



Feasibility Study for the Development of Indicators of Children's Health and the Environment in North America

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This feasibility study was commissioned by the Secretariat of the Commission for Environmental Cooperation (CEC) of North America, with an additional financial contribution from the Pan American Health Organization. It was prepared by the Canadian Institute of Child Health. The main purpose of the feasibility study was to inform the discussions of the Steering Group on the Development of North American Indicators of Children's Health and the Environment, as well as the trilateral Children's Environmental Health (CEH) Team.

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1.0 Introduction and Background

1.1 Introduction

The purpose of this project is to assess the feasibility of assembling a set of indicators of children's health and the environment for North America including Canada, Mexico and the United States, with publication of a first report on the state of children's health and the environment scheduled for 2004. While it is recognized that the total environment is comprised of the economic, social, and physical environments, this paper focuses upon the physical environment (land-air-water) and its relation to child health.

In recent years, the link between the environment and children's health has become a major concern for many organizations. In May 2000, the Commission for Environmental Cooperation (CEC) held a symposium as a first step in identifying issues of common concern for Canada, the United States and Mexico. The CEC Council, in adopting Resolution 00-10 during its regular session in June 2000, committed "to working together as partners to develop a cooperative agenda to protect children from environmental threats..." and decided "to focus, as a starting point, on specific health outcomes such as asthma and other respiratory diseases, the effects of lead including lead poisoning and the effects of exposures to other toxic substances". In June 2002, through Council Resolution 02-06, the CEC Council also identified water-borne diseases as a priority health endpoint for the CEC's children's health and the environment initiative, in addition to the priorities set out in Council Resolution 00-10. These issues represent the initial focal point of this feasibility study on children's health and the environment indicators.

Resolution 00-10 called for the development of a 'Cooperative Agenda' on children's health and the environment in North America, which was developed through a trilateral workshop and public consultation process. One of the activities identified within the Cooperative Agenda is the development of North American indicators of children's health and the environment. The CEC Secretariat, in collaboration with the International Joint Commission Health Professionals Task Force (IJC HPTF), the Pan American Health Organization (PAHO), the World Health Organization (WHO), the Organization for Economic Cooperation and Development (OECD), and the governments of the three countries involved, agreed to develop and periodically publish a core set of children's health and the environment indicators.

It is the intent of this feasibility study to identify relevant, ongoing activities and useful data sources in the three countries while outlining potential options for next steps in the development of a set of North American indicators of children's health and the environment. This initial core set of indicators will build on existing initiatives operating at the regional, national and international levels and will make use of existing data sets.

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The major challenge is finding a methodology that is flexible enough to accommodate the inherent differences between the three nations of interest (Canada, Mexico, and the United States) while providing a useful picture of the children's health and the environment situation for North America. This methodology must allow assessments of the conditions in all of North America, thereby permitting comparisons, tracking changes and assisting the three North American nations, the CEC and its partners to make informed policy decisions.

To complete this study the following activities were undertaken:

- 1) **Document Review:** A review of various documents and papers that addressed choosing and using indicators was undertaken. There was a focus upon papers dealing with specific indicators associated with environmental health^a, environment or health. From these papers:
 - A brief overview of problems related to children's health and the environment was compiled.
 - A proposed set of criteria for choosing indicators was compiled.
 - Different approaches for using indicators were assessed.
 - Sets of environmental health indicators were listed, with information for each on data availability, quality and comparability in the three countries.
- 2) **Key Informant Interviews:** A number of children's health and the environment and/or indicator experts, both members of the steering committee and others, were interviewed to access their views on key children's health and the environment indicators, to gather information on existing data sets and collection systems, and to obtain input regarding approaches to using data sets in the North American context.
- 3) **Steering Committee:** This group, assembled by the Commission for Environmental Cooperation (CEC), provided direction through ongoing discussions including assessing different models for indicator sets and setting priorities.

1.2 Background

The quality of human health^b in general and child health in particular is determined by a number of factors: economic, social, genetic and environmental. Child health data show a reduction in morbidity and mortality due to decreases in communicable diseases, low birth weight and infectious diseases. However, injuries remain the primary cause of death in young children and a major contributor to hospitalizations. Of concern is the fact that rates of pre-term birth, children's mental illness / behavioural problems, asthma and

^a "Environmental health" is defined by the WHO as "...those aspects of human health including quality of life, that are determined by physical, chemical, biological, social and psychological factors in the environment. It also refers to the theory and practice of assessing, correction, controlling and preventing those factors in the environment that can potentially affect adversely the health of present and future generations." WHO 1993

^b The word 'health' is defined as a "state of complete physical, mental, emotional, spiritual and social well-being" Preamble to WHO constitution. 1948

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respiratory problems are increasing, each of which may have potential linkages to environmental factors¹.

It is understood that the physical environment is not responsible for the entire burden of disease among children. However, environmental risk factors such as unsafe water, sanitation and hygiene, indoor smoke from solid fuels, ambient air pollution, lead, and climate change contribute significantly to the global burden of disease. For example, approximately 3.7% of Disability Adjusted Life Years (DALYs) worldwide are attributable to unsafe water, sanitation and hygiene, 0.8 % of DALYs are caused by ambient urban air pollution, and 2.7% of DALYs are attributable to indoor smoke from solid fuels. Lead results in approximately 234 000 deaths and is responsible for 0.9% of DALYs.² In the US, the cost associated with environmentally related lead poisoning, asthma, childhood cancer and neuro-behavioural disorders in children has been estimated to be 55.9 billion dollars annually³. Natural disasters are also part of the physical environment and these events can have a profound impact upon the health of children.

In Mexico, the *Programa de Acción en Salud Ambiental -PRASA* (National Action Plan on Environmental Health) has estimated that 35% of the burden of disease can be linked to environmental exposures where the most critical environmental risks include: pesticides exposure^c, water quality^d, indoor^e and outdoor air quality, hazardous wastes and heavy metals exposure^f.

There are many different possible definitions of the word ‘environment’. Broadly speaking, a child’s environment includes the psycho/social, economic, political and other circumstances that the child is subject to. This project focuses upon how the physical environment may affect the physical, mental and emotional health of a growing child.

The physical environment includes the air that children breathe (both indoor and outdoor), the water that they drink and food they eat, the products they are exposed to, and the soil, dust, etc. that they come in contact with.

^c There are 6,000 pesticide intoxications registered annually. From the non-occupational ones, 61% affect children under 6 years and 16% of all pesticide related deaths happen in children.

^d 150,000 people consume water with concentrations of arsenic well above the national norm.

^e In 2000, 18.7 million Mexicans (17.2 % of the population) cooked with charcoal or wood. Biomass fuels are also widely used in the ceramic and tile craft industry. In households where wood is used as fuel, the occupants, predominantly women and girls, are exposed to 350 “IMECAs”, the air quality index used in Mexico, during several hours/day. An IMECA index over 301 is considered ‘very bad’. Similarly, the population exposed to environmental tobacco smoke is over 18 million, which represents a serious public health problem. The home is the most common area of exposure, followed by the school, and the workplace.

^f Heavy metals, in particular lead, are considered a serious problem in Mexico. The primary source of lead comes from the production and use of glazed pottery and ceramic tiles. Both the glaze and the pigments used to make the pieces more attractive contain high levels of lead and mercury, which pose health risks to the population, especially children. The large majority of these ceramics are produced in family-owned business, baked in improvised, low-tech ovens. They are very popular and inexpensive, and are often used to prepare and consume food. These cottage-type ovens cannot reach a temperature high enough, and hence, lead is released into the food, and into the human body. Moreover, lead dissolves more easily in acid solutions, such as tomato-based preparations, which is a staple of the Mexican diet.

1.2.1 The Environment and Child Health

Children are not little adults. Because of their unique physical, biological, and behavioural characteristics, they may be more vulnerable to the health impacts of the environmental conditions they live in. As it is stated in the CEC's *Cooperative Agenda for Children's Health and the Environment in North America*:

“Children's bodies undergo rapid development, which increases their vulnerability to many environmental risks. Compared to adults they take in more food, air and water per kilogram of body weight, which can increase their risk, relative to an adult, of adverse impacts of contaminants that may be present. Because children spend their time in different “microenvironments” than adults—on or near the floor, for example, or playing in the soil—they have different exposure patterns than an adult living in the same home or neighbourhood”.

Children are often less able to cope with an environmental exposure than adults, for example, children take up more lead than do adults. Not only are the effects of environmental contaminants often more severe for children, but because children have more years of life ahead of them, these health effects continue for a long period of time⁴.

There is a wealth of literature that links the health of children with environmental conditions. Asthma, for example has been linked with environmental conditions including: poor indoor air quality⁵, meteorological factors⁶, and industrial air pollution^{7,8}. As well, specific pollutants or classes of pollutants are linked with health outcomes such as birth anomalies.

The links between exposure to lead in childhood with neuro-developmental effects including lower IQ, deficits in speech and language, increased risk of learning disabilities, reduced attention spans and others are also well known⁹.

Research studies have led to concerns regarding other toxic chemicals affecting the neurodevelopment of children, particularly mercury, PCBs and dioxin. Evidence is strong for effects due to prenatal exposure but early postnatal exposure to these chemicals can also subvert normal neurodevelopment^{10, 11, 12, 13, 14}.

There are, of course, a number of immediate health effects of environmental exposure. For example, poisonings due to accidental ingestion of pesticides, household products and other chemicals cause people to die every year (22 children under the age of 5 in the United States during 1997)¹⁵. In Canada there are approximately 25 deaths each year due to unintentional poisonings¹⁶.

There are also illnesses and deaths due to microbiological exposures from environmental media. In Canada, the best-known recent case was in Walkerton, Ontario, where seven

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people died and 2,300 fell ill due to *E. coli* and campylobacter poisoning from contaminated water. In Mexico, in 1995, intestinal infectious diseases were the third leading cause of death among children ages 1 to 4 (following accidents and pneumonia/influenza) causing 15.4 deaths per 100,000¹⁷. In all three nations, there are regular “boil water” advisories, although in Canada and the US these advisories tend to affect smaller and rural water systems.

Other examples of known or suspected links between environmental condition and health outcome are:

- Hyperactivity and pesticides¹⁸.
- Impaired stamina, coordination and memory with exposure to pyrethroids (a type of pesticide)¹⁹.
- Reduced IQ with exposures to organic solvents²⁰.
- Learning deficiencies and behavioural problems with exposures during pregnancy to trichloroethylene, xylene and styrene²¹.
- Various cancers and environmental factors including indoor air pollutants (tobacco smoke), ionizing radiation and carcinogenic chemicals^{22,23}.^{g h}
- Childhood cancers with exposure to indoor pesticides and parental occupational exposures to chemicals²⁴.
- Maternal exposure to pesticides during the first trimester and the potential for transposition of the great arteries in their infants²⁵.

“Environmental Contaminants and Child Health: Cause for Concern, Time for Action”²⁶ provides a good review of the relationship between environmental contaminants and their affects on the health of children, with an emphasis on certain heavy metals (lead, mercury, arsenic, cadmium and manganese); persistent organic pollutants; pesticides; polyhalogenated byphenyls; solvents; and airborne pollutants. The article notes that there is evidence that environmental exposures cause a number of health effects including: neurobehavioral developmental effects, immune system effects, endocrine disruption leading to early or late puberty, abnormal ovarian cycling, hypospadias, hypospermia, delayed testicular descent and abnormal sex differentiation; childhood cancer; asthma; and congenital malformations. The author has noted that toxic exposures to mothers, both before and during pregnancy, may affect birth outcomes and the health of the child. It has been shown that chemical contaminants enter the child both by crossing the placental barrier and via breast milk.

^g The World Health Organization estimates that 80% of all cancers are caused by environmental (including lifestyle) factors.

^h While there is no firm consensus that the environment is linked to childhood cancers, testicular cancer (a disease of young men) has increased by almost 60% in Ontario between 1964 and 1996 and is thought to be linked with environmental exposures that may have occurred during childhood.

1.3 Document Review

The key documents reviewed were:

- *Environmental Health Indicators: Development of a Methodology for the WHO European Region 2000*²⁷
- *Environmental Health Indicators for the WHO European: Update of Methodology 2002*²⁸
- *Making a Difference: Indicators to Improve Children's Environmental Health*²⁹ prepared by David Briggs for the WHO
- *America's Children and the Environment: A First View of Available Measures*³⁰ prepared by the US Environmental Protection Agency.
- *Proposed Core Environmental Public Health Indicators for the U.S. – Mexico Border Region*³¹

Lessons learned based upon an analysis of the above documents include:

- The DPSEEA framework and the MEME model (described in the following section) offer a conceptual starting point³².
- The priority issues must be clearly identified at the onset of any environmental health indicator project^{33 34}.
- Indicator projects involving more than a single nation will have to cope with differing indicator sets, collection infrastructures, and methodologies.
- Indicators are key to highlighting a problem and to tracking progress toward a solution, but they cannot warn of a novel or emerging problem³⁵.
- Indicator sets begin with existing data and information collection systems and are open to changes in data collection methodologies.

Environmental health indicator initiatives of the World Health Organization

The World Health Organization (WHO) has become a world leader in environmental health indicators for both the general population and more recently for a set of indicators for children's health and the environment. In 2000, the WHO released "Environmental Health Indicators for the WHO European Region: A Methodology" and more recently, in May of 2002 an "Update of Methodology". These programs addressed European environmental health issues and will be pursued in collaboration with the European Environment Agency.

Recently the WHO, in collaboration with the United Nations Environment Program and UNICEF, has begun a children's health and the environment initiative that includes an indicator aspect. This effort addresses the child health and environment issues for the entire world; as such the concerns of this effort may not completely reflect concerns specific to North America. However, this effort provides very useful information and analysis.

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In the course of the WHO work on environmental health indicators in Europe, they have arrived at a “core set” of indicators and have completed a pilot study using this core set. These indicators follow the “DPSEEA” framework.

DPSEEA and MEME: A Starting Point

A key starting point for this feasibility study is the DPSEEA framework and the related MEME model for indicators of children’s health and the environment. DPSEEA stands for: D – Driving Force P – Pressure S – State E – Exposure E – Effect A – Action. This framework was developed by the WHO and is used for all their environmental health indicator projects. The MEME framework is an adaptation of DPSEEA that provides a greater emphasis on the multiple links between environmental exposures and health outcomes, and on the settings where children are exposed.

The WHO European Region approach aims to find a common set of indicators for environmental health across 14 nations. One lesson learned from this experiment is that all nations will not collect an identical set of indicators. 25% of the WHO European Region environmental health indicators “are for future implementation across Europe since they require major harmonization”.¹

Moreover, the first set of indicators must be field tested across all the affected nations. The field test must assess both the usefulness of each specific indicator and how that indicator is collected and used. In Europe, the first iteration of the core list of indicators included a number of indicators that have since been removed and others that have been modified.

The WHO European Region’s initiative does not focus upon children specifically, although a number of the core set of indicators do specifically address children. (i.e. mortality of children due to air or water pollution).

Briggs has focused upon the conditions of children’s health and the environment based on the global burden of disease, which disproportionally affects developing countries. Among the premises for his efforts is that children are dependant upon adults (parents, teachers, doctors and policy makers) to protect them from the dangers and risks in their environments and to do so the adults need to better understand those risks and dangers. A key use of indicators is to help adults better understand environmental health risks and protect children from these risks. Prioritizing what matters is key, and different rationales may be followed. Briggs, based on the global burden of disease, identifies the five big killers for children under five as perinatal diseases, respiratory diseases, diarrhoeal diseases, injuries, and vector-borne disease. For each of these areas, he develops exposure, health outcome, action and contextual indicators. The way an issue is defined determines the manner in which it is measured and drives the selection of

¹ The future implementation indicators include: diarrhoea morbidity in children under 5, exceedance of guidelines for water quality and others. All the “Indicators for Future Implementation” are indicated in the associated table in Appendix 1.

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indicators - we measure what we manage and manage what we measure, and we measure what is easy to measure. Further, a set of indicators cannot predict or forecast a new and/or unanticipated problem³⁶. (See Appendix 1 for Briggs' list of indicators developed for the World Health Organization)

“Using Indicators to Measure Progress on Children’s Environmental Health: A Call to Action”, proposed 41 indicators to be used. These included rates for perinatal mortality, congenital malformations, respiratory disease mortality and morbidity, and diarrhoea mortality and morbidity. Also considered were the percentages of children living in unsafe housing, exposed to polluted air, and having access to clean water and good sanitation.

America’s Children and the Environment: A First View of Available Measures

In the United States, the Environmental Protection Agency (EPA) has led an initiative to assess the quality of children’s health and the environment titled “America’s Children and the Environment: A First View of Available Measures”. This report made use of existing information to assess the quality of children’s health and the environment in the US over a period of time. Of the 17 selected indicators, 13 address a “percentage” (e.g., of children, homes, fruit) and 11 a “percentage of children” (as in “percentage of children living in areas in which air quality standards were exceeded”). In contrast, five of 48 WHO European Region core indicators make use of percentages, however approximately half of the draft set of WHO children’s health and the environment indicators suggest the use of percentages. Using a national indicator such as “percentage of...” does offer a way to assess the environmental health condition of a large population spread across a wide area, however it does not help to explain geographic hot spots or to help identify particularly vulnerable populations (for example children living on farms or whose parents work in particular occupations). Ideally national indicators will allow disaggregating so that local/regional information can be accessed permitting targeted policy initiatives.

The EPA divided their indicators into the following three broad categories; Environmental Contaminants, Bio-monitoring, and Childhood Diseases. The EPA made this choice so that the lay reader will easily understand the information contained in the report. In the environmental contaminants section, the EPA “identified five important media for children’s exposure: outdoor air, indoor air, drinking water, food and soil”. For bio-monitoring, concentrations of lead in blood was the only indicator used. In childhood diseases there were indicators of respiratory disease and childhood cancer. (See Appendix 1 for the complete EPA list)

Proposed Core Environmental Public Health Indicators for the U.S. – Mexico Border Region (El Paso Indicators)

This report states that “those determinants most relevant to links between public health and the surrounding environment should be considered” when attempting to develop any project dealing with the creation of a core set of environmental health indicators.

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Gosselin et al. (2001) stated that indicator sets should reflect specific regional differences and unique needs by addressing variations in collection methods and local practices³⁷. Identifying similarities between existing border programs and other indicator feasibility studies would be a desirable outcome from this collaboration.

The El Paso indicators were the first attempt at selecting a common core set of environmental health indicators for the region. The document “*Environmental Public Health Indicators*” refers to the US-Mexico border region, and was jointly prepared by experts from Mexico and the United States, with the collaboration of the PAHO/WHO Collaborating Centre in Environmental and Occupational Health in Canada. The document establishes a conceptual framework for the collection, exchange, interpretation and use of indicators that orient the politics on environmental and health issues in the border populations and are also used to evaluate the effectiveness of future interventions in the border localities.

By developing a core set of indicators, border officials intended to provide a framework for local authorities to select those indicators that are relevant and attainable in their own communities, providing both the flexibility and the comparability options necessary when applying indicators to different regions.

***Primer Diagnostico de Salud Ambiental y Ocupacional* – First Assessment of Environmental and Occupational Health in Mexico**

Mexico has made significant efforts towards monitoring of the environmental health of the population. It participated in the development of the core set of environmental and occupational health indicators for the US-Mexico border region described above. More recently, through the *Diagnostico de Salud Ambiental y Ocupacional* (Environmental and Occupational Health Assessment), published in the summer of 2002, the Health Secretariat undertook important steps towards centralizing environmental health data into one agency. The general objective of the assessment was to assess the environmental and occupational health status of the country at national, state and municipal levels. The work aimed to identify regional differences and develop strategies, recognizing the variability across regions, to address environmental issues. Specific objectives included:

- Identifying the situation of environmental and occupational health in states and nationally in terms of:
 - Potential environmental risks
 - Population exposure
 - Health effects
 - (Institutional) capacity to respond
- Compiling and updating the available information on environmental and occupational health at a state level with the greatest possible level of detail.
- Establishing the basis for the systematization of the information
- Highlighting and emphasizing relevant aspects of the information available for future analysis, as well as identifying areas requiring major research or compilation work to cover existing gaps.

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Based on existing environmental health indicators previously developed by WHO and other national and international agencies, a meeting was convened with public health authorities from the different states to select the core set of indicators to be used in the study. The resulting list contained 150 indicators, which was narrowed down to 36 by a multidisciplinary working group. From the 36 indicators proposed, 24 were well populated once the study was completed.

The indicators are divided into eight areas: Environmental Disasters (6), Air (12), Water (8), Soil (1), Solid Municipal Wastes (1), Occupational Health (3), Toxic Substances (2), and Institutional Capacity for Response (3). The study uses risk, exposure effect and action indicators, and the criteria used to select this specific set of indicators was adapted from the criteria used for the development of the El Paso indicators.

Other documents

A number of other documents were reviewed during the preparation of this report. These included a set of 10 papers prepared for and presented at the Consensus Conference on Environmental Health Surveillance (held in October of 2000 in Quebec City, co-hosted by the International Joint Commission, PAHO/WHO, the U.S. Agency for Toxic Substances and Disease Registry, Health Canada, Environment Canada and the National Round Table on the Environment and the Economy); “Environmental Health Indicators” prepared for the Washington State Department of Health, and a compilation of “Environment and Health Related Indicators in Other Jurisdictions” prepared for the Government of British Columbia, among others.

The papers prepared for the Consensus Conference, along with a number of others, were key in formulating the general criteria that are proposed for choosing indicators (see Section 2.2.2 below).

1.4 Results of informant discussions

Interviews were conducted to obtain information on sources of data as well as informed opinions on a number of pertinent issues such as most useful indicators, and views on the different potential indicator frameworks. Informants included experts in children’s health and the environment from government, academia and non-governmental organizations and individuals knowledgeable of relevant information management within the three nations. A number of steering committee members were also informants.

Most informants agreed that a tighter focus upon fewer topic areas is preferable to attempting to cover all possible variations on environmental health concerns. One informant strongly urged that the program be broadened to include most of the priorities used by the WHO European Region including; Air Quality, Housing and Settlements, Traffic Accidents, Noise, Waste and Contaminated Land, Radiation, Water (Recreational and Drinking) and Sanitation, Food Safety, but not Chemical Emergencies or Workplace. Informants recommended that at least for the first iterations, there be a focus upon the

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four priority areas identified by the CEC Council; the quality of the air, lead, toxic chemicals, and water quality. In addition, health indicators (mortality and morbidity) along with emerging environmental health science should be continually scanned to help identify novel or emerging issues.

There were a number of comments indicating support for better and wider use of bio-monitoring, including the use of personal exposure monitoring, as indicators, for example: blood lead levels, personal exposures to air pollutants or body burdens. The advantages include: clear, accurate and unambiguous information on the exposure of children to contaminants of concern. Unfortunately, these procedures are expensive both to collect and to analyze enough samples to achieve a good overview of actual exposure. For indicators based upon bio-monitoring to be useful for policy development, it is critical that the results are mapped and that information about the populations of affected children be tied to the bio-monitoring results.

Among the considerations in drafting any list or set of environmental health indicators is the likelihood that at least some data would be available to populate the indicator in each country for each priority issue. The environmental health condition of parents, particularly the mother, also may be an issue of concern.

Among the potential indicators that were widely supported by informants in addressing “Asthma and Air Quality” are concentrations of ozone and PM₁₀ as there are clear links between these pollutants and respiratory disease.

Informants identified a number of potential problems associated with using asthma prevalence rates, such as under/over diagnosis and that in Canada and the US asthma rates are estimated through a survey of the public. In Mexico, doctors complete a diagnosis form that is centrally collected and tabulated. In all three nations it may be expected that children in under-serviced communities may go undiagnosed. As well, there are a number of triggers for asthma attacks other than poor outdoor air quality including, pet and other allergies, tobacco smoke, other indoor air pollutants and psychological factors. Nevertheless asthma prevalence rates are widely viewed as a useful indicator.

Virtually all informants agreed that water borne disease is an important issue for all three nations. Large parts of Canada and the US do not have constant access to disease free water. Private wells which service an important portion of the population in North America are very often contaminated, between 30-70% of private wells in Canada and US depending on study and time of year³⁸. As another example, campers are often reminded that they should not drink the water directly from Canadian lakes and streams. In Mexico, there is little attention paid to recreational waters, although there has been a recent attempt to collect information in this area. However, programs are still incipient, and information is mostly available in regions where there is a high volume of tourism. In the more impoverished areas of Mexico there is little access to clean water or sanitation.

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Informants agreed that total fecal coliform is the most useful indicator for determining water quality and the potential for water borne disease. To complete the water quality picture, informants suggested that measurement of chemical pollution be considered.

In discussions about lead, a number of informants suggested that the issue be broadened to address neuro-toxicants as a whole. When probed, however it became clear that blood lead levels are a useful indicator for assessing developmental issues although it might be possible to collect information on attention deficit – hyperactivity disorder (ADHD) based upon the understanding that a number of environmental contaminants may be linked to ADHD, including lead. ADHD prevalence data may be available; however there is concern regarding potential misdiagnosis that could taint the data.

As for other toxic chemicals, most informants suggested that data collected for pollutant release and transfer registers (PRTRs) should be used as an indicator. A few informants suggested that fish consumption advisories, often due to mercury or various persistent organic pollutants, be considered.

2. Scope and Methodology

2.1 Priority Areas

Children's health and the environment concerns can include a large number of topics including the quality of housing, noise, traffic and other accidents, industrial/chemical accidents, climate change, radiation, and poverty (socio-economic status) among others. There is a focus upon four priorities in this feasibility study based on those identified in CEC Council Resolution 00-10 and 02-06 and further developed and ratified by the project steering committee.

1. Air quality, asthma and other respiratory disease.
2. Lead, as an important neuro-toxicant that slows the intellectual development of children while affecting a number of other systems.
3. Toxic chemicals, in particular those linked with cancers, birth anomalies, and neurodevelopmental problems.
4. Water contaminated with bacteria and chemical pollutants which can cause a range of diarrhoeal and other diseases.

Each priority concern brings with it a unique set of problems and presents a unique set of solutions. The following sections attempt to outline each of the environmental health priority issues.

2.1.1 Asthma, Other Respiratory Disease and Air Quality

Asthma, bronchitis and other respiratory diseases are linked to exposure to air pollutants, particularly ozone and particulate matter^{39 40}. One study shows a link between air quality and causation of asthma⁴¹. In large cities in the US, admissions to hospitals for asthmatic attacks tend to occur among the poor – possibly because the wealthier populations tend to be treated by private physicians while the poor must use the local emergency rooms as

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they are less likely to be covered by health insurance plans that provide other treatment options⁴². Canada and the US do not require that asthma cases be reported. Asthma rates are ascertained via surveys through a question asking if anyone in the household has been diagnosed with asthma. In Mexico, doctors complete a diagnosis form that is collected by the Ministry of Health.

There is, across North America, a reasonably good network of air quality monitoring stations, particularly in urban areas. A case might be made that clean air is beneficial to health, particularly the health of children, so it may be preferable to simply use the quality of the air as an environmental health indicator. There are two possible ways to use the existing air quality indices. The first is to mine the data to allow a comparison with a common standard, such as the World Health Organization standard. The second is to permit an assessment using each nation's current air quality guidelines.

The quality of the air is a function of the amount of pollution released into the air shed and the amount of air movement (wind) through the air shed. It should be noted that air pollution is often exported to communities downwind from the source, thus any local jurisdiction may have only limited ability to implement programs to improve air quality.

Respiratory diseases and asthma are the two most common health effects associated with air pollution. For example in Mexico, according to the study, morbidity rates have increased since 1997, but mortality rates have decreased. This could be in part attributed to better diagnosis and improved reporting of the disease. Also in Mexico, respiratory disease is the main causes of child mortality in rural areas. Most of the exposure to air contaminants occurs in homes where charcoal or wood is used as fuel for cooking. According to the 2000 national census, roughly 17% of the population is affected by respiratory diseases.

In rural areas, the wide use of biomass fuels in the ceramic and tile craft industries adds to the problem of bad indoor air quality. This economic activity is widely practiced in Mexico, with an estimated 5 million artisans working in this cottage industry, the majority of which are aboriginals. This industry generates three important sources of pollution: occupational hazards arising from the exposure to lead, primarily used to glaze the pieces; exposure to particulate matter and other airborne contaminants; and the exposure to lead from the ceramics themselves.

2.1.2 Lead

Heavy metals, including lead, mercury and arsenic can affect brain development and cause a child to suffer learning disabilities, emotional control difficulties, neuro-developmental delays and reduced intelligence (as measured by standard IQ tests). Other compounds including pesticides and various persistent organic compounds are suspected of causing similar health outcomes.

Lead poisoning in particular is a very important issue that affects all three nations. One set of indicators that clearly addresses the lead issue is measurements of lead in blood

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and/or tissues. Environmental lead levels can be measured by the lead content in household dust, soil, air and water. The quality and currency of the data for either lead levels in blood and/or tissue, or concentrations of environmental lead vary greatly among the three nations.

In Canada and Mexico, national data on blood lead levels are not available. In Mexico, the Health Secretariat is considering conducting a national survey to determine lead levels in children. The initiative is controversial, for fear of a lack of institutional capacity to mitigate the problem, should the survey indicate high levels in the child population. A similar situation exists in Canada where the last national blood lead level survey for children was completed in 1978.

Historically, the most important source of environmental lead was leaded fuels. All three nations began to outlaw leaded fuel in the 1980's and finalized it by the end of 1990 for Canada and 1997 for Mexico (see <http://www.ns.ec.gc.ca/epb/envfacts/lead.html>). However, there does remain a legacy of lead contaminated soil adjacent to high traffic zones.

In the United States and Canada, the largest exposure of lead that affects children comes from the dust in older homes containing leaded house paint. A study conducted in Ottawa indicated that higher levels of lead can occur in indoor environments than in either outdoor environment or soil. This study also reported that older homes (pre 1950) tend to have higher lead content in household dust⁴³.

In all three nations there are concerns about higher lead exposures associated with mining operations and industrial lead use, including recycling operations. Mexico is an important producer of lead for the international market. As such, many of the actions around the control and mitigation of human exposure to lead have traditionally targeted the industrial sector. As a consequence, the industrial sector is relatively well controlled, and is comprised of high tech industries.

The real concern for Mexican authorities lies in the ceramic and tile industry, which is largely uncontrolled and presents one of the highest risks of exposure to the population. Lead exposure occurs in two important ways: occupational exposure to the workers, which often include the family's children, and exposure to consumers through the contamination of the food prepared in these ceramics.

Other sources of lead exposure include leaded water pipes, leaded crystal and food containers, water pipe solder and hobby pursuits such as stained glass.

2.1.3 Toxic Chemicals

There are many known or hypothesized links between a number of toxic chemicals and child health conditions including links with low birth weight, neural tube defects, various other birth defects, miscarriages, attention deficit – hyperactivity disorders, among others. There are many species of toxic chemicals including heavy metals and persistent organic

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pollutants (PCB's, dioxins and furans, various pesticides, etc.). There are thousands of toxic and potentially toxic chemicals in the environment, many of which have not been well tested for human toxicity. Even fewer have been tested for toxic effects on children. Toxic chemicals can be naturally occurring (such as arsenic), artificial such as PCBs (polychlorinated biphenyls), by-products of industrial processes (e.g. dioxins). Children can be exposed to toxic chemicals through all environmental media, for example air, water, food, skin contact with products, soil, and dust.

There are many toxic chemicals in the environment and exposure to toxins can have synergistic effects that are far greater than either a linear or extrapolation of the separate effects of each toxin would suggest.⁴⁴

Because of both the numbers of potentially toxic substances and the range of media for exposure, it can be difficult to identify indicators. However, in a review of other environmental health indicator initiatives, a number of potential indicators have been identified including: incidence of birth anomalies; reported poisonings of children; pesticide residues on fruit and vegetables; numbers of hazardous/toxic waste sites; and amount of toxic waste generated. For much of North America, it may be productive to add "fish consumption advisories" that are regularly published by departments of health, environment and/or natural resources, as an indicator of chemicals in the environment since fish concentrate (through a process of bioaccumulation) certain chemicals⁴⁵.

There is also information that is supplied through pollutant release and transfer registers (PRTRs), which collect data on annual releases and transfers of listed chemicals from industrial and other sources. The U.S. and Canadian systems are well developed. In Mexico, a voluntary reporting system is in place, and legislation was recently passed for a mandatory, publicly accessible register.

Information is also collected on chemical pesticide sales in Mexico and US, while Canada is only beginning to collect this information.

In Mexico, there is no adequate registry of poisonings due to toxic substances. The only information available is for pesticide poisoning, and generally only acute cases are reported. In an effort to generate adequate information on toxic poisonings, the *Red Nacional de Centros de Información Toxicológica* (National Network of Toxicological Information Centers) was created, with 23 centres across the country. Preliminary findings indicate that pesticides are the most common agent of chemical intoxication. There is little information on urban-rural variations.

2.1.4 Water borne disease

Water borne diseases may arise from two types of exposure to microbial contaminations—drinking water and surface water. All three nations are faced with the problem of contaminated water, although the problem is more widespread and severe in Mexico. Some water borne diseases are spread via food (for example *E. Coli*) and not every case is traceable to a specific source. Good data is available for outbreaks of water

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borne diseases and are reported to the public health authorities. However up to 90% of all water or food borne diseases remain unreported. It is often difficult to be certain that the source of an infection is food or water.

Globally, millions of children become ill and die due to exposure to water polluted with bacteria and other pathogens. In Canada and the US, few children become seriously ill from water borne diseases, although boil water advisories are common in both nations. In Mexico, water borne disease is a more serious problem.

Where there are piped water supplies, regular testing usually occurs for chemical contaminants, although this practice is not done as regularly as microbiological testing. For recreational waters, testing is less systematic for chemical contamination, although in many areas there is regular monitoring of the chemical contamination of fish.

In Mexico, The *Comisión Nacional del Agua*—CNA (National Water Commission) is the federal authority in charge of regulating and monitoring water quality nationwide. Monitoring is done by the municipalities who in turn report to the CNA. In impoverished areas, testing water samples adequately becomes very difficult due to scarce financial resources. The most frequently tested parameters are fecal coliform, *E-coli*, hepatitis A, chlorination and cholera. Water quality standards exist for bacteria, physical and chemical properties.

Water is scarce in Mexico, particularly in the border region where water tables are rapidly decreasing. Aquifer contamination is also a problem that compromises the quality of drinking water, especially in areas with rapid industrial and population growth.

2.2 Methodology and Identification of Models

The following discussion is based upon information gained during informant interviews, results of the document reviews and continuous input from and discussion with steering committee members.

2.2.1 *The Use and Limitations of Indicators*

Indicators are used to provide a picture of a complex system that cannot be easily or totally described. Indicators such as body temperature, heart and respiration rates, blood pressure etc. describe aspects of the health of a person, i.e. they provide an indication of the person's health. Indicators like the gross national product (GNP), employment/unemployment rates, and the prices of stocks describe the economy of a nation.⁴⁶ Put another way, “we require some form of measure or simplifications of reality to assess status, track changes, set goals, and protect and improve human health or the environments upon which we rely” (John Eyles and Chris Furgal).⁴⁷

Indicators have been successfully used by child advocates to highlight problems and to track progress toward solutions. One example of such an indicator is the prevalence of low birth weight – once the extent and scale of the problem was understood it became

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easier to identify problems and to implement protective action. Ideally, indicators should describe the prevailing condition in a meaningful manner so that public policy remedies can be applied.

While indicators are “simplifications of reality”, care must be taken to ensure that in the interpretation of the meaning of an indicator there is no “oversimplification”. Children’s health and the environment is a complex topic that requires carefully chosen indicators that are thoughtfully assembled to present a coherent and unbiased picture of the situation.

2.2.2 Criteria for choosing indicators

There are a number of global criteria that useful indicators must meet^{48,49,50}. These include:

1. **Useful and relevant:** The chosen indicator must be related to a specific condition of interest or question that reveals the situation regarding children’s health and the environment. The indicator should be useful in highlighting trends and/or providing a warning.
2. **Scientifically sound and credible:** The indicators must be unbiased, reliable, valid and based upon good quality data. The collection methodology should be robust and repeatable. There must be a clear and direct link between the environmental condition that the indicator addresses and the health outcome or between the health condition that the indicator addresses and an identified environmental condition (for example air quality and asthma rates, and asthma rates and air quality).
3. **Acquirable:** The data upon which the indicator is based must be reasonably easy to acquire at a reasonable cost, otherwise the information simply will not be collected. It should be possible to regularly collect the data.
4. **Applicable and understandable:** The indicator must be useful for policy makers and a non-specialist audience and acceptable to stakeholders and the wider public.

These four criteria offer a starting point for this feasibility study of indicators of children’s health and the environment. Additional considerations include 1) the priority areas that have been identified and 2) the similarities and differences in the collection infrastructures in the different affected jurisdictions. With respect to action indicators, those that relate to degree of implementation of a policy, degree of enforcement of a policy, and effect of the policy, are considered preferable to indicators that simply refer to existence of policies.

This initiative will start with existing data sets, collection methodologies, and sampling networks that will vary between and within the three nations.

2.3. Indicator Frameworks

Embedding indicators for children’s health and the environment within an appropriate framework has several advantages: A framework represents a simplified version of our

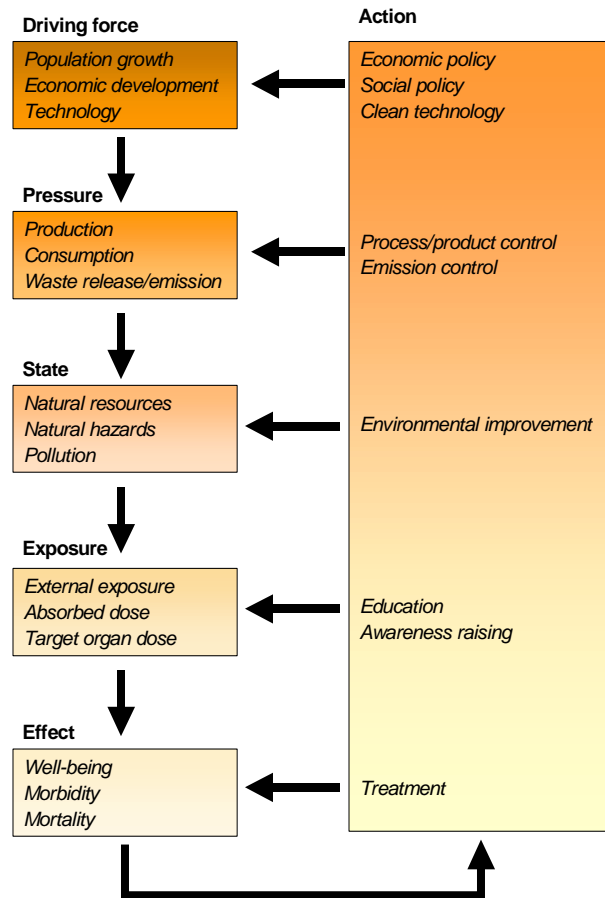
underlying concept of reality and makes this view of the world explicit to the target audience. A framework also helps us to be more systematic in defining the issues that confront us and in analysing and interpreting them.⁵¹

2.3.1 The DPSEEA Framework

A key starting point for this feasibility study was the DPSEEA framework for environmental health indicators that was developed by WHO.⁵² DPSEEA stands for: D – Driving Force P – Pressure S – State E – Exposure E – Effect A – Action (There are variations upon this framework such as the DPSIR: Driving Force – Pressure – State – Impact – Response framework.). The DPSEEA framework has been widely used as a way of both selecting and structuring environmental health indicators. It recognizes that the link between exposures and health effects is determined by many different factors operating through a chain of events, and one of its main strengths is that it clearly shows the many different entry-points for interventions that may directly address any point upon the DPSEEA environmental-health continuum. For example, industrial policy can address a Driving Force, regulation of emissions can address a Pressure or a State, education and public awareness programs can address Exposure and medical treatment can address Effects⁵³. However, despite its usefulness, the DPSEEA framework also has some important drawbacks. In particular, it stresses the linear links between environment and health and thereby neglects the actual complexity of the many-to-many associations between exposures and health outcomes.

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The DPSEEA Framework:



To follow an actual example of the DPSEEA model for air quality and health from the WHO European Set:

Driving Force	Pressure	State	Exposure	Effect	Action
Annual passengers-kilometres travelled by mode of transport Annual average consumption of fuel by type from road transportation	Annual emissions of SO ₂ , PM ₁₀ , secondary PM ₁₀ , NO _x , VOC; total and by economic sector		Population-weighted exceedance of the reference concentration of NO ₂ , PM ₁₀ , (or BS or TSP) and SO ₂ ; 8hr average O ₃	Mortality due to respiratory diseases in children > one month and < one year of age Mortality due to respiratory diseases all ages Mortality rate due to diseases of circulatory system – all ages	Capability for implementing and enforcing policies on Environmental Tobacco Smoke Exposure

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Here are two examples of Driving Forces, one that addresses the number of kilometres actually driven and the other addresses the fuel efficiency of that driving.

The Pressure indicator addresses the amount of pollution emitted to the air (not in itself a measure of human exposure).

While there is no State indicator listed, one might use an indicator such as average peak ozone or PM₁₀ levels. Note that this does not incorporate any implication of the actual exposure to people.

The Exposure indicator provides information on the *actual exposure of people* to air pollutants.

The three Effect indicators describe the health outcomes (in this case, deaths) that are related to the exposure to polluted air.

The Action indicator describes what the authorities have done to address the issue of concern. In this case the Action addresses environmental tobacco smoke – an important source of indoor air pollution – but does not address the Driving Forces listed.

The DPSEEA framework

The model describes six components of the environment-health chain:

- *Driving forces - that act as root causes for, and influences upon, the processes of concern*
- *Pressures on the environment - that arise as a result of these root causes*
- *State - changes to the environment as a consequence of these pressures*
- *Exposures - that take place when humans are exposed to these changed environmental conditions*
- *Effects - adverse impacts on health due to these exposures*
- *Actions - policy and other interventions, aimed at reducing or avoiding these adverse health effects*

2.3.2 The MEME Model

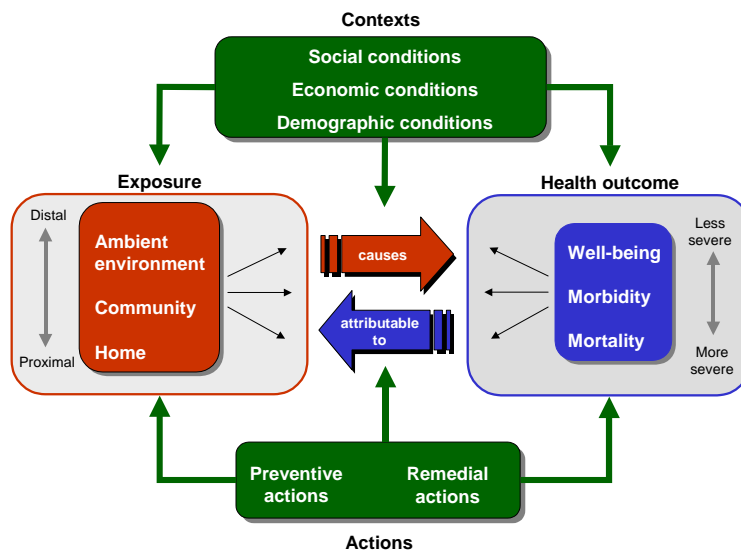
In contrast, the MEME model (Multiple Exposures - Multiple Effects), as the name implies, emphasizes these many-to-many relationships. Individual exposures can lead to many different health outcomes; specific health outcomes can be attributed to many different exposures. Both exposures and health outcomes—as well as the associations between them—are affected by contextual conditions, such as social, economic or demographic factors. The MEME model was especially developed for children’s health

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and the environment indicators and focuses on the child by distinguishing the settings where children's exposure occurs, including the home, the community and the ambient environment. Actions can be targeted at either exposures through the environment sector or health outcomes through the health sector.

However, the two models are compatible, with the MEME model representing both a simplification and an extension of the DPSEEA framework. In practice, it is often difficult to distinguish between the state and pressure components of the DPSEEA model. The MEME model combines the state, pressure and exposure components under the general heading of exposure, recognizing that indicators of exposure may be assessed more or less directly, with state or pressure components often serving as proxies for the actual exposure.

The MEME Model:



The US EPA in "America's Children and the Environment: A First View of Available Measures" implicitly uses the MEME approach. Of the 17 indicators in this set, five directly address health outcomes while the other 12 address State and Exposure. The choices for priorities were:

- Environmental contaminants—outdoor air, drinking water contaminants, pesticide residues in foods, and land contaminants;
- Bio-monitoring - concentrations of lead in blood;
- Childhood diseases - respiratory disease, and cancer.

The EPA presented information in this manner because they believe that the clarity of this framework (what is in the air, water, etc.) along with an indication of the pollutants

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in the body and health outcomes is easily understood by the wider public without interpretation from experts.

For the purpose of this feasibility study, the MEME model with its emphasis on children and on the many-to-many relationships between exposures and health effects seems more appropriate. As this model is also widely promoted by the World Health Organization for current and future children's health and environment indicators efforts in different regions of the world, it will eventually allow indicators collected in the North-American context to feed into a global framework.

2.4 Proposed Implementation Strategy

A flexible, "continuous improvement" approach to implementation is being proposed to enable the use of existing data and current methodologies, while building towards the goal of a core set of harmonized indicators for the three countries. While it aims for gradual improvement and comparability among the indicators for the three countries of the region, the approach, which is outlined below, does not insist upon a common set of indicators and common collection methodologies. An important aspect of the approach is the ongoing flexibility for the nations involved to first recognize and then harmonize indicator sets, collection methodologies and infrastructure over time. It asks each nation to answer as completely as possible: "What is the children's health and the environment condition with regard to air, water, lead, toxics and action in your nation?" This approach sets out the guidelines for answering the questions along with asking for information about the collection methodologies and indicator sets.

Recommended steps for implementation:

1. Agree upon theme areas and then priority concerns within those themes.
2. Articulate a set of indicators for each priority, including indicators of exposure, effect and action, following the MEME model. Ideally, a number of indicators will be used to assess the condition of each priority.
3. Gather data to populate the indicators, beginning with existing data. The methodologies for data collection need not be identical for each nation but each methodology and data collection network must be fully documented. Where data are not available to fill an indicator, that indicator can be left unpopulated if other indicators for the same priority allow for an adequate assessment of the situation. Where greater depth and quality of information is available, it should be used to populate the indicator set for that nation – even in the event that other nations currently cannot reach a comparable depth of information.
4. Assess the situation in each country for each priority area, using the populated indicator sets. This will require the judgement of (an) experienced children's health and the environment expert(s) to assist in interpreting the data.
5. Review the strengths, weaknesses and gaps in the indicator sets and the data used to populate the indicators, with a view to harmonizing indicator sets over time. Review priorities in light of new and emerging environmental threats to children's health.

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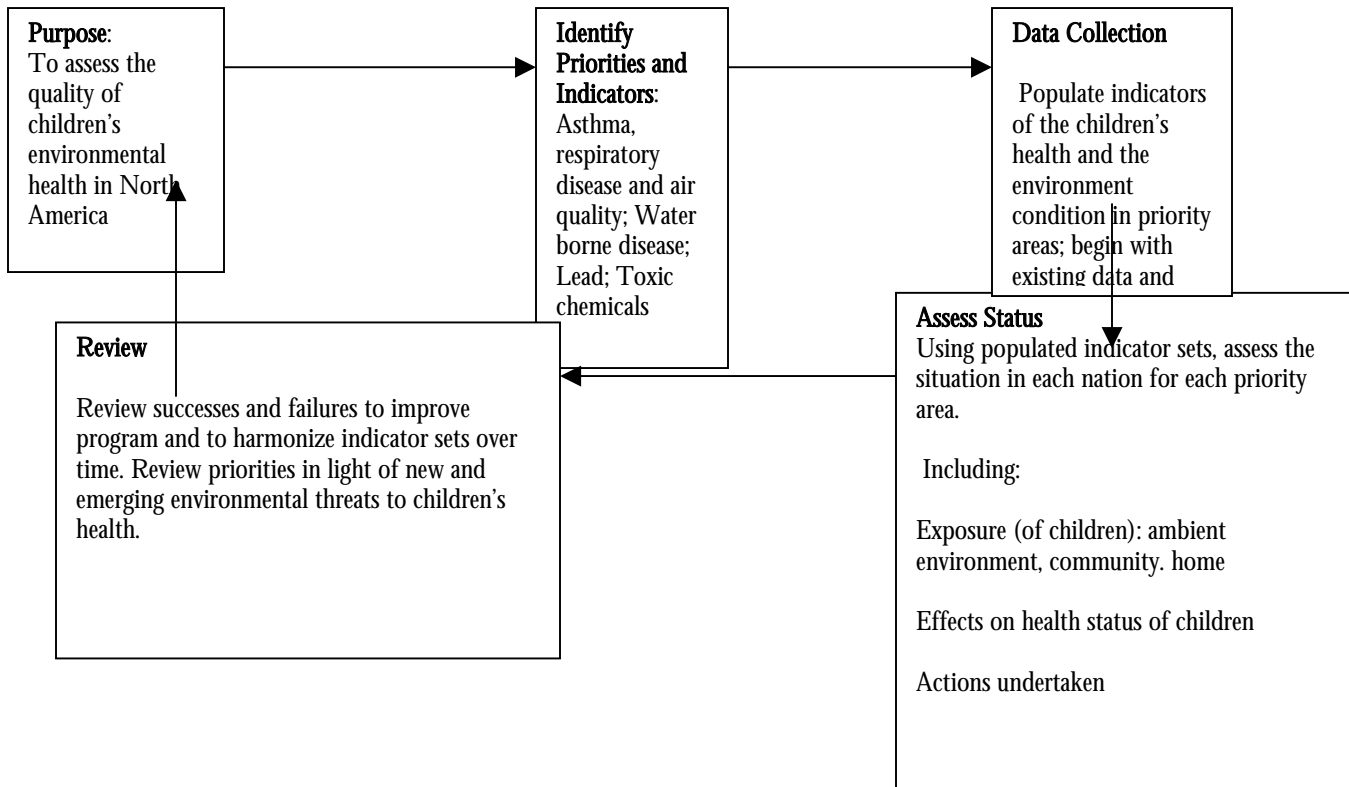
6. Conduct analyses of trends over time to see if there is a correlation between the changes that are occurring within each priority area and the effectiveness of actions taken to address those areas, as indicated by the indicators.

In this approach, the priority areas are the primary focus, rather than the actual indicators. The key is to acquire enough reliable information (via an indicator set) to conduct an assessment of the condition for that topic area. For example, there is more information on lead contamination for the United States than exists for either Canada or Mexico, however, there is enough useful information on lead for both Canada and Mexico to allow completion of an assessment of the lead exposure situation in all three nations.

This approach allows for using different, but comparable, information sets for each of the areas of interest, while at the same time working toward the goal of achieving a core set of harmonized indicators. While the approach does allow comparisons using different information sets, it does not permit using information sets that indicate different environmental health conditions.

Regions within each nation will have different sets of environmental conditions and problems (due to weather patterns, geology, level and type of industrialization, degree of urbanization, eco-zone, population density, etc.) The suggested approach will allow for regional as well as national assessments.

Figure 1. Implementation strategy for the development of children’s health and the environment indicators in North America. (Adapted from Fugal and Gosselin⁵⁴)



3.0 Results and Feasibility Analysis

3.1 Potential indicator sets for each area of interest

The following indicators, used as examples, have been judged to meet the four criteria listed above and are currently available and easily collected in at least one of the three nations. There are data to populate many of these indicators for each nation in each area of priority. Most are commonly used in other environmental health and children's health and the environment indicator initiatives. There is flexibility within each indicator to allow for the specific circumstances of each nation.

To compile a first list of indicators, numerous environmental health indicator documents were reviewed and a list of 294 possibilities was compiled.

To further narrow the list, documents were reviewed including the WHO European Region core list of environmental health indicators and the EPA's *America's Children and the Environment: A First View of Available Measures*, as well as indicator sets developed for other jurisdictions such as South Africa and the State of Washington. A selection of potential indicators was identified through key informant interviews. Further discussion of the initial list was held within the steering committee during their December 2002 meeting.

Note: The indicators represented in **bold text** below are the ones that are being recommended by the steering committee.

Action indicators may address actions by government as well as by industry, non-governmental organizations (NGOs), and individuals. Generally it is easiest to catalogue government actions, particularly the actions of federal governments, however the actions of other players in society are also important. For example, the number of businesses who have acquired an 'ISO 14000' designation provides an indication of how concerned and involved industry is with environmental issues.

A) Asthma and respiratory disease, and air pollution

A1) Exceedances based upon the air quality index that each nation uses

A2) Air quality measurements (ground level ozone, PM₁₀, etc.)

A3) Percent of children exposed to air pollution exceeding national standards

A4) Prevalence of asthma cases

A5) Hospitalizations due to respiratory distress

A6) Action: regulations addressing emissions of air pollutants from industrial sources and/transportation.

A7) Action: programs to reduce exposure to indoor air pollutants such as environmental tobacco smoke: **Percent of homes with children under a certain age exposed to indoor air pollution**

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Indicator Name	Significance (MEME)	Feasible for Canada	Feasible for Mexico	Feasible for US	Description/ Comment
A1) Exceedances based upon the air quality index that each nation uses	Exposure	Yes	Yes	Yes	An assessment of how regularly the nation's air quality standards are exceeded using the relevant air quality index
A2) Air Quality measurements (ground level ozone, PM ₁₀ , etc.)	Exposure	Yes	Yes	Yes	This can be measured in a number of ways including the number of days per year above a threshold, average peak measurement
A3) Percent of children exposed to air pollution exceeding national standards	Exposure	Yes	Yes	Yes	Obtainable by cross referencing air quality data with census data
A4) Prevalence of asthma cases	Effect	Yes	(Yes)	Yes	Can be the number of children under 18 or 14 or 5 or a combination. Mortality due to asthma is also commonly used. Information is obtained from surveys in Canada and the US. In Mexico it will need to be obtained from survey data.
A5) Hospitalizations due to respiratory distress	Effect	Yes	Yes	Yes	Based on discharge data and/or information from emergency room.
A6) Regulations addressing emissions of air pollutants from industrial sources and/transportation.	Action	Yes	Yes	Yes	Based upon a review of state, federal legislation and regulations.

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Indicator Name	Significance (MEME)	Feasible for Canada	Feasible for Mexico	Feasible for US	Description/ Comment
A7) Programs to reduce exposure to indoor air pollutants such as environmental tobacco smoke: Percent of homes with children under a certain age exposed to indoor air pollution	Exposure	Yes	Yes	Yes	Based upon a review of educational and other programs designed to improve indoor air quality. ETS for Canada and the States, biomass fuel use for Mexico. Anecdotal or regional information can be used to discuss such items as mold in schools

B) Effects of exposure to lead, including lead poisoning

B1) Blood lead levels (presented by range, e.g. detection limit – 2.5 ppm; > 2.5-10 ppm; > 10 ppm)

B2/B3) Children living in homes with a source of lead

B2) Children living in housing with lead dust above a threshold

B3) Number of residences built before 1950

B4) Incidence of lead poisonings

B5) Number of relevant programs designed to reduce childhood exposure to lead, according to the needs of each nation

Indicator Name	Significance (MEME)	Feasible for Canada	Feasible for Mexico	Feasible for US	Description/ Comment
B1) Blood lead levels (presented by range, e.g. below detectable level; detection limit – 2.5 ppm; > 2.5-10 ppm; > 10 ppm)	Exposure	Partly, there are a number of regional/local surveys but no national program currently	Partly, there are a number of regional/local surveys but no national program currently	Yes	Although lead may have health effects at lower level, 10 ppm is considered a trigger for medical intervention
B2/B3) Children living in homes with a source of lead	Exposure	yes	yes	yes	Sources of lead reflected in the indicators may vary by country, depending on the major sources of concern and data availability.
B2) Children living in housing with lead dust above a threshold	Exposure	No, although local studies point to a significant problem in unexpected	No	Partial	Lead dust in the home is a source of exposure

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Indicator Name	Significance (MEME)	Feasible for Canada	Feasible for Mexico	Feasible for US	Description/ Comment
		areas.			
B3) Number of residences built before 1950	Exposure	Yes	Not relevant	Yes	Older homes are much more likely to have leaded paint that contributes to lead contamination in dust.
B4) Incidence of lead poisonings	Effect	Yes – although it is thought that many cases are not diagnosed as lead poisoning	*	Yes	A count of the cases of lead poisoning from any source
B5) Number of relevant programs designed to reduce childhood exposure to lead, according to the needs of each nation	Action	*	*	Yes	All nations have relevant programs that educate and otherwise help potentially exposed population avoid lead

C) Exposures to toxic substances (other than lead)

C1) Birth anomalies such as neural tube defects or hypospadias

C2) Trends in sales of pesticides

C3) Trends in Pollutant Release and Transfer Register (PRTR) data

C4) Fish consumption advisories

C5) Legislation to limit emissions of toxic substances

C6) Number of inspections to enforce legislation

Indicator Name	Significance (MEME)	Feasible for Canada	Feasible for Mexico	Feasible for US	Description/ Comment
C1) Birth anomalies such as neural tube defects or hypospadias	Effect	Yes, however some provinces do not systematically collect conventional birth anomalies data	Potentially* collectable but not by the environmental health unit	Currently 40 states systematically collect birth anomalies data	Higher than expected occurrence of birth anomalies suggests an environmental cause
C2) Trends in sales of pesticides	Exposure	No mandatory system across Canada currently	Yes *	Yes	Sales data is proportional to the amount released into the air and water of a nation.
C3) Trends in	Exposure	Yes	Mandatory	Yes	PRTRs exist in the

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Indicator Name	Significance (MEME)	Feasible for Canada	Feasible for Mexico	Feasible for US	Description/ Comment
Pollutant Release and Transfer Register (PRTR) data			reporting system is under development*		three countries; data can help to highlight releases into the environment of a range of chemicals.
C4) Fish consumption advisories	Action	Yes	No	Yes	Fish bio-accumulate the persistent pollutants in their environment. Serves as an action indicator since the advisories are issues to prevent exposures to people.
C5) Legislation and regulations to limit emissions of toxic substances	Action	Yes	Yes	Yes	The number of federal and state/provincial laws that place limit(s) upon emissions of toxic substances including the number of substances included in the regulations.
C6) Number of inspections to enforce legislation	Action	*	*	*	It is not enough to have laws and regulations, they must be enforced to ensure compliance

D) Water Borne Disease

D1) Percent of children (households) served with treated water

D2) Percent of children (households) served with sanitary sewers

D3) Presence of faecal coliform in surface water

D4) Number of outbreaks of diarrhoeal disease

D5) Morbidity (number of childhood illnesses attributed to water borne disease)

D6) Mortality (number of child deaths attributed to water borne disease)

D7) Percent of sewage treated before release into local water bodies. – Number of sewage treatment plants per million urban population.

D8) Percentage of drinking water systems in violation of local standards

Indicator Name	Significance (MEME)	Feasible for Canada	Feasible for Mexico	Feasible for US	Description/ Comment
D1) Percent of children (households) served with treated water	Exposure /Action	Yes	Yes (%of households served with “piped water”)	Yes	A simple count of how many (children homes, population) who have access in their home to water that is piped from a centrally treated system. (Alternatively,

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Indicator Name	Significance (MEME)	Feasible for Canada	Feasible for Mexico	Feasible for US	Description/ Comment
					could be children without access to treated water)
D2) Percent of children (households) served with sanitary sewers	Exposure /Action	Yes	Yes	Yes	The percentage of children, (population, households) who have sewage removed from their immediate surroundings (will require further discussion and refinement)
D3) Presence of faecal coliform in surface water	Exposure	Yes. For populated areas and recreationally used waters	Yes, there is a norm but collection is not consistent across entire nation	Yes, with a focus on beach water.	Intended to assess the microbial quality of surface water that children may be exposed to.
D4) Number of outbreaks of diarrhoeal disease	Effect	Yes	Will confirm	Yes	Instances where a number of cases of a water borne illness is caused by the same agent
D5) Morbidity (number of childhood illnesses attributed to water borne disease)	Effect	Yes	Yes	Yes	How many children are affected by water borne illness, no matter what the agent.
D6) Mortality (number of child deaths attributed to water borne disease)	Effect	Yes	Yes	Yes	How many deaths of young children can be attributed to water borne illness
D7) Percent of sewage treated before release into local water bodies. – Number of sewage treatment plants per million urban population.	Action	Yes	Yes	Yes	Either measure provides an indication of the priority given to protecting surface waters from bacterial contamination – ultimately to source for much drinking water as well.
D8) Percentage of drinking water systems in violation of local standards	Action	Yes	Yes	Yes	Would need to further consider criteria to be used, e.g. <1 time per year, number of days in violation, etc.

* Information is subject to confirmation

3.2 Issues of Data Quality and Comparability

3.2.1 Asthma and Respiratory Disease, and Air Pollution

All three nations collect good information on respiratory disease and air quality, and while there are differences in the methodologies and air sampling networks used, all three nations collect enough data of sufficient quality to permit assessments and comparisons. Morbidity rather than mortality indicators are suggested because the latter information may be a better indicator of the quality of health care than of environmental health.

The specific concerns include:

- Use of “exceedance” of national standards. While very useful, this can present a problem in that the standard of one nation may be lower than that of another, resulting in fewer exceedances and perhaps masking a problem. However, the national standards better reflect the national conditions. One solution would be to use a common standard such as that published by the World Health Organization (WHO), however this would require more data mining in order to make comparisons possible. Early iterations of a North American children’s health and the environment indicator set might benefit from the application of both approaches in order to assess which provides the more useful information.
- The comparability of air quality data is not an issue however; there may be concerns about the extent of the network used in each nation. All of the major urban centres in North America have air quality sampling systems, however outside of those centres the sampling networks may vary. Also of concern may be differences in sampling locations within cities – for example, if in one nation the monitoring stations are located on rooftops, while in another they are at ground level, results will differ. As long as these variations are noted and understood it will be possible to make comparisons.
- There are different systems used to estimate the number of cases of asthma. Mexico relies upon reports from doctors, who are required to submit reports of diagnoses to the Health Secretariat. In Canada and the US, survey data is used. While the information is collected in very different ways, the results are comparable, assuming the surveys are carried out in an unbiased and statistically sound manner.
- Doctors vary in their likelihood to admit a patient into hospital, for a variety of reasons (hospital policies, ability to pay/insurance coverage, individual decisions of doctors). As such there may be variations in the quality of hospitalization data. This information should therefore be used in association with the survey data described above and may also serve as an indication of a ‘hot spot’ for respiratory distress.

3.2.2 The Effects of Lead Exposure Including Lead Poisoning (acute and chronic)

There is considerable variation between the three nations in terms of the amount and extent of information about lead and its health effects.

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The US is the only North American nation that regularly carries out nation wide blood lead level surveys for children. Canada and Mexico may carry out blood lead level surveys for particular communities in response to specific problems.

The specific concerns include:

- While neither Canada nor Mexico conduct regular national blood lead level surveys, both conduct local/regional surveys in response to specific concerns. Compiled, this data may be used as a starting point in lieu of a full national survey to compare with the US information.
- As children spend most of their time indoors it would be very useful to assess the contamination of the home with lead. The best indicator of this contamination is the concentration of lead in household dust⁵⁵. Unfortunately, this data is not comprehensive for any of the three nations.
- At least in the US, exposure of children to lead is predicted by the age and quality of housing. Information on the age of housing stock is readily available for Canada and the US, and is easily comparable. The availability of this data for Mexico is currently unknown.
- Cases of acute lead poisoning are counted in all three nations, however chronic lead poisoning cases may not be identified, unless medical professionals are aware of the possibility.

3.2.3 Toxic substances (other than lead)

This subject area presents a number of problems regarding the availability, quality and comparability of the indicator data.

- Data on birth anomalies is available for all three nations, but neither Canada nor the US collects complete data sets that cover the entire population. In Mexico, while it is understood that these conditions are captured in reports filed by doctors with the Secretariat of Health, the comprehensiveness of this data set requires confirmation. Thus, it will be necessary to carefully document the extent of that coverage. However, it is anticipated that the available information will permit comparability among the three nations.
- Information on pesticide sales will soon be available for all of North America when Canada establishes its collection system.
- Both Canada and the US have established pollutant release and transfer registers (PRTRs) that cover releases/transfers from many industrial activities. Mexico is establishing a similar program. There is an ongoing effort through the CEC's PRTR program to improve the comparability of the data collected (or to be collected) under these national systems. Currently, only data from the US and Canadian systems are comparable.
- As an indicator, fish consumption advisories are very useful. This information speaks to the presence of toxic chemicals in water and to the population's potential exposure to toxic chemicals. This information can also be used to highlight the geographic extent of toxic pollution. Good and comparable

information is available for Canada and the US, while the situation in Mexico requires further study.

Neuro-developmental outcomes as indicators. It has been suggested by steering committee members that the use of neuro-development outcomes be considered for use as an environmental health indicator based upon the growing body of evidence that exposure to lead and other toxic contaminants affect brain development resulting in lower intelligence, attention deficit and hyperactivity disorders, learning disabilities and even criminal behaviour⁵⁶. Using these health outcomes is compelling because these indicators will speak to the real concerns parents and policy makers (in fields such as health, education, social services, and criminal justice) have.

When discussed as a possibility with key informants a number of problems with using these indicators were highlighted. These included:

- Confounding factors: A number of non-natural environmental factors, particularly lifestyle choices, can cause the same or similar health outcomes. Foetal Alcohol Syndrome being perhaps the most important, however the psycho-social environment for the growing child and genetic influences are both confounders.
- Reliability of diagnosis. Attention deficit and hyperactivity disorders are difficult to diagnose and it is thought by a number of informants that they are over diagnosed in North America. Because of the potential for misdiagnosis it will be difficult to establish a baseline. Without a baseline measure, developing a trend analysis is difficult.
- Lack of databases. None of the three nations currently maintain a reliable database for these conditions (except for criminal statistics).

In spite of the above listed problems, the creation of a health outcome indicator for exposures to neuro-developmental toxins is a desirable goal. To reach that goal for North America, the following conditions will need to be met.

1. Reliable and consistent guidelines for diagnosis will need to be developed
2. Comprehensive databases will need to be established
3. The influence of confounding factors needs to be taken into account.

As well, the one or more specific choices of indicators must be made (rate of ADHD, number of learning disabilities, amount of criminal behaviour, etc.). This choice is at least partially dependant upon the confidence within the scientific community of the links between that health outcome and exposure to environmental contaminants.

3.2.4 Water Borne Disease

Using incidence of water borne disease as a children's health and the environment indicator has limitations. First as is the case of *E. coli* both water and food may carry the same disease, and it is often difficult to identify the source. Furthermore, water borne organisms may cause respiratory as well as gastro-intestinal disease.

- Indicators of the household conditions of children address potential exposures to water borne illness, based upon the assumption that children living in homes with treated, piped water and served with sanitary sewers are not likely to come into

- contact with contaminated water. The available information for these indicators is both comparable and of good quality but is limited to urban dwellers. In rural areas of Canada and the US, residents are often served with good quality septic systems that effectively treat sewage and also have access to clean well water. In these cases, their risks of exposure may be no higher than that of urban dwellers.
- In all three nations, the testing of surface waters for contamination focuses on recreational water such as beaches and certain lakes. Generally the water near cities is tested, and that information can be compiled and used for comparisons across the three nations. Care must be taken to document methodologies, and the extent of the sampling network when populating this indicator.
 - There are three suggested indicators for the health effects of water borne illnesses. These include the number of outbreaks of water borne disease, morbidity due to water borne disease, and mortality due to water borne disease. Many mild cases of water borne disease may be self-treated, without reports ever reaching a medical officer of health. Similarly, it is likely that many doctor treated cases are not identified as water borne making data for the number of outbreaks and morbidity questionable for all three nations. Mortality data may be more reliable, however the number of deaths resulting from water borne illness may be a better indicator of the quality of medical treatment, than of environmental health. That said, the best available data is comparable and of a high enough quality to be used as an indicator of children's health and the environment for North America.

3.3 Discussion and Recommendations

The WHO's DPSEEA (Driving Force, Pressure, State, Exposure, Effect, Action) framework for environmental health indicators offers a good starting point for any work on environmental health indicators. The Multiple Exposures – Multiple Effects model developed by WHO, as an adaption of DPSEEA, is better suited to children's health and the environment concerns, and should be used as the general framework for the North American initiative.

Any framework requires a clear focus. However, too tight a focus will cause the indicator set to be less useful in identifying new threats and emerging issues. We recommend that there be an ongoing review of child mortality and morbidity data that, combined with an up-to-date understanding of how the environment affects the health of children, will permit the identification of novel and emerging children's health and the environment priorities.

When addressing the needs for environmental health indicators for three different nations it becomes necessary to maintain a degree of flexibility in the selection of indicators and in the collection methodologies. The recommended implementation strategy outlined above offers flexibility to each nation in collecting the information required to assess the condition of children's health and the environment within the identified priority areas. It is expected that there will be a similar quality of data and information for some indicators (such as urban air, and disease prevalence) while for other indicator types the availability

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and or the quality of data will differ significantly between the three nations (for example, blood lead levels). The suggested implementation approach allows for one nation to collect and use a greater or lesser depth of data than is collected by the others. It also allows for change over time in the types of indicators collected and the methodologies used to collect that information. To begin, each nation can use the information that is currently available while adding new information as it becomes available without threatening the integrity of the framework.

Summary of recommendations:

- 1) Identify the priority issues at the beginning of the indicator initiative and maintain an ongoing reassessment of these priorities.
- 2) Maintain an ongoing review of basic morbidity and mortality data along with environmental health research findings to identify potential emerging issues
- 3) Begin with a flexible implementation approach using existing data and information.
- 4) Document data collection methodologies and population indicator sets

The indicator sets provided in this document are meant to be a starting point and are intended to be reviewed and modified as needed.

Conclusion:

Based upon the document review, informant interviews and steering committee discussions it is possible to develop and populate a set of indicators that can be used to assess children's health and the environment across North America.

3.4 Data Sources and Feasibility

Based upon information from key informants, documents and other research, the table below provides:

- An assessment of the feasibility of collecting information for a potential set of indicators.
- Sources for indicator information in Canada, Mexico and the United States.

Children's Health and the Environment Indicator Report: Canada

Priorities:

The Government of Canada through the Minister of Environment has expressed in a number of international forums (Health and Environment Ministers of the Americas - HEMA, CEC, World Summit on Sustainable Development - WSSD) his support for children's health and the environment work and a particular interest in how air quality affects child health. Canada is supportive of partnering with the WHO and the EPA on children's health and the environment initiatives. While the Canadian Government has not identified specific priorities within the field of children's health and the environment, it has made clear that how the environment affects the health of children is an important concern. Both Environment Canada and Health Canada have dedicated resources that directly address how the environment can affect child health. Environment Canada, through the Voluntary Sector Initiative, is providing substantial funding for "*Children's Environmental Health: Building capacity for policy development and facilitating policy change*", a project that will help to develop a Canada wide network of organizations interested in and working on children's health and the environment issues and to help the Government of Canada develop policy to address such issues.

Sources for indicator information:

Within Canada there are currently efforts underway to develop Environmental Public Health Indicators being driven by Health Canada, Environment Canada and the Canadian Institute for Health Information. The National Round Table on the Environment and the Economy are in the process of developing Sustainable Development Indicators.

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Indicator	Data Source	Feasibility
Air quality measurements (ground level ozone, PM10, etc)	<ul style="list-style-type: none"> Environment Canada compiles national data using the “The National Air Pollution Surveillance (NAPS) network monitors and assesses the quality of ambient air in Canadian cities and towns. The network was established in 1969 as a joint initiative of federal, provincial, and municipal governments. Overall, coordination is provided by the Analysis and Air Quality Division of Environment Canada. Most NAPS stations (around 180 but varies depending on the year and pollutant being measured) monitor all five common air pollutants, which are sulphur dioxide (SO₂), nitrogen dioxide (NO₂), carbon monoxide (CO), ground-level ozone (O₃), and total suspended particulates (TSP). Sulphur dioxide, nitrogen dioxide, and ground-level ozone readings are one-hour averages taken every hour throughout the year”. Trends available for O₃ since 1982 and since 1980 for the other 4 pollutants. PM10 monitoring (manually every 6 days) began in 1984 but only in 9 cities (12 in 2000) Data available as actual values, percent of standards or “good / fair / poor days” based on an index linked to standards. Actual values are best for comparisons since the 3 countries don’t have the same standards. <p>From: http://www.ec.gc.ca/soer-ree/English/Indicators/Issues/Urb_Air/Tech_Sup/uasup1_e.cfm</p>	Yes
% Children exposed to air pollution exceeding standards	<ul style="list-style-type: none"> Will require cross referencing census data from Statistics Canada with the air quality information from NAPS, however the Census Metropolitan Areas often used to cross reference only cover population centres of greater than 100,000 people, about 64% of the Canadian population. For Canada, this indicator could be phrased as “Percentage of urban children exposed to air pollution exceeding standards”. It should not be forgotten that children living in rural situations and smaller centres may also be exposed to air pollution through the drift of air pollution from industrial areas and from local sources such as a local industry and in certain cases, the heavy reliance on wood for heating. 	Yes
% Children under 18 with asthma	<ul style="list-style-type: none"> Statistics Canada includes questions regarding asthma in household surveys. This information is compiled and used by both Health Canada and the Canadian Institute of Health Information (CIHI) 	Yes

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Indicator	Data Source	Feasibility
Hospitalizations due to respiratory distress	<ul style="list-style-type: none"> Collected and compiled by CIHI 	Yes
% Children served with treated water	<ul style="list-style-type: none"> Environment Canada compiles the “Municipal Water Use Data Survey”(MUD) that collects information about water and sewage treatment including any boil water advisories (older data has problems, zero value represents both no data and no advisory), the level of treatment, source of water, how disinfection is accomplished (1994 only), number of days with water use restrictions etc. Does not include measurements of microbial or other pollution except for BOD as effluent from sewage treatment. The information on treated water is only for places that have services and for municipalities with 1000 or more people. Many Canadians rely upon wells Some of the MUD information has been compiled to present the percentage of the population serviced by wastewater treatment. (this belongs in following indicator) It will be necessary to cross-reference this information with census data from Statistics Canada. 	Yes
% Children (households) served with sanitary sewers	<ul style="list-style-type: none"> Some of the MUD information has been compiled to present the percentage of the population serviced by wastewater treatment. It will be necessary to cross-reference this information with census data from Statistics Canada. The MUD database give details on “% of population served by sewers that have treatment”, only 75% of Canadians are on sewers, 97% of those have treatment. Of the remaining 25% of the population, most are on septic systems which quite likely provide good levels of treatment however that quality is difficult to access. <p>See http://www.ec.gc.ca/soer-ree/English/Indicators/Issues/Urb_H2O/Bulletin/uwind3_e.cfm</p>	Yes
Faecal coliform presence in surface water	<ul style="list-style-type: none"> It will be necessary to compile data collected by a number of institutional actors including local and Provincial government agencies. 	Yes, for populated areas and recreationally used waters
Incidence of diarrhoeal	<ul style="list-style-type: none"> There are a number of water (and food) borne diseases (including: 	Yes, however only with the recognition

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Indicator	Data Source	Feasibility
disease in children	Campylobacteriosis, Giardiasis, Salmonellosis and Verltoxigenis E. coli) that must be reported upon diagnosis. Generally the local Medical Officer of Health receives the first reports. These reports are compiled by the Provincial Ministries of Health and then Health Canada may compile into a national report. It is thought that as few as 10% of all incidence of food/water bourn illnesses are reported	that many cases will not be reported – many are treated without reference to the medical system.
Morbidity (# of childhood illnesses attributed to water borne disease)	<ul style="list-style-type: none"> To populate this indicator the information collected on diarrhoeal disease will need to be separated into cases caused by water and cases caused by food. Generally the local medical officer of health traces the origins of any outbreak of these diseases. This information is compiled by provincial Ministries of Health. CIHI is building this information into their health indicators data set. There will also be a need to mine the data to address cases for children. 	Yes, however it may be necessary to mine the data extensively that may result in a time consuming and expensive process
Mortality (# of child deaths under 5 attributed to water borne disease)	<ul style="list-style-type: none"> Statistics Canada collects information and reports on all deaths in Canada 	Yes
Blood lead levels, number of children with blood lead > 10ppm	<ul style="list-style-type: none"> The last cross Canada survey of blood lead levels in children was in 1978. Since then there has only been local surveys in response to local concerns such as the presence of a lead recycler or smelter. 	Partly, there are a number of regional/local surveys but no national program currently. Over time there may be greater harmonization for the collection of this information for all three nations.
Children living in housing with lead dust above a threshold	<ul style="list-style-type: none"> There are indications the a problem may exist in many homes, particularly older homes that were painted with lead containing paints prior to 1978, and particularly before 1950. 	No, although local studies point to a significant problem in unexpected areas
Number of residences built before 1950	<ul style="list-style-type: none"> These home are often highly lead contaminated due to old paint. Renovations often release large quantities of lead into the home. Statistics Canada does collect information about the age of housing units during census and surveys. 	Yes

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Indicator	Data Source	Feasibility
Incidence of lead poisonings	<ul style="list-style-type: none"> Health Canada does compile reports of acute lead poisonings in Canada, however these are few as it is the indicator “Blood lead levels, number of children with blood lead > 10ppm” that provides more useful information. 	Yes – although it is thought that many cases are not diagnosed as lead poisoning
Birth anomalies such as neural tube defects or hypospadias	<ul style="list-style-type: none"> The provincial governments maintain data bases and most contribute to a National registry, however Ontario, which account for almost ½ of all births in Canada does not participate. It will be important to collect information of the number of pregnancy terminations due to birth defects. The Canadian Perinatal Surveillance system is maintained by Health Canada and data is collected through this system. 	Yes, however some provinces do not systematically collect conventional birth anomalies data
Sales of pesticides, other chemicals	<ul style="list-style-type: none"> Environment Canada has collected and presented this information in the past. According to Agriculture and Agri-Food Canada “Until 1999 there existed no national database on the use of pesticides in Canada except for the broad-scale statistics collected through the Census of Agriculture and sales information collected by the Crop Protection Institute (an industry organization)”. Now a National Pesticides Sales Database is being prepared by Health Canada’s Pest Management Regulatory Agency, supported by data from the Crop Protection Institute. Some provinces (e.g., Alberta, Ontario, and Quebec) also maintain databases on pesticide use. According to the census, the area of farmland receiving herbicides grew by 8% between 1991 and 1996, from 21.4 to 23.1 million hectares, or from about 52% to 56% of cultivated land” http://res2.agr.ca/research-recherche/science/Healthy_Water/e04e4.html This database is not yet accessible. 	Yes, while no mandatory system across Canada currently exists there is reasonable information for an assessment of the use of pesticides.
Pollutant Release and Transfer Register (PRTR)	<ul style="list-style-type: none"> Environment Canada’s developed and maintains the National Pollutant Release Inventory that collects information on a large number of pollutants released into the air, water and land. This information contributes to the “Taking Stock” program of the CEC. Data is collected from large facilities only and reporting thresholds are temporally variable. Differing definitions of “toxic” will affect what list of substances as reported on in each country, as will the speed of analysing chemicals to decide if that substance will be included in the inventory. The 	Yes, with qualifications regarding the possibility of the list changing over time and the identification of the threshold variability.

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Indicator	Data Source	Feasibility
	TSRI may change the list of subject chemicals over time.	
Fish consumption advisories	<ul style="list-style-type: none"> Because fish bio concentrate many persistent pollutants including mercury and PCBs health and environmental authorities are concerned about the consumption of various fresh and salt water fish, particularly for women of child bearing age and young children. 	Yes, mostly through provincial authorities and for fish in or near populations also for widely sold sea fish such as swordfish and tuna.

Children’s Health and the Environment Indicator Report: Mexico

Priorities:

Programa de Acción en Salud Ambiental (PRASA), (National Action Plan on Environmental Health):

- Component of the *Programa Nacional de Salud* (National Health Plan 2001-2006)
- Target populations: vulnerable groups, including children under 5, women of child-bearing age, workers, indigenous groups, adults over 65

General facts according to the (*PRASA*):

- 35% of the burden of disease can be linked to environmental exposures
- There are 6,000 pesticide intoxications registered annually. From the non-occupational ones, 61% affect children under 6 years and 16% of all pesticide related deaths happen in children.
- 150,000 people consume water with concentrations of arsenic well above the national norm.
- In households where wood is used as fuel, the occupants, predominantly women and girls are exposed to 350 IMECAs (see below for an explanation) during several hours/day.

The main programmatic areas of PRASA are:

- Physical risks
- Water quality

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- Sound management of wastes and waste water
- Heavy metals and their effect on human health
- Global environmental health
- Environmental and occupational risks control in medical care activities
- Industrial emergencies
- Sound management of chemicals
- Air pollution

Mexico has undertaken important steps towards the monitoring of environmental health of the population through the *Diagnostico de Salud Ambiental y Ocupacional* (Environmental and occupational health assessment) – published in the summer of 2002. (see section 1.3)

Sources for indicator information:

Mexico has a national system to collect epidemiological data called *Sistema Nacional de Vigilancia Epidemiologica (SINAVE)*. The *Secretaria de Salud* (Health Secretariat) is the Federal authority responsible for the program at a national scale, which collects epidemiological information from all health centres in the country. Compliance with the norm NOM-017-SSA2-1994 is obligatory and includes the public, social and private sectors that must conform to the *Sistema Nacional de Salud* (National Health System).

Environmental information is generated by the *Secretaria de Medio Ambiente (SEMARNAP)* and the *Instituto Nacional de Ecologia (INE)*. Health information is generated by the *Secretaria de Salud*, and census information comes from the *Instituto Nacional de Estadística, Geografía e Informática (INEGI)*. Other socio-economic data can be obtained from the *Secretaria de Desarrollo Social (SEDESOL)*, and the *Consejo Nacional de Poblacion (CONAPO)*.

Environmental information is generated by the *Secretaria de Medio Ambiente (SEMARNAP)* and the *Instituto Nacional de Ecologia (INE)*. Health information is generated by the *Secretaria de Salud*, and census information comes from *Instituto Nacional de Estadística, Geografía e Informática (INEGI)*. Other socio-economic data can be obtained from the *Secretaria de Desarrollo Social (SEDESOL)*.

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There is a national program to monitor air quality in major urban centres (Red Nacional de Monitoreo Atmosférico). In Mexico City, there is a program to monitor and improve the air quality in the Mexico Valley region (PROAIRE). This program measures “contingency” and “pre-contingency” levels of pollution, and collects health information data (primarily respiratory information) from selected health centres in the region. Contingency and pre-contingency levels are set according to the IMECA index (see below).

Indicator	Data Source	Feasibility
<p><i>Air quality measurements</i> (ground level ozone, PM10, etc)</p>	<p>Imeca – Índice Metropolitano de Calidad de Aire. A qualitative index for air quality that translates the national norm to the general population. 100 corresponds to Satisfactory, from 101 to 200 corresponds to Unsatisfactory, from 201 to 300 corresponds to Bad and 301 and over is considered Very Bad.</p> <p>The National Norm in Mexico to evaluate air quality are: O₃ NOM-020-SSA1-1993 (0.11 ppm as an average for an hour 216 µg/m³) SO₂ NOM-022-SSA1-1993 (0.13 ppm as a mobile average for 24 hours 341 µg/m³) NO₂ NOM-023-SSA1-1993 (0.21 ppm as the average for one hour 395 µg/m³) CO NOM-021-SSA1-1993 (11 ppm as a mobile average for 8 hours 12595 µg/m³) PM₁₀ NOM-026-SSA-1993 (150 µg/m³ as the mobile average of 24 hours)</p> <p>Information source: NOM-020-SSA1-1993, Instituto Nacional de Ecología – INE</p>	<p>Yes</p>
<p>% Children exposed to air pollution exceeding standards</p>	<ul style="list-style-type: none"> • Instituto Nacional de Estadística, Geografía e Informática (INEGI) generates regular census data for the entire country. • Red de monitoreo ambiental generates air quality information for most urban centres • Data on health outcomes as a consequence of bad air quality is generated for the Mexico Valley region through the program 	<p>Yes</p>

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Indicator	Data Source	Feasibility
	<p>PROAIRE.</p> <ul style="list-style-type: none"> Potential problem in using respiratory disease information (collected on a monthly basis) vis-à-vis days out of norm for air quality information (collected on an annual basis) 	
% Children under 18 with asthma	<ul style="list-style-type: none"> Morbidity and mortality rates collected by the national system of epidemiological surveillance. Actual cases 	Yes
Hospitalizations due to respiratory distress	Information available from the national system of epidemiological surveillance. They use the disease classification protocol from the WHO	
% Children served with treated water	<ul style="list-style-type: none"> Health Services at the state level, Comisión Nacional del Agua (CNA); INEGI; Consejo Nacional de Poblacion (CONAPO) Currently information is not broken down by age groups, but it would be feasible to collect it in the future Access to treated drinking water is also very limited. According to the 2000 national census, almost 20% of the population does not have access to piped water, which affects more than 18 million people. 	Yes
% Children (households) served with sanitary sewers	<ul style="list-style-type: none"> The Comisión Nacional del Agua (CNA) is the federal authority in charge of planning and executing all activities related to water, including sewers and water treatment plant. INEGI collects general census data. According to the 2000 census, 1 out of 3 dwelling does not have a sewer system, which translates to approximately 26% of the total population. This situation is even more critical in the southernmost states of Oaxaca, Guerrero, Yucatan, San Luis de Potosi and Chiapas, which can be anywhere between 60-40% of the population that does not have access to sewer systems. 	Yes
Faecal coliform presence in surface water	<ul style="list-style-type: none"> Information collected at the municipal/state level NOM-127-SSA1-1994: <p>Total Coliform organisms: 2 NMP/100 ml (NMP= most probable)</p>	Yes, there is a norm but collection is not consistent across entire nation

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Indicator	Data Source	Feasibility
	number) or 2 UFC/100 ml (UFC= colony forming units) Fecal Coliform organisms: No detectable NMP/100 ml or Zero UFC/100 ml	
Incidence of diarrhoeal disease in children (percentage of diarrhoeal disease in children)	Data collected through the Sistema Unico Automatizado de Vigilancia Epidemiologica (SUAVE) (Secretaria de Salud), Health Services at the state level, Consejo Nacional de Poblacion (CONAPO). Also data published on a weekly basis.	will confirm
Morbidity (# of childhood illnesses attributed to water borne disease)	Data collected through the Sistema Unico Automatizado de Vigilancia Epidemiologica (SUAVE) (Secretaria de Salud), Health Services at the state level, Consejo Nacional de Poblacion (CONAPO). Also data published on a weekly basis.	Yes
Mortality (# of child deaths under 5 attributed to water borne disease)	<ul style="list-style-type: none"> Data collected through the Sistema Unico Automatizado de Vigilancia Epidemiologica (SUAVE) (Secretaria de Salud), Health Services at the state level, Consejo Nacional de Poblacion (CONAPO). Also data published on a weekly basis. 	Yes
Blood lead levels, number of children with blood lead > 10ppm	<ul style="list-style-type: none"> Current data does not cover the entire children population. Only data from population living or working in industrial areas is available. There is a proposal to collect blood samples from children currently being considered. It has been identified as a problem, especially in cottage industries affecting a large segment of the population. 	Partly, there are a number of regional/local surveys but no national program currently
Children living in housing with lead dust above a threshold	<ul style="list-style-type: none"> Data not collected. Until recently, the majority of the houses were painted with lime, not containing lead. 	No
Number of residences built before 1950	<ul style="list-style-type: none"> Not relevant (see item above) 	Not relevant
Incidence of lead poisonings	This information is collected only for industrial areas, which does not include poisonings in cottage industry	*
Birth anomalies such as neural tube defects or hypospadias	<ul style="list-style-type: none"> Information collected through the Sistema Nacional de Salud, Health Secretariat 	Potentially * Collectable but not by the environmental health unit

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Indicator	Data Source	Feasibility
Pollutant Release and Transfer Register (PRTR)	<p>Registro de Emisiones y Transferencia de Contaminantes (RETC)</p> <ul style="list-style-type: none"> Based on information included in one section of an integrated industry reporting and permitting form, the Cedula de Operacion Annual (COA). Semarnat is the Federal authority in charge of COA data and the RETC program. Mexico reports on 110 substances from 11 industrial sectors, but reporting is voluntary. In December 2001, Mexico adopted legislation for mandatory and publicly accessible RETC. The Government is committed to enhancing comparability of data in the region, as indicated by the CEC's Council Final Communiqué in June 2002. 	Mandatory reporting system (RETC) is under development*

* Information subject to confirmation

Children’s Health and the Environment Indicator Report: United States

Priorities:

In 1996, the U.S. Environmental Protection Agency (EPA) implemented a seven-step *National Agenda to Protect Children’s Health from Environmental Threats*. This policy document directs the EPA to take children’s particular vulnerabilities into account when conducting risk assessments, and in setting public health standards for the United States. The *Agenda* outlines a number of priority areas for action on the part of the EPA, including asthma and other respiratory effects, childhood cancer, developmental and neurological toxicity, the health effects of pesticides, potential risk from contaminated surface and ground water, as well as public access to information.

President Clinton signed an Executive Order on the *Protection of Children from Environmental Health Risks and Safety Risks* in 1997, which requires all federal agencies to make the health and safety of children a high priority. One product of this Order was the creation of a Task Force on Environmental Health Risks and Safety Risks to Children. The aim of this Task Force is to coordinate the research agenda on children’s health and the environment, and to engage in public consultations around children’s health and the environment issues. In order to implement President Clinton’s Order, and the *National Agenda*, the EPA created the *Office of Children’s Environmental Health Protection (OCHP)* in May of 1997. Children’s health and the environment continues to be a priority for the Bush Administration and they have continued to support the OCHP.

Sources for indicator information:

Indicator	Data Source	Feasibility
Air quality measurements (ground level ozone, PM10, etc)	State and local environmental agencies measure concentrations of six criteria pollutants (carbon monoxide, nitrous dioxide, ozone, lead, PM10, sulphur dioxide), submit data to the EPA, which compiles it in a national database (Aerometric Information Retrieval System) and calculates exceedances, ambient concentration estimates, and the Air Quality Index (AQI)	Yes

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Indicator	Data Source	Feasibility
% Children exposed to air pollution exceeding standards	EPA obtains this percentage by cross-referencing its air quality data with the U.S. Census Bureau's Population by Race and Age data for counties in the U.S.	Yes
% Children under 18 with asthma	Data on the prevalence of asthma is collected by the National Center for Health Statistics through its National Health Interview Survey (NHIS). This is a nationwide sample survey of the civilian non-institutionalized population, in which data are collected through household interviews.	Yes
Hospitalizations due to respiratory distress	Data is collected by the National Center for Health Statistics (Hospital Care Statistics Branch), through its National Hospital Discharge Survey (NHDS). The NHDS draws on data from a sample of 270,000 in-patient records, from a national sample of approximately 500 hospitals.	Yes
% Children served with treated water	EPA sets national standards for drinking water, and maintains the Safe Drinking Water Information System (SDWIS), a national regulatory compliance database. States report any violations of EPA standards to the Office of Ground Water and Drinking Water. The EPA estimates the number of children served by the public water system by determining the ratio of children in the state where the public water system resides, and multiplying by the number of people served by that water system.	Yes
% Children (households) served with sanitary sewers	United States Census Bureau collects data on the number of households served with sanitary sewers, through its American Housing Survey. The percentage of children served with sanitary sewers could be obtained by cross-referencing with Census data on Population by Race and Age.	Yes
Faecal coliform presence in surface water	Microbiological quality of surface water is collected locally and for local purposes (i.e. to judge compliance with local standards for protection of public health). Monitoring methods vary with the objectives of those collecting the data, and thus it is difficult to provide a nationally consistent picture of the microbial quality of U.S. surface water. The U.S. Geological Survey has conducted a feasibility study to integrate local efforts into a national	Yes, but with a focus on beach water

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Indicator	Data Source	Feasibility
	microbiological monitoring program, under the National Water Quality Assessment (NAWQA) Program.	
Incidence of diarrhoeal disease in children	Data on the prevalence of diarrhoeal disease in children is collected by the National Center for Health Statistics through its National Health Interview Survey (NHIS). This is a nationwide sample survey of the civilian non-institutionalized population, in which data are collected through household interviews.	Yes
Morbidity (# of childhood illnesses attributed to water borne disease)	Data available from the Morbidity and Mortality Weekly Report (MMWR) published by the Centers for Disease Control. Surveillance reports contain data reported by state and territorial health departments.	Yes
Mortality (# of child deaths under 5 attributed to water borne disease)	Data available from the Morbidity and Mortality Weekly Report (MMWR) published by the Centers for Disease Control. Surveillance reports contain data reported by state and territorial health departments.	Yes
Blood lead levels, number of children with blood lead > 10ppm	Data obtained through the National Health and Nutrition Examination Surveys (NHANES) II and III, conducted by the National Centre for Health Statistics.	Yes
Children living in housing with lead dust above a threshold	Prevalence of lead-based paint hazards in U.S. housing available from the U.S. Department of Housing and Urban Development. The number of U.S. children living in housing with lead hazards could be obtained by cross-referencing with Census data on Population by Race and Age.	Partial
Number of residences built before 1950	United States Census Bureau collects data on the years that surveyed structures were built, through its American Housing Survey.	Yes
Incidence of lead poisonings	Data available from the Morbidity and Mortality Weekly Report (MMWR) published by the Centers for Disease Control. Surveillance reports contain data reported by state and territorial health departments.	Yes
Birth anomalies such as neural	State surveillance programs exist, and the CDC's National Center	Currently 40 states systematically collect

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Indicator	Data Source	Feasibility
tube defects or hypospadias	for Health Statistics (NCHS) conducts surveys of these programs. The NCHS also compiles birth defect data from checkboxes that appear on birth certificates. The National Birth Defects Prevention Network (NBDPN) (in cooperation with the CDC) collects both state and population-based birth defect surveillance data.	birth anomalies data
Sales of pesticides, other chemicals	No program currently exists that estimates the overall U.S. pesticide market in quantitative and dollar terms each year. However, the EPA and U.S. Department of Agriculture have coordinated their efforts to improve available data. The EPA has focused on non-agricultural use, while the USDA has focused on agricultural use of pesticides. EPA conducted a survey of pesticide usage by homeowners in 1990, and another survey of usage by commercial applicators in 1993. Since 1990, USDA's National Agricultural Statistics Service (NASS) and Economic Research Service (ERS) have been conducting annual surveys of pesticide use on field crops, and alternate-year surveys for selected vegetables and fruits.	Yes
Toxic Substances Release Inventories	The U.S. Environmental Protection Agency maintains Toxics Release Inventory (TRI). This database contains information on toxic chemical releases and other waste management activities reported annually by certain covered industry groups and federal facilities. The TRI contains information on releases of nearly 650 chemicals and chemical categories.	Yes

APPENDIX 1: Core sets of indicators from WHO European Region, Briggs (2002), and America's Children and the Environment: A First View of Available Measures

A. WHO European Region

Issue	Driving Force	Pressure	State	Exposure	Effect	Action
Air Quality	Annual passengers-kilometres travelled by mode of transport Annual average consumption of fuel by type from road transportation	Annual emissions of SO ₂ , PM ₁₀ , secondary PM ₁₀ , NO _x , VOC; total and by economic sector		Population-weighted exceedance of the reference concentration of NO ₂ , PM ₁₀ , (or BS or TSP) and SO ₂ ; 8hr average O ₃	Mortality due to respiratory diseases in children > one month and < one year of age Mortality due to respiratory diseases all ages Mortality rate due to diseases of circulatory system – all ages	Capability for implementing and enforcing policies on Environmental Tobacco Smoke Exposure
Housing and Settlements			Average living floor area per person	Percentage of the population living in substandard housing	Mortality due to external causes (domestic accidents, poisonings) in children <5 years	Scope and application of building regulations for housing Scope and application of regulations for land use planning in human settlements
Traffic Accidents					Mortality due to transport accidents Annual injury due to transport accidents	
Noise					% Population annoyed by certain sources of noise* % Population with sleep disturbance due to noise*	Capability to implement noise regulations and abatement measures
Waste and Contaminated Land		Annual amount of hazardous waste	Contaminated land sites			Scope and application of hazardous waste policies

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Land		generated and imported				
Radiation					Annual incidence rate of skin cancer	Existence of effective environmental monitoring of radiation activity in compliance with national and international programmes
Water (Recreational and Drinking) and Sanitation		Waste water treatment coverage	Exceedance of limit values recreational: microbiological * Exceedance of WHO guideline values for drinking water: microbiological * Exceedance of WHO guideline values for drinking water: chemical*	% of the population with access to safe drinking water % of the population with access to adequate sanitation	Outbreaks of water-borne diseases: number of outbreaks and total number of cases Diarrhoea morbidity in children under 5 years of age*	Effective monitoring of recreational water
Food Safety				Exposure to potentially hazardous chemicals monitored in food*	Outbreaks of food-borne diseases: number of outbreaks and total number of cases Incidence of food-borne disease	General food and safety policy Effectiveness of food safety controls
Chemical Emergencies		Number of sites containing large numbers of chemicals			Mortality rate from chemical incidence*	Regulatory requirements for land-use planning around upper tier establishments containing large amounts of chemicals Medical treatment guidelines Existence of poison centres service Government preparedness Chemical incidents register

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Workplace					Occupational injury fatality rate Annual incidence rate of occupational injury and illness* Sickness absence rates*	Statutory reports of occupational disease
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Taken from “*Environmental Health Indicators for the WHO European Region: Update of Methodology*” May 2002

* The Indicators marked with * are for future implementation across Europe since they require major harmonization.

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Table 2. Overview of WHO indicators for children's environmental health

	Context	Exposure	Health outcome	Action
Perinatal diseases	Children aged 0-14 years living in poverty	Famine risk	Perinatal mortality rate	Women of childbearing age within one-hour's travel of specialist maternity and perinatal care
		People living in informal settlements	Intrauterine growth retardation in newborn children	Annual rate of change in number of households lacking basic services
		Women of childbearing age who are malnourished	Congenital malformations requiring surgical correction in children under 1 year of age	Prevalence of stunting in children aged 0-4 years
		Women of childbearing age working in unregulated workplaces		
		Births to mothers living in unsafe or hazardous housing		
Respiratory diseases	Children aged 0-14 years living in poverty	Children aged 0-14 years living in unsafe, unhealthy or hazardous housing	Intrauterine growth retardation in newborn children	Annual rate of change in tobacco consumption
		Overcrowding	Mortality rate for children aged 0-4 years of age due to acute respiratory illness	Annual rate of change in atmospheric pollutant concentrations
		Children aged 0-14 years living in proximity to heavily trafficked roads	Morbidity rate for children aged 0-4 years due to acute respiratory illness	Annual rate of change in numbers of households relying on biomass fuels or coal as the main source of heating or cooking
		Mean annual exposure of children aged 0-4 years to atmospheric particulate pollution	Prevalence of chronic respiratory illnesses in children aged 0-14 years	
		Children aged 0-4 years living in households using biomass fuels or coal as the main source of heating and cooking fuel		
		Children aged 0-14 years living in households in which at least one adult smokes on a regular basis		
Diarrhoeal diseases	Children aged 0-14 living in poverty	Drinking water supplies failing national microbiological water quality standards	Diarrhoea mortality rate in children aged 0-4 years	Annual rate of change in the number of households lacking basic amenities

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		People living in informal settlements	Diarrhoea morbidity rate in children aged 0-4 years	Annual rate of change in number of food outlets failing food hygiene standards
		Children aged 0-14 years living in disaster-affected areas	Recurrence rate of outbreaks of diarrhoeal disease amongst children aged 0-14 years	Children aged 0-4 years able to obtain rehydration therapy within 24 hours of need
		Children aged 0-14 years living in households without basic amenities for water supply, sanitation and hygiene		
Insect-borne diseases	Population growth rate in areas endemic for insect-borne diseases	Total area of insect vector habitats	Mortality rate of children aged 0-4 years due to insect-borne diseases	At-risk children aged 0-14 years covered by effective, integrated vector control and management systems
		Children aged 0-14 years living in households providing suitable conditions for insect-borne disease transmission	Prevalence of insect-borne diseases in children aged 0-14 years	
		Children aged 0-14 years living in areas endemic for insect-borne diseases		
Physical injuries	Children aged 0-14 years living in poverty	People living in informal settlements	Mortality rate of children aged 0-14 years due to physical injuries	Children aged 0-14 years living within reach of specialist emergency medical services
		Children aged 0-14 years living in disaster-affected areas	Incidence of physical injuries to children aged 0-14 years requiring treatment	Annual rate of change in physical injuries to children aged 0-14 years
		Children aged 0-14 years living in proximity to heavily trafficked roads		
		Children aged 0-14 years involved in routine employment		
		Children aged 0-14 years living in unsafe, unhealthy or hazardous housing		
		Children aged 0-14 years living in homes lacking connections to a piped water supply		

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C. America's Children and the Environment: A First View of Available Measures (USEPA)

Environmental Contaminants

Outdoor Air:

- Percentage of children living in counties in which air quality standards were exceeded.
- Percentage of children's days with good, moderate or unhealthy air quality
- Percentage of children living in counties where at least one hazardous air pollutant concentration was greater than a health benchmark in 1990
- Percentage of homes with children under 7 where someone smokes regularly

Drinking Water Contaminants

- Percentage of children living in areas served by public water systems that exceeded a drinking water standard or violated treatment requirements
- Percentage of children living served by public water systems in which the nitrate/nitrite standard was exceeded
- Percentage of children living in areas with major violations of drinking water monitoring and reporting requirements

Pesticide Residues in Foods

- Percentage of fruits, vegetables, grains, dairy and processed foods with detectable pesticide residues.

Land Contaminants

- Percentage of children living in counties with Superfund sites
- Percentage of children living in counties that had Superfund sites in 1990

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Biomonitoring

Concentrations of lead in blood

- Average concentrations of lead in blood for children 5 and under
- Percentage of children ages 1 – 5 with concentration of lead in blood greater than 10 micrograms per decilitre

Childhood DiseaseRespiratory Disease

- Percentage of children under 18 with asthma and chronic bronchitis
- Percentage of children under 18 with asthma, 1997-98
- Asthma Hospitalization rate for children 0-14

Cancer

- Cancer Incidence and mortality for children under 20
- Cancer incidence in children under 20 by type

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