acceptable concentration for triallate in drinking water is 0.23 mg/L. Triallate is a thiocarbamate herbicide used for control of wild oats in grain crops, mustard and sugar beets.

Trichloroethylene (organic)

The maximum acceptable concentration for trichloroethylene in drinking water is 0.005 mg/L. Most trichloroethylene use is in dry cleaning. Some is used in metal degreasing operations and in tetrachloroethylene production. Trichloroethylene may be introduced into surface and ground water through industrial spills and illegal disposal of effluents.

2,4,6-Trichlorophenol (organic)

The maximum acceptable concentration of 2,4,6-trichlorophenol in drinking water is 0.005 mg/L and the taste related aesthetic objective is 0.002 mg/L. It is used in the manufacture of pesticides. The data is sufficient to classify 2,4,6-trichlorophenol as an animal carcinogen but inadequate for human carcinogenicity. The maximum acceptable concentration has been set taking into account additional safety factors.

2,4,5-T (2,4,5-Trichlorophenoxy acetic acid) (herbicide)

The maximum acceptable concentration for 2,4,5-T in drinking water is 0.28 mg/L and the aesthetic objective is 0.02 mg/L. 2,4,5-T is a phenoxy alkanoic acid herbicide that was once an important stem/foliage treatment for deciduous brush control on roadsides and power lines. 2,4,5-T is no longer used in Ontario.

Trifluralin (herbicide)

The interim maximum acceptable concentration for trifluralin in drinking water is 0.045 mg/L. Trifluralin is a dinitroaniline herbicide used for weed control in summer fallow and for controlling annual grasses in wheat, barley and canola. Trifluralin is very insoluble in water.

Trihalomethanes (organic)

The maximum acceptable concentration (MAC) for trihalomethanes (THMs) in drinking water is 0.10 mg/L based on a four quarter moving annual average of test results. Trihalomethanes are

the most widely occurring synthetic organics found in chlorinated drinking water. The four most commonly detected trihalomethanes in drinking water are chloroform, bromodichloromethane, chlorodibromomethane and bromoform. Primarily, trihalomethanes in drinking water are produced by the reaction of chlorine and the naturally occurring organics (precursors) left in the water after filtration.

Turbidity (physical)

Control of turbidity in drinking-water systems is important for both health and aesthetic reasons. The substances and particles that cause turbidity can be responsible for significant interference with disinfection, can be a source of disease-causing organisms and can shield pathogenic organisms from the disinfection process.

Turbidity is an important indicator of treatment efficiency and the efficiency of filters in particular. A significant relationship has been demonstrated between turbidity increases and the number of Giardia cysts and Cryptosporidium oocysts breaking through filters. Operational Guidelines for turbidity as an indicator of the efficiency of filters in relation to credits for Giardia cysts and Cryptosporidium oocysts removal have been provided in the "Procedure for Disinfection of Drinking Water in Ontario".

The effect of turbidity on disinfection efficiency, including potential for disinfection by-products, is related to the type and nature of the particles in the water. A raw water supply which is surface water or ground water under direct influence of surface water is likely to contain organic particles that cause turbidity and adversely affect disinfection efficiency. A significant factor in the formation of disinfection by-products is the organic or humic component of turbidity.

Raw water supply which is ground water with very low organic content may contain inorganic-based turbidity, which may not seriously hinder disinfection. For such waters, an Operational Guideline for turbidity is not established. Since ground water quality is inherently stable, any significant variation in turbidity, excluding pump startup, should be investigated and analyzed immediately for the potential of surface water influence and the presence of organic particles.

Inorganic turbidity formed during the disinfection process or post-disinfection treatment processes through oxidation and chemical participation would not likely interfere with disinfection effectiveness. Therefore the most meaningful location for taking a turbidity sample is before the disinfection process and where applicable after filtration.

Turbidity in excess of 5.0 NTU becomes visible to the naked eye and as such a majority of consumers may object to its presence. Therefore, an aesthetic objective of 5.0 NTU has been set for all waters at the point of consumption.

Uranium (inorganic)

The maximum acceptable concentration of uranium in drinking water is 0.02 mg/L. Uranium is normally present in biological systems and aqueous media as the uranyl ion (UO_2^{2+}). Ingestion of large quantities of uranyl ion may result in damage to the kidneys. The uranyl ion may also

be responsible for objectionable taste and colour in water, at much higher levels than the concentrations which may cause kidney damage.

Vinyl Chloride (chloroethene) (organic)

The maximum acceptable concentration of vinyl chloride in drinking water is 0.002 mg/L. Vinyl chloride is a synthetic chemical with no known natural sources. It is classified as a human carcinogen. It is used in making PVC (polyvinyl chloride) plastic items such as water main pipe, siding and many other common plastic items all of which are now made in such a way that there is no trace of vinyl chloride present in them.

Xylenes (organic)

There are three isomers of dimethyl benzene, which are almost identical chemically and are collectively called xylenes. The odour related aesthetic objective for total xylenes in drinking water is 0.3 mg/L. Xylenes are used as industrial solvents and as an intermediate for dyes and organic synthesis. They are a component of household paints and paint cleaners and gasoline and other petroleum products.

Zinc (inorganic)

The taste related aesthetic objective for zinc in drinking water is 5.0 mg/L. The concentration of zinc may be considerably higher at the consumer's tap in standing water because of corrosion taking place in galvanized pipes, but this can be cleared easily by brief flushing. Corrosion control using small concentrations of zinc based inhibitors has been found effective in some water systems.