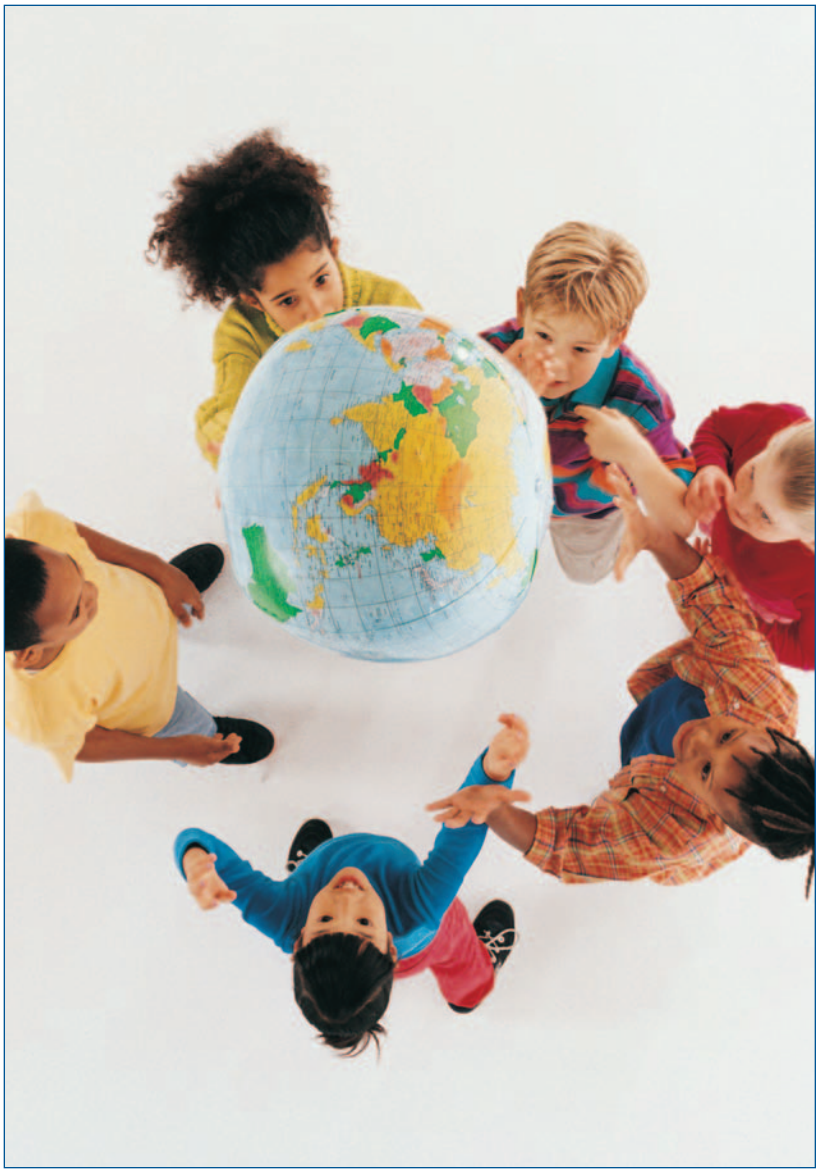
Environmental Threats to Children

Understanding the Risks, Enabling Prevention



Summary Report

Dr. David McKeown
Medical Officer of Health

September 2005

TORONTO Public Health

A Message from Toronto's Medical Officer of Health

As a society, we create the environment in which our children develop and grow. Over time, we have altered that environment in important ways. Our protective ozone layer is damaged, greenhouse gas emissions are still on the rise and climate change has set in. Our dependence on burning fossil fuels for heating, power production and transportation worsens our smog problems, and our reliance on consumer products containing persistent, toxic compounds brings these substances into our homes.

From the very beginning of their lives, children are routinely exposed to many different substances. Because they have immature and underdeveloped organs, their bodies take in and absorb more chemical contaminants than adults and are less able to withstand the harmful effects. From conception through to the end of adolescence, there are many "windows of vulnerability" where toxic exposures can lead to permanent, lifelong impacts. When testing is done, traces of many chemicals are detected in the tissues and fluids of children. However, our knowledge of the consequences of exposure to most of these chemicals is disturbingly inadequate.

In urban centres like Toronto, children are exposed to a wide variety of potentially hazardous agents in the air, water, food, soil and built environment. New research studies provide evidence that children's health is put at risk from these exposures as health problems that originate in the environment are identified.

When risks to human health are uncertain or not clearly measured, the wisest course of action is to reduce exposure as far as can be achieved, rather than incurring a risk that may prove unacceptable in the long run. Many solutions are within our grasp. Better protection for children's environmental health can come from three main strategies. We can:

- do more research to improve our understanding of the risks to children
- advocate for policies and regulations that are inherently protective of child health
- educate parents, parents-to-be and everyone with responsibility for children's well-being, about risks to health and ways of minimizing these risks.

It is often said that "children are our future". But what kind of future are we giving them? Children give us their trust. We are their custodians and we need to ensure their natural and built world provides a safe and healthy environment where their bodies and minds develop to the fullest potential. This is the key to a healthier future for all of us.

Dr. David McKeown
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Executive Summary

This report represents an important milestone in Toronto Public Health's long-term commitment to better understanding how the city's biophysical and built environment affects the health of its children. It is based on the technical report, "*Environmental Threats to Children: Understanding the Risks, Enabling Prevention*" which reviews the large and growing field of research on children's health and the environment.

Both reports expand on the results and recommendations of Toronto Public Health's earlier work on children's environmental health. They discuss the wider topic and context of environment and child health and focus on key issues for children in Toronto, completing a baseline assessment of the state of our knowledge.

Three major topic areas are covered in this report: the vulnerability of children; health outcomes of concern; and exposure sources and settings. Where possible, data specific to Toronto are provided. In addition, the report outlines the findings of a 2002 survey of Toronto parents as well as the policy context relevant for children in Toronto, including national, provincial and local initiatives.

Lastly, the report identifies priority actions to be undertaken in the areas of policy, research and education to enable the reduction and prevention of children's exposure to harmful substances in the environment.

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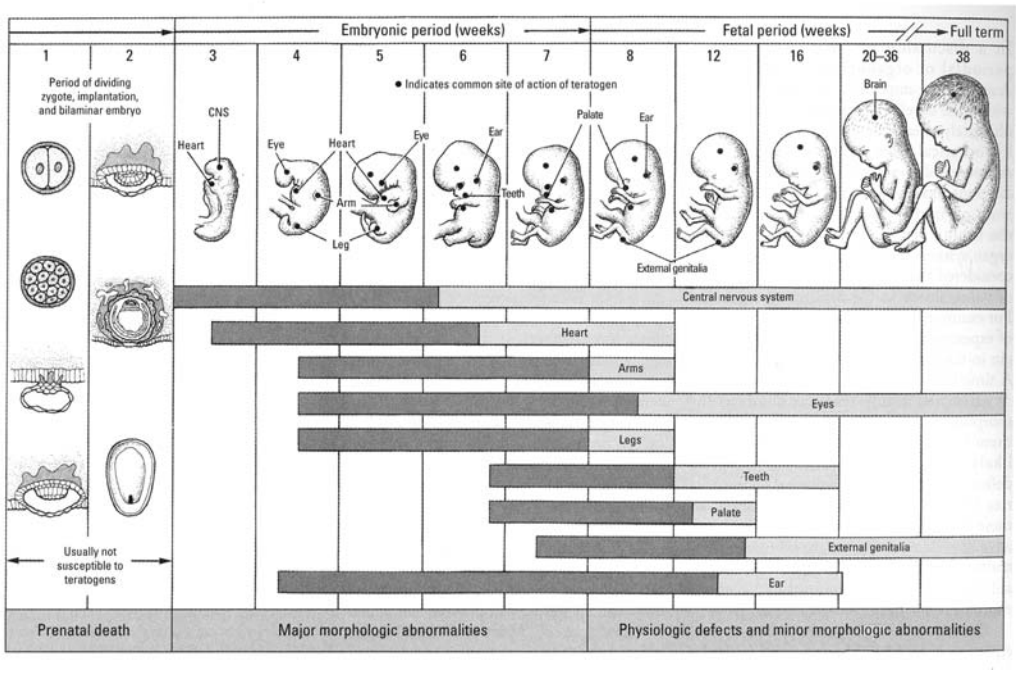
1. Children Are at Risk

In the field of child health and environment, experts often say, "children are not little adults". Although parents need little convincing of that fact, a great deal of scientific evidence confirms this, particularly when it comes to environmental exposure risks. There is substantial evidence in the scientific literature of environmental influences on children's health from exposures through air, food, water, soil, dust and consumer products. The health of Toronto's children, like that of all children in Canada, is at risk from environmental contaminants. There is scientific consensus that the developing fetus and infants up to age three years can experience greater exposure and are more vulnerable than adults to substances in the environment. Multiple exposures of uncertain risk occur during pregnancy and continue throughout the course of child development. Although windows of vulnerability exist throughout the stages of life leading up to adulthood, the prenatal period and early childhood represent critical periods where exposure is more likely to lead to delayed, permanent or lifelong health impacts.

Figure 1 illustrates when the developing fetus is most sensitive to morphological (structural) and physiological (functional) abnormalities. These windows are specific to each feature as it develops. For example, the most sensitive period to chemical exposure for the heart is different from that for the palate. Differences also exist over the course of development in the womb in terms of both susceptibility and outcome. For example, exposures occurring during the embryonic period are more likely to cause major structural abnormalities (major birth defects), whereas the same exposures during the fetal period have the potential to cause defects in functioning or minor birth defects.

Figure 1: Critical Windows of Vulnerability



There is greater understanding of critical windows during the prenatal period as illustrated in the graphic above. However, although less well-studied, windows of vulnerability also exist in early childhood and through puberty as discussed further in this section.

Source: Moore & Persaud, 1973 as cited in Selevan et al, 2000[1]

Much of the existing research focuses on prenatal exposures, even though developmental processes continue into adolescence and in adult males, are ongoing in the production of sperm. Limited attention is given to the effects of exposures occurring during puberty and adolescence. As well, although there is a growing interest in the impacts of child health for lifelong health, research into the consequences in adulthood of environmental exposures during development is largely lacking.

Children's lungs and brains are particularly susceptible to the long-term impact of environmental exposures because of the lengthy period of development they undergo. Increased risks for a variety of different health outcomes such as asthma and other respiratory conditions, neurodevelopmental delays and impairment, cancer, immune system effects, reproductive effects, injuries and poisonings have been associated with exposure to various environmental contaminants.

Overall, children's exposures are greater than adults because of differences in proportion, physiology and behaviour. Because they are smaller in body mass

and have higher metabolic rates, their intake of contaminants from inhalation, ingestion and absorption through the skin is proportionately greater. Once exposed, children may absorb and also retain more contaminants in their body tissues for a variety of reasons. Children's lungs and skin tend to be more permeable than that of adults, their gut efficiently absorbs certain contaminants and the blood-brain barrier, not fully developed until six months of age, is permeable to many substances.[2] [3] The body's systems that help metabolize or excrete toxicants, such as the kidneys, liver and biliary system (duct system which transports bile from the liver to the small intestine), are still developing in early life.[4] Children's behavioural characteristics such as, frequent hand-to-mouth activity, their tendency to explore the environment and play closer to the ground, as well as their limited food preferences, can all translate to greater exposure. Because they have much more of their life ahead of them, exposure in early life to contaminants that produce latent or long-term effects can have lasting impact.

Among the general population, children's exposures are more unique, varied and clearly different from those for most adults. Alongside the usual potential sources of exposure to contaminants (that is, air, water, food, soil or dust), parental preconception exposures, the maternal stored body burden and exposures during pregnancy, as well as exposures through breast milk, are all important to child health. The role of breast milk in exposure and in child health is further discussed below.

Scientific evidence exists for associations between environmental hazards and asthma, cancer, learning and developmental effects, low birth weight and birth defects. Emerging evidence exists that raises concerns about additional, equally serious health effects such as compromised immune system functioning and interference with the hormones of the endocrine system. Understanding the role, if any, played by environmental exposures in such health outcomes is extremely complex. Hundreds of environmental contaminants are suspected of contributing to these serious health outcomes in children, although only a small number of them have been fully evaluated for their effects on prenatal and child development.[5] There is also very limited Canadian information about children's exposures to key environmental contaminants.

Not only is the information base about environmental exposures limited, but it is well-established that multiple determinants of health including biological, social and physical factors and many specific factors within these broad determinants, influence each of the health outcomes of concern mentioned here. Of particular concern is the fact that poverty is a known risk factor for poor health overall as well as greater susceptibility and greater exposure to environmental contaminants.[6] [7] Children in Toronto are disproportionately affected by poverty, compared to children living in neighbouring regions.[8] [9] This suggests that

children's environmental health issues in Toronto are likely more pronounced than those of children elsewhere in the province.

Among the key types of contaminants discussed are heavy metals such as lead and mercury, indoor and outdoor air pollutants, some pesticides, organic solvents, and persistent organic pollutants (POPs) such as dioxins, PCBs and PBDEs. The strength of the evidence for cause and effect relationships between specific environmental exposures and health outcomes varies considerably. This reflects in part the complexities of science and the challenges of establishing causation from observational data in human populations.

Breast Milk: Still the Optimal Infant Food

Breast milk has been extensively studied as an indicator of exposure to environmental contaminants. It has long been known that human milk can carry persistent, bioaccumulating contaminants such as polychlorinated biphenyls (PCBs), DDT, dioxins and other persistent organic pollutants (known as POPs).[10] However, measures of contaminant levels in human milk have also been a bell weather of the success (or lack) of regulatory efforts to reduce environmental levels of many of these substances. For instance, in Canada, PCB levels in breast milk have declined over time since being substantially phased out in the 1970s.[11] Conversely, the levels in human milk of another category of POPs, polybrominated diphenyl ethers (PBDEs), a class of chemicals used for their flame retardant properties in furniture, carpeting, clothing and electronics, have been rapidly increasing in Canada, the U.S. and elsewhere. Only in Sweden, where the government has phased-out PBDEs since the late 1990s, have the breast milk levels of these substances been on the decline.[12]

Four different cohort studies have examined the health impacts from exposure to PCBs (the best studied of the POPs found in breast milk) in early life. A number of these have measured impacts on behaviour, cognition and neurological development.[13] [14] [15] [16] However, the weight of evidence supports that prenatal exposure, while the fetal nervous system is developing, rather than the transfer through breast milk, is the pivotal determinant of these impacts. In fact, data from two separate studies indicate that the adverse cognitive effects from early exposure to PCBs were stronger and only statistically significant among the children who were *not* breastfed, suggesting some protective effect to the infant from being breastfed.[17]

Consequently, the unclear risks of these early exposures do not diminish the multiple, proven benefits (to both mother and child) from breast milk and breast-feeding. Breast milk is an unsurpassed infant food, providing the precise nutrient

composition to support optimal growth of the human infant. Breastfeeding mothers have fewer postpartum complications and better postpartum menstrual function, along with long-term health benefits including, reduced risks for osteoporosis and premenopausal ovarian and breast cancers.[18] [19] [20] Breastfed babies gain protection against various childhood illnesses in both the short and long-term, including lesser risks for infectious diseases, postneonatal mortality, Sudden Infant Death Syndrome (SIDS), asthma, certain cancers, types 1 and 2 diabetes, obesity, and high cholesterol.[15] [21] Breastfeeding is therefore vigourously supported by many health experts[22] [23] and organizations including, Toronto Public Health,[24] the Ontario Public Health Association,[25] Health Canada,[26] the Canadian Paediatric Society,[27] the American Academy of Pediatrics[15] and the World Health Organization.[28]

The importance of breast milk as the best food source for infants reinforces the need to protect mothers from environmental contaminants during their own development and throughout their childbearing years in adulthood.

2. Health Effects and Trends

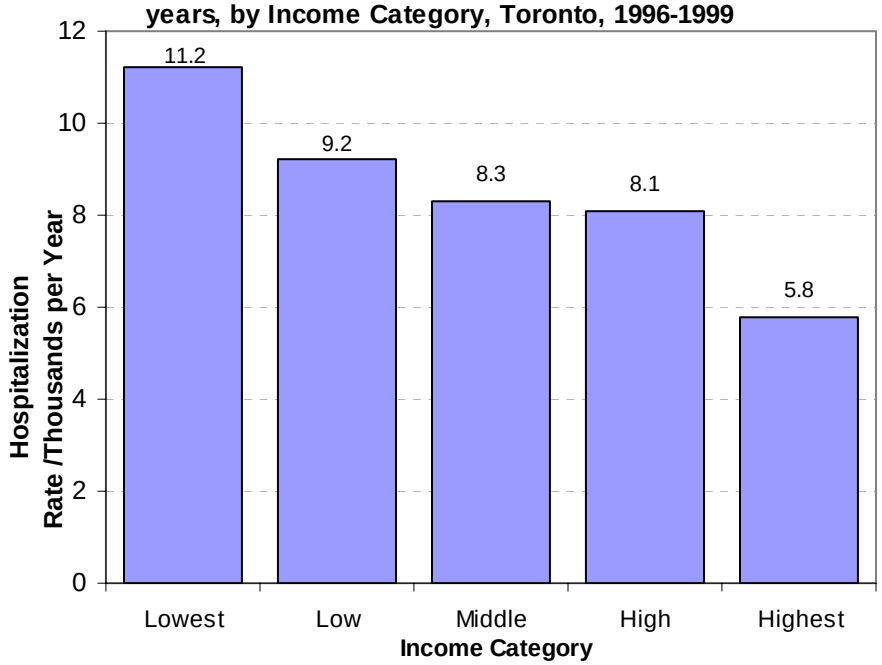
In the last century the picture of child health has changed substantially. Rates of infant mortality and historically common illnesses of early childhood have decreased significantly and life expectancy has dramatically increased. However, some chronic diseases and other debilitating conditions, including several having suspected or known associations with environmental exposures, are on the rise among children. Experts describe the array of environmentally-linked chronic conditions as the "new pediatric morbidity".[29] Although data for comparison purposes are limited, asthma, learning disabilities, cancer, low birth weight and birth defects appear to occur in the Toronto child population at rates that are similar to, or in some cases higher than, rates that occur among children in the rest of Canada and in other industrialized countries.

There are two broad categories of health outcomes for which exposures in children have been linked to some environmental pollutants. The first category encompasses important health outcomes that are observable in relatively large numbers of children in Toronto and elsewhere, including respiratory conditions, particularly asthma and a range of conditions related to cognitive and neurobehavioural functioning. The second category covers health outcomes that are less common and important in that they are severe conditions. Included in this category are cancers occurring during childhood or young adulthood, and birth defects, low birth weight, altered fetal growth, and other developmental and reproductive effects.

Effects on Many Children

Substantial evidence, including some data specific to Toronto, demonstrates associations between respiratory effects and exposure to indoor and outdoor air pollutants. The burden of illness from air pollution exposure is substantial among Toronto's children. Among children in Canada, 12% have asthma and Toronto physicians report treating children for acute and chronic respiratory symptoms more than any other health complaint.[30] [31] Poorer children in Toronto may be particularly vulnerable to air pollution as hospitalization rates for those living in the poorest areas of the City are nearly twice (93% greater) the respiratory hospitalization rate for children living in the highest income areas as show in Figure 2. This pattern is consistent with recognized links between income and harmful effects from outdoor air pollution.[32] [33]

Figure 2 Respiratory Hospitalization*, Children 0 to 14 years, by Income Category, Toronto, 1996-1999



Sources: Provincial Health Planning Database, Hospital Inpatient Data, Ministry of Health and Long Term Care; Statistics Canada Census, 1996

*due to asthma, croup, bronchitis or pneumonia

The developing brain and nervous system are thought to be particularly vulnerable, compared to other body systems and compared to the adult brain and nervous system. Health outcomes affecting the brain and nervous system result from many factors and can be developmental and/or functional. Overall, compared to the relationship between air pollutants and respiratory health outcomes, there is much less known about the impact of environmental exposures on the developing brain and nervous system. Experts increasingly suspect, however, that environmental pollution plays some role in the apparent increase in recent years among North American children of various learning, cognitive and behaviour conditions. This trend may be influenced by more aggressive diagnostic practices. Nonetheless, the burden of disabling conditions is high enough for some US-based physicians to refer to the problem as having reached epidemic proportions.[34]

There has been only limited research to date to explore the links between environmental exposures and learning, cognitive and behavioural problems in children. Effects on the developing brain and nervous system are well documented only for a small number of well-studied substances including lead, mercury, dioxins, PCBs and some solvents. Although these contaminants can also adversely affect several organ systems in the body, it is common for effects on the

nervous system to be observed at lower doses than are required to affect other body organs[3]. Although research is relatively less advanced, concern is also increasing about nervous system effects of early life exposure to environmental tobacco smoke (ETS), the organophosphate insecticides and polyhalogenated compounds such as the PBDE flame retardants. There are large numbers of substances and quantities of emissions, or other means of exposure, that are suspected of having the same kinds of neurotoxic effects.

The prevalence of learning disabilities, Attention Deficit Hyperactivity Disorder (AD/HD), autism and other neurobehavioural deficits in Toronto children appear similar to prevalence figures for the U.S., Canada and Ontario. Figures from the 1994 National Longitudinal Study on Children and Youth (NLSCY) indicate that:

- 26% of children in Canada ages 6 to 11 had at least one identifiable learning or behavioural problem;[35]
- Delayed vocabulary skills were found in 16% of children ages 4 to 5 years in Canada;[35]
- 14 to 16% of children living in Canada had cognitive deficits;[36]
- 17 to 22% had "behaviour problems" defined as hyperactivity and AD/HD[36]

According to Canadian school principals responding to the 1994 NLSCY, an average of 12% of children in their schools had a learning disability.[35] Although data are limited, Toronto appears to be at the higher end of the scale for students receiving special education in comparison with data reported by the Ontario Ministry of Education. For example, the Toronto District School Board (TDSB) reports that about 13% of enrolled elementary and secondary students are receiving special services for at least one or more learning or behavioural exceptionalities of concern.[37] Comparable figures from 2000 to 2001 for Ontario indicate that 9.5% of students are receiving special programs or services.[38] Without the benefit of current, direct estimates (that is, practitioner-diagnosed figures), it must be assumed that these data underestimate the population prevalence of learning and behaviour disorders among children in Toronto or the province as a whole.

Recommendations:

Environmental impacts on the developing brain and nervous system represent an area of emerging concern in children's environmental health. Research on developmental neurotoxicity (DNT) from most substances to which children are exposed is very limited and regulatory requirements for DNT testing are inadequate. Yet, the numbers of children presenting with learning, behaviour and developmental disabilities appear to have increased substantially in recent years.

There is a need for better research, including surveillance data, to inform prevention efforts in Canada. Consequently, it is recommended that:

- *The federal Minister of Health request*
  - *The Canadian Institutes of Health Research (CIHR) to place a high priority on funding research into environmental impacts on brain and nervous system development, including longitudinal studies.*
  - *The Public Health Agency of Canada to expand the Canadian Integrated Public Health Surveillance Program (CIPHS) to include data collection and analysis of trends in neurodevelopmental and neurobehavioural outcomes in Canadian children.*
- *The Ontario Minister of Children and Youth Services, through the Best Start Plan, explore the possibility that the information gathered from the enhanced developmental assessments of every 18-month old child in Ontario be centrally collected and analysed for trends in developmental abilities as an additional way to improve surveillance of children's exposures and health impacts.*

Rare but Severe Effects

Reproductive toxicity includes adverse effects of substances on sexual maturation, production and transport of gametes (sperm in males, oocytes/ova in females), the female reproductive cycle, sexual behaviour, fertility, gestation and lactation.[39] [40] Information is limited about the influence of chemical exposures as contributing factors in these reproductive effects in humans. Men and women can develop reproductive disorders as a result of chemical exposures experienced prenatally, in early childhood and as adults. Several studies suggest that a number of reproductive disorders observed among men living in industrialized countries may reflect exposure to chemicals such as PCBs, phthalates, some solvents, lead, and certain pesticides.[41] [42] Available Canadian data on reproductive disorders are limited to what is known about maternal age-specific birth rates (an indirect indicator of fertility) and very limited non-population-based data on rates of infertility in men and women. With current data it is not possible to determine whether, or to what degree, environment influences the patterns of fertility in Canada distinct from other important influences such as improvements in contraception, individual choice, economic or employment issues.

The causes and mechanisms of developmental health effects are largely unknown but are considered to arise from a combination of genetic and environmental factors. As with the other health effect types already discussed, developmental

effects are similarly influenced by multiple determinants of health and various factors within those determinants.

Developmental effects can involve structural changes (which present as birth defects) or can affect viability of the embryo or fetus when exposures happen in early pregnancy. Most often, developmental effects manifest as functional changes in different organs or body systems which can result from exposures in late pregnancy or during sensitive times of tissue development postnatally. Functional changes can be more difficult to ascertain, particularly if effects are subtle but alter fetal growth, birth weight and other body measures, or the functioning of organs, tissues and enzyme systems.

The strength of evidence for developmental effects from exposure to environmental substances ranges from weak to robust and comes from animal studies and/or epidemiological studies. Conclusive knowledge is limited to a small number of substances and adverse effects are suspected for many more substances. Several types of chemical substances (including lead, mercury, arsenic, some pesticides, PCBs, organic solvents and air pollutants) and physical agents (such as ionizing radiation) appear to be capable of producing developmental effects in children.[39]

Infant mortality rates and low birth weight rates are two available indicators of child health. Although the Toronto infant mortality rate has decreased from a rate of 7.8 infant deaths per 1000 live births in 1989 to 5.8 infant deaths per 1000 live births in 2000, in recent years, it exceeded the rate for the rest of the province for most of this time.[43] Trend data for low birth weight (LBW) (babies weighing less than 2500 grams at birth) are not entirely reliable, particularly in Ontario, due to an increasing problem of unregistered births. This problem is particularly pronounced in Toronto. TPH reports that the total rate of LBW for Toronto (6.6%) was consistently higher than the rate for the rest of Ontario (5.5%) from 1997 to 2002.[44] Moreover, the total low birth weight rates vary significantly across the city from 3.8% to 6.9%. The causes for developmental health effects are related to many, often inter-related, not entirely understood factors. There is insufficient information to link trend data to particular environmental exposures in Toronto or elsewhere.

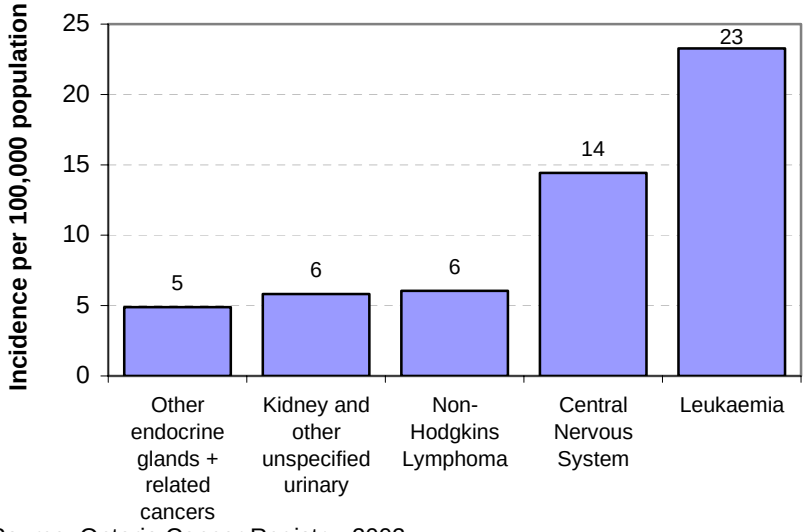
Cancer that occurs in the young is another rare, severe type of health impact. Very little is known about the environmental links to childhood cancer because chemicals in use or production in society have not been assessed specifically for their ability to produce cancer in children, as distinct from their carcinogenic effects in adults. Also, childhood cancers are relatively rare compared to adult cancers and more difficult to study. As well, governments and federal funding agencies have not placed sufficient priority for research on childhood cancer let

alone its causes. Research to date does suggest that early life exposures (as well as pre-conception exposure of parents) to some environmental substances contribute to increased risks of some cancers in childhood and in later years. There are few established environmental risk factors for cancer in children. Epidemiological studies suggest that ionizing radiation, extremely low frequency magnetic fields, environmental tobacco smoke (ETS), some pesticides and air toxics such as polycyclic aromatic hyrdrocarbons (PAHs) and benzene, are associated with certain cancers in children. [39 45]

Cancer rates have been rising among children in the US and countries in Europe for many years but such increases are not apparent in children in Canada. Although still very rare, cancer remains the leading cause of illness-related death for children in Canada older than one year of age. Moreover, cancer rates among young adults (aged 20 - 44 years) in Canada have increased gradually since the 1970s.[46] For certain cancers, such as thyroid and testicular cancer in men, brain cancer in women and non-Hodgkin's lymphoma in both men and women, incidence rates increased by more than two percent per year or just under 20 percent per decade.[46] Causes for these increases are unknown but given the long latency period for most carcinogens, early childhood, prenatal or even parental preconception exposures, especially during windows of vulnerability, could be contributing factors.

In Toronto, 234 cases of cancer in total were diagnosed among children 0 to 14 years, in the five-year period from 1996 to 2000. This equates to a rate of 55 new cancer cases per 100,000 children (ages 0 to 14 years) over the time period. Leukemia and cancer of the central nervous system were the leading child cancer diagnoses, at 23 and 14 cases per 100,000 children respectively in Toronto between 1996 and 2000 as shown in Figure 3.[47]

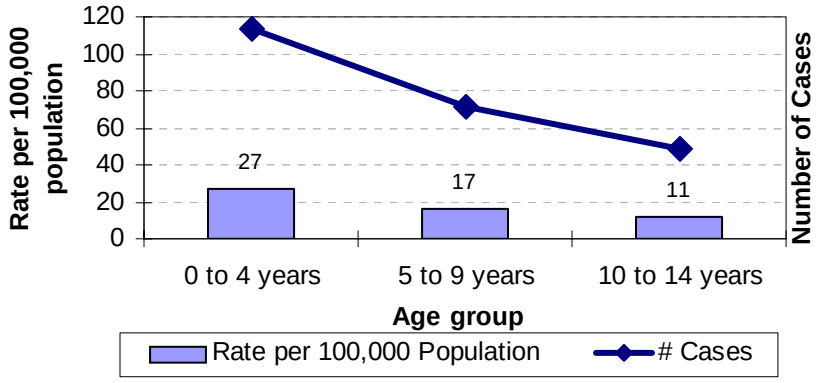
Figure 3 Incidence of Selected Childhood Cancers, 0 to 14 years, Toronto, 1996-2000



Source: Ontario Cancer Registry, 2002

Toronto childhood cancer incidence is greatest among children under 5 years of age as shown in Figure 4.

Figure 4 Incidence of 5 Major Childhood Cancers by Age Group, Toronto 1996-2000



Source: Ontario Cancer Registry, 2002

The Costs of Children's Environmental Illnesses

Research into the economic burden of the diseases and disorders of concern with respect to toxic exposures suggests that preventing exposure during the periods of pre-conception, in utero, infancy and childhood could result in substantial savings (on the order of billions of dollars at a national scale) in health care, human productivity and social costs. For example, an American health economics analysis estimated that the environmentally-attributable costs of lead poisoning, asthma, cancer and neurobehavioural disorders in U.S. children total $54.9 billion (U.S.) annually.[48] Other economic analyses suggest that harmful exposures to lead and methylmercury independently are responsible for substantial impacts on the US economy. These impacts were estimated as costs from lost productivity, educational attainment and earnings related to intelligence quotient (IQ) deficits.[49] [50] [51]

Canadian data generally agree with the hypothesis that cumulative costs from environmentally-related health outcomes are substantial.[52] The Ontario Medical Association (OMA) recently reported that air pollution "costs" at least $7.8 billion annually from premature deaths, hospital admissions, emergency room visits, minor illnesses and absenteeism.[53] Children with asthma are reported to represent over one-third of the Ontario Hospital Insurance Plan (OHIP) expenditures for the general population of children each year.[54]

Improving Research on Environmental Threats to Children's Health

This chapter has already highlighted the need to support more research that improves understanding of environmental impacts on the developing brain and nervous system specifically. There is, however, an overall need for enhancing research into environmental threats to children's health in Canada.

In the U.S., several federal agencies recently begun implementation of the National Children's Study – a longitudinal cohort study that will track the health of 100,000 American children from *in utero* to adulthood. This 21-year endeavour is estimated to cost $2.7 billion (US).[55] Researchers will collect information relevant to describing exposures from pre-pregnancy and in early pregnancy. Data collected will include biological samples from the mother and child, as well as from air, water, dirt and dust in the child's environment. As well, the study will gather information on the children's genetics. The study intends to examine the possible impacts from exposures together with consideration of how environment and genes interact.[56]

In the planning phases, the American agencies sought participation from Health Canada and Environment Canada in the study. Although Health Canada and Environment Canada held national consultations to determine the feasibility for a Canadian arm of the study, ultimately, the substantial costs of the proposed study have thwarted attempts for Canadian participation. A Canadian arm of the National Children's Study would help gather valuable data and benefit from the collaboration with US researchers. This effort to study and understand the long-term impacts of the environment on the health of a representative cohort of Canadian children is a unique and important opportunity that should be supported by the Federal government.

The Federal government must also, through agencies such as the Canadian Institutes of Health Research support independent research that expands knowledge of children's environmental exposures and associated health outcomes in Canada. This might best be achieved by establishing a separate research institute or other integrating mechanism devoted to supporting research on the impacts of the physical environment on children's health.

Recommendation

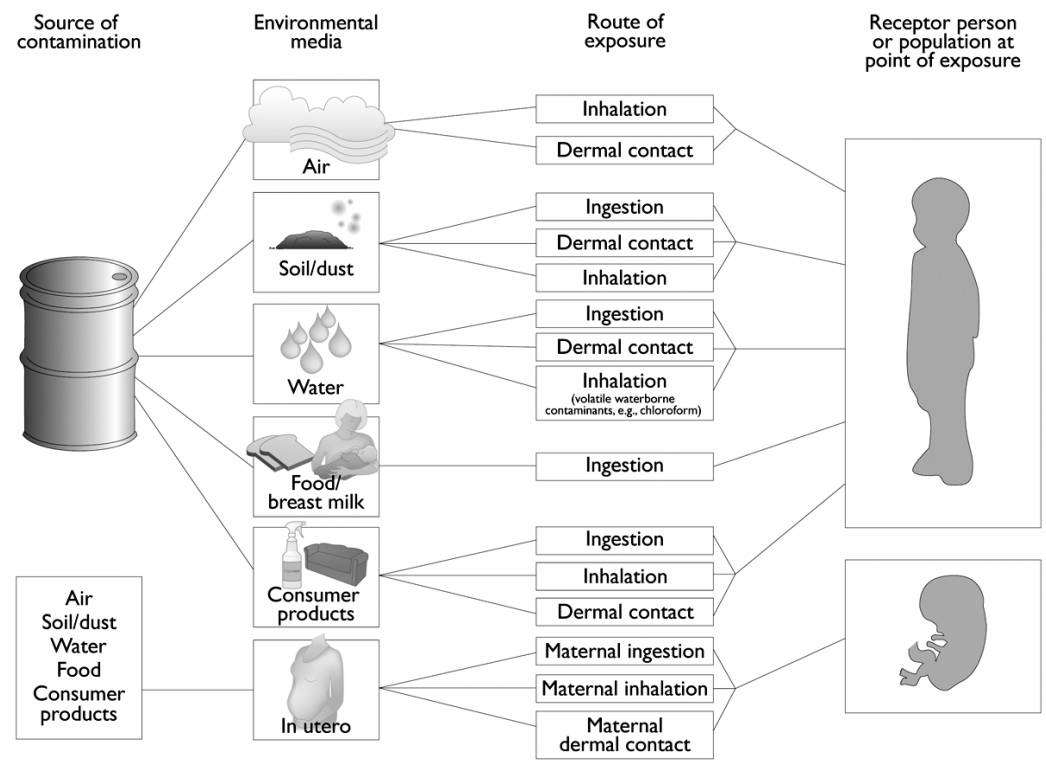
There is a need for more research into the environmental threats to child health in Canada. This includes research using large, nationally representative cohorts through longitudinal study designs. Both government-sponsored and independent research should be supported and would expand knowledge of the impacts on children's (and adult) health from early-life exposures. Consequently, it is recommended that:

- *The federal Minister of Health:*
  - *fund a Canadian arm of the US National Longitudinal Children's Study that will assess exposures and health of a cohort of children from birth through to the end of adolescence; and*
  - *request the Canadian Institutes of Health Research (CIHR) to support independent research on environmental threats to children's health in Canada by establishing a separate research institute or integrating mechanism devoted to children's environmental health.*

3. Understanding Children's Exposures

Measuring actual environmental exposures for children is challenging. Children are exposed via many potential pathways and they are often more exposed to environmental contaminants than adults. Beyond the four main environmental media through which contaminants travel to people (namely air, water, soil, dust and food), there are unique exposure media for children. These include the placenta, breast milk and non-food products, such as toys, carpets and floor surfaces, all of which may contain or transfer contaminants to children. The complexity of children's exposure sources and pathways is illustrated in Figure 5.

Figure 5: Pathways of Exposure for Children



Source: CPCHE (2005) Child Health and Environment – A Primer, as adapted from Health Canada (1998) *The Health & Environment Handbook for Health Professionals.* Ministry of Supply & Services. Cat. No. H49-96/2-1995E.

There are many thousands of contaminants in the environment. There are also factors such as noise, heat, ultraviolet radiation, electromagnetic and radio frequencies and other physical factors to which children are exposed. Hundreds of contaminants are suspected of contributing to the health outcomes of concern

mentioned already. Only a small number of these contaminants have been fully evaluated for their effects on prenatal and child development. Moreover, many of the substances of greatest concern are often known or suspected of being associated with multiple effects. Exposure can also occur in multiple ways. Timing of exposure is critically important given that many windows of vulnerability exist during prenatal development and the stages of childhood. Therefore to assess the risk to children from environmental exposures it is crucial to have an understanding of the degree of exposure (how much and when during a child lifetime) and the variety of substances or factors to which children are exposed. The gaps in information are even more pronounced for exposure data than for the scientific investigation of health effects in children. These gaps also explain the inability to assess accurately or thoroughly the exposures of children in Toronto.

Measurement of exposure to most pollutants of concern is limited. Since exposure to harmful substances can occur via several possible pathways, measurement of exposure can include various sampling techniques. To be thoroughly representative of an entire population, sampling ideally should be within the context of a longitudinal survey of exposure to a large group of people over time and across different media. Measurement should include levels in environmental media (such as in air, food, water, soil or dust) as well as in people (such as in their urine or blood).

Biomonitoring

Biomonitoring is the direct measurement of substances (or their breakdown products) in human tissues, such as hair, blood, breast milk or urine. Biomonitoring is a direct and useful means of measuring exposure. Recent data collected by the US Centers for Disease Control and Prevention (US CDC) on the general US population indicate that people of all ages have measurable evidence of exposure to many contaminants (including metals, some pesticides, persistent organic pollutants, among others) or their metabolites.[57] [58] [59] The health significance of exposures to most of these substances is uncertain or unknown at this time. These data provide a baseline of information to better understand the nature of exposure. For pesticide residues in particular, biomonitoring data are essential to improving understanding of exposure and to evaluating both the need for and the efficacy of regulatory measures to minimize exposure wherever possible.

When compared to the small number of substances for which there are health-based reference values, biomonitoring can help to identify subpopulations at greater risk for potentially harmful exposures. For example, recent US data

indicate that nearly 6% of women of childbearing age had blood mercury levels that were at or above the US Environmental Protection Agency's reference dose, an exposure level estimated to be without health concern.[60] These data can also show trends within populations. For example, blood-lead levels have been consistently highest among urban-dwelling US children, children from a visible minority and among children living in poverty.[61] The most recent data for blood lead levels in Canadian children are about ten years old and need to be updated through current assessment. Although useful to medical and scientific experts, biomonitoring data have also provided an unexpected and often unwelcome indication to many people of the pervasiveness of environmental contamination.

Unfortunately, except for limited cross-sectional data (such as the Great Lakes population)[62] or biomonitoring that involves special populations (such as sampling of Arctic populations through the Northern Contaminants program),[63] we have less than ideal measures of exposure among Canadians. Data collection has not been done systematically, such as among a representative sample of Canadian adults or children. This represents is a major gap in our ability to adequately characterize exposure in the current Canadian population, let alone exposure in children, or specifically in Toronto's children. Although a biomonitoring study is due to be conducted in 2006 by Statistics Canada as part of the Canada Health Measures Survey,[64] current funding will allow for testing only a narrow range of contaminants. Statistics Canada reports that they have funding to test for four heavy metals - lead, mercury, cadmium and manganese, however, they are exploring ways to test for a fuller suite of environmental contaminants.[65] Statistics Canada researchers report that the survey is to include testing of blood samples from children but only those 6 years of age or older. At present this biological sampling through the Canada Health Measures Survey is planned as a one-time data collection rather than a long-term biomonitoring program. These baseline data are needed to provide a better understanding of children's exposure to environmental contaminants at a national level and may help identify sub-populations with elevated exposures. However, unless sampling is conducted over the long-term, tracking trends in exposure and the development of health-based reference values for exposure will not be possible. In contrast, the US CDC biomonitoring program is assessing long-term exposure to an expanding range of contaminants among US adults and children. For example, the recent biomonitoring report presents data collected (between 2001 and 2002) on exposure to 148 chemicals including some of the persistent organic pollutants (POPs) like dioxins, furans and PCBs, some organochlorine pesticides, as well as pyrethroid and organophosphate insecticides, metals, PAHs, disinfectants, and phthalate metabolites.[59] This represents a substantial increase in testing since the first study, which included only 27 chemicals.[57]

More often, exposure in Canada is assessed indirectly by monitoring levels of contaminants in environmental media. Environmental levels, while useful, are an indirect measure of exposure because the dose, or actual amounts that are taken up by people, are not easily estimated from contaminant measures in media. Levels in food, air, water and soil figure prominently in regulatory measures to minimize exposure and therefore, risk.

Recommendations:

Biomonitoring is a direct measure of human exposure to environmental contaminants. For substances such as lead or mercury where there is knowledge of the dose-response relationship between exposure and health effects, biomonitoring allows for identifying subpopulations with exposure in the range where adverse health effects might be expected. Biomonitoring can also allow for determining patterns of exposure, through time and according to ethnicity, socioeconomic status, age or gender, that can inform public health exposure reduction measures. There is a need for Canadian population exposure data in order to better understand the types and concentrations of different contaminants that are found in Canadians. Likewise, information on the exposures of Canadian children is largely absent. For these reasons it is recommended:

- *That the federal Minister of Health, working in conjunction with appropriate government departments (such as Statistics Canada, Health Canada and Environment Canada), ensure that:*
  - *the biological sampling component of the Canada Health Measures Survey is implemented;*
  - *biological samples are tested for the full range of contaminants proposed by Statistics Canada; and*
  - *sampling be further expanded into an ongoing, comprehensive biomonitoring program mirroring that conducted by the US Centers of Disease Control and Prevention;*

- *That the federal Minister of Health and the Ontario Minister of Health and Long-Term Care implement targeted testing for blood lead among children ages 0 to 10.*

Child Exposure Sources and Settings

Children's environmental exposures are described here according to sources and settings. Priority is given to summarizing the information on exposure to substances that are related to the health effects of concern and to those where the scientific knowledge is most advanced. Emphasis is placed on the sources or

settings where the largest exposures occur, and they are grouped broadly into outdoor and indoor exposures.

Outdoor Exposures

Air

Air remains one of the most significant media for environmental exposures. There are comparatively better data for several pollutants in air than for most other media. All too well understood in Toronto, urban outdoor air is a complex mix of chemicals, including numerous substances that are proven to be harmful to children's health at current levels of exposure. In Toronto, the levels of many smog pollutants, from local and transboundary sources, have not decreased overall during the last ten years.[66] In fact, the concentration of ozone, the key ingredient in smog, continues to climb in downtown Toronto.[66] Based on the most recent data available, Toronto has relatively high concentrations of several smog pollutants compared to other Ontario cities.[66] In addition to the pollutants that make up smog, toxic air pollutants continue to be a concern. For example, volatile organic compounds (VOCs) and mercury continue to be emitted by vehicles and coal-fired power plants respectively, and are impacting Toronto's air quality.

Other outdoor exposures of importance to children include those encountered while travelling and playing outdoors (whether at home, school or in parks). The air inside cars and buses is its own microenvironment. Schools in particular face the need to address the quality of air inside school buses. What little data exists suggest that the air inside buses using diesel fuel can be significantly polluted due to the diesel exhaust.[67] [68]

Pesticides

Home and garden use of pesticides creates an exposure risk for children. Pesticide exposure can occur from contact with treated lawns and plants with outdoor use. Exposure to lawn and garden pesticides can also occur when residues are tracked indoors where they persist longer. Use of pesticides to treat pests in the indoor environment is also a particular concern for children's exposure. The concern for potentially overexposing children from these uses that can be controlled has led to greater restrictions on the use of pesticides in areas frequented by children. These are reflected in both changes to allowable uses determined from pesticide re-evaluations conducted by the Pest Management Regulatory Agency (PMRA) and in local initiatives, such as municipal by-laws restricting the non-essential use of pesticides outdoors or in school policies and guidelines on pesticide use both indoors and outside. Limited research indicates that regulation to reduce pesticide exposure can lessen health impacts in children. For example, an ongoing prospective study by Columbia University researchers found that after federal

government restriction to limit home uses of chlorpyrifos and diazinon in 2000, there was lower exposures and no longer an impact on fetal growth compared to before the government restrictions.[69 70]

Indoor Exposures: Air, Dust, Food & Consumer Products

Air

Indoor air quality is a largely unregulated source of exposure to a variety of contaminants. Children's exposures in schools, child care and indoor recreational facilities are as much a part of the indoor exposure picture as the home environment. Indoor air contaminants of concern for children include ETS (where smoking occurs indoors), inhalable particles from combustion products (from woodstoves and wood-burning fireplaces), NO_2 (from poorly vented gas furnaces or stoves), VOCs (from building materials, floor coverings and furniture) and biological allergens (moulds, pet dander, house dust mites and cockroach feces). In addition, contaminant levels in indoor dust are of increasing concern and present a significant exposure pathway for children Exposure to various indoor air contaminants is believed to increase the risks of developing asthma or other respiratory and health problems.[71]

Food

Children's exposure via food requires information on contaminant levels in dietary items as well as food consumption patterns. Canadian Food Inspection Agency data appear to reveal a multi-year trend of decreasing levels of pesticide residues on food. Monitoring of pesticide residues on food in Canada paints a picture of fairly strong regulatory compliance. However, at the same time, US-based biomonitoring data demonstrate that pesticides and their metabolites are extremely common in people's bodies. It is difficult to know either the extent, or the implications to children's health, of combined exposures to multiple pesticide residues on food, either at detection levels or for those found (fairly rarely) in excess of Maximum Residue Limits (MRLs). It is essential to combine such data with actual biomonitoring results to know whether the record of minimal exceedences of MRLs in food is reflective of "safe" exposure levels. This work is of particular importance to the work required to re-evaluate the majority of pesticides in use, in most cases, to determine their potential for exposure and health effects in children.

Exposure to heavy metals and POPs in the Canadian diet has also been studied. Data from Health Canada and OMAFRA show a steady downward trend in levels of POPs (such as PCBs or organochlorine pesticides or their breakdown products) in food. PCB levels in breast milk have also decreased substantially over time since being phased out from most uses in the 1970s.[11]

Methylmercury exposure from fish is best studied in sport fish as monitored by the Ontario Ministry of Natural Resources which publishes biannual updates to its sport fish consumption guides. Methylmercury levels in store-bought fish are monitored by the Canadian Food Inspection Agency (CFIA) and they report that most fish have methyl mercury levels below the Canadian guidelines of 0.5 part per million (ppm).[72] However, there are some large predatory species of fish (such as shark, swordfish and fresh or frozen tuna) that are more likely to be at or exceed the federal guidelines.

Minimizing exposure to methyl mercury in fish is important for children and women in their childbearing years. Health Canada has fish consumption guidelines recommending that pregnant women, women of child-bearing age and young children limit their consumption of certain high mercury species of fish, such as shark, swordfish and fresh or frozen tuna, to no more than one meal per month.[73] Currently there is some debate about whether or not advisories should include cautions on eating canned tuna as well. Canned tuna is an affordable, widely available form of fish (including in local food banks). Although on average canned tuna does not exceed the Health Canada guidelines, it may contribute substantially to mercury intake, particularly for children who can be frequent consumers. Canned white (also known as albacore) tuna has more than double the amount of methylmercury found in light tuna and therefore should be limited for children and women in their childbearing years.[74] [75] Toronto Public Health is currently assessing its own advice on fish consumption for these special subpopulations. As mentioned earlier, there are no data to characterize exposure to mercury among Canadians. There is only limited information on fish consumption patterns specific to Toronto but fish is consumed by certain cultures, particularly Asian-Canadians, in much greater amounts and can result in relatively high exposure to methylmercury.[76] [77]

Water

Chemical contaminants such as pesticides, metals and industrial chemicals can occur in drinking water, although Toronto's water typically contains very low or non-detectable levels of these substances.[78] Lead can enter drinking water from lead service lines, from solder containing lead or from brass fixtures. In Toronto, older lead supply lines (in older neighbourhoods) are gradually being replaced. In homes built prior to the 1950s, internal plumbing may include lead pipes. The use of lead solder for incoming water pipes was banned in Ontario in 1989.[79] The risk of lead exposure can be minimized so long as flushing occurs to avoid consumption of water left standing in either solder-based plumbing or plumbing that includes brass fixtures.

Disinfection by-products (DBP) are substances created by the reaction of chlorine with naturally-occurring organic material in raw water. Chlorine treatment is necessary to remove infectious microbes which can be of serious concern to child health. Toronto's water source, Lake Ontario, has a low level of organic material and hence low levels of DBPs.[78]

Consumer Products

An increasing number of indoor exposures of concern originate directly from the routine use of a wide range of consumer products containing substances of emerging or increasing concern. For example, several chemicals within the group of substances called polybrominated diphenyl ethers (PBDEs) are widely used as flame retardants in numerous consumer products. These substances are released during normal use as they have been measured at very high levels in indoor dust and have also been found in indoor air.[80 81 82 83] PBDEs have also been measured on the organic film collected from window surfaces in Toronto and the GTA.[84] PBDE levels in indoor dust are estimated to account for the largest contribution to exposure among toddlers and most life stages except infancy.[85] PBDE levels in breast milk have been rising dramatically in recent decades and levels among North American women are the highest among those measured internationally.[86] [87 88 89]

Phthalates are another example of substances from consumer products which present an exposure concern. Phthalates are softeners found in PVC plastics that are used to make products such as toys and vinyl flooring. They are also added to some personal care products and cosmetics The US CDC biomonitoring study results indicated that for most phthalate metabolites measured, levels were slightly higher among children compared to adults and higher among women compared to men. It is not clear whether these differences are due to differences in exposure, pharmacokinetics or dose per body weight.[59]

For many of these substances derived from consumer products there is concern about persistence and bioaccumulation. As well, laboratory or animal research indicates effects on development or reproduction that may result from endocrine-mediated changes with exposure to these substances. Overall, there is not enough evidence to fully understand the potential for harm in humans. Indoor air or dust is not subject to traditional environmental regulation and there are no legal requirements in Canada to provide information about the use or levels of most of these substances on product labels.

Multimedia

Exposures to toxic substances can often occur in several media. For example, pesticide exposure can occur in house dust, in water or in food depending on its origin and specific chemical characteristics. Hence, a child's hands may pick up a

pesticide residue via direct contact with treated surfaces or as tracked-in (on shoes, pets, wheels) contamination in homes, schools or recreational facilities. Children may ingest minute amounts of pesticides via the residues that remain in agricultural produce and, generally to a lesser extent, in drinking water as discussed further below.[90] [91] Persistent pesticides, such as several of the organochlorines that are banned in Canada, may also be present due to ongoing use, (including illegal use) in other countries, or due to historical environmental contamination and ongoing environmental circulation due to their persistence. These residues will be highest in foods with high fat content due to the physical and chemical characteristics of these older-style pesticides. However, CFIA monitoring data reveals very low exposure levels to these pesticides.

Some media of exposure can be far more significant than others. This underlines the need for good public education materials that raise awareness about where risks are greatest and the necessary precautionary response. For example, lead exposure can occur via water, food, soil or air. However, exposure to lead in indoor dust now appears to be the single greatest exposure pathway for children due to its greater presence in dust than in other media and because of children's exploratory and hand-to-mouth behaviour. Awareness of dust as an important exposure pathway for children must be increased along with ways to minimize exposure.[92]

As has been suggested throughout this section, there has been only limited study of the range of exposures specific to children in Toronto. However, based on what is known from a variety of other data sources, there is a very real potential for children in Toronto to be exposed to multiple environmental substances that may compromise health and well being in both the short and the long-term even at low exposure levels. Preventive measures to lessen the potential impact of environmental exposures on children's health in Toronto are warranted.

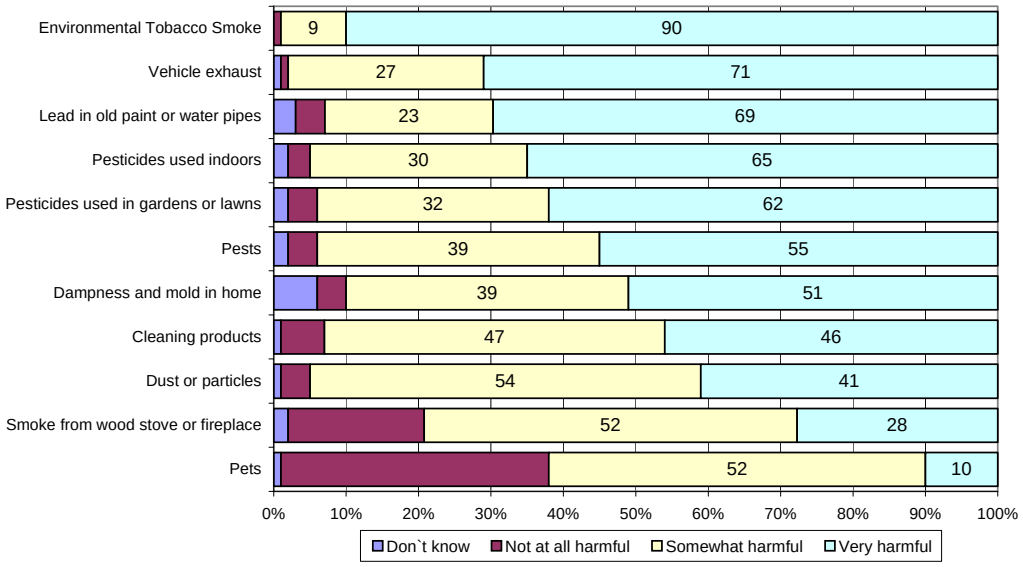
4. Toronto Parents: Knowledge, Awareness and Practices

Public opinion surveys indicate that people generally have great concern for the effects of environmental factors on children's health.[93] [94] [95] However, it is not clear how specific that awareness is, nor whether awareness translates into parents taking effective protective measures to avoid harmful exposures to children.

Results of a 2002 telephone survey indicate what Toronto parents know about environmental risks to children and where knowledge gaps exist. The survey explored awareness of environmental risks to child health focussing largely on indoor exposures. Parents were also asked about their practices to protect children from exposures both indoors and outside. The survey randomly sampled parents of children age 0 to 12 years, from areas of Toronto with the highest proportions of children. The 75% response rate was high and captured information from over 450 parents. According to census figures for the City, the survey sample is closely representative of parents in Toronto, although survey respondents had slightly higher education levels and fewer individuals reporting household incomes at the extremes (that is, below $20,000 and above $100,000 per year).

Parents were asked assess the harmfulfulness to children of a series of items listed in Figure 6.

Figure 6. Parents Perceptions of Harm to Children from Select Environmental Elements



Responses to the question: "How harmful is it for children to come in contact with these items?"

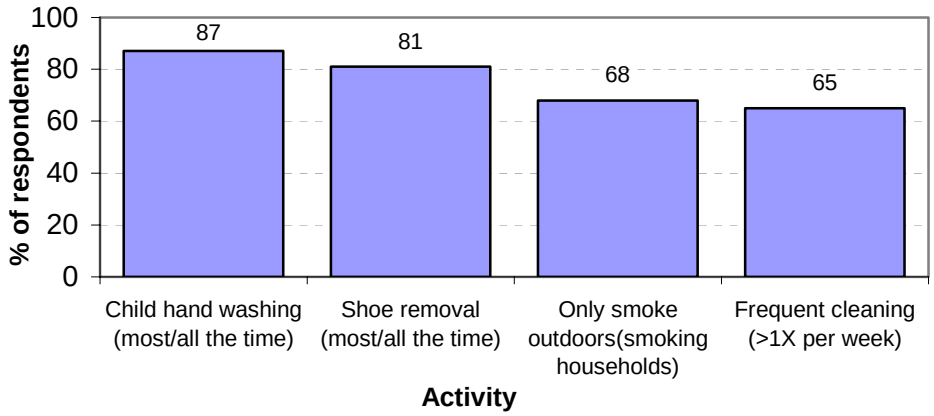
Source: Toronto Public Health 2002[96]

Toronto parents have a fairly accurate sense of the harmfulness to children's health from exposures that are reported in the media or are already well covered in TPH health promotion work. Environmental tobacco smoke (ETS) was recognized as "very harmful" by 90% of parents. Most respondents also felt it was "very" harmful for their child to come into contact with exhaust from vehicles (71%), lead in old paint or water pipes (69%), pesticides used indoors (65%) and pesticides used in gardens or lawns (62%). Fewer parents felt that certain lesser-known environmental exposures were very harmful to children, including cleaning products (46%), dust or particles (41%) or wood stove or fireplace smoke (28%). When parents were asked for "top of mind" thoughts, air pollution (77%), water quality (57%) and pesticides (in water, food and on lawns and gardens) (35%) were mentioned most often as being harmful to children.

Parents also feel these same areas are worthy of action on the part of the City through policies, by-laws or other measures that protect environmental quality, or through education activities. While most parents feel they can do a fair amount to protect their children themselves, there is a need to enhance that sense among some parents. Parents without a high school certificate were significantly less likely (55%) to feel they could protect their children from hazards in the environment compared to those with high school level or higher education (81% or more). This suggests that the literacy level of any written educational materials is very important and also that development of non-written resources (such as videos, pictorials or oral information sessions) should be considered as well.

Most parents or caregivers are already taking some practical measures that may reduce their child's exposures in and around the home such as shoe removal, frequent floor cleaning and hand-washing, attention to sources of drinking water and use of sunscreen as shown in Figure 7. They also widely report precautionary household practices that mean children's exposure to potentially harmful substances is minimized. For example, a substantial proportion of Toronto parents report avoiding the use of pesticides (28% reported pesticide use outdoors and 17% for indoor use). A survey of the adult population in Toronto revealed that 38% of households with a lawn had used pesticides outdoors.[97] Although the surveys were different, the results of the parents' survey suggest that households with children may be less likely to use pesticides. In terms of smoking practices, over 70% of parents reported there were no smokers in the household. In addition, nearly 70% of the households with smokers provided a smoke-free home environment by smoking only outdoors.

Figure 7 Parental engagement in simple activities that limit their child's exposure to contaminants inside the home



Source: Toronto Public Health 2002 96

The survey also identified public education needs. These include support for additional sun protection measures, further reducing pesticide use (indoors and outside) and avoiding smoking indoors in homes with regular smokers, among other topics. The vast majority (nearly 90%) reported relying on sunscreen as their main sun safety measure with very few parents mentioning the use of hats or other protective clothing or avoiding sun by staying in the shade. Although both pesticide use and smoking were reported in fairly low proportions among this sample of parents, there is still room to improve practices in these areas, given the concerns for children's exposure to these substances.

Overall, parent behaviour changes based on the ages of children in their care. For example, parents of young children (18 months or younger) reported more frequent cleaning, smoking outdoors (for households with regular smokers) and buying of organic foods for their children. It is reassuring to see the attention that Toronto parents place on protecting their children when they are infants, toddlers or preschoolers, but there is a need to encourage parents to sustain the protective behaviours in children as they get older.

This survey has increased understanding of the perceptions and awareness of Toronto parents regarding environmental threats to children's health, in particular, highlighting knowledge gaps that require additional health promotion initiatives. The survey highlights that resources should be developed with particular attention to literacy levels, format and medium and by ensuring content that fills information gaps. The results should allow for risk communication activities and

the development of children's environmental health resources and programs that are relevant, appropriate and address the information needs of Toronto parents.

Recommendations:

The 2002 survey of Toronto parents indicates the variability in concerns, awareness and practices, which is important to assist in development of resources and implementation of programs. Although most parents are already aware of important environmental threats to children and practicing some practical measures that may reduce their child's exposure in and around the home, there is room to improve both awareness and practices. There is also a particular need to enhance education and health promotion activities that support high risk, low-income families in reducing exposures to their children. Consequently, it is recommended that the Medical Officer of Health for the City of Toronto continue to:

- *Pursue opportunities within existing Toronto Public Health programs for integrating environmental awareness and supportive, preventive practices for parents-to-be, pregnant and nursing women, infants and children, with particular emphasis on those with increased risk; and*
- *Identify opportunities within the City of Toronto to disseminate educational resources, such as through Parks, Forestry and Recreation, Toronto Public Libraries and Children's Services.*

5. Enabling Prevention in Canada

Public Policy Context

Among environmental and health agencies at all levels of government, there is increasing consensus about the need to address the child health issues discussed in this report. As a result, policy reforms have been initiated or recommended to address child health concerns during the assessment of substances that pollute the environment or from evidence of human exposure through the use and/or deterioration of consumer products.

Numerous international and continental agreements have been signed by Canada recognizing the vulnerability of children and committing to policy and related efforts to address these risks. Three important examples of Canada's commitment to children's environmental health issues on an international scale are: (1) the 1989 United Nations Convention on the Rights of the Child; (2) the "Miami Declaration on Children's Environmental Health by the G8 Environment Ministers" (1997); and (3) the "Cooperative Agenda for Children's Health and the Environment" (2002) by the Commission for Environmental Cooperation representing countries of the North American Free Trade Agreement (NAFTA).

International efforts are required to minimize exposure to several environmental contaminants that pose risk of harm to children. For example, the persistence, bioaccumulation, long-range transport and cycling of persistent organic pollutants (POPs) has meant contamination on a global scale. Canada is among 50 countries that have ratified the Stockholm Convention on Persistent Organic Pollutants, which came into effect in 2004. This global treaty seeks to have all ratifying countries implement plans to phase-out and ultimately ban a group of twelve priority substances, often called the "Dirty Dozen," including dioxins, furans, PCBs and several organochlorine contaminants. It is important to ensure that the Convention is extended to cover POPs of emerging concern as well. In May 2005, a number of substances, including octa and penta forms of the polybrominated diphenyl ethers (PBDEs), perfluorooctanyl sulfonate (PFOS) and its salt, lindane, hexachlorobutadiene, polychlorinated naphthalenes and short-chained chlorinated paraffins, were nominated by other jurisdictions including the European Commission, Norway, Mexico and Sweden as possible additions to the Convention. A Persistent Organic Pollutants Review Committee (POPRC), responsible for evaluating prospective chemicals to be added to the convention, was established. Parties to the Convention will discuss recommendations from this committee. Among the first five chemicals to be reviewed is pentabromodiphenyl ether (PBDE), a substance commonly used as a flame retardant.[98] Certain forms of the PBDE flame retardants have been rapidly accumulating in the environment and in breast milk. In Sweden, where

longitudinal monitoring revealed a dramatic rise of PBDEs in breast milk over time, swift regulatory action to phase out these substances resulted in reduced environmental levels and exposure as measured via breast milk.[12]

Recommendation:

Persistent toxic substances are a particular exposure problem for the fetus and infants. These substances are transferred across the placenta and through breast milk. The Stockholm Convention is a key international effort that seeks to eliminate and reduce the twelve POPs that pose the greatest risks to human health. However, research is revealing that other substances have the same characteristics of persistence and ability to bioaccumulate, as well as a high likelihood of exposure, particularly to children. The POPs Review Committee will meet in November 2005 to evaluate five substances proposed for addition to the list of POPs targeted for phase-out. Canada has played a leadership role in the international community and therefore can be influential in determining the success of efforts to reduce children's exposure to persistent contaminants globally. Therefore it is recommended that:

- *The federal Ministers of Health and Environment support the addition of newly identified persistent, toxic substances including, octa and penta forms of the polybrominated diphenyl ethers (PBDEs), perfluorooctane sulfonate (PFOS) and its salt, lindane, hexachlorobutadiene, polychlorinated naphthalenes and short-chained chlorinated paraffins, to the list of substances targeted for global phase out and ban under the Stockholm Convention on Persistent Organic Pollutants.*

Some progress has occurred in terms of revising federal and provincial regulatory approaches to take children's health into account. Since the mid-1990s, it has been standard practice in new evaluations by the federal government, (and the Ontario government), of the human health impacts of commercial substances (pesticides, industrial or automotive emissions) to take into consideration key aspects of the greater vulnerability of children.

An important example of progress in Canadian legislation is the *Pest Control Products Act* (PCPA). The PCPA, revised in 2003, contains several child-protective features to be applied to the registration of new pesticides or the re-evaluation of older ones. Noteworthy among these are: the provisions to apply greater margins of safety for products used around homes or schools to protect children; provisions for reporting adverse effects from pesticides; mandatory re-evaluations every fifteen years; as well as, placing the onus of demonstrating that any associated risks are acceptable on the individual registering the pesticide.[99] These changes give legal force to what has been customary procedure in recent

years but also include several elements that will, if implemented, apply a more precautionary approach to regulating pesticides.[99]

Recommendation:
The PCPA exemplifies how Canadian legislation should better incorporate child protective and precautionary features. The revised PCPA and its attendant regulations have yet to be proclaimed into law by the federal government. Therefore, it is recommended that:

- *The federal Minister of Health ensure final proclamation of the Pest Control Products Act (PCPA) by the end of 2005.*

Under the *Canadian Environmental Protection Act* (CEPA), toxics are managed through a process that largely considers chemicals individually. Also, to date few comprehensive evaluations have been conducted as required by CEPA. Only 69 substances, or groups of substances, (out of 23,000 on the Domestic Substances List - DSL) have been fully evaluated. The backlog of untested substances remains considerable. By 2006, Environment Canada and Health Canada are to have short-listed those DSL substances that appear to be persistent, bioaccumulative or inherently toxic, and for which there is a high potential for human exposure. These substances then will be subject to either regulatory action, or more likely, further detailed assessment to support various risk management choices (which may or may not include regulatory action). The act specifies a goal of virtual elimination of those substances classified as "CEPA-toxic". However, the act is written in such a way that a requirement to meet this goal is lacking.[100] In addition, while CEPA 1999 includes a commitment to the precautionary principle, it has been criticized for only weakly implementing precaution as governed by the "cost effectiveness" of measures.[100] To be truly precautionary, considerations of "cost effectiveness" should account for economic and illness burden from exposure to toxic substances, particularly for the lifelong and societal costs when children are exposed.

Recommendation:
The forthcoming review of the *Canadian Environmental Protection Act* (CEPA) would benefit from legislative amendments that provide the same level of precautionary and mandatory child-protective measures as have been incorporated into the revised PCPA described above. As a result, it is recommended that:

- *The federal Ministers of Health and Environment ensure that the forthcoming review of the Canadian Environmental Protection Act incorporates legislative amendments that provide a similar level of precautionary and mandatory child-protective measures as found in the revised PCPA.*

Further, the exercise to create a priority list of substances on the DSL according to persistence or bioaccumulative ability and inherent toxicity (to humans and non-humans) will identify additional persistent toxic substances. These priority list substances should be put forward by Canada as possible additions to the Stockholm Convention. Ultimately this work under CEPA will also assist in fulfilling Canada's National Implementation Program under the requirements of the Convention. Therefore it is recommended that the federal Ministers of Health and of Environment:

- *Strengthen Canada's National Implementation Plan under the Stockholm Convention by committing to identify, on a separate list, all substances on the Domestic Substances List that meet the Convention criteria of persistence or bioaccumulation and inherent toxicity be nominated for consideration by the POPs Review Committee established under the Stockholm Convention; and*

- *Ensure that such substances are made subject to control under CEPA.*

Much remains to be done at the federal and provincial levels. For example, within the federal system of evaluating toxic substances or pesticides, such evaluations do not have a requirement for assessing effects on the developing brain and nervous system before their registration and use. Evaluations may optionally include developmental neurotoxicity testing (DNT) if tests in adult animals indicate potential for neurotoxic effects. US EPA researchers have determined however that for most pesticides developmental neurotoxicity tests assess the most sensitive health end-points and that tests in adults may not be sufficient to identify all chemicals that might produce these impacts.[101] Developmental neurotoxicity tests are more sensitive than the standard animal studies (such as, tests for developmental or reproductive toxicity, or adult neurotoxicity tests) which only assess crude toxicological endpoints.[102] Finally, researchers raise the concern that although animal tests are indicative of the potential for adverse effects in humans, rodent tests in particular have been inadequate for deriving intake levels that are sufficiently protective of human health (for example from known neurotoxins such as lead, mercury and PCBs).[103]

It is a serious concern to scientists and health professionals that, along with most pesticides, most commercial chemicals have not been tested for their toxicity to the developing nervous system in animals.[100 39 102]

Recommendation:

The developing brain and nervous system are highly vulnerable to impacts from toxic exposures. Currently the systems for evaluating chemical substances in Canada and the US rely on evidence of neurotoxicity in adult animal subjects as a

trigger before developmental neurotoxicity testing is undertaken. However, research has shown that tests on adult animals cannot adequately predict the impacts on the developing brain and nervous system, nor can they predict tolerable levels of exposure in humans. Most chemicals substances, including most pesticides, have not been tested for developmental neurotoxicity. Consequently, it is recommended that:

- *The federal Minister of Health require that testing for developmental neurotoxicity be included within the mandatory core testing requirements for evaluations of chemical substances, including pesticides.*

Increasing evidence points to consumer products as either contributing to or being the major source for certain contaminant exposures. Canada's *Hazardous Products Act*, however, as a reactive, product-by-product regulatory tool, is inadequate for regulating toxic substances that are found in consumer products and pose risks to child health. It is not structured to prevent problems before they occur. Important deficiencies include: a lack of pre-market assessment for these products; extremely limited labeling requirements that focus only on situations of very high hazard and/or acute health effects; no provision for the government to legally issue product recalls or demand the removal of products from store shelves once problems are identified; and, if regulatory action is taken, it is extremely slow.[100] The incomplete and obsolete nature of Canada's regulation of potentially hazardous substances in consumer products is therefore another area of particular concern.

Recommendation:

Greater child-protective and precautionary measures should be incorporated into the Hazardous Products Act (HPA). A revised HPA should ensure that children's exposure to toxic substances in consumer products is prevented instead of the current approach of responding to contamination problems or other hazardous circumstances after they become apparent.

- *It is recommended that the federal Minister of Health revise the Hazardous Products Act (HPA) and associated regulations to incorporate a similar level of precautionary and mandatory child-protective measures as found in the revised Pest Control Products Act (PCPA) such that:*
    - *Children's exposure to toxic substances used in consumer products is prevented; and,*
    - *Requirements for labeling and disclosure of ingredients in consumer products are improved.*

Shared, Intersectoral Initiatives

Within Health Canada, the Office of Children's Environmental Health (OCEH) carries out its stated mandate to advance the protection of children's health in Canada from environmental risks by collaborating with various government agencies, non-governmental organizations, academics and the community. The OCEH is the designated lead for coordinating activities on children's environmental health and has a stated objective to "catalyze action to manage environmental risks to child health".[104] For example, the OCEH is currently coordinating the activity of the Children's Task Group (discussed below) to develop a set of indicators that address the status of children's environmental health in Canada. However, in comparison to the Office of Children's Health Protection, its counterpart in the US EPA, Health Canada's OCEH is a small and under-resourced unit.

The US EPA's Office of Children's Health Protection (OCHP), established in May 1997, supports the EPA as it implements both President Clinton's 1997 Executive Order on the Protection of Children from Environmental Health Risks and Safety Risks as well as the National Agenda to Protect Children's Health from Environmental Threats. The Executive Order requires all federal agencies to place a high priority to addressing health and safety risks to children. The OCHP is a dedicated office, which has institutionalized child health protection within the US federal government. It works with internal and external partners to improve scientific understanding of children's environmental health issues. Its contribution to children's health protection in the US and worldwide is noteworthy with substantial, far-reaching work in the areas of research, regulation, outreach and education.

Recommendation:

Since the late-1990s, there has been an increase in activities to address children's environmental health issues within the federal government. One initiative was Health Canada's establishment of a very small Office of Children's Environmental Health (OCEH). However, by comparison to its counterpart in the United States Environmental Protection Agency, progress has been slow and there have been few tangible contributions or resources directed to children's health protection in Canada. There is an urgent need for strong political leadership and clear accountability and resources for children's environmental health at both the federal and provincial level. There must be greater integration across departments where policies and programs can minimize exposure to environmental hazards. At the provincial level, particular attention needs to be directed at coordinating the activities of the Ministries of the Environment, Health and Long-Term Care, and Children and Youth services into a comprehensive cross-cutting provincial program.

It is therefore recommended that:

- *The federal Minister of Health and the Premier of Ontario take a leadership role in protecting children from environmental threats to health by:*

  - *At the federal level, establishing a comprehensive Children's Environmental Health Program to oversee federal resources, research and surveillance initiatives, and to propose new policies and regulations; and*
  - *At the provincial level, creating a new Children's Environmental Health Initiative to strengthen provincial legislation and regulations, establish comprehensive surveillance programs to better understand exposure trends and health risks, and expand public education and outreach.*

For some key areas of environmental and health regulation, the federal, provincial and territorial governments coordinate activities within the terms of various accords signed by the Canadian Council of Ministers of the Environment. Key among these accords is agreement that provinces, territories and the federal government will establish Canada-Wide Standards (CWS) on certain pollutants, typically where the level of concern, and controversy, is very high and potential impacts of regulatory or other management decisions are far-reaching. Among the pollutants for which there is a CWS are: mercury, dioxins and furans, benzene, ground-level ozone and fine particulate matter.

The Committee on Health and Environment (CHE) is a relatively new Federal / Provincial / Territorial (F/P/T) initiative established in 2003 by the Deputy Ministers of Health and Environment. At its inaugural meeting in 2004, the Committee identified children's health and the environment as one of three priority themes for F/P/T action. Further, the Children's Task Group (CTG) of the F/P/T Committee on Health and Environment is pursuing three projects. These include: 1) an inventory of children's health and environment initiatives in governments and other organizations in Canada, 2) an inventory of blood lead level studies and review of the recent science for the blood lead intervention level and strategies, and 3) development of indicators to address the status of children's environmental health in Canada.[105]

Provincial laws in Ontario include standards for contaminant levels in water (including surface water, drinking water and emissions to waterways) and standards for air pollutants (emission limits, ambient air quality criteria or "point of impingement" standards around industrial facilities). Many of the provincial standards for air and water quality need to be updated to better account for health and specifically child health protection. The Ontario Ministry of the Environment is making ongoing efforts to strengthen air pollution control regulations. The

Ministry has promulgated new air standards that will place stricter controls on 29 hazardous air pollutants.[106] The province's Industry Emission Reduction Plan, designed to address regional air quality issues, proposes emission caps for NO_x and SO_2 for seven new industrial sectors under the existing emissions trading framework. While TPH supports the capping of emissions from the industrial sector, the proposed caps are not sufficiently stringent.[107] Toronto Public Health remains engaged in discussions with the Ministry of the Environment on these issues.

Shared jurisdiction also exists between provincial and municipal governments on health matters. The Mandatory Health Programs and Services Guidelines, issued by the Ministry of Health and Long-Term Care (MOHLTC), set out minimum requirements for core programs and services targeted at disease prevention, health promotion and health protection under Ontario's *Health Protection and Promotion Act*. The provincial rules establish the programs and services eligible for provincial funding and local health units can then tailor the programs for local circumstances. The Child Health and Reproductive Health Program Standards are two programs for which Toronto Public Health urged greater focus on environmental health issues in a 2003 review of the Mandatory Health Programs and Services Guidelines. Health Hazard Investigation standards are also a logical platform for enhancing attention to children's environmental health issues. In June 2004, the Ontario Public Health Association also called for revisions to the Mandatory Health Programs and Services Guidelines to incorporate a distinct Environmental Health Program with cross-links to other program areas such as Child Health.[108] The OPHA noted for example, that currently the Guidelines make almost no mention of air quality except as it relates to environmental tobacco smoke.

Recommendations:

The Mandatory Health Programs and Services Guidelines of the Ontario Ministry of Health and Long-term Care need revisions to enhance attention to environmental impacts on preconception, prenatal and children's health. Therefore, it is recommended that:

- *The Minister of Health and Long-Term Care:*
  - *Revise the Mandatory Health Programs and Services Guidelines to include Environmental Health as a separate, expanded program area that includes the Health Hazard Investigation Program; and*
  - *In addition, ensure that there is enhancement of other Mandatory Health Programs, such as Child Health and Reproductive Health, to include strategies for protecting preconception, prenatal and children's health from environmental threats.*

A number of other province-wide initiatives offer the opportunity for enhancing health promotion work in children's environment health. The Best Start Resource Centre (Ontario's Maternal, Newborn and Early Childhood Development Resource Centre) is a key program of the Ontario Prevention Clearinghouse and is funded by the Government of Ontario.[109] This resource centre seeks to enhance the capacity of service providers to implement effective health promotion programs for expectant and new parents (including both men and women), newborns and young children. Noteworthy among the Best Start Resource Centre initiatives is the recent "Health Before Pregnancy" social marketing campaign to increase awareness in women and men ages 20 to 35 about the importance of preconception health.[109] The associated "Health Before Pregnancy" workbook includes a section on the environment along with a companion "Environmental Checklist".[110] These are available online and are distributed to Ontario Public Health Units and interested community groups as well.

In addition to the Best Start Resource Centre, the Ontario Early Years program is establishing community-based Early Years Centres across the province to provide services to parents and prospective parents.

Finally, in November 2004, the Ontario Ministry of Children and Youth Services announced the Best Start Plan, a separate initiative from the Best Start Resource Centre. This initiative focuses on child care as well as children's healthy development and well being. Important elements of the plan include: universal newborn screening and ongoing screening and services to identify needs and provide vital developmental supports, a province-wide comprehensive developmental assessment for every child in Ontario at the 18 month old well baby visit, and the establishment of Best Start neighbourhood early learning and care hubs that provide one-stop services for families.

Schools

From the age of four until nearly the end of adolescence, children spend a substantial part of each weekday at school. The school environment (outside and indoors) is therefore an important influence on a child's health. A healthy physical environment is one among four core components (along with curriculum, services and a supportive social environment) in the Comprehensive School Health Model (CSHM), a model endorsed by the Toronto Board of Health in 2000 and that guides the delivery of school health services by Toronto Public Health.[111]

The CSHM states that the key elements of a healthy physical environment in schools include acceptable air quality and ventilation, safe water, low allergen environment and safe playground equipment.

The exposures of greatest concern, including many that children might be exposed to in a school setting have been identified in this report and in the technical report. The two largest boards of education in Toronto, the Toronto District School Board (TDSB) and the Toronto Catholic District School Board (TCDSB) have initiated progressive policies to protect children. Their policies with respect to pesticides, CCA-treated wood play structures and mould abatement have been particularly noteworthy. However, the ability of school boards to apply progressive or proactive environmental controls is limited by both funding constraints and the magnitude of the issues needing to be addressed. Indoor air quality is a particularly complex and important issue that needs enhanced resources and action to remediate more Toronto schools.

Using the school setting as one example, Appendix 1 briefly summarises both outdoor and indoor exposures at school and some suggested actions for addressing the concerns. It is intended to provide schools and school boards with a reference point against which to assess the need for further change. From a public health perspective, it is important for the school boards to reaffirm a commitment to improving the school environment by continuing to make progress towards implementing safeguards that address the exposures outlined.

While many issues are raised in Appendix 1, it is important to highlight the fact that indoor air quality is probably the most significant concern facing schools in terms of the potential for harmful exposures and the high cost to remediate. After many years of inadequate funding for routine maintenance and major repairs, schools across Ontario, particularly in Toronto, in both TDSB and TCDSB schools are literally crumbling, especially those buildings that were built decades ago. A litany of problems exists from leaking roofs to badly deteriorating electrical and plumbing systems, antiquated heating systems, peeling paint, broken windows and poor ventilation.

Looking at the full range of repair issues, the two Toronto Boards estimate that catching up on necessary repairs and, in some cases, rebuilding, would cost $1 billion. Costs for the entire province have been estimated at close to $6 billion. In response, the Ontario government established the Good Places to Learn Initiative to address these and other costs.[112] The province committed $2.1 billion towards all identified costs and to annual maintenance budgets. While this additional money may not address all the issues of concern, it represents an enormous opportunity to make some strategic investments in schools and children's health. Given the solid scientific evidence of harmful effects of poor indoor air quality

and the high burden of respiratory illness among children, high priority should be given to improving indoor air quality as school boards make investment decisions about the infrastructure and maintenance of Toronto's schools.

Recommendation:

School boards in Toronto, while making modest progress on children's environmental health, would make much greater gains by committing to a process of detailed evaluation and prioritization of policies, procedures and specific actions that seek to improve environmental conditions in schools. Addressing indoor air quality is one of the most important and challenging children's environmental health concerns facing schools. Consequently, it is recommended that:

- *The Toronto District School Board and the Toronto Catholic District School Board, Conseil scolaire de district catholiques and Conseil scolaire de district du Centre-Sud-Ouest and where appropriate, private/independent schools in the City:*
  - *Commit to a process of detailed evaluation and prioritization of policies, procedures and pilot projects that address indoor and outdoor environmental exposure risks in the school environment;*
  - *Choose strategic investments when applying the new provincial monies under the Good Places to Learn Initiative to the maintenance, renovation or reconstruction of Toronto's schools to address indoor air quality problems and to achieve important benefits such as energy efficiency gains and provision of shade in school grounds; and*
  - *Continue to work in partnership with Toronto Public Health to increase awareness about measures to protect children from environmental threats in the school environment.*

Municipalities

The Ontario *Municipal Act* provides a general power to establish by-laws in response to local concerns and for purposes related to the health, safety and well-being of the inhabitants of the municipality. Many Canadian municipalities have exercised leadership in applying precautionary action to recognized risks to health, including child health, through the passage of progressive bylaws and other actions. Toronto has been at the forefront of this precautionary action with a number of progressive by-laws aimed at protecting health and the environment. Notable among these are the Pesticides, Idling Control, Sewer-use and Environmental Tobacco Smoke (ETS) by-laws. Toronto Public Health has played

an important role in providing the health protective rationale for such progressive regulation.

The City's Strategy for Children adopted by Toronto City Council in 1999 notes a shared responsibility with families to improve children's well-being as a legitimate part of the City's public service agenda. Key components of the Strategy include a holistic response to issues affecting children, the promotion of equity of access and responsive service approaches. Further, the Strategy promotes innovation, education and advocacy to achieve an agenda for the well-being of children.

Toronto Public Health's work on children's environmental health is progressing but could be enhanced with some designated resources for community outreach. To date, some of the most important work has come from activities in partnership with the community. For example, beginning in 1996, Toronto Public Health, the South Riverdale Community Health Centre (SRCHC) and the Sunnybrook and Women's College Environmental Health Clinic (SWC-EHC) collaboratively developed "Hidden Exposures", a fact sheet series for prenatal educators. The fact sheets cover information on reproductive health risks identified by women attending TPH prenatal education classes as areas of concern and ways of minimizing exposure to these agents.

TPH, a founding member of the Canadian Partnership for Children's Health and Environment (CPCHE),[113] has helped facilitate development of the educational resource, *Child Health and the Environment – A Primer*. This flagship publication, along with its associated fact sheets for the public and the environmental "childproofing tips" outlined in these resources, will greatly assist TPH in its future health promotion work aimed at addressing children's environmental health issues.

Recommendations:

The City of Toronto and Toronto Public Health place priority on children's health and well being. TPH's work to improve protection of children in Toronto should be enhanced. Community partnerships are essential to leveraging resources, extending the reach of TPH and ensuring that community needs are met. Therefore, it is recommended that:

- ❒ *The Medical Officer of Health continue to work with member organizations from the Canadian Partnership for Children's Health and Environment (CPCHE) to:*
  - *Create new educational resources for parents and caregivers, as needed;*

- *Further develop educational materials for identifying and preventing environmental health risks in different settings, such as child care and recreational facilities;*
- *Disseminate educational resources through key organizations involved in promoting the health of children including school-based parent groups, environmental and community groups and health-care practitioners and organizations, particularly Community Health Centres;*

6. Conclusions

Toronto's children, like other children in Canada, are at risk from environmental threats. Children, but particularly the developing fetus and infants up to age three years, are more exposed and more vulnerable than adults to environmental contaminants in air, food, water, soil, dust and in consumer products. The early stages of life represent critical periods where exposure can result in delayed, permanent or lifelong health impacts. Children's lungs and brains are particularly susceptible to long-term impact from environmental exposures because of the lengthy period of development they undergo.

Some children in Toronto and elsewhere are at greater risk than others from environmental threats. Poverty, a known risk factor for poor health overall, heightens both susceptibility and exposure to environmental contaminants. The disproportionately higher rates of child poverty in Toronto compared to neighbouring regions reinforces the need to continue efforts to address child poverty in this city.

That children have greater vulnerability to some substances such as lead, methylmercury and PCBs was learned following poisoning incidents where signs of toxicity were obvious. More recently however, research has indicated that although less overt and often more difficult to detect, many health impacts of concern can result from low-level exposures to these and other toxicants. Increased risks for a variety of different health outcomes such as asthma and other respiratory conditions, neurodevelopmental delays and impairment, cancer, immune system effects and reproductive and developmental effects have been associated with exposure to various environmental contaminants. Data on many of these diseases and conditions among children in Toronto, and indeed in Canada, are notably limited.

There is concern that, while chemicals are tested for their effects in isolation by and large, a multiplicity of exposures occurs over a child's lifetime. Epidemiological data and animal studies implicate many environmental exposures with the health concerns identified. Biomonitoring data indicate that semen, follicular and amniotic fluids, cord blood, meconium (newborn stool), blood, and urine, bear evidence of the traces of *in utero* or lifetime exposure to environmental contaminants. Heavy metals such as lead and mercury, indoor and outdoor air pollutants, some pesticides, organic solvents, and persistent organic pollutants (POPs) such as dioxins, PCBs and PBDEs and phthalates, have all been found in the bodies of children and adults in places where biological testing has been carried out. The long-term impact of these measured exposures, either individually or in mixtures is not currently known.

The good news is that exposure reduction at home and in school and child care settings is helpful in protecting children. Parents and caregivers can make a difference with their practices and with increased awareness. Toronto parents are already quite engaged, aware and taking practical steps to protect their children in and around the home. There is a solid foundation upon which to build and enhance Toronto Public Health's work to protect children in this city from environmental threats. More can be done and the "childproofing tips" found in the new resources from the Canadian Partnership for Children's Health and Environment (CPCHE) provide guidance to parents, caregivers and others that have responsibility for child health and well-being.

Some progress has occurred in terms of ever expanding research and revised federal and provincial regulatory approaches to take children's health into account. However, much remains to be done at all levels of government and within communities. Priorities for action are guided by the need to address exposure risks that are: a) preventable; b) have the potential to affect large numbers of children, including children whose health status is compromised by other circumstances such as poverty; and c) associated with serious or irreversible health effects or with long-term consequences. Six priority areas for actions are recommended to gather momentum on protecting Canadian children from environmental threats:

1. There is an urgent need for strong political leadership and clear accountability and resources for children's environmental health federally and provincially. There must be greater integration of activities across departments where policies and programs can minimize exposure to environmental hazards. Specifically, TPH and its CPCHE partners are calling for establishment of a Children's Environmental Health Program within Health Canada, modeled after the US EPA's Office of Child Health Protection. This program should oversee and coordinate federal resources and initiatives (such as a national agenda for children's environmental health). It should also propose new policies and regulations, support research on children's environmental health (for example, by establishing national Centres of Excellence) and support local and community action to protect children from environmental threats. It would serve an important outreach function by acting as a central hub for translating and transferring knowledge that facilitates broader protective action for children. In addition, it is recommended that the Premier of Ontario create a new Children's Environmental Health Initiative to strengthen provincial legislation and regulations, establish comprehensive surveillance programs to better understand exposure trends and health risks, and expand public education and outreach. This is required to complement and amplify the effectiveness of federal activities.

2. There is an overall need to enhance research into environmental threats to children's health in Canada. A Canadian arm of the National Children's Study, a long-term cohort study already underway in the US, would gather valuable data and benefit from the collaboration with US researchers. This effort to study and understand the long-term impacts of the environment on the health of a representative cohort of Canadian children is a unique opportunity and should be supported by the Federal government. The Federal government must also, through agencies such as the Canadian Institutes of Health Research support independent, investigator-driven research in Canada by establishing a separate research institute or other integrating mechanism devoted to funding research on the impacts of the physical environment on children's health. Particularly lacking is research to better understand the types of exposures affecting brain and nervous system development and the long-term impact of such exposures. Of relevance to children in Toronto is a need for research focussed on how other factors, such as poverty, interact to heighten susceptibility and exposure to environmental contaminants that are developmental neurotoxins. There is also a need for information on the prevalence and trends in neurodevelopmental and neurobehavioural outcomes among children in Canada.
3. There is an urgent need to improve surveillance of exposures and health impacts of Canadian children. Key is the recommendation that the Federal government support a national biomonitoring program, similar to that conducted regularly in the US by the Centers for Disease Control and Prevention (US CDC). These data would provide a baseline of Canadian information to better understand the nature of children's exposure, help identify subpopulations with elevated exposures and, if conducted over the long-term, provide the ability to track trends in exposure. Unfortunately, current funding for the upcoming Canada Health Measures Survey, a one-time survey, will allow analysis of only a handful of contaminants. Research and surveillance data are also required on the prevalence and trends in environmentally-linked health outcomes, particularly, neurodevelopmental and neurobehavioural outcomes among children in Canada.
4. There is ongoing need for legislative reform to better account for children's vulnerabilities. Risks to prenatal and child health must be addressed proactively rather than reactively. There is also a particular need for a precautionary approach to specific federal legislation. The revised Pest Control Products Act, which received royal assent in 2002, serves as a positive example, but government proclamation of the new Pest Control Products Act needs to be expedited. Specific legislation identified as needing greater precaution and child-protective measures include the 36-

year old Hazardous Products Act (HPA) and the Canadian Environmental Protection Act (CEPA). A revised Hazardous Products Act should ensure that children's exposures to substances in consumer products is prevented before these substances are allowed into commerce. Revisions to the Hazardous Products Act should also improve public disclosure requirements.

5. Public Health programming and education can also be enhanced to better address environmental threats to children's health. There is a need to increase funding or make strategic investments to expand the mandates of appropriate programs and standards such that they better address preconception, prenatal and children's environmental health. The Mandatory Health Programs and Services Guidelines of the Ontario Ministry of Health and Long-term Care need revisions to include Environmental Health as a separate, expanded program area that replaces the current Health Hazard Investigation Program. In addition, existing programs such as Child Health and Reproductive Health should be revised to specifically address environmental threats to preconception, prenatal and children's health.
6. Finally, school boards in Toronto, have made modest progress in addressing environmental threats to children. They would make much greater gains by committing to a process of detailed evaluation and prioritization of policies, procedures and specific actions that seek to improve environmental conditions in schools. To address indoor air quality, one of the most important and challenging children's environmental health issues facing schools, it is recommended that school boards make strategic investments in the maintenance, renovation or reconstruction of Toronto schools taking into account results of their evaluations and prioritization exercises.

Toronto Public Health is committed to continuing to identify opportunities to integrate supportive, preventive practices and increase awareness of prenatal and children's environmental health issues in its program work with parents-to-be, pregnant women, infants, children and families. Toronto Public Health is also committed to working in partnership with City partners, school boards, other health units and particularly, with CPCHE partners, to increase awareness about measures to protect children from environmental threats.

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Appendix One – Addressing Environmental Health Issues in Schools

Children spend their time in many different settings, at home, in early learning and child care facilities, outdoors in their communities and in the school environment. The table below focuses on one setting - the school environment - as an example of health risks and possible remedies. It summarizes a range of potential exposures and related action steps that can be taken in the school environment. It has been prepared as a template for application to other settings.

Note that specific actions noted in column three may be governed by specific provincial or federal law, regulations or guidelines, or industry codes of practice. There may be specific requirements noted in regulatory, policy or guidance documents for dealing with potentially hazardous circumstances (such as mould abatement or during renovations) or for dealing with hazardous materials/substances (such as lead, asbestos, pesticides, etc).

Potential Environmental Threats in Schools: Concerns and Actions for Prevention

Indoor Exposures		
Potential Concern	**Why it is a Concern?**	**Action to reduce the concern.**
Mould	Mould growth is related to moisture problems (e.g. high humidity, water damage). Mould growth in portables has been a particular problem in the past. Health effects include allergic reactions and respiratory symptoms.	☑ Proactively address moisture problems (e.g. flooding, leaks) ensuring no area remains damp for more than 24 hours. ☑ Prevent mould by keeping ventilation systems dry and clean ☑ Remove identified mould growth promptly
Indoor pesticide use	Pesticides, in particular the organophosphate insecticides, have been associated with a wide range of health effects including some cancers and possible impacts on developing brain and nervous system. Indoor pesticides are particularly of concern because they can	☑ Adopt an Integrated Pest Management (IPM) approach focusing on prevention (e.g. caulking cracks, eliminating pest habitats and food sources) ☑ If pesticide use becomes necessary for health or safety reasons, choose non-toxic or least toxic products. If non-

Indoor Exposures

Potential Concern	Why it is a Concern?	Action to reduce the concern.
	present a greater exposure risk, due to poor ventilation and slower biodegradation.	toxic alternatives are not available, seek out options that present the lowest exposure risk, such as baits, gels or pastes, rather than sprays. Apply pesticides only at times when children are not in school (e.g. weekends, holidays). Ensure that children are not allowed to enter any locations where pesticide applications have been necessary.
Cleaning products	Studies have associated cleaning products with a range of health effects including decreased respiratory function. Many such products contain volatile organic carbons (VOCs) such as formaldehyde.	☑ Adopt and follow a purchasing policy, choosing only non-toxic or least toxic products (e.g. low VOC products) ☑ Ensure products are stored appropriately and are not accessible to students.
Classroom materials (e.g. Arts & Science supplies)	Arts (e.g. markers, paints, glues) and science (e.g. solvents, acids, compressed gasses) supplies may release potentially harmful substances during their use and storage. For example, mercury has been found in some U.S. science classrooms where there was inadequate clean-up after thermometers broke.	☑ Adopt and follow a purchasing policy, choosing only non-toxic or least toxic products ☑ Ensure supplies are stored according to manufacturer's instructions and that storage areas are separate from classrooms and properly ventilated
Lead Paint	Schools built before 1976 (but especially before 1960) are likely to have painted surfaces that contain some lead. Lead is a known neurotoxin. Lead dust can be released from normal decay of old painted surfaces. Renovations that involve old painted surfaces can generate substantial amounts of lead dust indoors.	☑ Wipe painted surfaces with a damp cloth to clean dust (do not dry dust or scrape the paint). ☑ Assume all old paint contains lead. Intact painted surfaces are better dealt with by painting over them with new, lead-free paint that seals in the old lead paint. ☑ Check for peeling paint in areas where children might gain access. ☑ Dry scrape but never power sand to remove any flaking and

Indoor Exposures

Potential Concern	Why it is a Concern?	Action to reduce the concern.
		peeling paint. Use HEPA-filtered vacuum cleaners for cleaning up paint flakes and dust. Dispose of old paint flakes or dust as hazardous waste. ☑ During renovations, thorough dust control measures should also be in place.
Lead in Drinking Water	Schools built before the 1950s are more likely to have plumbing pipes made of lead. Schools in older areas of the City may have municipal water supply pipes made of lead. Since the 1950s, lead solder was used on copper plumbing. Lead solder was banned in the late 1980s. Water that has been sitting in pipes for several hours may contain dissolved lead. Lead is a known neurotoxin.	☑ Ensure any school built before 1990 has, and is following, a policy on daily flushing (running the water for a few minutes every morning) of pipes. Priority should be given to drinking water fountains, or other sources where water is likely to be ingested (e.g. taps for filling water bottles). This practice gets rid of water that has been sitting in the pipes and may contain dissolved lead.
Building Materials	New materials, adhesives etc. may release volatile organic compounds (VOCs). Carpeted surfaces may harbour contaminants and dust mites and other allergens. Older carpets can contain up to 400 times more dust and associated contaminants than an adjoining area of bare floor.	☑ Choose products with low levels of emissions where possible. ☑ When materials with potentially harmful emissions are used, increase ventilation and allow time for off-gassing before the area is reoccupied. ☑ Remove carpeting where possible. If carpeting is necessary, choose low VOC carpets that have not been subject to chemical treatments (e.g. stain resistance) ☑ Vacuum carpets frequently using a High Efficiency Particulate Air (HEPA) filter
Maintenance and Renovation Activities	Renovations can release dust, asbestos, mould and lead from paint into the air. New materials may release VOCs. Concentrations of potentially	☑ Adopt and follow a policy that limits potential exposures (e.g. painting, renovations) to times when children are not in school (e.g. holidays, on weekends)

Indoor Exposures		
Potential Concern	**Why it is a Concern?**	**Action to reduce the concern.**
	toxic substances may diminish with time as the substance becomes diluted and ventilated from the building.	whenever possible ☑ Prior to renovation, ensure inspection of work areas for hazardous materials including asbestos, lead, mould, etc. ☑ Ensure careful dust control and clean-up practices during all renovations
Ventilation systems	Ventilation systems play an important role in improving indoor air. Two approaches may be used. Passive systems rely on windows and air leaks, and are used by the older schools in Toronto. Mechanically-based systems may include central exhausts, or Heating, Ventilation and Air Conditioning systems (HVAC). Some HVAC systems can filter out particulate matter from the air, but may be costly. Improperly maintained HVAC systems may be the source or contribute to the distribution of contaminants.	☑ Install mechanical ventilation where feasible. ☑ Ensure mechanical ventilation systems are properly maintained (i.e. free of mould growth, filters are routinely changed, air vents are unobstructed, no standing water). ☑ Combine opening windows with the use of portable fans as an inexpensive way to draw air into the classroom.

Outdoor Exposures

Potential Concern	Why it is a Concern?	Action to reduce the concern.
Pressure Treated Wood	Existing playground equipment constructed from wood treated with chromated copper arsenate (CCA) requires specific mitigation measures. CCA contains arsenic, a known human carcinogen. Small amounts of CCA may leach from the wood and be ingested by children via frequent hand to mouth activity. CCA wood was phased out for residential and commercial use and has not been available since January 2004.	☑ CCA-treated wood playground structures should be coated with an oil-based penetrating sealant every one to two years. Sealant surfaces should be monitored for wear and to assess need for re-sealing. ☑ Encourage hand washing after playing outdoors. ☑ Regularly till or refresh sand/soil or other base material underneath play structures made of CCA-treated wood.
UV Radiation	Exposure to UV radiation may cause sunburns, which can increase risk of skin cancers later in life. UV radiation is strongest between 11am and 4pm from May through September.	☑ Provide adequate shade in areas of active play on school grounds ☑ Encourage the use of hats and sunscreen by children and staff.
Diesel Exhaust	Diesel exhaust contains known carcinogens and large amounts of fine particulate matter (FPM). Air quality inside buses can be worse than inside buildings. Children may be exposed while travelling in school buses.	☑ Retrofit school buses with appropriate technologies that result in reduced emissions and FPM. ☑ Ensure that there is regular ventilation of air inside buses
Outdoor Air Pollution	Outdoor air pollution including fine particulate matter, ground level ozone and VOCs have been associated with decreased lung function. Smog alerts indicate when outdoor air pollution is high.	☑ Moderate children's play or activities outdoors during smog and/or alerts. That is, reduce the intensity of activity and allow for frequent breaks, adequate water intake, access to shade. ☑ Or, if *air conditioned space* is available schedule vigourous exercise or play activities indoors during smog alerts. ☑ Ensure that a no-idling policy is enforced around schools. ☑ Reduce vehicle emissions around schools by encouraging

Outdoor Exposures		
Potential Concern	**Why it is a Concern?**	**Action to reduce the concern.**
		families to participate in a Walking School Bus program, where two or more families travel to school together.