13 April 2004

Subject: Draft Report *Taking Stock: A Special Report on Toxic Chemicals and Children's Health in North America*

On behalf of the Secretariat of the Commission for Environmental Cooperation (CEC), I would like to invite your comments on the above-noted draft report on toxic chemicals and children's health. A copy is available at: <http://www.cec.org/pubs_docs/documents/index.cfm?varlan=english&ID=1457>.

The preparation of this report stems from the CEC's *Cooperative Agenda for Children's Health and the Environment in North America* <http://www.cec.org/pubs_docs/documents/index.cfm?varlan=english&ID=794> and forms part of the CEC's *Taking Stock* report series. This draft report analyzes, from the perspective of children's health, publicly available data from the National Pollutant Release Inventory (NPRI) in Canada and the Toxics Release Inventory (TRI) in the United States. The current draft presents data for the 2000 reporting year and tracks trends from 1995–2000. It should be noted that as releases do change over time, these data may not reflect the current situation. For that reason we are proposing to include Taking Stock data for 2002 in the final version of this report. Please note that reporting under the Mexican *Registro de Emisiones y Transferencia de Contaminantes* was voluntary in 2000, thus comparable data are not available for Mexico. The Secretariat will also work with the Parties to call together some key experts to provide their input into the document through a peer review process. The expert review will also consider comments received within the comment period.

I look forward to receiving your comments by 15 May 2004. Please direct your ideas and feedback to <info@ccemtl.org> with "Comments on Draft Report" in the subject line. Please also note that this is a draft report. The views contained within the draft report should not be interpreted as representing the views of the CEC, or the governments of Canada, Mexico or the United States of America.

Sincerely,

William V. Kennedy
Executive Director
Commission for Environmental Cooperation

TAKING STOCK

A Special Report on Toxic Chemicals and Children's Health in North America

Commission for
Environmental Cooperation
of North America

March 2004

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The Commission for Environmental Cooperation (CEC) was established under the North American Agreement on Environmental Cooperation to address environmental issues in North America from a continental perspective, with a particular focus on those arising in the context of liberalized trade.

This draft report was prepared by the Secretariat of the Commission for Environmental Cooperation (CEC) of North America. The views contained herein do not necessarily reflect the views of the CEC, or the governments of Canada, Mexico or the United States of America.

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Disclaimer

The National Pollutant Release Inventory (NPRI) and the Toxics Release Inventory (TRI) data sets are constantly evolving, as facilities revise previous submissions to correct reporting errors or make other changes. For this reason, both Canada and the United States "lock" their data sets on a specific date and use the "locked" data set for annual summary reports. Each year, both countries issue revised databases that cover all reporting years.

The CEC follows a similar process. For the purposes of this report, the TRI data set of May 2002 and the NPRI data set of January 2002 were used. The CEC is aware that changes have occurred to both data sets for the reporting year 2000 since this time that are not reflected in this report.

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Executive Summary

Across North America, in every school, playground and home, are the eager faces of our children. We do whatever we can so they grow up healthy. Social, biological and environmental factors will interact in complex ways to affect their health. In this report, we focus on one of these environmental factors—toxic chemicals—that can affect children's health adversely. The unique vulnerabilities and exposures of children pose a responsibility for us, the "grown-ups" of North America, to ensure that we are adequately assessing, preventing and reducing risks to our children's health wherever possible.

Children Are Uniquely Vulnerable to Many Chemicals

Children are not small adults. Because of their unique physiology, developmental and behavioral characteristics they are often more vulnerable to toxic chemicals. Compared to adults, children breathe more rapidly, drink more fluids and eat more food on a kilogram basis. Because of these physical size differences, children can have greater exposure to chemicals than adults.

Children also live in different worlds than adults. They live closer to the floor, where pollutants tend to accumulate, they are more likely to eat contaminated soil and dust, and they spend more time outdoors. Because of these behavioral differences, children can also have greater exposure to chemicals than adults.

In addition, because children's bodies are in dynamic states of growth, they can be more sensitive to chemicals than adults. A child's ability to break down and eliminate pollutants is poorly developed at birth, because the liver and kidneys are still developing. These changes mean that at various stages of development, children may be more or less capable of breaking down, excreting, activating or inactivating toxic substances. Because children are at the beginning of their lives, effects with long latency have a longer time to manifest themselves than would be the case with middle- or old-aged adults. These differences in children's size, behavior and development mean that they are more susceptible to environmental contaminants like toxic chemicals.

Children Have "Windows of Vulnerability"

Because children are rapidly growing and developing, there are "windows of vulnerability" from gestation through adolescence where systems are particularly sensitive to damage. Any insult during these critical developmental windows can lead to lifelong alterations in behavior, disease and development. Newborns and infants have been recognized as critical windows for exposure to many contaminants. Now, the sensitivity of the fetus to toxic chemicals is being increasingly recognized as one of the most vulnerable developmental windows. Exposure to small amounts of chemicals during critical days of fetal development can change the architecture of the brain. This poses a new challenge: to identify when during a child's development an exposure to chemicals takes place.

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Some Childhood Diseases Are of Increasing Concern

There are several childhood health effects that are of particular concern. These include: acute poisonings, cancer, developmental, learning and behavioral disabilities, impaired brain development, birth defects, asthma and other respiratory diseases, infections (respiratory and gastrointestinal) and injuries. There are many factors that interact to produce these health effects. Social factors, such as income level, family customs and behavior, have been documented as playing a major role in determining children's health. Biological factors, such as age, genetics and gender, all affect health. In addition, such environmental factors as diet, smoking, pollutants and injury are responsible for disease and death in children.

Pollutant Release and Transfer Registers: One Source of Information on Releases and Transfers of Toxic Chemicals

One source of information about the amount of chemicals being released into the environment are pollutant release and transfer registers (PRTRs). Every year across North America, industries report on the amount of chemicals released into the air, land, and water and injected underground. The amount of chemicals transferred off-site for disposal, treatment and recycling is also reported. This information is collected by national governments each year and compiled into annual reports and electronic databases.

PRTRs are an innovative tool that can be used for a variety of purposes. They track certain chemicals and can thereby help industry, government and citizens identify ways to prevent pollution, reduce waste generation, decrease releases and transfers and increase responsibility for chemical use. Many corporations use the data to report on their environmental performance and identify opportunities for reducing and preventing pollution. Governments can use PRTR data to shift program priorities, or track progress in reducing certain chemicals or in certain regions. Communities and citizens can use PRTR data to gain an understanding of the sources and management of pollutants and as a basis for dialogue with facilities and governments.

PRTR data are releases and transfers of chemicals, and do not necessarily reflect exposures to the public of these chemicals. PRTR data, in combination with other information can be used as a starting point in evaluating exposures that may result from releases and transfers of these chemicals.

PRTR data are just one source of information on toxic chemicals in the environment. Other sources include measurements of concentrations of chemicals in the air, land and water in our communities, specialized chemical and air pollutant inventories, hazardous waste databases, modeling estimates, body burdens in plants, fish and people, and industrial emission rates of chemicals.

This report analyzes publicly available data from the Canadian National Pollutant Release Inventory (NPRI) and the US Toxics Release Inventory (TRI). Mexico is implementing mandatory reporting under its PRTR, the *Registro de Emisiones y Transferencia de Contaminantes* (RETC), which up until now has been voluntary. Because of the differences between mandatory and voluntary data, data from Mexico's RETC are not included in this PRTR analysis. This report also matches the common chemicals and industrial sectors between the NPRI and the TRI to create a matched data set for analysis. This matched NPRI-TRI data set therefore excludes some data which are unique to one system, such as on-site recycling, reporting from the mining sector and some chemicals such as ammonia and hydrogen sulfide.

Large Amounts of Carcinogens, Developmental Toxicants and Neurotoxicants Are Released in North America

Each year, large amounts of chemicals known or suspected to be carcinogens, developmental toxicants and neurotoxicants are released into the air, land, and water and injected underground in North America. This report analyzes the common chemicals and sectors reported to both the US TRI and the Canadian NPRI.

Over half a million tonnes of known or suspected carcinogens were released and transferred in North America in 2000. Over 80,000 tonnes of carcinogens were released into the air.

In 2000, over two million tonnes of known or suspected developmental toxicants were released and transferred in North America from industrial facilities. Almost 40 percent were released on- and off-site, with 371,000 tonnes being released to the air.

Most of the chemicals released at company sites go into the air. Much smaller amounts of chemicals are released into the water or injected underground. Large amounts of chemicals are often sent to land disposal or storage on-site. Large amounts of chemicals are also transferred off the facility site for treatment, sewage, disposal and recycling.

Over two million tonnes of suspected neurotoxicants were released or transferred in 2000. Of particular concern are the almost half a million tonnes of neurotoxicants that are directly released into the air from facilities.

Toxic chemicals arising from two sectors, primary metals and chemicals, are responsible for a large percentage of total releases. In 2000, these two sectors accounted for:

- 34 percent of total releases of carcinogens,
- 42 percent of total releases of developmental toxicants
- 44 percent of total releases of neurotoxicants.

Other sectors, such as manufacturers of rubber and plastics products, are also large emitters of carcinogens (11 percent) and neurotoxicants (5 percent). Manufacturers of paper products released 11 percent of developmental toxicants and 10 percent of neurotoxicants. Hazardous waste management and solvent recovery facilities released 18 percent of carcinogens and 9 percent of both neurotoxicants and developmental toxicants.

Three jurisdictions in North America—Texas, Ontario and Ohio—released the largest amounts of developmental toxicants and neurotoxicants in 2000. Texas, Ohio and Pennsylvania released the largest amounts of carcinogens.

A few facilities with the largest emissions stand out among the 20,000 facilities in North America:

- Ameripol Synpol Corporation in Port Neches, Texas, emitted the largest amount of carcinogens to the air in North America (mainly styrene).
- Magnesium Corporation of America, Renco Group Inc. in Rowley, Utah, emitted the largest quantities of neurotoxicants to the air in North America (mainly chlorine).
- Lenzing Fibers Corporation in Lowland, Tennessee, and Acordis Cellulosic Fibers Inc., in Axis, Alabama, both emitted to the air, large quantities of carbon disulfide, which is a known developmental toxicant and a suspected neurotoxicant.

Some of these facilities have shown recent reductions.

It is encouraging that releases of carcinogens, neurotoxicants and developmental toxicants are decreasing over time. From 1995 to 2000, releases of carcinogens went down by 10 percent, developmental toxicants by 14 percent, and neurotoxicants by 13 percent. It is particularly encouraging to see decreases in air releases of carcinogens, developmental toxicants and neurotoxicants.

PRTR Data Will Underestimate the Chemical Load

PRTR data provides important insights into the large amounts of chemicals entering our environment each year. However, PRTR data will tend to underestimate the actual loads of chemicals into the environment because these registers only collect information on a limited list of chemicals from larger industrial facilities. The data do not include emissions from mobile sources, agricultural sources, small sources, consumer products or natural sources. PRTR data also represent the tip of the iceberg with respect to the number of chemicals reported. The matched North American data set contains approximately 200 chemicals, or less than one percent of the approximately 80,000 chemicals known to have been manufactured in North America.

Chemicals are being released into our environment continuously. The PRTR data provides information on approximately 200 chemicals that are released or transferred each year. Some of these chemicals will break down quickly in the air or water. Other chemicals will not break down easily, and persist in the environment for long periods of time. Still others may bio-accumulate in organisms and humans. Releases of these persistent and bio-accumulative chemicals are of particular concern.

Many of the Chemicals Have Not Been Tested for Health or Environmental Effects

Many of the chemicals in common use lack basic testing for health and environmental effects. A 1998 US EPA report found that only seven percent of high production volume chemicals had a complete set of six basic tests. Just under half of the high production volume chemicals (43 percent) were missing all the basic tests. Recently, steps have been taken to fill these testing gaps through the High Production Volume Challenge Program and other programs, but challenges remain in how to design, conduct and analyze tests that reflect "real life" exposures. Children are exposed to a wide mixture of chemicals throughout their day. Our understanding of the effects of long-term, multiple, simultaneous, intergenerational exposure to low levels of chemicals is just beginning.

The Levels Previously Considered "Safe" for Some Toxic Chemicals Are Being Revised Downwards

As our knowledge increases, the levels considered "safe" for chemicals have been consistently lowered. Often we have underestimated the health effects of exposure to toxic chemicals. In 1960, the initial blood lead level considered "safe" was 60 µg/dL, which was steadily revised downwards to the current action level of 10 µg/dL in 1990. Many scientists now believe that lead may not have a threshold; in other words, there may be no "safe" exposure level. Other chemicals—mercury, dioxins and such other pollutants as ozone and particulates—have shown a similar pattern of steadily decreasing "safe" levels.

Many Actions Are Underway to Reduce Chemical Loading to the Environment

At every level of government, in many industrial sectors and in many communities, there have been concerted efforts to reduce releases of chemicals into the environment and also to reduce children's exposure to toxic chemicals. The development of new emission standards, the voluntary reduction of releases from companies, and community improvement programs have all helped to reduce releases. PRTR data reflect the reductions seen over the years in many chemicals. However, PRTR data also document that over two million tonnes of developmental toxicants and neurotoxicants and half a million tonnes of carcinogens were released and transferred from industrial facilities, utilities and hazardous waste management facilities in North America in 2000.

More Actions Are Needed

Certainly there are many factors that contribute to the increases in some types of childhood diseases, such as asthma, leukemia, brain cancer, certain birth defects and a range of learning, behavioral and developmental disabilities. Exposure to toxic chemicals is one of these multiple, interacting factors, often acting during critical developmental windows.

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Important progress has been made in the past decades to recognize, prevent and reduce children's exposure to toxic chemicals, but more action is needed. We need to increase efforts to reduce releases of chemicals into the environment, reduce children's exposure to toxic chemicals and improve our monitoring of chemicals and children's health.

Our lack of knowledge about the risks posed by toxic chemicals makes it difficult to quantify the extent to which environmental contaminants may contribute to many of the leading causes of illness, hospitalization and death of children. Particularly, we lack understanding about the long-term health effects of simultaneous, cumulative exposure to multiple, low-level, toxic contaminants. **What we do know is this: toxic chemicals are a largely preventable factor in many of these childhood diseases.**

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Introduction

Almost 120 million children live and play in North America. Some of these children face economic, social and environmental challenges every day. In our hypothetical world, Jordi Dalger lives within one mile of a power plant and needs daily medication to control his asthma. Sam Toner struggles to understand long division and control his aggressive outbursts. Hernando Ramos has just recovered from another bout of gastrointestinal disease. Camille Moreau inadvertently smokes at home whenever her mother lights up another cigarette.

Children are uniquely vulnerable to many environmental health challenges. As anyone who has spent time with children can attest, they are truly different from adults in many ways. Compared to adults, children breathe more rapidly, eat more food, live closer to the floor where pollutants tend to accumulate, are more likely to eat contaminated soil and dust, and spend more time outdoors. In addition to these increased pathways of exposure, children's bodies are also more vulnerable. There are windows of vulnerability in fetal development and childhood, when the lungs, brain and other systems are maturing. Any harmful health effect during these critical developmental windows can lead to lifelong alterations in behavior, disease occurrence and development. Childhood is a critical life phase, through which we all pass. Thus, children's health cannot be separated from the health of all of us.

These differences in children's size and development mean that they can be more susceptible to environmental contaminants such as pesticides, toxic chemicals and air pollutants. The unique vulnerabilities and exposures of children pose a responsibility for us, the "grown-ups" of North America, to ensure that we are adequately assessing, preventing and reducing environmental risks to our children's health wherever possible.

Scope of This Report

This report builds upon work of the Commission for Environmental Cooperation (CEC) in:

- analyzing chemicals reported to pollutant release and transfer registers in North America (*Taking Stock* reports);
- coordinating trilateral efforts to reduce contaminants through the Sound Management of Chemicals (SMOC) initiative;
- documenting the ability of some contaminants to travel long distances (*Continental Pollutant Pathways*);
- linking the dioxin and furan emissions in Canada, the US and Mexico to the Canadian Arctic (*Long-range Air Transport of Dioxin from North American Sources to Ecologically Vulnerable Receptors in Nunavut, Arctic Canada*); and
- presenting linkages between children's health and the environment (*Making the Environment Healthier for Our Kids: An Overview of Environmental Challenges to the Health of North America's Children*).

The report also reflects the three governments' commitment to work together as partners through the CEC to implement and periodically update the *Cooperative Agenda for Children's Health and the Environment in North America*. This Cooperative Agenda was adopted in June 2002 through Council Resolution 02-06, and has an initial focus on asthma and other respiratory diseases, the effects of exposure to lead and other toxic chemicals. The present report on toxic chemicals and children's health in North America is one of the planned activities (activity 3.2) described in the CEC's *Cooperative Agenda for Children's Health and the Environment*.

The CEC facilitates cooperation and public participation in fostering the conservation, protection and enhancement of the North American environment for the benefit of present and future generations, in the context of increasing economic, trade and social links among Canada, the United States and Mexico. For more information on the programs of the CEC or to view the above documents, please see <www.cec.org>.

Important sources of information about the amount of chemicals being released into the environment are Pollutant Release and Transfer Registers (PRTRs). Every year across North America, industries report on the amount of chemicals released into the air, land, and water and injected underground. The amount of chemicals transferred off-site for disposal, treatment and recycling is also reported. This information is collected by national governments each year and compiled into annual reports and electronic databases. This report analyzes the matched data reported to the Canadian National Pollutant Release Inventory and the US Toxics Release Inventory.

Pollutants come in a variety of forms. They include molds, air pollutants in smog like nitrogen oxides, sulfur dioxides, particulates and ozone, greenhouse gases, biological contaminants, pesticides and toxic chemicals. One of the goals of this report is to foster increased trilateral action to prevent and reduce children's exposure to harmful chemicals. **Its focus is an analysis of available data on one category of pollutant, toxic chemicals, and emphasizes the reporting of chemical carcinogens, developmental toxicants and neurotoxicants**. It discusses in specific terms the impacts of these substances on the health of children in North America. It also describes the limits of what we can know about these impacts based on present data.

For instance, some pollutants may cause asthma attacks and other respiratory effects. However, some of the major chemicals thought to be associated with asthma and respiratory diseases, such as particulates, sulfur dioxide and nitrogen oxides, are not currently reported to the pollutant releases and transfer registers used for this report. This situation is changing, with the first data on releases and transfers of these chemicals from some PRTRs expected this year, but until it does change, we face limits on what we can extrapolate from the available data.

This report focuses on children up to the age of 18 years, although other age distributions are sometimes cited, depending on the data involved. Exposure to chemicals prior to birth can also be important to a child's future development, and so are discussed in this report.

In recent years, a number of comprehensive reports on children's environmental health have been produced (see for example, *The State of Children's Health and Environment 2002*, available at <www.chec.net>, *Polluting our Future*, available at <www.psr.org> and *Environmental Standard Setting and Children's Health*, available at <http://www.cela.ca/>). This CEC report builds upon this growing information and provides a unique North American perspective as a basis for trilateral action.

In this report:

- **Chapter 1:** Describes the number and conditions of children in North America
- **Chapter 2:** Describes the sources, pathways and health effects of chemicals
- **Chapter 3:** Analyzes industrial pollutant release and transfer data for carcinogens, developmental toxicants and neurotoxicants, and other chemicals of concern to children's health
- **Chapter 4:** Describes examples of current programs to prevent and reduce children's exposure to chemicals
- **Chapter 5:** Provides an overview of future directions for action to reduce and prevent toxic chemicals

What is the **CEC'S COOPERATIVE AGENDA** for Children's Health and the Environment?

The CEC's *Cooperative Agenda for Children's Health and the Environment in North America* serves as the blueprint for trilateral action to advance the protection of North American children from environmental risks to health. Some of the activities in the *Cooperative Agenda* have been started and will be implemented in the next two to three years, while others will be implemented over the longer term.

This agenda was the result of trilateral cooperation, advice from the CEC Expert Advisory Board, public review and inputs from experts' workshops. In June 2002, the three federal environmental ministers who form the Council of the Commission for Environmental Cooperation of North America signed Resolution 02-06, thereby adopting the *Cooperative Agenda*.

The Cooperative Agenda, an overview document entitled *Making the Environment Healthier for Our Kids: An Overview of Environmental Challenges to the Health of North America's Children*, additional information on the CEC's children's environmental health initiative and relevant Council Resolutions can be viewed under the Pollutants and Health section of the CEC's web site at <www.cec.org>. Copies may also be requested from the CEC Secretariat.

CHAPTER 1

Children in North America

DEMOGRAPHICS

The 120 million children in North America are our most precious resource. In 2001, the US had the largest number of children in North America, with over 74 million children, followed by Mexico, with over 39 million and Canada, with 7 million **(Figure 1)**.

Children account for a larger share, over one-third, of the total population in Mexico. Children in Canada make up about one-fifth of the total population, and one-quarter in the US (Canada 23 percent and US 26 percent) **(Appendix A)**. Mexico also has a larger percentage of children under five years of age. Over 11 million children in Mexico, or 11 percent of the population, are less than five years old. In Canada and the US, about six percent of the population is less than five years old **(Figure 2)**.

This difference in age distribution in North America is largely a result of differing birth rates. Mexico has the highest birth rate, with 23 births per 1,000 people. Next is the US with a birth rate of 13 births per 1,000 people. And in Canada the rate is 11 births per 1,000 people (United Nations Children's Fund 2003).

Health has been defined broadly as "a complete state of physical, mental and social well being" (WHO 1948), and more recently as "a positive concept emphasizing social and personal resources, as well as physical capacity" (WHO 1997). Children's health is the net result of a complex interaction of social, biological and environmental factors **(see Figure 3)**. Social factors such as income level, family customs and behavior have been documented to play a major role in determining children's health. Biological factors such as age, genetics and gender all affect health. Environmental factors, such as diet, smoking, pollutants and injury, are responsible for disease and death in children.

Many of the children in North America—approximately 23 million kids, or 20 percent—live in poverty, which increases the likelihood of environmental health problems. Mexico and the US now top the list of OECD countries with the largest percentages of children living in "relative" poverty (living in a household where income is less than half the national median).

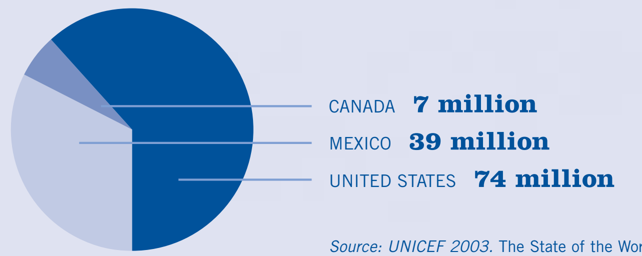
The 120 million children in North America are our most precious resource.

About one in four children in Mexico (26 percent), one in five children in the US (22 percent), and one out of six children in Canada (16 percent) are "relatively" poor (United Nations Children's Fund 2000).

Poor children can have limited access to clean water, health care, food, and housing. Children in low-income homes or attending distressed schools can be exposed to lead from deteriorated old paint and to frequent applications of chemical pesticides used to reduce high pest levels. Often parents or siblings may work in the dirtiest, most hazardous jobs, which increases the probability of "take home" exposures (Chaudhuri 1998). Also, poor children are more likely to live in polluted areas or close to polluting factories. Hunger can reduce the body's ability to withstand environmental insults. For example, poor nutrition may result in more lead being absorbed in the body. (See, for instance, Calderon *et al.* 2001, Bradman *et al.* 2001, and Mahaffey *et al.* 1986.) Children are therefore challenged by the triple threats of poverty, poor nutrition and increased exposure to toxics.

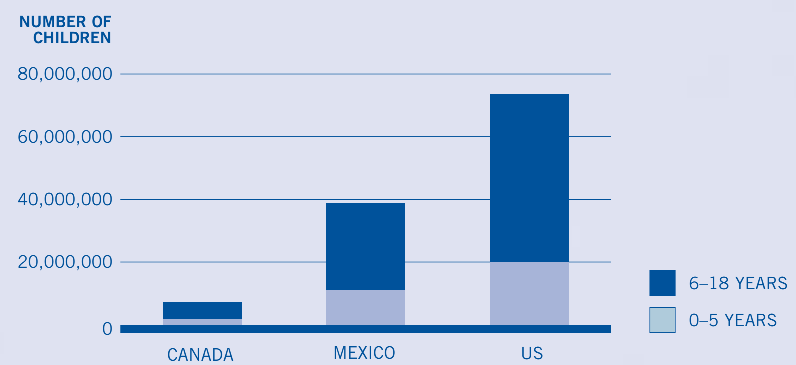
About three-quarters of the 120 million children in North America live in urban areas. The percentage of people living in urban areas is similar among the three nations (79 percent for Canada, 77 percent for the US and 75 percent for Mexico) (United Nations Children's Fund 2003). Children living in urban and rural areas may face different sources of environmental pollution. In Mexico, people in rural areas are less likely to have access to safe drinking water and sanitation

FIGURE 1. Number of Children, aged 0 to 18 years, in North America in 2001 (Total—119,787,000 children)



Source: UNICEF 2003. The State of the World's Children 2003.

FIGURE 2. Age Distribution of Children in North America in 2001



Source: UNICEF 2003. The State of the World's Children 2003.

FIGURE 3. Children's Health is the Net Result of Many Interacting Factors

services. It is estimated that in rural areas in Mexico, 31 percent of people lack access to improved drinking water and 66 percent to adequate sanitation services. For urban areas, five percent of Mexican people lack access to improved drinking water and 12 percent to adequate sanitation services (United Nations Children's Fund 2003).

The children in North America are from a variety of backgrounds. In Canada, children are predominately Caucasian, with approximately half a million children under the age of 15 years old of Asian background, over a quarter of a million children with an indigenous background and smaller black, Arab/west Asian and Latin American populations. In Mexico, almost 13 million people or 13 percent of the total population is indigenous (National Indigenist Institute 2001). About seven percent of the Mexican population speaks an indigenous language. Almost 22 million US children under the age of 15 are from minority groups. About 10 million US children have Latin American backgrounds, 9 million children are African American, almost 3 million children have Asian backgrounds and less than one million children are indigenous (FIRCFS 2001).

Ethnicity does correlate to differences in environmental exposure. Children from minority or low-income backgrounds are often at a greater risk of exposure to toxic chemicals. In the US, several studies have noted a higher proportion of African American, Hispanic and Native American children who live within one mile of a National Priorities hazardous waste site. African Americans are over-represented in many of the counties in the US with the highest air emissions of developmental toxicants (National Environmental Trust *et al.* 2000).

Our children are the future. In Mexico, this statement will be particularly accurate, with a projected population of 41 million children under 15 years old by 2015. The US will have almost 62 million children under 15 by 2015. Canada is the exception to this rule, with the number of children under 15 expected to decline in the future, from 6 million in 1998 to 5.7 million by 2015.

HEALTH

Mothers, infants and children face different health challenges in the three countries of North America. In Mexico, 55 mothers die with every 100,000 live births. In the US and Canada the rate is much lower. Across North America, perinatal disorders, which include preterm birth, low weight births and complications from pregnancy, labor and delivery are leading causes of infant mortality. Some of these perinatal disorders are the result of a number of factors including poor nutrition, lack of medical care, smoking, infectious diseases and environmental and occupational exposures. Congenital malformations are the second leading cause of infant death in North America. Over the past 40 years in Canada, Mexico and the United States, infant and child (under five years old) mortality rates have decreased (Unicef, 2003).

Mexican infants (less than one year old) are more likely to die than infants born in Canada or the US. The rate of death from congenital malformations in Mexican infants is twice that of Canada and the US. The rate of infants dying of perinatal disorders in Mexico is four times that of Canada and the US; for infectious intestinal disease, eight times; for influenza and pneumonia, 24 times; and for unintentional injuries, three times **(Table 1)**.

These disparities in health are known to result from a number of factors, most of which are related to poverty, and are not completely understood nor necessarily the same from one country to another (Black *et al.* 2003). First, infants who live in conditions of poverty are more likely to live in circumstances that are associated with exposure to infectious agents, for example, pathogens contaminating food and drinking water and overcrowded living conditions that are conducive for secondary spread of intestinal and respiratory pathogens from older children and adults to infants (WHO 2003). Second, children who live in conditions of poverty throughout North America are more likely to be less well nourished, which increases susceptibility to infectious diseases. In this regard it is heartening to see that rates of child mortality from infectious causes in the Americas have been decreasing over time; this decrease is attributed to better nutrition and safer water and food supplies (PAHO 1991). Likewise, poor children are more likely to live in polluted environments; severe air pollution is known to increase rates and severity of respiratory

TABLE 1. Annual Mortality Rates for Specific Causes of Death for Children in North America (rate per 100,000) (2000)

Cause of Death	Infant < 1 YR	Pre-schooler 1–4 YRS	School Age 5–14 YRS
Congenital malformations			
Canada	162.6	2.3	1.1
Mexico	341.4	16.1	0.2
US	142.2	3.1	1.0
Certain perinatal disorders			
Canada	274.9	0.1	0.1
Mexico	1,454.7**	*	*
US	334.6	0.6	+
Infectious intestinal diseases			
Canada*	6.7	1.1	0.4
Mexico	92.8	8.8	0.08
US	13.0	+	+
Acute respiratory infections			
Canada	+	+	+
Mexico	87.7	4.0	0.02
US	+	+	+
Septicemia			
Canada	+	+	+
Mexico	27.2	1.8	0.04
US	7.1	0.6	0.2
Influenza and pneumonia			
Canada	5	0.4	0.1
Mexico	144.8	8.1	0.09
US	6.4	0.6	0.2
Unintentional injuries			
Canada	16.2	10.6	10.8
Mexico	75.9	21.3	1.1
US	20.3	11.7	7.3

Cause of Death	Infant < 1 YR	Pre-schooler 1–4 YRS	School Age 5–14 YRS
Malnutrition, anemia and other nutritional deficiencies			
Canada	+	+	+
Mexico (anemia)	13.1	29.8	19.5
Mexico (other malnutrition, adjusted by height-for-age)	8.5	20.1	15.2
US	+	+	+
Tumors			
Canada	2.2	3.7	2.8
Mexico	4.8	5.2	0.5
US	3.8	2.6	2.6
Chronic Bronchitis non-specific and Asthma			
Canada	+	0.1	+
Mexico	6.1	1.4	0.03
US (1999)	0.9	0.4	0.5

+ Reliable data not available due to sparse numbers
** Rate is tabulated as "Infectious and parasitic diseases"*
*** Rate per 100,000 births*

Sources:
(1) Statistics Canada, 1997.
(2) Mexico: INEGI 2000 preliminary results. SSA 1999.
(3) FIRCFS 2001; Anderson 1999.

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infections (Rosales-Castillo *et al.* 2001); whether there are exposures to toxic substances in the environment that would cause further negative impacts is speculative. Such infants and their families are less likely to benefit from preventive medical interventions such as vaccinations; in the US poor children are much more likely to have delayed immunizations (Wood 2003). Finally, infants in poverty, particularly in the US and Mexico where there are more financial barriers to basic medical care, are more likely to have delayed access to medical care; even simple interventions such as oral rehydration therapy are often enough to save the life of an infant with severe intestinal disease (Gutiérrez *et al.* 1996).

Preschoolers (aged 1 to 4 years) in Mexico generally fare a little better than infants, although they are still worse off than their preschool counterparts in Canada and the US. Rates of Mexican children dying of influenza and intestinal diseases fall from almost 145 per 100,000 in infancy to 8 per 100,000 by the time they reach preschool age. This is still almost eight times the mortality rate for US and Canadian preschoolers who die of influenza or pneumonia. Rates of congenital malformations in Mexican preschoolers also fall from the infant rates, but are still five times those for preschoolers in Canada and the US **(Table 1)**.

In Mexico, the major causes of death for preschoolers are anemia, malnutrition, injury, congenital defects, infectious intestinal diseases and influenza and pneumonia. In Canada and the US, the major causes of death for preschoolers include injury, congenital malformations and tumors.

Across North America, school-age children (5 to 14 years old) are generally less likely to die than preschoolers or infants. The differences in mortality rates for school-age children among the three countries are also less striking. Anemia, malnutrition and injuries remain leading causes of death for Mexican school-age children. Injuries and tumors are the leading causes of death for school-age children in Canada and the US.

The different causes of death at different stages of childhood in North America suggest some common and unique areas of prevention. In infancy, the priority may be on preventing preterm births; improving access to medical care for mothers during pregnancy, labor and delivery; and preventing congenital malformations. Across poor communities in North America, provision of sanitation and safe drinking water is also a priority, as well as reduction of air pollution in severely polluted areas. For preschoolers, the priority may be prevention of injuries and, particularly in Mexico, the prevention of malnutrition, anemia and infectious diseases. For older children across North America, the prevention of injuries and tumors could be a priority. In Mexico, prevention of malnutrition and anemia would contribute to marked improvements in children's health.

CHAPTER 2

Children are often unaware of the range of hazards that they may face every day. This report focuses on one of these factors that affects children's health: toxic chemicals.

There are millions of chemicals that are known to exist in the world and some 100,000 that have been synthesized in enough quantity to be registered in North America, Europe, or by other OECD countries (US EPA 1998a). New chemicals are discovered every day, but few have commercial potential or are produced in significant enough quantities to warrant concern about exposures (outside the research laboratory) or that require notice to regulatory authorities. There is a mismatch between our ability to synthesize new chemicals and our ability to understand their environmental and health impacts. For example, chemicals that are produced inadvertently in manufacturing, disposal or breakdown of other chemicals are not necessarily included in national registries and almost never are included in screening and testing efforts.

Canada and the United States follow a similar procedure for evaluation of new chemicals. A list of existing chemicals is established. A new chemical, not on the existing chemical list, requires notification to government and submission of specified types of information. The government agency reviews the information and can then impose conditions or limitations on the use of the chemical. In Canada, all chemicals not on the Domestic Substances List of approximately 23,000 chemicals are considered "new" to Canada. These new chemicals must be reported prior to importation or manufacture so that they can be assessed to determine if they are toxic or could be considered toxic under the Canadian Environmental Protection Act 1999. The Non-Domestic Substances List (NDSL) contains chemicals that are new to Canada but are used commercially in the US. Chemicals listed on the NDSL still require notification, but have reduced information requirements. Typically, over 800 new chemicals are notified per year in Canada. Guidelines describe the types of information required to be submitted for assessment. For more information, see <http://www.ec.gc.ca/substances/nsb/eng/sub_e.htm>. In the US, the Toxic Substances Control Act Chemical Substance Inventory is a list of approximately 75,000 "existing" substances. A chemical not on the original TSCA Inventory is considered a "new" chemical; between 1,000 and 3,000 "new" chemicals have been submitted to the EPA each year under TSCA. A notice under Section 5 of the TSCA must be filed with EPA before manufacture or importation of a new chemical for general commercial use. These notices are reviewed by EPA within a mandated period of 90 days. If EPA determines that the new substance may present an unreasonable risk of injury to human health or the environment, testing and restrictions may be used. EPA takes action to control the potential risks to health or the environment on approximately 10 percent of the notices filed. For more information, see <www.epa.gov/opptintr/newchems/>.

HIGH TIME TO FOCUS ON

High Production Volume Chemicals (HPV)

Approximately 2,800 chemicals are known as high production volume (HPV) chemicals. These are substances that are produced in the US and/or imported in high volumes there—at over 1 million pounds (454,000kg) a year per chemical, or between 4 and 7 trillion pounds (1.8–3.2 trillion kg) annually. Pesticides, food additives, drugs, polymers and inorganic chemicals (such as lead, mercury, cadmium) are not included on the HPV list produced by the US EPA (another list of over 4,000 HPV chemicals is compiled by the Organization for Economic Cooperation and Development, OECD).

Following the 1998 US EPA review indicating the lack of basic testing data for 93 percent of HPV chemicals, EPA issued the HPV Challenge Program. The goal of this program is to ensure a baseline set of health and environmental data is made available to the EPA and the public on the HPV chemicals by 2005. Over 430 companies, some working through 155 consortia, have publicly committed themselves to sponsor HPV chemicals. Companies volunteer to assess the current information on a particular chemical, conduct new testing as required and make the existing and new tests available to the public.

Companies are now submitting plans for new testing of the HPV chemicals and also summaries of existing information. These plans and summaries are available for public review at EPA's Chemical Right-to-Know web site at <www.epa.gov/chemrtk>.

Two other similar HPV programs are also in progress: one testing approximately 4,000 chemicals identified through the OECD HPV Screening Information Data Program (SIDS) and the other developed by the International Council of Chemical Associations testing approximately 1,000 high priority chemicals by 2004.

The end result? More publicly available baseline testing data on HPV chemicals. While still providing only the basic set of data, this will significantly help our understanding of chemicals and their potential health and environmental effects.

Mexico does not have a consolidated list of 'existing' chemicals. The Ministry of Health (*Secretaría de Salud*) uses a number of lists to determine if a chemical is "new." An application must then be made to Mexican authorities before the new chemical can be manufactured or used.

These "new" chemical prescreening processes are an improvement over the past, when "new" chemicals received little review or assessment. These processes also need to continuously evolve to reflect additional information about health and environmental impacts and strive for a convergence and consistency of approach in the three countries.

Screening and basic toxicity information is lacking on many existing chemicals. Recently, governments and industry groups have increased their efforts to fill the gaps about the toxicity of existing chemicals. In Canada, new environmental legislation requires the Domestic Substances List of approximately 23,000 existing chemicals in Canada to be categorized by 2006 and, if necessary, screened to determine whether they are toxic or capable of becoming toxic. The chemicals are categorized by persistence, ability to bio-accumulate, inherent toxicity and/or whether they have a high potential for exposure to Canadians. A pilot program has developed a list of 123 chemicals that meet these criteria. Screening assessments are being developed for these chemicals and will recommend one of three outcomes: the chemical can be considered not toxic to human health or the environment, can be considered toxic and placed on the Priority Substance List for further assessment or placed on Schedule 1 for regulatory or other action. For more information, see <www.ec.gc.ca/substances>.

A 1998 EPA review found that no basic toxicity testing was publicly available for a significant portion of chemicals considered to be produced or imported in high volumes (more than 450,000 kg annually). Six tests are necessary for a basic understanding of the hazardousness of a chemical: acute toxicity, chronic toxicity, developmental and reproductive toxicity, mutagenicity, ecotoxicity and environmental fate.

According to EPA, only seven percent of high production volume (HPV) chemicals have had a complete set of the six tests; almost all of the HPV chemicals (93 percent) were missing one or more of these basic tests, and just under half of the HPV chemicals (43 percent) were missing all of the tests (US EPA 1998a). Of the 830 companies making HPV chemicals, 148 had no test results available on their chemicals. The basic set of tests for one chemical costs about US$200,000. Recently, EPA, other agencies and chemical manufacturers have moved to fill in missing information.

Some of the HPV chemicals may be of particular concern to children's health. A set of 23 chemicals found in human tissue or the environment has been identified by the US EPA for additional testing. Under the Voluntary Children's Chemical Evaluation Program, started in late 2000, 35 companies and 10 consortia have agreed to sponsor 20 chemicals. Companies will collect and develop, if need be, health effects and exposure information on their sponsored chemical and integrate this information into a risk assessment. Additional data needed to fully characterize the risks to children would also be identified.

The health effects information requested is a subset of the test battery developed by the EPA to assess the impacts of pesticides on children's health, and so is designed to assess some of the unique vulnerabilities and exposures that children may face (e.g., prenatal developmental toxicity, neurotoxicity screening battery and developmental neurotoxicity). Some of the chemicals included in this program are benzene, toluene, xylenes, and trichloroethylene. For more information, please see <http://www.epa.gov/chemrtk/vccep/index.htm>.

These initiatives in North America are complementing information developed globally under international agency programs for chemical testing. Most of the data collected under these programs are available on the Internet, allowing for increased sharing of results among countries.

TYPES of Chemicals

Chemicals can be classified by their:

- **Properties**, such as persistence, toxicity, and flammability; and
- **Uses**, such as pesticides, solvents and plasticizers (or the products they find their way into, e.g., plastics in toys).

Chemicals that are of environmental or health concern often have three properties in common: they are highly persistent, bioaccumulative and toxic. Persistent chemicals remain in the environment for long periods of time, can travel long distances, and are thus often found hundreds of kilometers from their source. Some chemicals are bioaccumulative, that is they accumulate in the tissues of living species. And some are toxic, known to harm people, plants and animals. Chemicals with all these properties are known as persistent, bioaccumulative, toxic (PBT) chemicals. Some common PBT chemicals include dioxins and furans, lead, mercury, PCBs and hexachlorobenzene.

Chemicals can also be changed when heated or processed. For example, dioxins and furans are not intentionally manufactured, but can be created during incineration, backyard burning, iron sintering, pesticide manufacture, etc.

The common pollutants that create smog, such as nitrogen oxides, volatile organic compounds and particulates, are not the main focus of this report. These compounds have well-documented effects on children's health, particularly respiratory health. In addition, greenhouse gases such as carbon dioxide are also not a focus of this report. The linkages between climate change and its potential to increase the spread of infectious disease, the incidence of heat- and cold-related illnesses, and the formation of smog and its effect on children's respiratory health, are just beginning to be explored.

PESTICIDES

Toxic chemicals can be used as pesticides on farms, in homes, schools and daycare centers. Three of the common groups of pesticides are **organophosphates** such as chlorpyrifos (Dursban) and diazinon, **organochlorides** such as DDT and **pyrethroids**. Other contaminants such as dioxins can be found in pesticides. Pesticides can contaminate food, air, ground and surface water, land and people. Up to five million people are accidentally poisoned by pesticides each year across the globe (WHO 1992). About four percent of all reported poisonings in Canadian children are the result of accidental pesticide exposure (Health Canada 1995). More than 100,000 children in the US accidentally ingest pesticides (US EPA 1998b). In Mexico, where pesticide poisonings are a reportable disease, children ages one to five have the highest rates of poisoning (1.5 cases per 10,000 people compared to 0.9 for infants of less than one year and 0.1 for older children 5 to 14 years old) (SSA 1999).

Concern is growing over low-level, chronic exposures to pesticides which may interfere with immune, thyroid, respiratory and neurological processes in children (IPCS 1998) and may be linked to childhood cancers, endocrine disruption and developmental neurotoxicity. Children living in homes whose parents frequently use pesticides have a seven times higher risk of getting non-Hodgkin's lymphoma than children living in homes where pesticides are not used (Buckley *et al*. 2000). Because children eat more fruits and vegetables per kilogram of body weight, and because their bodies are developing, children can be especially vulnerable to the health effects of pesticides. Animal studies of several pesticides indicate that there are critical windows of vulnerability during fetal development. Small exposures of pesticides during these critical windows may permanently alter levels of neurotransmitters in the brain and cause hyperactivity in the animals as adults. These health effects differ from adult pesticide exposures.

North America is the world's leading consumer of pesticides. Sales of pesticides have increased by 50 percent in the US in the past three decades (US EPA 1997a). Since 1990, they have increased about six percent a year, particularly for "cosmetic" uses, for example, to make gardens weed-free. Sales of pesticides are also increasing in Mexico, from the 12,000 tonnes of pesticides sold within Mexico in 1960 to the 54,000 tonnes sold in 1986 (Ortega-Cesena *et al.* 1994). Pesticide imports into Mexico have also increased by 28 percent from 1999 to 2000 (*Subcomité de Comerico y Fomento Industrial* 2001).

Unlike most OECD countries, Canada does not require reporting of pesticide sales data. This will change once Canada's recently-revised pesticide legislation is fully promulgated in 2004. For now, conflicting data exist. Pesticides are also not reported to the national chemical reporting system in Canada, the National Pollutant Release Inventory.

SOURCES of Chemicals

Chemical emissions can come from a variety of sources including:

- Manufacturing plants
- Electricity generating plants
- Waste treatment, sewage and recycling plants
- Neighborhood sources such as gas stations and dry cleaners
- Mining, forestry, farming and fishing
- Agricultural, home and institutional uses of pesticides
- Vehicles such as cars, trucks, buses and construction equipment
- Consumer products such as toys, paints, solvents, household cleaners and building materials
- Natural sources such as forest fires and erosion

The importance of a particular source to children's health will vary with many factors, including the quantities and properties of the chemical, the nature, extent, location and timing of the exposure pathways, and the physiological, developmental and behavioral stage of the child.

PATHWAYS of Chemicals

Once a chemical has been emitted into the environment, a variety of pathways may bring it to children, including:

- Air
- Water
- Food
- Land/soil
- Consumer products
- *In utero* exposures
- Breastfeeding

Children are particularly vulnerable to air pollutants. They are often more active than adults, spend more time outside and breathe more rapidly. With their large lung surface area relative to their body size, they breathe 50 percent more air per kilogram than adults (Toronto Public Health 1999). Younger children's lungs are still developing until they reach almost full development around age eight, but they will continue to develop alveoli through adolescence (American Academy of Pediatrics 1999).

Even though children tend to spend more time outdoors than adults, they are indoors 85 to 90 percent of the time. Indoor air, because it can be more contaminated than that outdoors, can also be a significant pathway of chemicals to children. Several studies have found high concentrations of contaminants in indoor air, often from a variety of sources, including tobacco smoke and consumer products such as flooring, furniture and wood stoves, cleaning products and hobby materials. In Mexico, indoor particulate levels can be high (exceeding national standards by up to five times) from burning wood and other materials for cooking and heating (Riojas-Rodríquez *et al.* 2001).

A focus on children's health has prompted the growing awareness of the vulnerabilities of children *in utero*. Chemical exposures at this time can have significant, life-long and irreversible effects. For example, pregnant women eating fish contaminated with methyl mercury can damage the brains of their developing children.

Breastfeeding, which we know provides optimal nutrition for infants, can unfortunately also be a significant pathway of children's exposure to some chemicals and other hazards. Contaminants such as organochlorine pesticides, PCBs, and dioxins are generally present in breast milk. Some studies show that increased concentrations of contaminants in breast milk can increase the risk of infant infections (DeWailly *et al.* 2000, 2001). Through breast milk, babies can consume the maximum recommended lifetime dose of dioxin and five times the adult allowable daily PCB intake. Infants during breastfeeding can be exposed to higher daily intakes of some persistent organic pollutants per unit body weight than at any other time in their lives (Patandin *et al.* 1999).

However, breastfeeding confers numerous nutritional and immunological advantages to the developing infant. It must be emphasized strongly that despite such high exposures at the start of one's life, breastfeeding is still recommended as the optimum method of nourishing babies, as the benefits of breast milk outweigh the risks from exposure to contaminants from breast milk for most people.

HEALTH EFFECTS of Chemicals

Tracking diseases in North America is a bit of a detective game. Unfortunately there is no common reporting of diseases across North America. Pieces of information can be drawn from national surveys in each country. This lack of common reporting system is one of the barriers to understanding the links between childhood diseases and their underlying causes (Pew Environmental Health Commission 1999).

Children's health is the end result of many interacting biological, social and environmental factors. Some individuals, because of their genetic makeup, can be more sensitive to contaminants than others (Furlong *et al.* 2000). For example, about four percent of the US population has a gene that produces a faulty version of an enzyme normally used for the proper functioning of the nervous system. When these individuals are exposed to certain organophosphate pesticides, their already challenged bodies are more likely to be affected by those pesticides (Trundle and Marcial 1988). These individual differences in vulnerability also pose a challenge for regulators.

Furthermore, the type, nature and severity of a health effect may vary with the timing of chemical exposure. We know, for instance, that pregnant rats fed one meal containing dioxin on the critical fifteenth day of gestation produced male rats with reproductive dysfunction (Gray and Ostby 1995).

Mixtures of chemicals can have different health and environmental effects than the effects of individual chemicals. Some mixtures of chemicals can have effects that are greater than the individual chemical effect. In one study, a PCB compound (PCB153) given alone did not result in liver damage in rats, but when given with dioxin as a mixture produced 400 times the effect of dioxin (2,3,7,8-tetrachlorodibenzo-p-dioxin [TCDD]) alone (Van Birgelen *et al.* 1996). Alternatively, chemical mixtures can have less than individual chemical effects. High levels of selenium may reduce the uptake of mercury in plants (Siegel *et al.* 1991).

This observation of differing health effects of chemical mixtures poses real difficulties for toxicity testing and regulation, which often rely on chemical-by-chemical testing. This approach does not reflect the reality for children, who are exposed to a mixture of chemicals throughout their day. Our understanding of the effects of long-term, multiple, simultaneous, intergenerational exposures to low-level chemicals is just beginning. Creating a testing, standard setting and regulatory framework that reflects "real life" exposures is one of our next great challenges (Bucher and Lucier 1998).

In the past, regulations have sought to identify a "threshold" below which a chemical does not cause health effects. For many chemicals, such a threshold may not exist. For example, on a theoretical basis, for carcinogens, each decrement of exposure down to zero conveys some level of health risk. For other chemicals, a threshold may exist in certain situations.

Chemicals may have a variety of health effects on children, including:

- Cancer
- Learning, developmental and behavioral disabilities
- Endocrine toxicity
- Birth defects
- Respiratory problems such as asthma

Following is a brief overview of these health endpoints.

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CANCER

Many possible factors may play a role in the development of childhood cancer, including genetic abnormalities, ionizing and ultraviolet radiation, viral infections, prenatal maternal exposure to certain medications, tobacco, alcohol, and industrial and agricultural chemicals (Zahm and Devesa 1995; Schmidt 1998).

In Canada, leukemia is the most common childhood cancer, followed by brain cancer (National Cancer Institute of Canada 2002). This is similar to the US, where leukemia and brain cancer are the most common childhood cancers (Ries *et al.* 2001). In Mexico, mortality statistics may provide a better picture of trends due to under-reporting. In 1996, in Mexico, cancer was the eighteenth-leading cause of death in children aged five and under, and the eighth-leading cause in children 4 to 14 years old (SSA 1997).

Cancer incidence rates in children are increasing. After injury, childhood cancer is the most common cause of death among all children between the ages of one and 17 in Canada and the US (Statistics Canada 1997 and Anderson 1999). In the US, overall cancer incidence rates in children increased by 13 percent from 1973 to 1997 (Ries *et al.* 2001).

Some types of childhood cancers are increasing at substantially greater rates than the average. From 1973 to 1997 in the US, childhood cancer rates increased by 30 percent for non-Hodgkin's lymphoma, 21 percent for brain cancer and 21 percent for acute lymphocytic leukemia (Ries *et al.* 2001).

Certain types of cancers are also increasing in young Canadian adults (ages 20 to 44), such as non-Hodgkin's lymphoma and thyroid cancer in both men and women, lung and brain cancer in women and testicular cancer in men (National Cancer Institute of Canada 2002). Data released in Canadian Cancer Statistics reported a long-term increase in testicular cancer in young males, with an average rate of 1.7 percent increase per year between 1987 and 1996 (Canadian Cancer Statistics 2002). Given that cancer in young adults reflects a relatively short latency, contributing factors could well have occurred during childhood. This increases our need to further understand risk factors and to prevent exposures from as early an age as possible.

Despite the above indications, more children are also surviving cancer (Ries *et al.* 2001). Some scientists feel that the increase in incidence is due to diagnostic improvements and reporting changes (Linet *et al.* 1999). The decline in the death rate is due to improved and earlier detection and treatment of common childhood cancers, especially leukemia (Ries *et al.* 1999).

Evidence is accumulating that as children's exposure to pesticides, such as home, lawn and garden pesticides increases, children may have an increased risk of non-Hodgkin's lymphoma and brain cancer (Leiss and Savitz 1995) and leukemia (Buckley *et al.* 2000).

Learning, Developmental and Behavioral DISABILITIES

Another childhood health issue is developmental, learning and behavioral disabilities. These disabilities are the result of many complex interactions of genetic, social and environmental factors, often during a critical time in a child's development. Toxic chemicals, one of the many interacting factors, are of special concern because they are preventable causes of damage.

Teachers, parents, childcare workers and doctors are more and more concerned about children suffering from one or more learning, developmental or behavioral disabilities. Nearly 17 percent, or 12 million, of US children suffer from one or more learning, developmental or behavioral disabilities (CDC 2003a). Learning disabilities alone may affect 5 to 10 percent of US children (Goldman and Koduru, 2000). In Canada, 28 percent of Canadian children (ages 0 to 11) have at least one identifiable learning or behavioral problem and 16 percent of Canadian children (ages four to five) show delayed vocabulary skills (Landy and Tam 1998).

A visit into many classrooms in North America will illustrate a wide range of disabilities—from mild to severe autism, attention deficit hyperactivity, learning disabilities and mental retardation. Johnny can't read yet. Kyle sits by himself. Brian shouts and can't follow instructions. Emma has to leave now for special education classes. This is daily life in many of our schools.

In the US, Ritalin has been prescribed to approximately 1.5 million children to control attention deficit hyperactivity disorder (ADHD). The number of US children taking this drug has doubled every four to seven years in the US since 1971. ADHD is estimated to affect three to six percent of all school children, with some evidence to suggest rates as high as 17 percent in the US (CDC 2003a). Exposures to some toxic chemicals such as lead, manganese, solvents, dioxins and PCBs, and pesticides have been linked to changes in behavioral areas such as activity levels and attention, but it is not yet known if these chemicals are related to ADHD (Goldman and Koduru 2000). For example, lead is known to cause reduced attention spans, and increased distractibility and aggressive behavior in children at levels well below those that cause clinical symptoms (Lanphear *et al.* 2000). PCBs and methylmercury also have been reported to cause adverse impacts on IQ and behavior with low-level exposure (Grandjean *et al.* 1997, Longnecker *et al.* 1997).

As many as 2 per 1000 US children may suffer from autism. California's autism rates increased nearly 2.5-fold between 1987 and 1994. It is not yet known whether this increase is "real" or due to changes in diagnosis (Croen *et al.* 2002).

BIRTH DEFECTS

Birth defects are one of the leading causes of infant mortality in North America. Often, the causes of birth defects are unknown. Improved research on birth defects may help provide some answers.

About two to three percent of Canadian newborns, or between 7,000 and 10,500 babies, have a major birth defect (Health Canada 2002a). Nearly 1 out of every 28 US babies is born with a birth defect (March of Dimes 2002). One of the most common birth defects in the US is hypospadias (an abnormal formation of the penis in which the opening of the urethra does not emerge at the tip of the penis, but rather lower down on the penis). Approximately 1 in every 125 US boys has hypospadias (Baskin *et al.* 2001).

Some birth defects seem to be becoming more common. Defects of the male reproductive system, such as undescended testicles and hypospadias, have doubled in the US from 1970 to 1993 (Paulozzi *et al.* 1997). Various studies have suggested that some of these birth defects are associated with exposure to persistent organic chemicals (Gray *et al.* 1999, Skakkebæk *et al.* 2001).

The rates of anencephaly (where part or all of the brain is missing) vary among the three countries, with the highest rates in the US, at 6 per 10,000 births, compared to Mexico, 5 per 10,000 and Canada, 2.4 per 10,000 (CDC 2000, INEGI 1999, Rouleau *et al.* 1995). These statistics are from national sources and so there may be differences in collecting and reporting among the countries.

ENDOCRINE TOXICITY

While the link between chemicals and cancer has been explored for many decades, only recently has more attention been focused on a wider range of subtle, non-cancer effects. Some chemicals are thought to alter and interfere with hormonal activity, causing significant health and developmental impacts. These chemicals are known as endocrine disrupters or, in the popular media, as "gender benders" or "environmental estrogens." Endocrine disruptors can interfere with the body's normal hormonal functioning by binding to receptors, blocking them, or interfering with proteins which regulate the amount and activity of hormones (Goldman and Koduru 2000). Endocrine disrupters can work at low doses; they cause effects in the next generation and only during critical windows of vulnerability (Melnick *et al.* 2002). Because of these ways of acting, endocrine disruption has challenged traditional toxicity and health research.

Chemicals such as PCBs, pentachlorophenol, DDT, nonylphenol, atrazine, and dioxins and furans are thought to have endocrine disrupting properties (Environment Canada 2002b). In wildlife, altered sex ratios, thinning eggs, and reduced immune and reproductive function have been observed (Vos *et al.* 2000, Guillette and Gunderson 2001).

Endocrine disruptors have been associated with a variety of human health effects, including endometriosis, breast cancer, thyroid cancer, early onset of female puberty,

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infertility, testicular cancer, and abnormalities of the male reproductive organs such as hypospadias, undescended testicles, and reduced sperm counts (Foster 1998).

A recent global review of endocrine disruptors by the International Program on Chemical Safety, sponsored by the World Health Organization (WHO), the United Nations Environment Programme (UNEP) and the International Labor Organization (ILO), concluded that "the evidence that wildlife have been adversely affected by exposures to [endocrine disruptors] is extensive." The current evidence that human health has been adversely affected by exposure to endocrine disruptors was characterized as "generally weak." The report noted large gaps in knowledge, suggested that "concerns remain," and stated that there is an "urgent need" for studies in vulnerable populations such as infants and children (IPCS 2002).

ASTHMA on the Rise

Asthma is a disease of chronic airway inflammation and hyper responsiveness to environmental triggers. Some of these triggers include mites, dander from pets, fungal spores, tobacco smoke, viral infections and air pollution.

Asthma is one of the diseases that seems to be increasing in North America. Reported asthma prevalence is higher in the US and Canada (up to 17 percent of the population suffers from it) than in Mexico (six percent) (ISAAC 1998). This translates into millions of children in North America with asthma—approximately five million children in the US alone (Mannino *et al.* 2002). Approximately 12 percent of Canadian children are asthmatic and 29,000 children are hospitalized each year with asthma (Environment Canada 2002a). US asthma prevalence rates increased 74 percent from 1980 to 1995. The number of US children dying from asthma tripled from 1979 to 1996 (Wargo and Wargo 2002).

Outdoor air pollutants such as ozone, particulates, sulfates and nitrogen oxides and indoor air pollutants such as tobacco smoke and animal/insect antigens may aggravate asthma symptoms, resulting in a range of effects from wheezing, to staying home from school, to visiting the doctor or emergency room. Across North America, asthmatic kids are more likely to visit emergency rooms as levels of such air pollutants as ozone and particulates increase (Institute of Medicine 1999). The disease is one of the leading causes of absenteeism; for instance, in Canada, asthma is responsible for 25 percent of all school absences (Environment Canada 2002a).

CHAPTER 3

Releases of Chemicals: Data from Industrial Pollutant Release and Transfer Registers

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What do we know about the amount of chemicals being emitted into the environment in North America? Where are the chemicals released that are most likely to be of concern to children's health? Are chemical releases increasing or decreasing over time? How can I find out about chemical releases in my neighborhood?

Every year across North America, industries report on the amount of chemicals released into the air, land, and water and injected underground. The amount of chemicals transferred off-site for disposal, treatment and recycling is also reported. This information is collected by national governments and compiled into annual reports and electronic databases called pollutant release and transfer registers (PRTRs).

PRTRs are innovative tools that can be used for a variety of purposes. They track certain chemicals and thereby can help industry, government and citizens identify ways to prevent pollution, reduce waste generation, decrease releases and transfers and increase responsibility for chemical use. Many corporations use the data to report on their environmental performance and identify opportunities for reducing and preventing pollution. Governments can use PRTR data to shift program priorities or track progress in reducing certain chemicals or in certain regions. Communities and citizens can use PRTR data to gain an understanding of the sources and management of pollutants and as a basis for dialogue with facilities and governments.

PRTR data are just one source of information on toxic chemicals in the environment. Other sources include measurements of concentrations of chemicals in the air, land and water in our communities, inventories of chemicals such as specialized chemical and air pollutant inventories, hazardous waste databases, modeling estimates, body burdens in plants, fish and people, and industrial emission rates of chemicals.

PRTRs track certain chemicals and thereby can help industry, government and citizens identify ways to prevent pollution, reduce waste generation, decrease releases and transfers and increase responsibility for chemical use.

Taking Stock
of Chemicals in North America

North American factories, electric utilities, hazardous waste management/solvent recovery facilities and coal mines released and transferred over 3.3 million tonnes of chemicals in 2000. Almost 254,000 tonnes of chemicals were released (on- and off-site) which are known to cause cancer, birth defects and other reproductive problems.

The six-year trend shows a small decrease in the amount of chemicals released and transferred from 1995 to 2000, but big changes in how those pollutants are handled. The 28-percent reduction in chemicals released into the air was offset by a 41-percent increase in chemicals sent mainly to landfill, and a 27-percent increase in chemicals sent to lakes, rivers and streams.

There was a reduction in the release of cancer causing chemicals. Total releases of known or suspected carcinogens fell by 10 percent, compared to an eight-percent decrease for all chemicals (CEC 2003).

The CEC's annual Taking Stock report and queries to the matched data set can be viewed at <http://www.cec.org/takingstock>. *Taking Stock 2000* also presents, for the first time, data on many of the PBTs such as dioxins/furans and hexachlorobenzene.

An important consideration in making good use of PRTR data is to know their limitations. They constitute one part of the pollution "picture" but they do not include:

- all potentially harmful chemicals—just those on the lists of chemicals to be reported;
- chemicals released from mobile sources such as cars and trucks;
- chemicals released from natural sources such as forest fires and erosion;
- chemicals released from small sources such as dry cleaners and gas stations;
- chemicals released from small manufacturing facilities with fewer than 10 employees;
- information on the toxicity or potential health effects of chemicals;
- information on risks from chemicals released or transferred; or
- information on exposures to humans or the environment from chemicals released or transferred.

For some toxics, such as benzene, mobile sources may be the chief source of contaminants to the environment. For others, such as carbon tetrachloride, industrial sources are the main source.

Each country in North America collects information on chemical releases and transfers. In Canada, the National Pollutant Release Inventory (NPRI) collected its first information on chemical releases and transfers in 1993. Since then it has expanded to 265 chemicals reported by over 2,000 facilities for the 2001 reporting year. Fifty-five of these chemicals have been declared toxic under the Canadian Environmental Protection Act of 1999. More information on the NPRI and a Citizen's Guide to NPRI can be viewed at Environment Canada's web site at <www.ec.gc.ca/pdb>.

With the passage of enabling legislation in 2001, Mexico began implementing a mandatory reporting under its PRTR, the *Registro de Emisiones y Transferencia de Contaminantes* (RETC), which up until then had been voluntary. Currently, approximately 300 industrial facilities under federal jurisdiction voluntary report their annual releases and transfers of 104 chemicals. Information has been available by sector and by region only. For more information on Mexico's RETC program, see <http://sat.semarnat.gob.mx/dggia/retc/>.

Now coming up to its fifteenth year in operation, the Toxics Release Inventory (TRI) in the US currently collects information on the releases and transfers of over 650 chemicals from over 22,000 facilities. For more information on the TRI program, please see <www.epa.gov/tri>.

Each country has set up its PRTR to reflect local conditions, laws and objectives. Fortunately, a common basic set of elements allows much of the information collected in the Canadian NPRI and the US TRI to be matched. The voluntary nature of RETC reporting currently makes these data difficult to match.

The CEC, through its annual *Taking Stock* report, provides a North American perspective on the amounts of chemicals released to the air, land, water, and transferred off-site. The CEC takes the common chemicals and elements of the NPRI and TRI data and produces a matched North American data set. Data from the mandatory RETC in Mexico will be included in future reports as they become available. For more information about *Taking Stock* or for a customized search of the matched database for sectors, chemicals or facilities, please see <www.cec.org/takingstock/>.

PRTR ANALYSIS

PRTR data are useful for identifying chemicals, sectors and facilities that are releasing and transferring chemicals in North America. Many of these PRTR chemicals are known or suspected carcinogens, developmental toxicants or neurotoxicants. Some of these chemicals, such as lead, mercury and dioxins, have been identified in numerous reports as being of special concern to children. PRTR data also can provide valuable time-trend pictures of releases and transfers of chemicals. We can use this information to help tailor programs and actions to reduce chemical releases and thereby help reduce some of our children's exposures to chemicals.

This report presents findings from two approaches to analyzing PRTR data:

- the **health effects approach**: analyzing PRTR data using lists of chemicals with similar health effects; and
- the **chemical-specific approach**: analyzing PRTR data for specific chemicals of concern to children's health.

Health Effects APPROACH

In this approach, three lists of chemicals with different health effects are used to analyze PRTR data:

1. Carcinogens
2. Developmental toxicants
3. Neurotoxicants

Chemical lists exist for other health effects such as respiratory toxicity, liver and kidney toxicity and endocrine toxicity. We chose these three lists based on the type of health effects seen in children and the match to PRTR chemicals. Two web sites use a variety of chemical lists to analyze PRTR data: <www.Scorecard.org> analyzes TRI data, and <http://www.pollutionwatch.org/> analyzes NPRI data.

Carcinogens are chemicals that are known or suspected to cause cancer.

Developmental toxicants are those substances that can produce detrimental effects during fetal development. Some of these effects include structural abnormalities and other birth defects, low birth weight, growth retardation, fetal death, metabolic or biological dysfunction, as well as psychological and behavioral defects that manifest as the child grows (Goldman and Koduru 2000; National Environmental Trust *et al.* 2000; <www.scorecard.org/health-effects/explanation.tcl?short_hazard_name=devel>).

Neurotoxicants are chemicals that alter the structure or functioning of the central and/or the peripheral nervous system. Symptoms of neurotoxicity include muscle weakness, loss of motor control, and loss of sensation, tremors, and changes in cognition. Chemicals that are toxic to the central nervous system (the brain and spinal cord) such as mercury and lead can cause confusion, fatigue, irritability and behavioral changes. Chemicals that are toxic to the peripheral nervous system (all nerves except brain or spinal cord) can disrupt communication throughout the body (<www.scorecard.org/health-effects/explanation.tcl?short_hazard_name=neuro>).

In North America, certain types of childhood cancers such as leukemia and brain cancer seem to be becoming more common. We may be seeing increases in many childhood developmental problems such as learning disabilities, attention deficit hyperactivity disorder, developmental delays and emotional and behavioral problems. The incidence of congenital malformations is also high. Therefore, we asked the questions:

- *What quantity* of carcinogens/developmental toxicants/neurotoxicants are released and transferred in North America?
- *Which* carcinogens/developmental toxicants/neurotoxicants are released and transferred in largest quantities?
- *Where* are the largest quantities of carcinogens/developmental toxicants/neurotoxicants being released or transferred?
- Which industrial *sectors* are releasing the largest quantities of carcinogens/developmental toxicants/neurotoxicants?
- Which *facilities* are releasing the largest quantities of carcinogens/developmental toxicants/neurotoxicants?
- Has the quantity of carcinogens/developmental toxicants/neurotoxicants released and transferred increased or decreased *over time*?

Description of the Matched PRTR Data

This report is based on publicly available data from the Canadian National Pollutant Release Inventory and the US Toxics Release Inventory. The report was created using the chemicals and industrial sectors common to the NPRI and TRI data. The report is therefore based on a subset of the larger NPRI and TRI data sets. It is important to realize that some sectors with significant releases, such as metal mining, some chemicals with large releases, such as ammonia, and some chemicals with environmentally significant releases, such as dioxins and furans, do not match between TRI and NPRI and therefore are not part of this report.

In the future, data from Mexico may be available for inclusion in this analysis. Currently, however, there are no comparable data from the Mexican RETC. The voluntary nature of the RETC program results in relatively few reports being filed, and these reports are not publicly available by facility.

There are two data sets used in this report. The first data set is based on the matched data from TRI and NPRI for the year 2000.

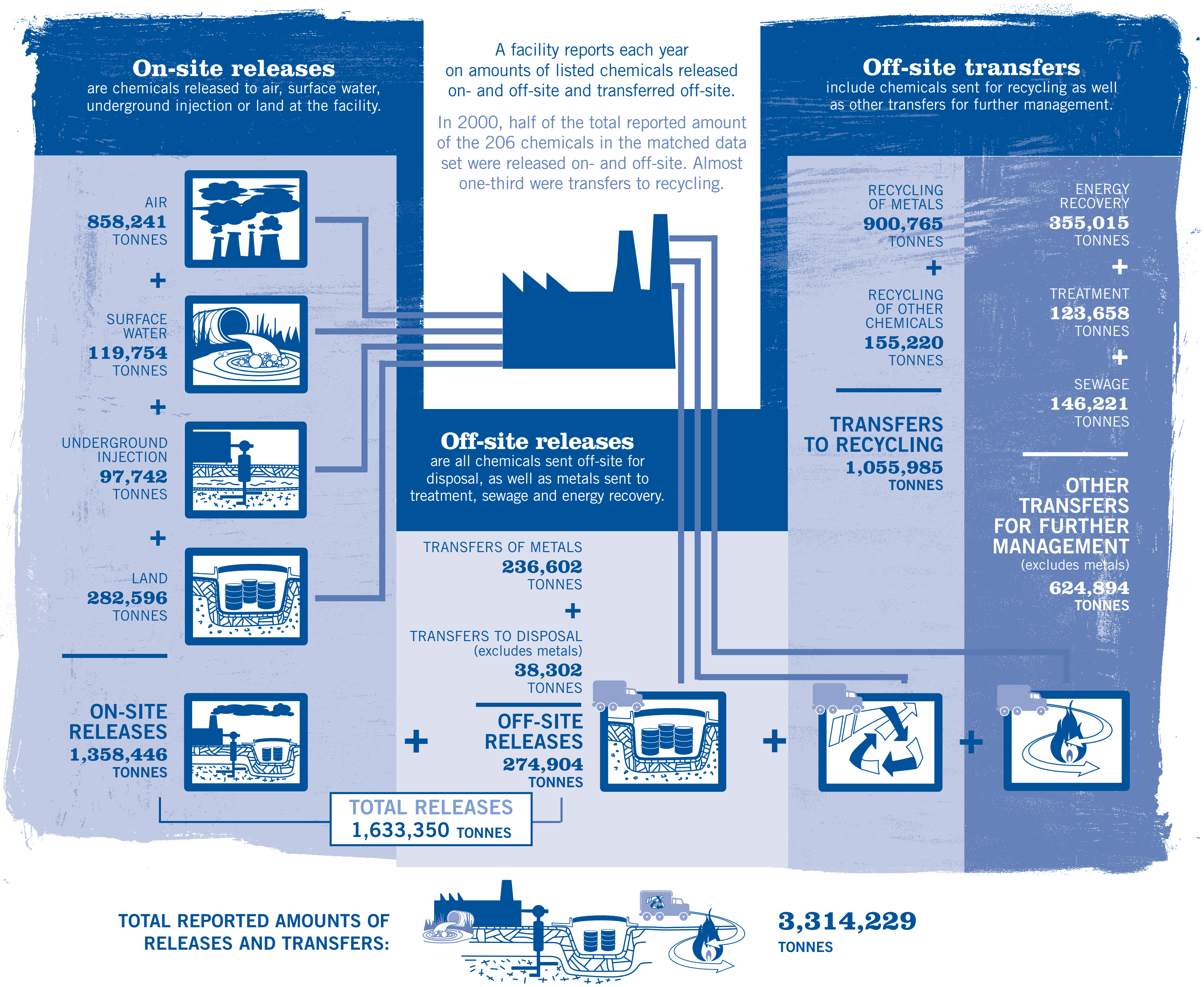
Data Set Attribute	2000 Data Set	1995–2000 Time Trend Data Set
Number of chemicals?	206	159
Includes sectors such as utilities, hazardous waste management/solvent recovery facilities?	yes	no
Includes transfers to recycling and energy recovery?	yes	no

The second data set is used for the time-trend analysis and is based on the matched data set from 1995–2000. These two data sets are necessary because not all of the chemicals and sectors that report in 2000 have consistently reported from 1995 to 2000. The 1995–2000 data set therefore contains only the elements that have been consistently reported over this time period. The attributes of the two sets are shown in the box above.

Data Set 1: 2000 Matched Data Set

The data used in this analysis are based on the matched data for the 2000 reporting year from the TRI and NPRI programs. The matched data set for the year 2000 contains 206 chemicals. The sectors included in the matched data set are: manufacturing facilities, federal facilities, electric utilities, hazardous waste management/solvent recovery facilities, chemical wholesalers and coal mining. The matched data set for the year 2000 contains transfers to recycling and energy recovery. This matched data set includes approximately half of the chemical reports in NPRI and three-quarters of the TRI reports.

FIGURE 4. Diagram of Releases and Transfers from Facilities (Transfer to recycling and to energy recovery are in the 2000 and 1998–2000 matched data sets and are not in the 1995–2000 matched data set, used for analyses covering the years 1995 to 2000.)



Note: Transfers to recycling and to energy recovery are not included in analyses that compare data for 1995 through 2000 because these transfers were not required to be reported to NPRI until 1998.

Data Set 2: Time Trends: 1995–2000 Matched Data Set

The data used for the time-trend analysis are based on a set of chemicals and industries commonly reported in all years from 1995 to 2000. Because of changes in reporting requirements over the period, this time-trend data set is smaller than that used for the 2000 reporting year analyses and contains 159 chemicals. Several sectors that report large releases such as utilities, hazardous waste management/solvent recovery facilities are not included in the time-trend analysis because these sectors began reporting to TRI in 1998. The time-trend analysis also does not include transfers sent for recycling or energy recovery, as this was not mandatory in NPRI for all the years from 1995 to 2000.

This report uses the following categories for presenting PRTR information (see **Figure 4** for a graphic portrayal of these flows):

- *Releases* are chemicals put into the air, water and land or are injected underground.
  - *On-site releases* are releases that occur at the site of the facility.
  - *Off-site releases* are chemicals sent offsite to another location for disposal, as well as metals sent to treatment, sewage and energy recovery.
- *Total releases* are the sum of on-site releases and off-site releases.
- *Transfers to recycling* describes chemicals sent off-site for recycling.
- *Other transfers for further management* describes chemicals (other than metals) sent for treatment and energy recovery and to sewage plants.
- *Transfers for further management* represent the sum of chemicals sent for recycling and other transfers for further management.
- *Total reported amounts* describe the sum of all above categories, i.e., total releases, recycling and other transfers for further management.

Chemical Lists

The chemicals considered as **known or suspected carcinogens** and used in this analysis are based on lists from the International Agency for Research on Cancer (Categories 1, 2A and 2B) <www.iarc.fr/> and the US National Toxicology Program <http://ntp-server.niehs.nih.gov/>. Of the 206 chemicals in the matched TRI and NPRI 2000 data set, 58 are known or suspected carcinogens.

The chemicals considered as **known or suspected developmental toxicants** for this report were compiled by a US nongovernmental group, Environmental Defense, in consultation with other agencies. This list, posted on their Scorecard web site as of November 2002, is a combination of the recognized California Proposition 65 list and chemicals derived from other government and academic references. It identifies chemicals which are considered recognized developmental toxicants and those chemicals, with less weight of evidence, that are considered suspected development toxicants. Of the more than 300 chemicals on this list, 74 matched the TRI and NPRI data and so form the basis of the developmental toxicant analysis. The full Scorecard list of known or suspected developmental toxicants is available at: <http://www.scorecard.org/health-effects/chemicals.tcl?full_hazard_name=Developmental Toxicity&all_p=t>.

Environmental Defense also compiled the list of chemicals considered as suspected neurotoxicants for this report, in November 2002, in consultation with other agencies. As there is no recognised authoritative list of neurotoxicants, this Scorecard list of suspected neurotoxicants was compiled from government and academic sources. Of the over 300 chemicals on this list, 144 chemicals matched the TRI and NPRI data and so form the basis of the neurotoxicant analysis. The full Scorecard list of suspected neurotoxicants is available at: <http://www.scorecard.org/health-effects/chemicals.tcl?full_hazard_name=Neurotoxicity&all_p=t>.

Appendix B provides a list of chemicals reported to both TRI and NPRI in 2000 that are considered known or suspected carcinogens, developmental toxicants and neurotoxicants.

Findings from the PRTR HEALTH EFFECTS APPROACH

In this section, releases and transfers of known or suspected carcinogens, developmental toxicants and neurotoxicants are presented, based on the matched (TRI-NPRI) data set for 2000, with trends over time established from the 1995–2000 data set. More information on these releases and transfers from the matched data set can be found on the CEC *Taking Stock Online* web site at <www.cec.org/takingstock>. With its user-friendly "query builder," the web site enables users to generate their own reports on chemicals, sectors, facilities and time trends of particular interest.

Releases and Transfers of Carcinogens

What quantity of carcinogens are released and transferred in North America?
In Canada and the United States, over half a million tonnes of chemicals known or suspected to be carcinogens were released and transferred in 2000. Over 81,500 tonnes of carcinogens were released into the air that year. Almost as many carcinogens were disposed of on-site (mainly into landfills: 70,500 tonnes). Another 63,000 tonnes of carcinogens were sent off-site, mainly for disposal. About one hundred times fewer carcinogens were released into the water (about 900 tonnes) than air **(Table 2)**.

Carcinogens made up approximately 17 percent of the total amount of matched chemicals released and transferred in North America (3.3 million tonnes).

Which carcinogens are released and transferred in largest quantities?
In 2000, the carcinogens released and transferred in the largest quantities were:

- Lead and its compounds
- Chromium and its compounds
- Nickel and its compounds
- Dichloromethane (also known as methylene chloride)
- Styrene

The metals lead, chromium and nickel and their compounds were landfilled and recycled in large quantities. In contrast, large amounts of dichloromethane and styrene were released into the air and sent off-site for further management. Other carcinogens that were released into the air in large quantities are formaldehyde, acetaldehyde, trichloroethylene and ethylbenzene **(Table 3)**.

Where are the largest quantities of carcinogens being released?
Five areas led North America in total releases (on- and off-site) of carcinogens in 2000:

- Texas, with 20,500 tonnes
- Ohio, with 15,000 tonnes
- Pennsylvania, with 13,000 tonnes
- Indiana, with 13,000 tonnes
- Ontario, with 13,000 tonnes

All of these areas also ranked in the top seven jurisdictions in North America for releases of carcinogens to air **(Table 4)**.

Which industrial sectors are releasing the largest quantities of carcinogens?
Three sectors were responsible for over half of the carcinogens released (on- and off-site) in North America in 2000 **(Figure 5)**:

- Hazardous Waste Management/Solvent Recovery, with 42,600 tonnes
- Primary Metals, with 40,200 tonnes
- Chemicals, with 38,500 tonnes

The rubber and plastics products sector released the largest amounts of carcinogens to the air (almost 23,000 tonnes). The chemical manufacturing sector released almost 14,500 tonnes of carcinogens to the air, and the transportation equipment sector released 11,500 tonnes of carcinogens to the air.

Which facilities are releasing the largest quantities of carcinogens?
The NPRI facilities with the largest total releases (on- and off-site) of carcinogens in 2000 were **(Table 5)**:

- Safety-Kleen Ltd., in Corunna, Ontario (2,847 tonnes)
- BFI Canada Inc., Calgary Landfill, in Calgary, Alberta (2,586 tonnes)

Three TRI facilities reported the largest amounts of total releases (on- and off-site) of carcinogens in 2000:

- Kennecott Utah Copper Smelter and Refinery, in Magna, Utah (7,654 tonnes)
- Chemical Waste Management Inc., in Kettleman City, California (5,317 tonnes)
- Chemical Waste Management of the North West Inc., in Arlington, Oregon (5,093 tonnes)

TABLE 2. Summary of Releases and Transfers of Known or Suspected Carcinogens (2000 Matched Data Set)

	North America (tonnes)	North America (%)	Canadian NPRI (tonnes)	Canadian NPRI (%)	United States TRI (tonnes)	United States TRI (%)	NPRI as % of North American Total	TRI as % of North American Total
*Total On-site Releases**	*168,384*	*5*	*17,367*	*6*	*151,017*	*5*	*10*	*90*
Air	81,533	2	10,185	3	71,349	2	12	88
Surface Water	913	0.03	106	0.03	806	0.03	12	88
Underground Injection	15,386	0.5	203	0.1	15,183	1	1	99
Land	70,523	2	6,844	2	63,679	2	10	90
Total Off-site Releases	*62,901*	*2*	*8,330*	*3*	*54,571*	*2*	*13*	*87*
Transfers to Disposal (except metals)	6,254	0.2	2,001	1	4,252	0.1	32	68
Transfers of Metals to disposal, energy recovery, treatment and sewage	56,647	2	6,329	2	50,319	2	11	89
Total Releases On- and Off-site	*231,285*	*7*	*25,697*	*8*	*205,588*	*7*	*11*	*89*
Transfers to Recycling	*271,239*	*8*	*25,696*	*8*	*245,543*	*8*	*9*	*91*
Other Transfers Off-site for Further Management	*62,237*	*2*	*2,503*	*1*	*59,734*	*2*	*4*	*96*
Transfers to Energy Recovery (except metals)	32,691		1,019		31,672	1	3	97
Transfers to Treatment (except metals)	25,307	1	1,301	0.4	24,006	1	5	95
Transfers to Sewage (except metals)	4,239	0.1	183	0.1	4,056	0.1	4	96
Total Reported Amounts of Releases and Transfers of Carcinogens	**564,761**	**17**	**53,896**	**17**	**510,865**	**17**	**10**	**90**
Total Reported Amounts of Releases and Transfers of All Matched Chemicals	**3,314,229**	**100**	**312,124**	**100**	**3,002,106**	**100**	**9**	**91**

Note: Canada and US data only. Mexico data not available for 2000. Data include 58 chemicals common to both NPRI and TRI lists from selected industrial and other sources. The data reflect estimates of releases and transfers of chemicals, not exposures of the public to those chemicals. In combination with other information, these data can be used as a starting point in evaluating exposures that may result from releases and other management activities which involve these chemicals.

** The sum of air, surface water, underground injection and land releases in NPRI does not equal the total on-site releases because in NPRI on-site releases of less than 1 tonne may be reported as an aggregate amount.*

TABLE 3. Largest Releases and Transfers of Known or Suspected Carcinogens (2000 Matched Data Set)

CAS Number	Chemicals	Total Reported Amounts of Releases and Transfers (tonnes)	Total Reported Amounts of Releases and Transfers (rank)	On-site Releases: Air (tonnes)	On-site Releases: Surface Water (tonnes)	On-site Releases: Underground Injection (tonnes)	On-site Releases: Land (tonnes)	Off-site Releases (tonnes)	Transfers to Recycling (tonnes)	Other Transfers Off-site for Further Management (tonnes)	Canadian NPRI: Reported Amounts of Releases and Transfers (tonnes)	Canadian NPRI: Reported Amounts of Releases and Transfers (rank)	United States TRI: Reported Amounts of Releases and Transfers (tonnes)	United States TRI: Reported Amounts of Releases and Transfers (rank)
–	Lead (and its compounds)	172,550	1	1,058	45	124	21,310	22,674	127,336	0	17,908	1	154,642	1
–	Chromium (and its compounds)	93,918	2	619	127	1,569	14,163	17,899	59,535	0	10,933	2	82,985	2
–	Nickel (and its compounds)	74,566	3	1,062	137	321	10,770	11,051	51,221	0	5,852	3	68,714	3
75-09-2	Dichloromethane	38,346	4	16,018	5	91	41	114	5,187	16,888	2,644	5	35,701	4
100-42-5	Styrene	37,465	5	27,554	2	118	122	1,007	1,202	7,457	1,959	7	35,507	5
50-00-0	Formaldehyde	16,733	6	7,028	214	5,556	50	223	145	3,516	2,178	6	14,555	6
100-41-4	Ethylbenzene	16,092	7	4,336	8	257	21	127	3,569	7,770	1,560	8	14,532	7
1332-21-4	Asbestos (friable)	15,434	8	1	0	0	12,325	3,106	0	2	4,262	4	11,173	8
–	Arsenic (and its compounds)	12,235	9	258	77	94	8,214	2,866	725	0	967	10	11,267	9
127-18-4	Tetrachloroethylene	8,688	10	1,601	1	27	7	19	3,912	3,120	378	15	8,310	10
79-01-6	Trichloroethylene	8,686	11	5,009	0	22	4	76	1,958	1,617	847	12	7,838	11
75-07-0	Acetaldehyde	8,224	12	6,541	112	490	10	2	0	1,069	952	11	7,272	14
108-05-4	Vinyl acetate	8,154	13	1,608	1	241	48	14	4	6,238	595	13	7,559	12
71-43-2	Benzene	7,522	14	3,938	9	330	22	80	832	2,310	1,351	9	6,171	16
107-06-2	1,2-Dichloroethane	7,493	15	255	0	78	1	203	5,586	1,369	73	20	7,419	13
–	Cobalt (and its compounds)	7,328	16	56	38	17	1,989	647	4,581	0	189	17	7,140	15
79-06-1	Acrylamide	4,024	17	7	0	3,918	0	5	0	94	0	35	4,024	17
67-66-3	Chloroform	3,779	18	1,580	26	103	6	6	915	1,143	45	21	3,734	18
–	Cadmium (and its compounds)	3,430	19	48	5	31	1,196	1,510	640	0	491	14	2,939	19
107-13-1	Acrylonitrile	2,922	20	437	0	1,795	52	147	2	487	9	30	2,913	20
117-81-7	Di(2-ethylhexyl) phthalate	2,694	21	128	0	0	3	566	1,818	179	231	16	2,462	22
64-67-5	Diethyl sulfate	2,657	22	4	0	0	0	0	0	2,653	0	–	2,657	21
106-99-0	1,3-Butadiene	1,986	23	1,092	1	0	27	84	284	497	119	19	1,867	23
56-23-5	Carbon tetrachloride	1,646	24	129	0	28	0	1	1,225	262	15	28	1,631	24
98-95-3	Nitrobenzene	1,544	25	19	0	135	0	3	0	1,387	0	–	1,544	25
	Subtotal for Top 25	**558,116**		**80,386**	**808**	**15,346**	**70,382**	**62,431**	**270,677**	**58,060**	**53,559**		**504,558**	
	All Others	**6,644**		**1,148**	**105**	**40**	**141**	**470**	**562**	**4,177**	**337**		**6,307**	
	Total for Carcinogens	**564,761**		**81,533**	**913**	**15,386**	**70,523**	**62,901**	**271,239**	**62,237**	**53,896**		**510,865**	

Note: Canada and US data only. Mexico data not available for 2000. Data include chemicals common to both NPRI and TRI lists from selected industrial and other sources. The data reflect estimates of releases and transfers of chemicals, not exposures of the public to those chemicals. In combination with other information, these data can be used as a starting point in evaluating exposures that may result from releases and other management activities which involve these chemicals.

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TABLE 4. North American States/Provinces with the Largest Total Releases (On- and Off-site) of Known or Suspected Carcinogens (2000 Matched Data Set)

State/Province	Total Releases On- and Off-site (tonnes)	(rank)	ON-SITE RELEASES Air (tonnes)	(rank)	Surface Water (tonnes)	Underground Injection (tonnes)	Land (tonnes)	Total On-site Releases (tonnes)	Total Off-site Releases (tonnes)
Texas	20,628	1	7,747	1	35	5,565	2,543	15,889	4,739
Ohio	14,995	2	3,136	7	26	2,016	4,112	9,290	5,705
Pennsylvania	12,982	3	3,517	6	20	0	1,870	5,407	7,575
Indiana	12,925	4	5,519	2	23	9	2,334	7,885	5,040
Ontario	12,882	5	4,609	4	11	0	3,412	8,045	4,837
Tennessee	11,873	6	4,919	3	49	0	1,387	6,354	5,519
California	11,168	7	2,236	14	28	0	7,113	9,377	1,791
Louisiana	10,165	8	2,146	15	43	6,649	792	9,631	534
Utah	9,786	9	130	48	1	0	9,089	9,220	566
Michigan	7,946	10	2,082	16	10	53	4,210	6,354	1,592
Illinois	7,311	11	2,847	9	7	0	1,991	4,845	2,466
Oregon	7,212	12	1,596	19	5	0	5,102	6,703	509
Florida	5,585	13	3,812	5	15	61	1,260	5,148	437
Alberta	5,418	14	1,366	23	0	203	2,978	4,551	868
Alabama	5,380	15	1,715	17	56	5	3,167	4,944	436
Missouri	5,003	16	1,482	22	7	0	2,090	3,579	1,424
Georgia	4,994	17	2,884	8	31	0	1,200	4,116	878
Kentucky	4,484	18	1,331	24	47	1	1,802	3,182	1,302
Quebec	4,402	19	2,481	13	18	0	198	2,703	1,699
North Carolina	4,369	20	2,663	10	50	0	1,196	3,909	460
Idaho	4,045	21	174	45	5	0	3,861	4,039	6
South Carolina	3,959	22	2,509	12	35	0	296	2,839	1,120
Mississippi	3,739	23	2,578	11	10	778	208	3,573	165
New York	3,518	24	1,041	28	79	0	1,442	2,562	956
Montana	3,222	25	323	39	0	0	1,364	1,687	1,535
Arkansas	3,005	26	919	30	22	0	492	1,433	1,572
Wisconsin	2,663	27	1,669	18	10	0	52	1,731	932
Virginia	2,539	28	1,510	20	14	0	435	1,959	580
West Virginia	2,256	29	534	34	47	0	1,231	1,811	445
Iowa	2,128	30	1,108	27	10	0	221	1,339	789
Minnesota	1,854	31	1,256	25	6	0	164	1,425	429
Washington	1,804	32	1,492	21	43	0	104	1,639	164

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TABLE 4. (continued) North American States/Provinces with the Largest Total Releases (On- and Off-site) of Known or Suspected Carcinogens (2000 Matched Data Set)

State/Province	Total Releases On- and Off-site (tonnes)	(rank)	ON-SITE RELEASES Air (tonnes)	Air (rank)	Surface Water (tonnes)	Underground Injection (tonnes)	Land (tonnes)	Total On-site Releases (tonnes)	Total Off-site Releases (tonnes)
Oklahoma	1,775	33	698	32	1	0	776	1,476	300
Arizona	1,434	34	437	38	0	0	334	772	662
Kansas	1,274	35	946	29	1	45	100	1,091	183
New Jersey	1,271	36	533	35	7	0	21	561	710
Puerto Rico	1,256	37	1,172	26	4	0	3	1,179	77
Nebraska	1,049	38	207	42	0	0	52	259	790
British Columbia	1,022	39	733	31	14	0	10	760	262
Connecticut	979	40	525	36	3	0	0	527	452
Maryland	941	41	668	33	6	0	81	755	186
New Brunswick	880	42	275	40	41	0	41	357	524
Massachusetts	744	43	203	43	27	0	44	274	470
Manitoba	630	44	446	37	21	0	79	549	80
North Dakota	617	45	101	49	11	0	243	354	263
Delaware	466	46	170	46	2	0	117	289	176
New Mexico	441	47	39	54	0	0	257	296	146
Wyoming	402	48	28	58	0	0	231	259	143
Maine	342	49	245	41	10	0	1	256	87
Nevada	291	50	37	55	0	0	230	267	24
Colorado	235	51	82	52	0	0	48	130	105
Saskatchewan	207	52	183	44	1	0	14	198	8
New Hampshire	201	53	143	47	1	0	3	147	54
Nova Scotia	201	54	58	53	1	0	99	158	42
Rhode Island	120	55	83	51	0	0	0	83	37
South Dakota	103	56	90	50	0	0	10	100	3
Newfoundland	55	57	33	57	0	0	12	46	9
Hawaii	53	58	33	56	0	0	0	33	19
Vermont	24	59	7	61	0	0	0	7	17
Virgin Islands	22	60	20	59	0	0	0	21	1
Alaska	9	61	9	60	0	0	0	9	0
Prince Edward Island	0	62	0	62	0	0	0	0	0
District of Columbia	0	63	0	–	0	0	0	0	0
Total	**231,285**		**81,533**		**913**	**15,386**	**70,523**	**168,384**	**62,901**

Note: Canada and US data only. Mexico data not available for 2000. The data are estimates of releases and transfers of chemicals reported by facilities. None of the rankings are meant to imply that a facility, state or province is not meeting its legal requirements. The data do not predict levels of exposure of the public to those chemicals.

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TABLE 5. Industrial Facilities with the Largest Releases (On- and Off-site) of Known or Suspected Carcinogens (2000 Matched Data Set)

North American Rank	Facility	City, State/Province	Industry	Total Releases On- and Off-site (kg)	Air (kg)	Surface Water (kg)	Underground Injection (kg)	Land (kg)	Total On-site Releases (kg)	Total Off-site Releases (kg)
	Canada									
7	Safety-Kleen Ltd., Lambton Facility	Corunna, ON	Ch	2,847,011	11	0	0	2,847,000	2,847,011	0
9	BFI Canada Inc., Calgary Landfill	Calgary, AB	HW	2,586,040	0	0	0	2,586,040	2,586,040	0
23	Inco Limited, Copper Cliff Smelter Complex	Copper Cliff, ON	PM	1,197,043	277,043	0	0	0	277,043	920,000
	United States									
1	Kennecott Utah Copper Smelter & Refy., Kennecott Holdings Corp.	Magna, UT	PM	7,654,803	35,107	794	0	7,603,973	7,639,873	14,930
2	Chemical Waste Management Inc., Waste Management Inc.	Kettleman City, CA	HW	5,317,324	692	0	0	5,315,705	5,316,397	927
3	Chemical Waste Management of the Northwest Inc. Waste Management Inc.	Arlington, OR	HW	5,092,516	33	0	0	5,092,465	5,092,498	18
4	Exide Corp.	Bristol, TN	EE	4,274,310	319	4	0	0	323	4,273,987
5	Wayne Disposal Inc., EQ Holding Co.	Belleville, MI	HW	4,239,977	982	0	0	3,716,632	3,717,614	522,363
6	Monsanto Luling, Pharmacia Corp.	Luling, LA	Ch	3,785,080	19,909	0	3,765,170	0	3,785,079	0
8	ASARCO Inc.	East Helena, MT	PM	2,804,354	12,405	15	0	1,259,273	1,271,694	1,532,660
10	US Ecology Idaho Inc., American Ecology Corp.	Grand View, ID	HW	2,526,524	356	0	0	2,526,168	2,526,524	0
11	Chemical Waste Management, Waste Management Inc.	Emelle, AL	HW	1,877,997	692	0	0	1,860,208	1,860,899	17,098
12	BP Chemicals Inc., Green Lake Facility, BP America Inc.	Port Lavaca, TX	Ch	1,877,692	8,595	0	1,868,481	485	1,877,560	132
13	Heritage Environmental Services L.L.C.	Indianapolis, IN	HW	1,771,048	9	7	0	0	16	1,771,032
14	Envirosafe Services of Ohio Inc., ETDS Inc.	Oregon, OH	HW	1,764,760	34	0	0	1,762,812	1,762,846	1,914
15	Ameripol Synpol Corp.	Port Neches, TX	Ch	1,634,827	1,633,098	0	0	0	1,633,098	1,730
16	Envirite of Ohio Inc., Envirite Corp.	Canton, OH	HW	1,567,163	349	9	0	0	358	1,566,805
17	Elementis Chromium L.P., Elementis Inc.	Corpus Christi, TX	Ch	1,507,116	3,624	113	0	293,968	297,705	1,209,410
18	Cytec Inds. Inc., Fortier Plant	Westwego, LA	Ch	1,344,547	5,263	11	1,339,229	0	1,344,504	43
19	Solutia Chocolate Bayou, Solutia Inc.	Alvin, TX	Ch	1,333,366	22,674	0	1,310,689	2	1,333,366	0
20	CWM Chemical Services L.L.C, Waste Management	Model City, NY	HW	1,325,821	2	65	0	1,319,918	1,319,985	5,836
21	Waste Management Inc.	Port Arthur, TX	HW	1,246,234	1,152	374	1,379	0	2,905	1,243,329
22	Vickery Environmental Inc., Waste Management Inc.	Vickery, OH	HW	1,232,646	0	0	1,232,200	0	1,232,200	447
24	Nucor-Yamato Steel Co., Nucor Corp.	Blytheville, AR	PM	1,162,420	1,061	0	0	0	1,062	1,161,358
25	Safety Kleen Lone & Grassy Inc., Grassy Mountain Facility	Grantsville, UT	HW	1,127,320	45	0	0	1,124,239	1,124,284	3,035

Note: Canada and US data only. Mexico data not available for 2000. The data are estimates of releases and transfers of chemicals reported by facilities. None of the rankings are meant to imply that a facility, state or province is not meeting its legal requirements. The data do not predict levels of exposure of the public to those chemicals. Some facilities may have reduced or increased releases and transfers since 2000.

Legend: Ch = Chemicals HW = Hazardous Waste Mgt./Solvent Recovery PM = Primary Metals EE = Electronic/Electrical Equipment

FIGURE 5. Industrial Sectors with the Largest Releases (On- and Off-site) of Known or Suspected Carcinogens
(2000 Matched Data Set)

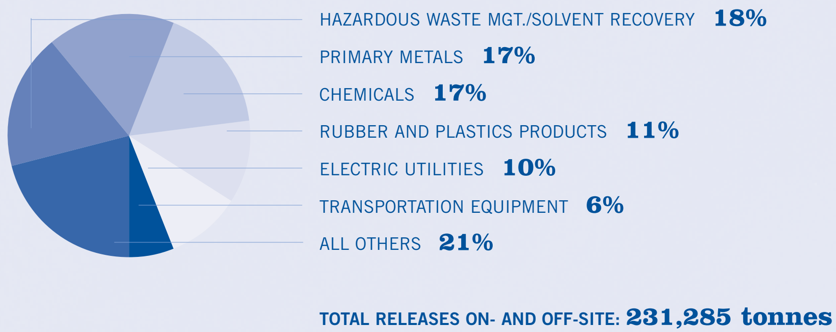
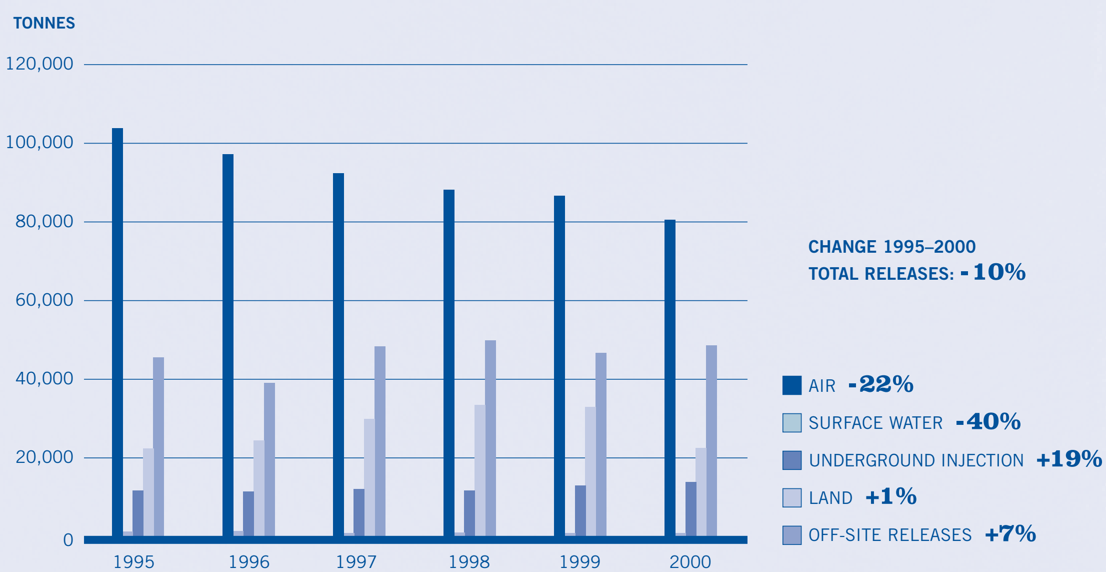


FIGURE 6. Releases (On- and Off-site) of Known or Suspected Carcinogens in North America, TRI and NPRI (1995–2000 Matched Data Set)



These facilities reported disposing of large amounts of carcinogens into landfills on-site. Different facilities reported large on-site air releases of carcinogens.

The following TRI facilities were responsible for the largest air releases of carcinogens:

- Ameripol Synpol Corp., in Port Neches, Texas (1,633 tonnes)
- Carpenter Co, Tupelo Div., in Verona, Massachusetts (875 tonnes)
- Foamex L.P., in Corry, Pennsylvania (807 tonnes)
- Aguaglass Corp., Masco Corp., Adamsville, Tennessee (660 tonnes)
- Abbott Health Products Inc., Abbott Labs, Barceloneta, Puerto Rico (600 tonnes)

The NPRI facilities with the largest air releases of carcinogens in 2000 are:

- Carpenter Canada Co., in Woodbridge, Ontario (454 tonnes)
- Inco Ltd., Copper Cliff Smelter Complex, in Copper Cliff, Ontario (277 tonnes)
- Vitafoam Products Canada Ltd., Toronto Facility, in Downsview, Ontario (273 tonnes)
- Celanese Canada Inc., Edmonton facility, in Edmonton, Alberta (239 tonnes)
- Domfoam International, Vale Foam Industries (1995) Inc., in St. Leonard, Quebec (210 tonnes)

Companies making rubber and plastics products can release large quantities of carcinogens to the air. This is mainly the result of large emissions of one chemical, methylene chloride, also known as dichloromethane.

Has the quantity of carcinogens released increased or decreased over time?

The quantity of carcinogens released decreased by 10 percent from 1995 to 2000. Most of this decrease was due to the 22-percent reduction in carcinogens released to the air at the facility site **(Figure 6)**. Most of the decrease came from TRI facilities, with some increases seen in NPRI facilities. Carcinogens shipped off-site to disposal increased.

These trends are based on 159 chemicals and industries that were commonly reported over this time period. Thus, electric utilities, hazardous waste/solvent recovery facilities and transfers to recycling are not included.

Releases and Transfers of Developmental Toxicants

Developmental toxicants are those substances that can produce detrimental effects during fetal development. Some of these effects include structural abnormalities and other birth defects, low birth weight, growth retardation, fetal death, metabolic or biological dysfunction, as well as psychological and behavioral defects that manifest as the child grows (Goldman and Koduru 2000; National Environmental Trust *et al.* 2000; Scorecard 2002). PRTR data provide one source of information on releases and transfers of these developmental toxicants from larger industrial facilities.

What quantity of developmental toxicants are released and transferred in North America?

In North America, over 2 million tonnes of chemicals that are known or suspected development toxicants were released and transferred in 2000. Ninety percent of the North American total load of developmental toxicants originated from US TRI facilities, and ten percent came from Canadian NPRI facilities. Over half a million tonnes of this total amount of developmental toxicants were released at the site of the facility, directly into the air, land and water, and injected underground. Of particular concern are the 371,000 tonnes of chemicals known or suspected to be developmental toxicants that were directly released into the air from facilities **(Table 6)**. Known or suspected developmental toxicants made up approximately 63 percent of the total amount of matched chemicals released and transferred in North America (3.3 million tonnes).

Which developmental toxicants are released and transferred in largest quantities?

In 2000, the known or suspected developmental toxicants released or transferred in the five largest quantities were:

- Copper and its compounds
- Zinc and its compounds
- Methanol
- Lead and its compounds
- Toluene

Of special concern are the developmental toxicants methanol, toluene, hydrogen fluoride and xylenes released into the air in the largest amounts **(Table 7)**.

Where are the largest quantities of developmental toxicants being released?

Texas, Ontario and Ohio led North America in releasing (on- and off-site) the largest quantities of known or suspected developmental toxicants:

- Texas, with 51,500 tonnes
- Ontario, with 47,300 tonnes
- Ohio, with 46,000 tonnes

Ontario narrowly led North America in releases of developmental toxicants to air (25,673 tonnes), followed by Texas (24,696) **(Table 8)**.

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TABLE 6. Summary of Releases and Transfers of Known or Suspected Developmental Toxicants (2000 Matched Data Set)

	North America (tonnes)	North America (%)	Canadian NPRI (tonnes)	Canadian NPRI (%)	United States TRI (tonnes)	United States TRI (%)	NPRI as % of North American Total	TRI as % of North American Total
*Total On-site Releases**	*580,285*	*28*	*69,453*	*33*	*510,832*	*27*	*12*	*88*
Air	370,565	18	53,564	25	317,001	17	14	86
Surface Water	5,461	0.3	1,331	0.6	4,130	0.2	24	76
Underground Injection	34,864	2	3,088	1	31,776	2	9	91
Land	169,313	8	11,388	5	157,925	8	7	93
Total Off-site Releases	*186,051*	*9*	*18,712*	*9*	*167,339*	*9*	*10*	*90*
Transfers to Disposal (except metals)	13,770	1	2,840	1	10,930	1	21	79
Transfers of Metals to disposal, energy recovery, treatment and sewage	172,281	8	15,872	8	156,409	8	9	91
Total Releases On- and Off-site	*766,336*	*36*	*88,165*	*42*	*678,171*	*36*	*12*	*88*
Transfers to Recycling	*891,895*	*42*	*98,150*	*47*	*793,745*	*42*	*11*	*89*
Transfers to Recycling of Metals	755,663	36	84,099	40	671,565	35	11	89
Transfers to Recycling (except metals)	136,232	6	14,051	7	122,181	6	10	90
Other Transfers Off-site for Further Management	*445,797*	*21*	*24,461*	*12*	*421,336*	*22*	*5*	*95*
Transfers to Energy Recovery (except metals)	303,437	14	14,892	7	288,544	15	5	95
Transfers to Treatment (except metals)	85,356	4	8,320	4	77,036	4	10	90
Transfers to Sewage (except metals)	57,004	3	1,248	1	55,756	3	2	98
Total Reported Amounts of Releases and Transfers	**2,104,028**	**100**	**210,776**	**100**	**1,893,252**	**100**	**10**	**90**

Note: Canada and US data only. Mexico data not available for 2000. Data include 74 chemicals common to both NPRI and TRI lists from selected industrial and other sources. The data reflect estimates of releases and transfers of chemicals, not exposures of the public to those chemicals. In combination with other information, these data can be used as a starting point in evaluating exposures that may result from releases and other management activities which involve these chemicals.

** The sum of air, surface water, underground injection and land releases in NPRI does not equal the total on-site releases because in NPRI on-site releases of less than 1 tonne may be reported as an aggregate amount.*

TABLE 7. Largest Releases and Transfers of Known or Suspected Developmental Toxicants (2000 Matched Data Set)

Rank	CAS Number	Chemical	Total Reported Amounts of Releases and Transfers (tonnes)	Total Reported Amounts of Releases and Transfers (rank)	ON-SITE RELEASES Air (tonnes)	ON-SITE RELEASES Surface Water (tonnes)	ON-SITE RELEASES Underground Injection (tonnes)	ON-SITE RELEASES Land (tonnes)	Total Off-site Releases (tonnes)	Transfers to Recycling (tonnes)	Other Transfers Off-site for Further Management (tonnes)	CANADIAN NPRI Reported amounts of releases and transfers (tonnes)	CANADIAN NPRI (rank)	US TRI Reported amounts of releases and transfers (tonnes)	US TRI (rank)
1	--	Copper (and its compounds)	455,885	1	1,544	228	230	41,580	16,463	395,835	0	32,947	2	422,937	1
2	--	Zinc (and its compounds)	384,489	2	5,450	700	264	81,407	116,871	179,793	0	55,353	1	329,135	2
3	67-56-1	Methanol	256,782	3	103,121	2,696	9,870	679	1,528	8,518	130,359	26,063	3	230,720	3
4	--	Lead (and its compounds)	172,550	4	1,058	45	124	21,310	22,674	127,336	0	17,908	5	154,642	4
5	108-88-3	Toluene	151,013	5	42,416	19	249	64	1,351	15,898	91,005	16,582	6	134,431	5
6	--	Xylenes	122,951	6	32,952	41	82	63	1,772	23,566	64,464	20,472	4	102,479	6
7	--	Nickel (and its compounds)	74,566	7	1,062	137	321	10,770	11,051	51,221	0	5,852	8	68,714	7
8	78-93-3	Methyl ethyl ketone	69,025	8	20,044	18	1,411	54	704	9,197	37,591	11,098	7	57,927	9
9	107-21-1	Ethylene glycol	60,834	9	2,307	376	359	491	3,141	32,657	21,498	2,524	11	58,310	8
10	110-54-3	n-Hexane	43,317	10	27,083	8	52	5	50	3,586	12,529	3,263	10	40,054	10
11	7664-39-3	Hydrogen fluoride	39,287	11	35,692	12	2,132	45	321	146	940	3,601	9	35,686	11
12	100-42-5	Styrene	37,465	12	27,554	2	118	122	1,007	1,202	7,457	1,959	13	35,507	12
13	108-10-1	Methyl isobutyl ketone	23,764	13	6,346	15	36	29	122	5,972	11,242	2,077	12	21,687	13
14	75-05-8	Acetonitrile	20,348	14	339	7	10,221	0	46	934	8,800	46	38	20,302	14
15	872-50-4	N-Methyl-2-pyrrolidone	20,205	15	1,478	6	939	68	419	7,656	9,639	195	27	20,009	15
16	75-15-0	Carbon disulfide	18,609	16	18,477	2	8	1	2	0	119	72	35	18,538	16
17	100-41-4	Ethylbenzene	16,092	17	4,336	8	257	21	127	3,569	7,770	1,560	14	14,532	17
18	108-95-2	Phenol	12,660	18	3,182	36	1,129	98	641	828	6,744	1,014	16	11,646	18
19	--	Arsenic (and its compounds)	12,235	19	258	77	94	8,214	2,866	725	0	967	17	11,267	19
20	127-18-4	Tetrachloroethylene	8,688	20	1,601	1	27	7	19	3,912	3,120	378	23	8,310	20
21	79-01-6	Trichloroethylene	8,686	21	5,009	0	22	4	76	1,958	1,617	847	19	7,838	21
22	75-07-0	Acetaldehyde	8,224	22	6,541	112	490	10	2	0	1,069	952	18	7,272	23
23	71-43-2	Benzene	7,522	23	3,938	9	330	22	80	832	2,310	1,351	15	6,171	24
24	107-06-2	1,2-Dichloroethane	7,493	24	255	0	78	1	203	5,586	1,369	73	34	7,419	22
25	91-20-3	Naphthalene	5,751	25	1,104	22	94	86	154	2,987	1,300	219	26	5,532	26
		Subtotal for Top 25	**2,038,406**		**353,145**	**4,579**	**28,936**	**165,153**	**181,658**	**883,915**	**420,942**	**207,340**		**1,831,066**	
		All Others	**65,622**		**17,420**	**882**	**5,928**	**4,161**	**4,394**	**7,981**	**24,854**	**3,436**		**62,186**	
		Total for All Developmental Toxicants	**2,104,028**		**370,565**	**5,461**	**34,864**	**169,313**	**186,051**	**891,895**	**445,797**	**210,776**		**1,893,252**	

Note: Canada and US data only. Mexico data not available for 2000. Data include chemicals common to both NPRI and TRI lists from selected industrial and other sources. The data reflect estimates of releases and transfers of chemicals, not exposures of the public to those chemicals. In combination with other information, these data can be used as a starting point in evaluating exposures that may result from releases and other management activities which involve these chemicals.

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TABLE 8. North American States/Provinces with the Largest Total Releases (On- and Off-site) of Known or Suspected Developmental Toxicants (2000 Matched Data Set)

State/Province	Total Releases On- and Off-site (tonnes)	Total Releases On- and Off-site (rank)	ON-SITE RELEASES: Air (tonnes)	ON-SITE RELEASES: Air (rank)	ON-SITE RELEASES: Surface Water (tonnes)	ON-SITE RELEASES: Underground Injection (tonnes)	ON-SITE RELEASES: Land (tonnes)	ON-SITE RELEASES: Total On-site Releases (tonnes)	OFF-SITE RELEASES: Transfers to Disposal (except metals) (tonnes)	OFF-SITE RELEASES: Transfers of Metals (tonnes)	OFF-SITE RELEASES: Total Off-site Releases (tonnes)
Texas	51,581	1	24,696	2	196	14,564	3,938	43,394	2,069	6,117	8,186
Ontario	47,280	2	25,673	1	282	0	7,418	33,413	2,094	11,773	13,867
Ohio	46,212	3	13,343	10	110	6,609	9,202	29,264	1,048	15,900	16,948
Indiana	44,757	4	14,888	6	253	79	6,790	22,010	951	21,796	22,747
Illinois	40,428	5	14,363	8	52	0	13,839	28,254	443	11,730	12,174
Pennsylvania	36,293	6	10,806	15	107	0	2,324	13,236	255	22,801	23,057
Tennessee	32,686	7	24,159	3	140	0	1,914	26,214	400	6,073	6,473
Alabama	30,852	8	17,087	4	158	5	10,886	28,136	784	1,932	2,716
Michigan	27,834	9	12,541	12	81	828	6,044	19,493	413	7,927	8,340
Utah	27,355	10	644	50	4	0	24,804	25,451	26	1,878	1,904
Louisiana	26,359	11	15,503	5	148	8,220	924	24,796	180	1,383	1,562
Missouri	22,416	12	10,298	16	13	0	10,323	20,634	114	1,668	1,782
Montana	21,978	13	1,744	38	2	0	17,807	19,554	1	2,423	2,424
South Carolina	19,516	14	12,763	11	142	0	798	13,703	92	5,721	5,813
Arkansas	19,486	15	7,190	21	80	664	1,003	8,937	86	10,464	10,550
Georgia	19,255	16	14,715	7	151	0	1,478	16,344	221	2,691	2,912
Arizona	18,345	17	1,120	42	1	0	16,351	17,472	140	732	873
North Carolina	18,295	18	13,945	9	108	0	1,268	15,321	628	2,345	2,973
Virginia	14,902	19	11,450	14	63	0	1,046	12,559	168	2,174	2,343
Florida	14,598	20	11,477	13	34	398	2,047	13,957	31	611	642
Quebec	14,259	21	9,495	17	161	0	1,933	11,605	117	2,536	2,653
Kentucky	13,785	22	9,346	18	217	1	2,793	12,358	103	1,324	1,427
California	12,954	23	4,010	31	897	3	4,707	9,618	1,232	2,104	3,336
Oregon	11,071	24	5,448	23	37	0	1,388	6,874	21	4,176	4,197
Iowa	10,341	25	5,065	25	113	0	340	5,518	208	4,614	4,823
Alberta	10,109	26	5,146	24	39	3,079	698	8,971	526	612	1,138
Wisconsin	9,693	27	7,318	20	53	0	75	7,446	91	2,156	2,247
Mississippi	9,273	28	8,127	19	63	253	362	8,805	53	415	469
Idaho	9,104	29	991	45	26	0	8,065	9,083	1	21	21
New York	7,343	30	3,851	32	101	0	1,037	4,989	140	2,214	2,354
West Virginia	7,048	31	4,489	28	145	0	1,805	6,440	165	443	608
Minnesota	7,008	32	4,574	27	80	0	468	5,122	23	1,863	1,886

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TABLE 8. (continued) North American States/Provinces with the Largest Total Releases (On- and Off-site) of Known or Suspected Developmental Toxicants (2000 Matched Data Set)

State/Province	Total Releases On- and Off-site (tonnes)	Total Releases On- and Off-site (rank)	ON-SITE RELEASES: Air (tonnes)	Air (rank)	Surface Water (tonnes)	Underground Injection (tonnes)	Land (tonnes)	Total On-site Releases (tonnes)	OFF-SITE RELEASES: Transfers to Disposal (except metals) (tonnes)	Transfers of Metals (tonnes)	Total Off-site Releases (tonnes)
British Columbia	6,691	33	6,330	22	173	0	47	6,561	3	127	130
Oklahoma	6,192	34	4,251	30	23	2	903	5,178	34	981	1,014
Nebraska	5,745	35	1,866	37	5	0	220	2,091	37	3,616	3,653
Washington	5,650	36	4,698	26	195	0	160	5,053	258	340	598
Kansas	5,144	37	4,489	29	11	124	206	4,831	42	271	313
New Jersey	5,143	38	3,041	33	108	0	39	3,188	172	1,783	1,955
Manitoba	4,088	39	2,855	34	26	0	1,020	3,905	4	178	183
New Brunswick	3,650	40	2,351	35	639	0	31	3,021	95	534	629
Maryland	2,716	41	2,213	36	61	5	254	2,533	7	176	183
Maine	2,066	42	1,673	39	58	0	117	1,847	19	200	218
Massachusetts	2,065	43	1,248	40	17	0	77	1,342	89	634	722
Connecticut	1,681	44	1,094	44	10	0	1	1,106	38	538	576
Colorado	1,411	45	772	47	1	0	137	910	10	491	501
Puerto Rico	1,363	46	1,116	43	10	0	5	1,131	72	160	232
South Dakota	1,306	47	768	48	0	0	517	1,285	1	20	20
Saskatchewan	1,199	48	1,167	41	9	9	3	1,189	1	9	10
North Dakota	1,174	49	642	51	15	0	230	887	1	286	287
Wyoming	1,169	50	296	53	0	21	392	709	3	456	460
New Hampshire	1,016	51	849	46	5	0	5	859	21	136	157
New Mexico	1,014	52	283	56	3	0	408	695	7	312	319
Delaware	931	53	700	49	26	0	111	836	0	95	95
Nevada	836	54	421	52	0	0	312	733	2	100	103
Nova Scotia	551	55	256	57	1	0	200	457	0	93	93
Rhode Island	398	56	295	54	0	0	0	295	27	76	103
Newfoundland	338	57	289	55	1	0	38	328	0	9	9
Virgin Islands	155	58	152	58	1	0	0	153	0	1	1
Hawaii	88	59	68	60	0	0	0	68	1	19	21
Alaska	87	60	81	59	4	0	1	87	0	0	0
Vermont	54	61	30	61	0	0	0	30	4	20	24
Prince Edward Island	1	62	1	62	0	0	0	1	0	0	0
District of Columbia	0	63	0	63	0	0	0	0	0	0	0
Total	**766,336**		**370,565**		**5,461**	**34,864**	**169,313**	**580,285**	**13,770**	**172,281**	**186,051**

Note: Canada and US data only. Mexico data not available for 2000. The data are estimates of releases and transfers of chemicals reported by facilities. None of the rankings are meant to imply that a facility, state or province is not meeting its legal requirements. The data do not predict levels of exposure of the public to those chemicals.

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FIGURE 7. Industrial Sectors with the Largest Releases (On- and Off-site) of Known or Suspected Developmental Toxicants (2000 Matched Data Set)

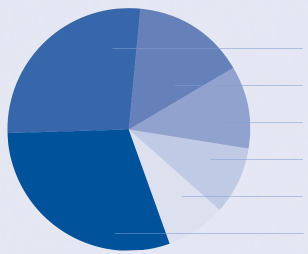
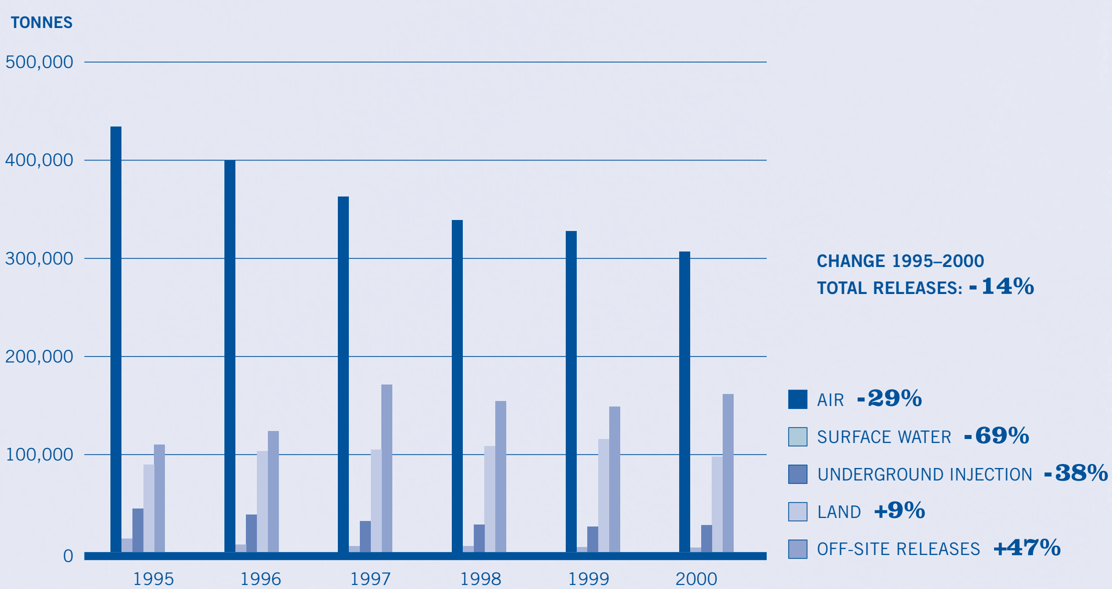


FIGURE 8. Releases (On- and Off-site) of Known or Suspected Developmental Toxicants (1995–2000 Matched Data Set)



Which industrial sectors are releasing the largest quantities of developmental toxicants?

Three sectors released (on- and off-site) the largest quantities of known or suspected developmental toxicants in 2000 **(Figure 7)**:

- Primary metal industries (includes steel mills, etc.), with 205,000 tonnes
- Chemicals (includes chemical manufacturing and processing), with 114,000 tonnes
- Paper products (include pulp and paper mills and paper manufacturers, etc.), with 85,500 tonnes

Which facilities are releasing the largest quantities of developmental toxicants?

In Canada, three facilities released (on- and off-site) the largest quantities of known or suspected developmental toxicants in 2000 **(Table 9)**:

- Safety Kleen Ltd., in Corunna, Ontario (5,939 tonnes)
- Dofasco Inc., in Hamilton, Ontario (4,394 tonnes)
- Celanese Canada Inc., in Edmonton, Alberta (3,117 tonnes)

In the US, many more facilities released more than 3,000 tonnes of developmental toxicants. Some of the largest releases were from three primary metals plants:

- Kennecott Utah Copper Smelter and Refinery, in Magna, Utah (22,236 tonnes)
- ASARCO Inc., in East Helena, Montana (20,017 tonnes)

- ASARCO Inc., in Hayden, Arizona (15,934 tonnes)

Two US TRI facilities had large air releases of developmental toxicants, mainly carbon disulfide:

- Lenzing Fibers Corp., in Lowland, Tennessee (7,711 tonnes)
- Acordis Cellulosic Fibers Inc., in Axis, Alabama (5,106 tonnes)

Has the quantity of developmental toxicants released increased or decreased over time?
In North America, the amount of developmental toxicants released decreased by 14 percent from 1995 to 2000. Encouragingly, some of the largest decreases have been to air, with a 29-percent decrease in releases of developmental toxicants to the air from 1995 to 2000. Both Canada and the US showed similar, decreasing trends in releases of developmental toxicants from 1995 to 2000. In contrast, off-site releases increased by 47 percent from 1995 to 2000 **(Figure 8)**.

These trends are based on 159 chemicals and industries that were commonly reported over this time period, thus electric utilities, hazardous waste/solvent recovery facilities and transfers to recycling are not included.

TABLE 9. **Facilities with the Largest Total Releases of Known or Suspected Developmental Toxicants** (2000 Matched Data Set)

North American Rank	Facility	City, State/Province	Industry	Total Releases On- and Off-site (kg)	ON- AND OFF-SITE RELEASES / ON-SITE RELEASES: Air (kg)	Surface Water (kg)	Underground Injection (kg)	Land (kg)	Total On-site Releases (kg)	Total Off-site Releases (kg)	Total Reported Amounts of Releases and Transfers (kg)
	Canada										
13	Safety-Kleen Ltd., Lambton Facility	Corunna, ON	Ch	5,938,846	46	0	0	5,938,800	5,938,846	0	5,938,846
19	Dofasco Inc., Dofasco Hamilton	Hamilton, ON	PM	4,394,169	173,190	556	0	2	173,748	4,220,421	5,803,578
26	Celanese Canada Inc., Edmonton Facility	Edmonton, AB	Ch	3,117,065	319,713	0	2,797,200	152	3,117,065	0	3,878,108
	United States										
1	Kennecott Utah Copper Smelter & Refy.,Kennecott Holdings Corp.	Magna, UT	PM	22,235,556	90,796	1,474	0	22,107,717	22,199,986	35,569	22,235,558
2	ASARCO Inc.	East Helena, MT	PM	20,017,185	17,751	30	0	17,579,041	17,596,822	2,420,362	20,017,185
3	ASARCO Inc., Ray Complex/Hayden Smelter & Concentrator, Grupo México S.A. de C.V	Hayden, AZ	PM	15,933,794	51,038	0	0	15,882,618	15,933,656	138	16,892,272
4	Zinc Corp. of America, Monaca Smelter, Horsehead Inds. Inc.	Monaca, PA	PM	12,234,793	210,312	126	0	0	210,439	12,024,355	12,234,793
5	Chemical Waste Management, Waste Management Inc.	Emelle, AL	HW	8,317,010	1,544	0	0	8,170,883	8,172,427	144,583	8,369,800
6	Steel Dynamics Inc.	Butler, IN	PM	7,960,401	11,913	0	0	0	11,913	7,948,488	7,960,401
7	Lenzing Fibers Corp.	Lowland, TN	Ch	7,865,289	7,711,102	1,751	0	152,435	7,865,289	0	7,865,289
8	Nucor-Yamato Steel Co., Nucor Corp.	Blytheville, AR	PM	7,403,589	7,132	5	0	0	7,136	7,396,453	7,403,589

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TABLE 9 (continued). Facilities with the Largest Total Releases of Known or Suspected Developmental Toxicants (2000 Matched Data Set)

					ON- AND OFF-SITE RELEASES							
					ON-SITE RELEASES							
North American Rank	Facility	City, State/Province	Industry	Total Releases On- and Off-site (kg)	Air (kg)	Surface Water (kg)	Underground Injection (kg)	Land (kg)	Total On-site Releases (kg)	Total Off-site Releases (kg)	Total Reported Amounts of Releases and Transfers (kg)
9	Peoria Disposal Co. #1, Coulter Cos. Inc.	Peoria, IL	HW	7,229,921	124	0	0	7,229,796	7,229,920	1	7,229,921
10	Doe Run Co., Herculaneum Smelter, Renco Group Inc.	Herculaneum, MO	PM	6,539,180	145,066	231	0	6,393,108	6,538,406	774	6,539,180
11	Wayne Disposal Inc., EQ Holding Co.	Belleville, MI	HW	6,278,826	3,397	0	0	5,079,270	5,082,668	1,196,158	6,278,826
12	Nucor Steel, Nucor Corp.	Crawfordsville, IN	PM	6,092,755	1,502	55	0	0	1,556	6,091,198	6,092,755
14	Envirosafe Services of Ohio Inc., ETDS Inc.	Oregon, OH	HW	5,770,514	322	0	0	5,767,347	5,767,668	2,846	5,770,514
15	US Ecology Idaho Inc., American Ecology Corp.	Grand View, ID	HW	5,686,592	1,694	0	0	5,684,898	5,686,592	0	5,686,605
16	Cytec Inds. Inc., Fortier Plant	Westwego, LA	Ch	5,342,382	14,216	3,489	5,314,286	0	5,331,991	10,391	5,409,158
17	Acordis Cellulosic Fibers Inc., Acordis US Holding Inc.	Axis, AL	Ch	5,249,773	5,105,655	9,878	0	134,240	5,249,773	0	5,249,773
18	National Steel Corp., Greatlakes Ops.	Ecorse, MI	PM	4,562,539	59,244	7,651	0	0	66,895	4,495,644	4,577,410
20	Exide Corp.	Bristol, TN	EE	4,274,310	319	4	0	0	323	4,273,987	4,609,402
21	BP Chemicals Inc., BP America	Lima, OH	Ch	3,790,358	34,063	0	3,755,785	0	3,789,848	510	3,794,273
22	Nucor Steel, Nucor Corp.	Huger, SC	PM	3,643,407	8,708	65	0	0	8,773	3,634,634	3,677,173
23	BP Chemicals Inc. Green Lake Facility, BP America Inc.	Port Lavaca, TX	Ch	3,503,802	11,530	0	3,491,655	485	3,503,670	132	3,506,141
24	Chemical Waste Management Inc., Waste Management Inc.	Kettleman City, CA	HW	3,484,010	2,107	0	0	3,480,742	3,482,849	1,161	3,484,636
25	Keystone Steel & Wire Co., Keystone Consolidated Inds. Inc.	Peoria, IL	PM	3,165,837	25,868	290	0	202,268	228,426	2,937,410	3,347,243

Note: Canada and US data only. Mexico data not available for 2000. Data include chemicals common to both NPRI and TRI lists from selected industrial and other sources. The data reflect estimates of releases and transfers of chemicals, not exposures of the public to those chemicals. In combination with other information, these data can be used as a starting point in evaluating exposures that may result from releases and other management activities which involve these chemicals. Some facilities may have reduced or increased releases and transfers since 2000.

Legend: Ch = Chemicals HW = Hazardous Waste Mgt./Solvent Recovery PM = Primary Metals EE = Electronic/Electrical Equipment

Releases and Transfers of Neurotoxicants

Neurotoxicants are chemicals that alter the structure or functioning of the central and/or peripheral nervous system.

What quantity of neurotoxicants are released and transferred in North America?

In North America, over 2 million tonnes of suspected neurotoxicants were released and transferred in 2000. Of particular concern is the nearly half a million tonnes of suspected neurotoxicants that were directly released into the air from facilities.

Suspected neurotoxicants make up approximately 62 percent of the total amount of matched chemicals released and transferred in North America (3.3 million tonnes).

Almost 90 percent of the North American total load of suspected neurotoxicants originated from the US TRI facilities, and ten percent from Canadian NPRI facilities. Over one-third of this total amount was released at the site of the facility, directly into the air, land and water, and injected underground **(Table 10)**.

TABLE 10. Summary of Total Reported Releases and Transfers of Suspected Neurotoxicants (2000 Matched Data Set)

	North America (tonnes)	(%)	Canadian NPRI (tonnes)	(%)	United States TRI (tonnes)	(%)	NPRI as % of North American Total	TRI as % of North American Total
*Total On-site Releases**	*724,015*	*35*	*83,813*	*38*	*640,203*	*35*	*12*	*88*
Air	446,744	22	62,294	28	384,450	21	14	86
Surface Water	9,426	0.5	2,184	1	7,242	0.4	23	77
Underground Injection	58,199	3	3,237	1	54,962	3	6	94
Land	209,552	10	16,003	7	193,549	11	8	92
Total Off-site Releases	*220,910*	*11*	*24,554*	*11*	*196,356*	*11*	*11*	*89*
Transfers to Disposal (except metals)	18,826	1	3,290	1	15,537	1	17	83
Transfers of Metals to disposal, energy recovery, treatment and sewage	202,083	10	21,264	10	180,819	10	11	89
Total Releases On- and Off-site	*944,925*	*46*	*108,366*	*49*	*836,559*	*46*	*11*	*89*
Transfers to Recycling	*594,009*	*29*	*86,344*	*39*	*507,665*	*28*	*15*	*85*
Other Transfers Off-site for Further Management	*507,522*	*25*	*26,117*	*12*	*481,405*	*26*	*5*	*95*
Transfers to Energy Recovery (except metals)	337,201	16	15,210	7	321,991	18	5	95
Transfers to Treatment (except metals)	108,429	5	9,438	4	98,990	5	9	91
Transfers to Sewage (except metals)	61,892	3	1,469	1	60,424	3	2	98
Total Reported Amounts of Releases and Transfers of Neurotoxicants	**2,046,456**	**100**	**220,827**	**100**	**1,825,629**	**100**	**11**	**89**

Note: Canada and US data only. Mexico data not available for 2000. Data include 144 chemicals common to both NPRI and TRI lists from selected industrial and other sources. The data reflect estimates of releases and transfers of chemicals, not exposures of the public to those chemicals. In combination with other information, these data can be used as a starting point in evaluating exposures that may result from releases and other management activities which involve these chemicals.

** The sum of air, surface water, underground injection and land releases in NPRI does not equal the total on-site releases because in NPRI on-site releases of less than 1 tonne may be reported as an aggregate amount.*

TABLE 11. Largest Releases and Transfers of Suspected Neurotoxicants (2000 Matched Data Set)

CAS Number	Chemicals	Total Reported Amounts of Releases and Transfers (tonnes)	(rank)	ON-SITE RELEASES Air (tonnes)	Surface Water (tonnes)	Underground Injection (tonnes)	Land (tonnes)	Total Off-site Releases (tonnes)	Transfers to Recycling (tonnes)	Other Transfers Off-site for Further Management (tonnes)	CANADIAN NPRI Reported Amounts of Releases and Transfers (tonnes)	(rank)	UNITED STATES TRI Reported Amounts of Releases and Transfers (tonnes)	(rank)
–	Zinc (and its compounds)	384,489	1	5,450	700	264	81,407	116,871	179,793	0	55,353	1	329,135	1
67-56-1	Methanol	256,782	2	103,121	2,696	9,870	679	1,528	8,518	130,359	26,063	2	230,720	2
–	Lead (and its compounds)	172,550	3	1,058	45	124	21,310	22,674	127,336	0	17,908	5	154,642	3
–	Manganese (and its compounds)	164,967	4	1,473	3,529	4,367	51,770	37,912	65,904	0	23,557	3	141,410	4
108-88-3	Toluene	151,013	5	42,416	19	249	64	1,351	15,898	91,005	16,582	6	134,431	5
–	Xylenes	122,951	6	32,952	41	82	63	1,772	23,566	64,464	20,472	4	102,479	6
–	Nickel (and its compounds)	74,566	7	1,062	137	321	10,770	11,051	51,221	0	5,852	8	68,714	7
78-93-3	Methyl ethyl ketone	69,025	8	20,044	18	1,411	54	704	9,197	37,591	11,098	7	57,927	9
107-21-1	Ethylene glycol	60,834	9	2,307	376	359	491	3,141	32,657	21,498	2,524	14	58,310	8
110-54-3	n-Hexane	43,317	10	27,083	8	52	5	50	3,586	12,529	3,263	11	40,054	10
7664-39-3	Hydrogen fluoride	39,287	11	35,692	12	2,132	45	321	146	940	3,601	10	35,686	12
75-09-2	Dichloromethane	38,346	12	16,018	5	91	41	114	5,187	16,888	2,644	12	35,701	11
100-42-5	Styrene	37,465	13	27,554	2	118	122	1,007	1,202	7,457	1,959	17	35,507	13
108-10-1	Methyl isobutyl ketone	23,764	14	6,346	15	36	29	122	5,972	11,242	2,077	16	21,687	14
7429-90-5	Aluminum (fume or dust)	23,597	15	735	2	0	5,561	5,306	11,992	0	5,678	9	17,919	21
7782-50-5	Chlorine	22,314	16	21,494	120	76	135	24	39	425	877	24	21,437	15
1344-28-1	Aluminum oxide (fibrous forms)	21,445	17	63	0	4	19,270	1,778	245	85	160	43	21,285	16
74-85-1	Ethylene	20,931	18	13,126	0	14	0	0	0	7,797	2,608	13	18,324	20
75-05-8	Acetonitrile	20,348	19	339	7	10,221	0	46	934	8,800	46	58	20,302	17
872-50-4	N-Methyl-2-pyrrolidone	20,205	20	1,478	6	939	68	419	7,656	9,639	195	37	20,009	18
75-15-0	Carbon disulfide	18,609	21	18,477	2	8	1	2	0	119	72	53	18,538	19
50-00-0	Formaldehyde	16,733	22	7,028	214	5,556	50	223	145	3,516	2,178	15	14,555	22
100-41-4	Ethylbenzene	16,092	23	4,336	8	257	21	127	3,569	7,770	1,560	19	14,532	23
108-95-2	Phenol	12,660	24	3,182	36	1,129	98	641	828	6,744	1,014	21	11,646	24
–	Arsenic (and its compounds)	12,235	25	258	77	94	8,214	2,866	725	0	967	22	11,267	25
	Subtotal for top 25	**1,844,525**		**393,090**	**8,077**	**37,772**	**200,269**	**210,051**	**556,318**	**438,870**	**208,307**		**1,636,218**	
	All Others	**201,931**		**53,654**	**1,349**	**20,427**	**9,282**	**10,859**	**37,691**	**68,653**	**12,520**		**189,411**	
	Total for carcinogens	**2,046,456**		**446,744**	**9,426**	**58,199**	**209,552**	**220,910**	**594,009**	**507,522**	**220,827**		**1,825,629**	

Note: Canada and US data only. Mexico data not available for 2000. Data include chemicals common to both NPRI and TRI lists from selected industrial and other sources. The data reflect estimates of releases and transfers of chemicals, not exposure of the public to those chemicals. In combination with other information, these data can be used as a starting point in evaluating exposures that may result from releases and other management activities which involve these chemicals.

Which neurotoxicants are released and transferred in largest quantities?
In 2000, the five chemicals suspected to be neurotoxicants released or transferred in the largest quantities were:

- Zinc and its compounds
- Methanol
- Lead and its compounds
- Manganese and its compounds
- Toluene

The neurotoxicants released into the air in large amounts were methanol, toluene, hydrogen fluoride, xylenes, styrene, n-hexane and chlorine **(Table 11)**.

Where are the largest quantities of neurotoxicants being released or transferred?
Texas, Ohio, Ontario, Indiana and Illinois led North America in largest reported releases (on- and off-site) of suspected neurotoxicants:

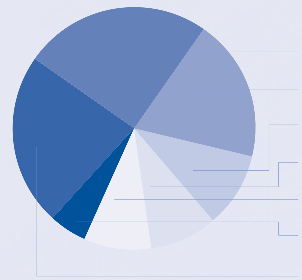
- Texas, with 75,000 tonnes
- Ohio, with 59,500 tonnes
- Ontario, with 56,500 tonnes
- Indiana, with 54,000 tonnes
- Illinois, with 48,000 tonnes

Texas led North America in releases of suspected neurotoxicants to air, with 34,500 tonnes, and Ontario was second, with 30,250 tonnes **(Table 12)**.

Which industrial sectors are releasing the largest quantities of neurotoxicants?
Three sectors released (on- and off-site) the largest quantities of suspected neurotoxicants:

- Primary metals (239,000 tonnes)
- Chemicals (176,500 tonnes)
- Paper products (96,500 tonnes)

FIGURE 9. Industrial Sectors with the Largest Releases (On- and Off-site) of Suspected Neurotoxicants (2000 Matched Data Set)



These three sectors released more than half of the suspected neurotoxicants in North America in 2000 **(Figure 9)**. Two of these sectors, primary metals and chemicals, also contributed almost half of the total amounts of suspected neurotoxicants released and transferred in 2000.

Which facilities are releasing the largest quantities of neurotoxicants?
In Canada, two facilities released the largest quantities of suspected neurotoxicants on- and off-site in 2000 **(Table 13)**:

- Safety Kleen Ltd., in Corunna, Ontario (6,982 tonnes)
- Dofasco Inc., in Hamilton, Ontario (5,783 tonnes)

In the US, four facilities released more than 10,000 tonnes of suspected neurotoxicants on- and off-site in 2000:

- ASARCO Inc., in East Helena, Montana (20,444 tonnes)
- Chemical Waste Management of the Northwest, in Arlington, Oregon (19,861 tonnes)
- Magnesium Corp. of America, Renco Group, in Rowley, Utah (19,116 tonnes)
- Zinc Corp. of America, in Monaca, Pennsylvania (12,455 tonnes)

The TRI facilities with the largest releases of suspected neurotoxicants to the air were:

- Magnesium Corporation of America, Renco Group, in Rowley, Utah (19,116 tonnes)
- Lenzing Fibers Corp., in Lowland, Tennessee (7,712 tonnes)

TABLE 12. North American States/Provinces with the Largest Total Releases (On- and Off-site) of Suspected Neurotoxicants (2000 Matched Data Set)

State/Province	Total Releases On- and Off-site		ON-SITE RELEASES						Total Off-site Releases
			Air		Surface Water	Underground Injection	Land	Total On-site Releases	
	(tonnes)	(rank)	(tonnes)	(rank)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)
Texas	74,903	1	34,533	1	407	23,223	7,689	65,852	9,051
Ohio	59,673	2	15,645	10	244	7,370	15,060	38,318	21,355
Ontario	56,646	3	30,253	2	365	0	8,869	39,531	17,115
Indiana	54,150	4	18,288	6	278	91	9,428	28,084	26,066
Illinois	48,143	5	16,353	8	74	0	16,485	32,912	15,232
Pennsylvania	41,445	6	13,044	14	139	0	3,404	16,587	24,858
Tennessee	40,510	7	26,142	3	229	0	7,109	33,480	7,030
Louisiana	39,589	8	18,304	5	383	15,195	3,969	37,851	1,738
Utah	33,588	9	19,887	4	5	0	11,485	31,376	2,212
Michigan	31,595	10	13,980	13	137	870	6,531	21,517	10,078
Alabama	31,139	11	18,158	7	527	20	8,185	26,890	4,249
Oregon	30,805	12	5,964	26	73	0	20,000	26,037	4,768
Missouri	24,102	13	10,666	19	16	0	11,426	22,108	1,994
Montana	23,440	14	1,995	40	16	0	19,037	21,048	2,392
South Carolina	22,643	15	14,402	12	318	0	1,206	15,927	6,716
Arkansas	21,454	16	8,001	21	323	664	1,156	10,144	11,311
Georgia	20,451	17	15,869	9	369	0	1,893	18,132	2,319
North Carolina	20,386	18	15,558	11	234	0	1,627	17,419	2,967
Florida	19,047	19	12,659	15	91	2,700	2,742	18,193	854
Quebec	18,488	20	10,934	17	314	0	3,015	14,284	4,204
Mississippi	18,162	21	10,287	20	170	4,563	2,684	17,704	458
Kentucky	17,516	22	10,738	18	190	1	4,578	15,507	2,009
California	16,647	23	5,131	27	942	8	7,283	13,364	3,283
Virginia	16,549	24	12,438	16	162	0	1,207	13,806	2,743
Alberta	13,673	25	7,237	23	78	3,228	1,517	12,071	1,603
Iowa	13,178	26	6,357	25	127	0	1,095	7,579	5,599
Wisconsin	12,661	27	7,942	22	93	0	195	8,230	4,431
Idaho	10,724	28	1,040	46	69	0	9,531	10,640	84
New York	9,321	29	4,745	32	214	0	1,170	6,129	3,192
West Virginia	8,569	30	4,856	30	220	0	2,128	7,205	1,364
Arizona	8,458	31	1,167	45	1	0	6,487	7,654	804
British Columbia	8,046	32	6,581	24	538	0	641	7,772	274
Minnesota	7,067	33	5,096	28	93	0	880	6,069	998

TABLE 12. (continued) North American States/Provinces with the Largest Total Releases (On- and Off-site) of Suspected Neurotoxicants (2000 Matched Data Set)

State/Province	Total Releases On- and Off-site (tonnes)	Total Releases On- and Off-site (rank)	On-site Releases: Air (tonnes)	On-site Releases: Air (rank)	On-site Releases: Surface Water (tonnes)	On-site Releases: Underground Injection (tonnes)	Land (tonnes)	Total On-site Releases (tonnes)	Total Off-site Releases (tonnes)
Oklahoma	6,971	34	4,583	33	30	2	842	5,456	1,515
Washington	6,675	35	4,979	29	349	0	362	5,690	985
Nebraska	6,192	36	2,154	39	5	0	211	2,370	3,822
Kansas	6,030	37	4,746	31	14	209	581	5,550	480
New Jersey	5,953	38	3,723	34	108	0	43	3,874	2,079
New Brunswick	4,603	39	2,560	36	826	0	270	3,656	947
Maryland	4,569	40	2,472	37	221	24	1,620	4,337	232
Manitoba	4,269	41	2,845	35	37	0	1,209	4,097	173
Maine	2,687	42	1,800	41	183	0	349	2,332	355
North Dakota	2,608	43	677	51	19	0	1,100	1,796	812
Puerto Rico	2,447	44	2,212	38	11	0	5	2,228	219
Delaware	2,401	45	737	50	42	0	118	897	1,505
Massachusetts	2,292	46	1,331	43	44	0	88	1,462	830
Connecticut	1,965	47	1,447	42	19	0	0	1,466	498
Nevada	1,864	48	463	52	6	0	402	871	993
Colorado	1,862	49	853	48	5	0	293	1,151	711
Wyoming	1,450	50	335	53	2	21	631	989	461
New Mexico	1,389	51	318	54	1	0	638	958	431
South Dakota	1,374	52	786	49	0	0	571	1,357	17
Saskatchewan	1,356	53	1,288	44	24	9	21	1,344	12
New Hampshire	1,024	54	890	47	34	0	24	948	76
Nova Scotia	934	55	280	57	2	0	439	720	214
Rhode Island	388	56	311	56	0	0	0	311	77
Newfoundland	348	57	314	55	1	0	21	337	12
Virgin Islands	180	58	172	58	1	0	1	174	6
Hawaii	153	59	82	60	0	0	0	82	70
Alaska	112	60	105	59	4	0	2	112	0
Vermont	61	61	31	61	0	0	0	31	29
Prince Edward Island	1	62	1	62	0	0	0	1	0
District of Columbia	0	63	0	63	0	0	0	0	0
Guam	0	—	0	—	0	0	0	0	0
Total	**944,925**		**446,744**		**9,426**	**58,199**	**209,552**	**724,015**	**220,910**

Note: Canada and US data only. Mexico data not available for 2000. The data are estimates of releases and transfers of chemicals reported by facilities. None of the rankings are meant to imply that a facility, state or province is not meeting its legal requirements. The data do not predict levels of exposure of the public to those chemicals.

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TABLE 13. Facilities with the Largest Total Releases (On- and Off-site) of Suspected Neurotoxicants (2000 Matched Data Set)

North American Rank	Facility	City, State/Province	Industry	Total Releases On- and Off-site (kg)	ON- AND OFF-SITE RELEASES: ON-SITE RELEASES: Air (kg)	Surface Water (kg)	Underground Injection (kg)	Land (kg)	Total On-site Releases (kg)	Total Off-site Releases (kg)	Total Reported Amounts of Releases and Transfers (kg)
	Canada										
12	Safety-Kleen Ltd., Lambton Facility	Corunna, ON	Ch	6,982,450	450	0	0	6,982,000	6,982,450	0	6,982,450
17	Dofasco Inc., Dofasco Hamilton	Hamilton, ON	PM	5,783,197	199,458	756	0	2	200,216	5,582,981	7,387,506
	United States										
1	ASARCO Inc.	East Helena, MT	PM	20,444,199	18,820	451	0	18,052,716	18,071,987	2,372,211	20,444,199
2	Chemical Waste Management of the Northwest Inc., Waste Management Inc.	Arlington, OR	HW	19,860,840	580	0	0	19,860,147	19,860,727	113	19,863,366
3	Magnesium Corp. of America, Renco Group Inc.	Rowley, UT	PM	19,115,646	19,115,646	0	0	0	19,115,646	0	19,115,646
4	Zinc Corp. of America, Monaca Smelter, Horsehead Inds. Inc.	Monaca, PA	PM	12,455,006	210,412	457	0	0	210,869	12,244,137	12,455,006
5	Steel Dynamics Inc.	Butler, IN	PM	9,033,716	13,523	0	0	0	13,523	9,020,192	9,033,716
6	Kennecott Utah Copper Smelter & Refy., Kennecott Holdings Corp.	Magna, UT	PM	8,274,572	37,935	1,703	0	8,219,660	8,259,297	15,275	8,274,586
7	Nucor-Yamato Steel Co., Nucor Corp.	Blytheville, AR	PM	8,101,618	7,826	5	0	0	7,831	8,093,787	8,101,618
8	Peoria Disposal Co. #1, Coulter Cos. Inc.	Peoria, IL	HW	8,096,436	235	0	0	8,096,200	8,096,434	2	8,096,436
9	Lenzing Fibers Corp.	Lowland, TN	Ch	7,870,762	7,712,311	1,978	0	156,473	7,870,762	0	7,870,762
10	Nucor Steel, Nucor Corp.	Crawfordsville, IN	PM	7,673,513	1,774	69	0	0	1,843	7,671,671	7,673,513
11	Doe Run Co., Herculaneum Smelter, Renco Group Inc.	Herculaneum, MO	PM	7,617,852	143,468	220	0	7,473,418	7,617,106	746	7,617,852
13	Envirosafe Services of Ohio Inc., ETDS Inc.	Oregon, OH	HW	6,876,464	400	0	0	6,873,107	6,873,507	2,957	6,876,464
14	US Ecology Idaho Inc., American Ecology Corp.	Grand View, ID	HW	6,574,231	1,805	0	0	6,572,426	6,574,231	0	6,574,243
15	Wayne Disposal Inc., EQ Holding Co.	Belleville, MI	HW	6,347,284	3,982	0	0	5,138,189	5,142,171	1,205,112	6,347,284
16	Cytec Inds. Inc., Fortier Plant	Westwego, LA	Ch	6,318,132	14,745	3,489	6,296,404	0	6,314,638	3,494	6,357,995
18	ASARCO Inc., Ray Complex/Hayden Smelter & Concentrator, Grupo México S.A. de C.V.	Hayden, AZ	PM	5,740,580	13,625	0	0	5,726,923	5,740,548	32	6,658,277
19	Chemical Waste Management Inc., Waste Management Inc.	Kettleman City, CA	HW	5,739,533	1,522	0	0	5,736,273	5,737,795	1,738	5,740,960
20	Acordis Cellulosic Fibers Inc., Acordis US Holding Inc.	Axis, AL	Ch	5,249,773	5,105,655	9,878	0	134,240	5,249,773	0	5,249,773
21	BP Chemicals Inc., Green Lake Facility, BP America Inc.	Port Lavaca, TX	Ch	5,029,099	26,547	458	4,999,025	2,938	5,028,968	132	5,034,130
22	National Steel Corp., Greatlakes Ops.	Ecorse, MI	PM	4,923,225	85,882	10,957	0	0	96,839	4,826,386	4,944,889
23	USS Gary Works, USX Corp.	Gary, IN	PM	4,873,507	163,924	26,301	0	4,419,566	4,609,791	263,716	6,175,984
24	Monsanto Luling, Pharmacia Corp.	Luling, LA	Ch	4,840,774	49,757	86	4,790,930	0	4,840,773	1	4,872,904
25	BP Chemicals Inc., BP America	Lima, OH	Ch	4,630,249	59,195	0	4,570,197	0	4,629,392	857	4,639,556

Note: Canada and US data only. Mexico data not available for 2000. Data include chemicals common to both NPRI and TRI lists from selected industrial and other sources. The data reflect estimates of releases and transfers of chemicals, not exposure of the public to those chemicals. In combination with other information, these data can be used as a starting point in evaluating exposures that may result from releases and other management activities which involve these chemicals. Some facilities may have reduced or increased releases and transfers since 2000.

Legend: Ch = Chemicals HW = Hazardous Waste Mgt./Solvent Recovery PM = Primary Metals EE = Electronic/Electrical Equipment

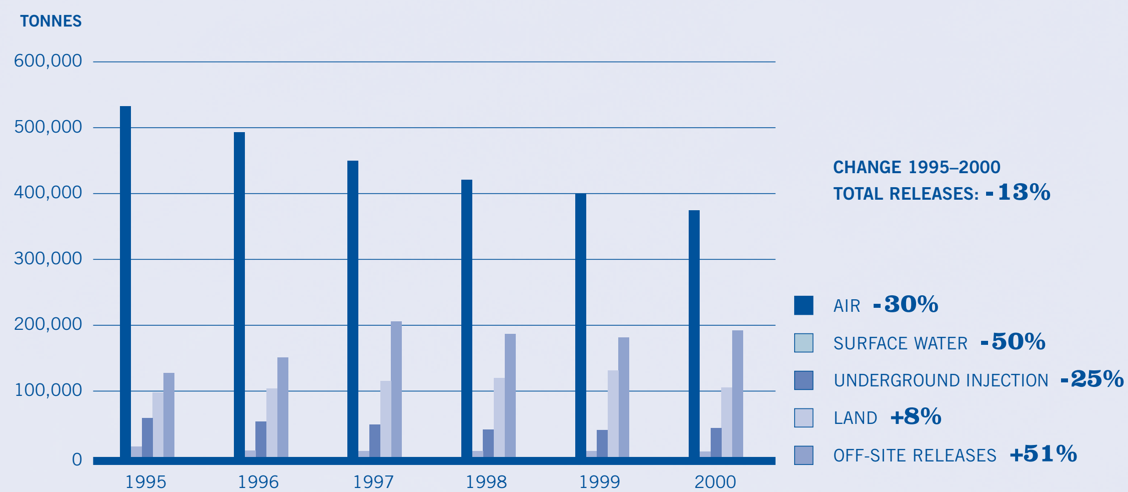
- Acordis Cellulosic Fibers, Acordis US Holding Inc., in Axial, Alabama (5,106 tonnes)
- International Paper, in Hampton, South Carolina (1,690 tonnes)

In Canada, the following NPRI facilities had the largest releases of suspected neurotoxicants to the air:

- Bowater Pulp and Paper Canada, Thunder Bay Operations, in Thunder Bay, Ontario (1,757 tonnes)
- Bayer Inc., Sarnia Site, Bayer AG, in Sarnia, Ontario (1,499 tonnes)
- General Motors Inc., (Canada) Oshawa Car Assembly Plant, in Oshawa, Ontario (1,302 tonnes)
- Fraser Paper Inc., (Canada) Edmundston Operations, Nexfor Inc., in Edmundston, New Brunswick (1,164 tonnes)

Has the quantity of neurotoxicants released increased or decreased over time?
Similar to the situation with carcinogens and developmental toxicants, releases of suspected neurotoxicants from manufacturing facilities decreased from 1995 to 2000. Air releases of neurotoxicants fell 30 percent in North America from 1995 to 2000. Off-site releases (mainly disposal in landfills) of neurotoxicants increased by over 50 percent during this time period **(Figure 10)**. These trends, however, are based on reports of 159 chemicals and industries over this entire time period; thus electric utilities, hazardous waste/solvent recovery facilities and transfers to recycling are not included.

FIGURE 10. Releases (On- and Off-site) of Suspected Neurotoxicants
(1995–2000 Matched Data Set)

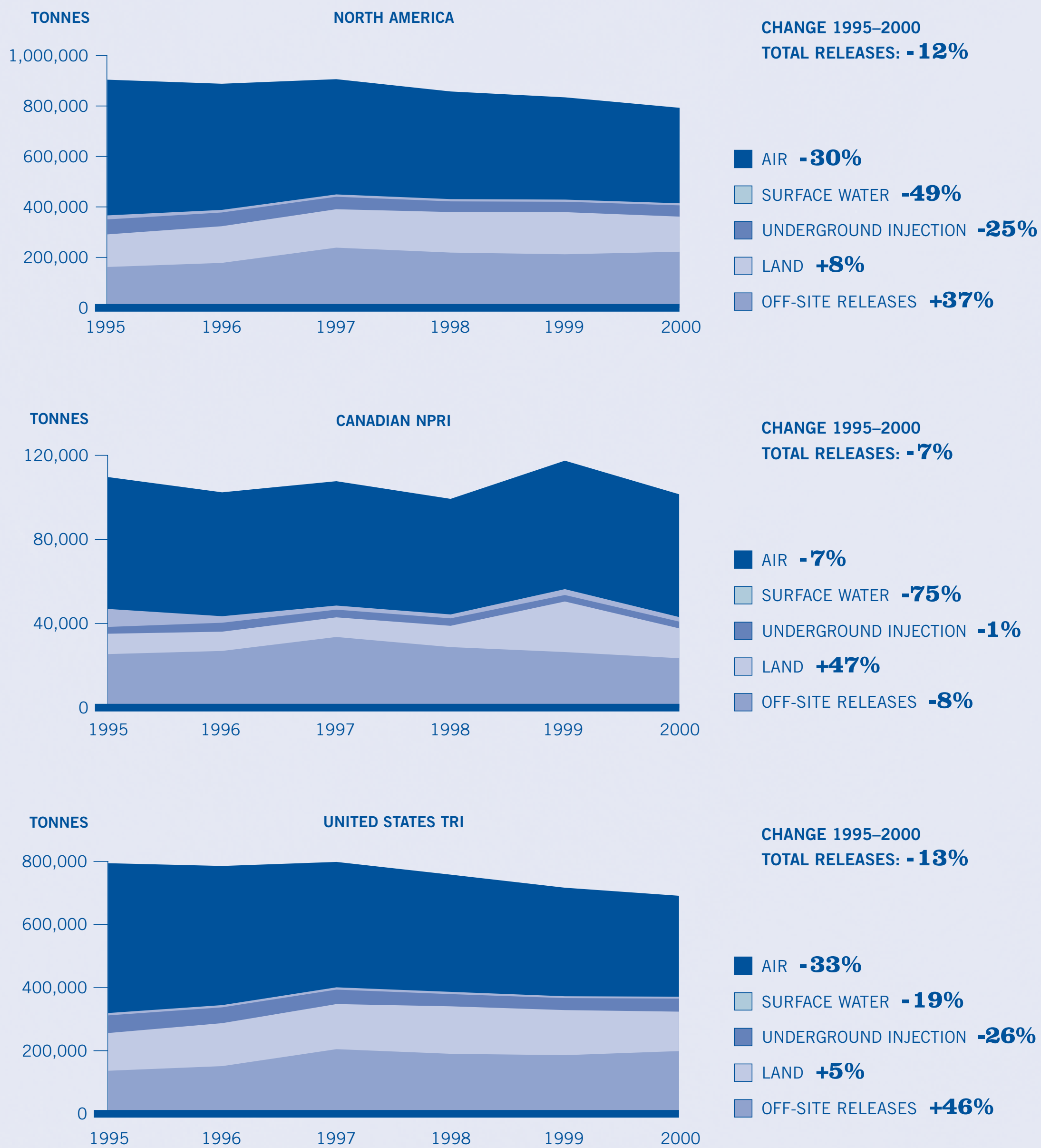


Combined Carcinogens, Developmental Toxicants and Neurotoxicants

Some of the carcinogens are also known or suspected developmental toxicants and neurotoxicants: lead, arsenic and benzene are some common examples. Other chemicals may exhibit one of these health effects and not the other. Because children are exposed to a mixture of chemicals, we looked briefly at the trends in the group of chemicals that fall into one, two or all of the three categories—carcinogens, developmental toxicants or neurotoxicants.

In North America from 1995 to 2000, releases of chemicals considered as carcinogens, developmental toxicants and/or neurotoxicants decreased by 12 percent. Canadian NPRI facilities showed a lesser decline over the period (seven percent) than US TRI facilities (13 percent). Particularly encouraging is the

FIGURE 11. Releases (On- and Off-site) of Known and Suspected Carcinogens, Developmental Toxicants and Neurotoxicants
(1995–2000 Matched Data Set)



progress made in decreasing air releases of the group of carcinogens, developmental and/or neurotoxicants, which fell 30 percent from 1995 to 2000. Again, Canadian facilities reporting to NPRI showed a smaller decrease (seven percent) in air releases over the period than US TRI facilities (33 percent) **(Figure 11)**.

More information on these releases and transfers can be found on the *Taking Stock* web site at <www.cec.org/takingstock/>. With its user friendly Query Builder, the web site enables users to generate their own reports on chemicals, sectors, facilities and time trends of particular interest.

Chemical-specific Approach: CHEMICALS OF CONCERN to Children's Health

In addition to analyzing releases and transfers of carcinogens, developmental toxicants and neurotoxicants reported to PRTRs, we can look at individual chemicals often considered to be a particular concern to children's health. Some of these chemicals are:

- Lead
- Mercury
- PCBs
- Dioxins and furans

This list is illustrative of some of the chemicals that may affect children's health. Many more chemicals, some just being recognized and others not traditionally monitored, are also likely to have health impacts.

Lead and its Compounds

Uses of lead

Lead is produced by mining and smelting of ores and is captured through recycling. In North America, a major use is in the lead acid batteries used in automobiles. The second-largest use of lead is in pigments and compounds (nine percent of Western world demand in 1999). Other uses of lead are in PVC stabilizers, in color pigments, and in the manufacture of glass (crystal, light bulbs, insulators and television/computer screens). Regulations are reducing or eliminating lead solder in plumbing and electronic applications.

Elemental lead and lead alloys are also used for the production of steel and brass, in rolled sheet and strip roofing applications, in power and communication cable sheathing (especially underground and submarine), as a sound barrier in construction, and as shielding around X-ray equipment and at nuclear installations. Lead is used as a weight in the keels of boats and to balance tires. It has a number of other consumer uses as well, including glazing for pottery, and has been found at hazardous levels in a long list of consumer products in recent years, including some imported crayons, plastic mini-blinds, a wide range of inexpensive jewelry and toy figurines, and even in some candle wicks. It has also been used in folk remedies (Flattery 1993).

Health effects of lead

Lead as a metal and in its compounds behaves as a carcinogen, neurotoxicant and developmental toxicant. Lead can damage a child's developing brain, kidneys and reproductive system. Even low levels of lead are associated with learning disabilities, hyperactivity, behavioral problems, impaired growth and hearing loss (Needleman and Bellinger 1991). Low-level exposure stunts the growth of children, both *in utero* and as they grow to adolescence. As our knowledge of lead's effects increases, many researchers have come to realize that there may not be any safety threshold for lead's impact on human health (Federal/Provincial Committee on Environmental and Occupational Health 1994). Recent research suggests a relationship between impaired IQ and blood lead levels even below the intervention level of 10 micrograms of lead per deciliter (µg/dL) of blood (Canfield *et al.* 2003).

Given the same exposure dosage of lead, children will absorb more than adults. An infant may absorb up to 50 percent of the lead dose through the intestine, while an adult may absorb only 10 percent of the same lead dose (Plunkett *et al.* 1992). Infants also have an immature blood-brain barrier, which allows lead to pass more easily into brain tissue (Rodier 1995).

Moreover, the effects of lead may be irreversible. Adolescents, who as children had high lead levels in their teeth in Grades 1 and 2, were seven times more likely to be high school dropouts and six times more likely to read at least two grade levels below expectation (Needleman *et al.* 1990). They also showed higher rates of absenteeism in their final year of school, along with a lower class rank, poorer vocabulary, lower grammatical scores, longer reaction times and poorer hand-eye coordination.

What can PRTR data tell us about releases and transfers of lead and its compounds?

PRTR data provide information on one source of lead releases and transfers: those from larger industrial and other facilities. Children may also be exposed to lead from a number of other sources, including mobile sources (now much reduced due to the removal of lead from gasoline in North America), mining, pottery glazes, lead-based paint, consumer products, and from a parent or sibling working in a lead-related industry or in a cottage industry as a hobbyist or artist. The importance of a particular source of lead will vary with the amount of lead, the type and the extent of exposure. For children in some areas, PRTR data may capture important sources of lead such as smelters and hazardous waste facilities. PRTR data can also help identify potential areas, facilities and sectors that may be important starting points for reducing lead exposure to children. However, for children in other areas, the most important sources of lead exposure may be from lead pottery and consumer products, which are not captured by PRTR data.

TABLE 14. Summary of Total Reported Releases and Transfers of Lead and its Compounds (2000 Matched Data Set)

	North America (tonnes)	Canadian NPRI (tonnes)	United States TRI (tonnes)
*Total On-site Releases**	*22,540*	*3,640*	*18,900*
Air	1,058	468	590
Surface Water	45	5	39
Underground Injection	124	0	124
Land	21,310	3,163	18,147
Total Off-site Releases	*22,674*	*1,528*	*21,146*
Total Releases On- and Off-site	*45,214*	*5,168*	*40,046*
Transfers to Recycling	*127,336*	*12,741*	*114,595*
Other Transfers Off-site for Further Management	*0*	*0*	*0*
Total Reported Amounts of Releases and Transfers of Lead and its Compounds	**172,550**	**17,908**	**154,642**

Note: Canada and US data only. Mexico data not available for 2000. The data reflect estimates of releases and transfers of chemicals, not exposures of the public to those chemicals. The data, in combination with other information, can be used as a starting point in evaluating exposures that may result from releases and other management activities which involve these chemicals.

** The sum of air, surface water, underground injection and land releases in NPRI does not equal the total on-site releases because in NPRI on-site releases of less than 1 tonne may be reported as an aggregate amount.*

Based on the matched TRI and NPRI data for 2000, 172,550 tonnes of lead and its compounds were released and transferred **(Table 14)**. Almost three-quarters of this total amount was lead sent for recycling. Over 1,000 tonnes of lead were released into the air from matched TRI and NPRI facilities. Canadian NPRI facilities reported 468 tonnes of lead released into the air, comprising almost half of the North American total. This is surprising, given that NPRI facilities make up only 10 percent of the total number of North American facilities.

Three facilities, all smelters, released lead in the largest amounts of any facilities into North America's air in 2000 **(Table 15)**:

- Hudson Bay Mining and Smelting Company, HBM&S Co., Ltd., Anglo-American PLC, in Flin Flon, Manitoba (167 tonnes)
- Inco Limited, Copper Cliff Smelter Complex, in Copper Cliff, Ontario (131 tonnes)
- Doe Run Co., Herculaneum Smelter, Renco Group Inc., in Herculaneum, Missouri (127 tonnes)

These three facilities all increased the amount of lead emitted to the air from 1995 to 2000.

Three sectors in North America released (on- and off-site) the largest amounts of lead in 2000:

- Primary metals (includes smelters) (18,000 tonnes)
- Hazardous waste management/solvent recovery (12,000 tonnes)
- Electronic/electrical equipment (5,500 tonnes)

From 1995 to 2000, total releases (on- and off-site) of lead increased by 27 percent in North America. Most of this increase was due to a 41 percent increase in the amount of lead and its compounds being landfilled off-site, and smaller increases in landfilling of lead on-site (14 percent). Air releases of lead and its compounds decreased by almost 400 tonnes, or 29 percent, from 1995 to 2000 **(Figure 12)**. The decrease in lead releases to the air from some facilities is encouraging, as this can be an important source of lead exposure for children in some areas. These trends are based on industries commonly reported over this time period, thus electric utilities, hazardous waste/solvent recovery facilities, and transfers to recycling are not included.

Lead levels and exposures in North America

Health Canada states that Canadian children are most likely to be exposed to lead from food, then air, then drinking water. Estimates of daily lead exposure for preschoolers (ages 1 to 4) are 1.1 µg/kg body weight from food, 2–10 µg/kg body weight from air, 2.9 µg/kg body weight from drinking water. Soils and household dust can also be significant sources of lead exposure for young children (Health Canada 1998b). A recent study (Rasmussen *et al.* 2001) found that indoor sources, unrelated to outdoor soil lead levels, can contribute significantly to lead exposures. There are no national data on lead exposure for Canadian children.

The removal of lead from gasoline has reduced atmospheric concentrations of lead and is reflected in the lower levels of lead in children's blood. Blood screening surveys conducted in Ontario from 1983 to 1992 indicated a steady decline in these levels: 1.04 μg/dL of blood each year (Wang *et al.* 1997). In 1992, blood lead levels of children (ages 1 to 5) in Ontario averaged 3.11 μg/dL. This was similar to the US mean of 3.52 μg/dL. Averages, however, can cloak children with high blood levels who require treatment. The distribution of Ontario's blood lead levels indicates that a portion of children have blood lead levels at or above the intervention level.

In the early 1990s, between 40 and 88 percent of Mexican children had blood lead levels that exceeded the US Centers for Disease Control and Prevention (CDC) intervention level of 10 μg/dL. Several studies found that Mexican children with higher lead levels had reduced IQ, increased frequency of crying, lower birth weight, and were shorter at birth and at three years old. Mexican mothers with high lead levels had increased risk of miscarriage and a three-fold increase in the frequency of premature babies (less than 37 weeks).

TABLE 15. Facilities with the Largest On-Site Air Releases of Lead and its Compounds (2000 Matched Data Set)

Rank	Facility	City, State/Province	SIC CODE Canada	SIC CODE US	On-site Air Emissions (kg)
	Canada				
1	Hudson Bay Mining and Smelting Company Ltd., HBM&S Co., Ltd., Anglo American PLC	Flin Flon, MB	29	33	166,870
2	Inco Limited, Copper Cliff Smelter Complex	Copper Cliff, ON	29	33	130,662
3	Noranda Inc., Fonderie Horne	Rouyn-Noranda, QC	29	33	84,700
4	Falconbridge Ltd-Kidd Metallurgical Div., Kidd Metallurgical Site	Timmins/ District of Cochrane, ON	29	33	29,559
5	Noranda Inc., Fonderie Gaspé	Murdochville, QC	29	33	19,500
	United States				
1	Doe Run Co., Herculaneum Smelter, Renco Group Inc.	Herculaneum, MO		33	126,803
2	Kennecott Utah Copper Smelter & Refy., Kennecott Holdings Corp.	Magna, UT		33	24,218
3	ASARCO Inc., Amarillo Copper Refy., ASARCO Inc.	Amarillo, TX		33	22,327
4	GE Co., Bridgeville Glass Plant	Bridgeville, PA		32	20,741
5	Doe Run Co., Glover Smelter, Renco Group Inc.	Glover, MO		33	19,436

Note: Canada and US data only. Mexican data not available for 2000. Data include chemicals common to both NPRI and TRI lists from selected industrial and other sources. The data reflect estimates of releases and transfers of chemicals, not exposure of the public to those chemicals. In combination with other information, these data can be used as a starting point in evaluating exposures that may result from releases and other management activities which involve these chemicals. Some facilities may have reduced or increased releases and transfers since 2000.

Legend: SIC codes 29/33 = Primary metals SIC code 32 = Electronic/Electric equipment

In 1991, Mexico phased out the use of lead in gasoline, decreasing airborne lead concentrations in Mexico City by 90 percent (Rothenberg *et al.* 1998), contributing to lower blood lead levels there. More recently, full-term babies born in three Mexico City hospitals have averaged blood lead levels of 8 μg/dL (Torres-Sanchez *et al.* 1999). However, the use of lead pigment in pottery glazes is still common in parts of Mexico, as well as lead emissions from battery recycling and vehicle repair shops and smelters. These exposures cause many children in Mexico to have blood lead levels exceeding 10 μg/dL. For example, children living within one kilometer of a smelter in Torreón averaged 17 μg/dL blood lead levels, compared to children living almost five kilometers from the smelter, whose levels were approximately 5 μg/dL (Calderon-Salinas *et al.* 1996). Children of radiator repairmen had blood lead levels of almost 19 μg/dL, compared to control group children with 7 μg/dL (Garduno *et al.* 2000).

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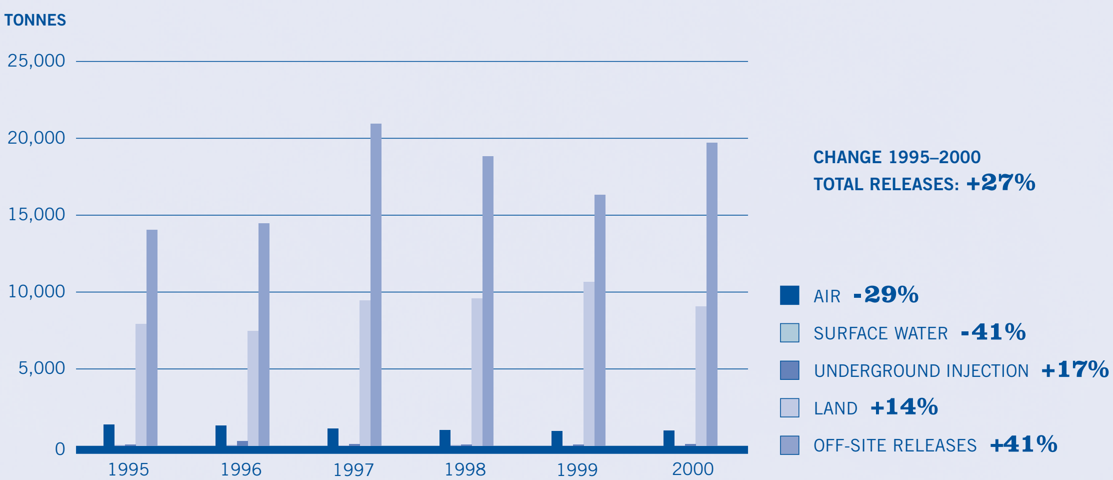
FIGURE 12. Releases (On-and Off-site) of Lead and its Compounds
(1995–2000 Matched Data Set)



Lead levels in bone can be used as a longer-term indicator of lead exposure than blood lead levels. In pregnancy, lead stored in the bone is rapidly turned over, which can expose the developing child to lead even if the mother is not currently exposed. This means that fetal exposure to lead, not just daily exposure in a child's environment, can cause mental impairment in infants.

A recent, groundbreaking study conducted in Mexico City by a team that included researchers from the Harvard School of Public Health showed that mothers with higher levels of lead in their bones gave birth to infants with impaired mental development. Cognitive development was more affected than motor skill development. It is, therefore, important to lower the amount of lead a mother is exposed to not only during pregnancy, but also in the years before pregnancy. This finding suggests that lead is an intergenerational problem. A mother's exposure to lead many years before pregnancy can significantly affect the mental functioning of her infant (Gomaa 2002).

Blood lead levels in US children have decreased over the last twenty years. The current blood lead level in children which triggers intervention is 10 µg/dL. Between 1976 and 1980, the average blood lead level was between 14.1 and 15.8 µg/dL, which decreased to between 3.3 and 4.0 µg/dL between 1988 and 1991, and then to between 2.0 and 2.5 µg/dL in 1999–2000 (CDC 2003b). However, averages do not tell the whole story.

Among poor children, average blood lead levels remain four times higher than those of children who do not live in poverty (Brody *et al.* 1994). Approximately two million US children under the age of six live in homes with decaying or deteriorating lead paint (CDC 1997).

Lead is under consideration for the development of a North American Regional Action Plan as part of the Sound Management of Chemicals program at the CEC. For more information, see <http://www.cec.org/pubs_docs/documents/index.cfm?varlan=english&ID=1261>.

Mercury

Uses of mercury

Mercury is a naturally occurring metal, found in the environment. It has a wide spectrum of uses, from medical applications (medical instruments, dental amalgams and disinfectants) to pesticides (fungicides), industrial thermometers, switches in thermostats, pressure measuring devices and fluorescent lamps (CEC 2000). The use of mercury in batteries, once very common, is declining. However, people are generally exposed to mercury through diet and dental amalgam fillings.

Health effects of mercury

Mercury exists in three different forms (Health Canada 2002b):

- Elemental mercury—a silvery, shiny, volatile liquid, which slowly transmutes to a colorless, odorless vapor at room temperatures.
- Inorganic mercury—formed when elemental mercury combines with other elements, such as sulfur, chlorine, or oxygen to create mercury salts.

First Systematic Picture OF CHEMICAL BODY BURDENS in Children emerges

In 2003, the US National Center for Environmental Health (part of the US Centers for Disease Control and Prevention) continued to fill an important gap in our knowledge of the exposure of children to several common contaminants. The Second National Report on Human Exposure presented data on the body burdens of 116 chemicals, including metals (lead, mercury and cadmium), pesticide metabolites, phthalate metabolites, polycyclic aromatic hydrocarbons (PAHs); dioxins/furans; polychlorinated biphenyls (PCBs), and phytoestrogens and cotinine (which tracks exposure to tobacco smoke).

The second assessment showed that overall blood lead levels in children have continued to decline in the US. In the early 1990s, 4.4% of US children aged 1 to 5 years had elevated blood lead levels (greater than or equal to 10 µg/dL). This has declined to 2.2% of US children with elevated blood lead levels in 1999–2000. However, children living in some environments remain at high risk for lead exposure. Blood levels in children of some pesticides, such as chlorpyrifos, were twice that of adults.

The EPA has estimated that about 5 million US women, or 8 percent of those at the childbearing ages of 16 to 49, had at least 5.8 parts per billion of mercury in their blood, as of 2000. The EPA has found that children born to women with blood concentrations of mercury above 5.8 parts per billion are at some risk of adverse health effects, including lower developmental IQ and problems with motor skills such as eye-hand coordination (US EPA 2003).

These results will help improve our understanding of exposure to toxic chemicals. For more information, see <www.cdc.gov/nceh/dls/report>.

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FIGURE 13. Industrial Sectors with the Largest Releases (On- and Off-site) of Mercury and its Compounds (2000 Matched Data Set)

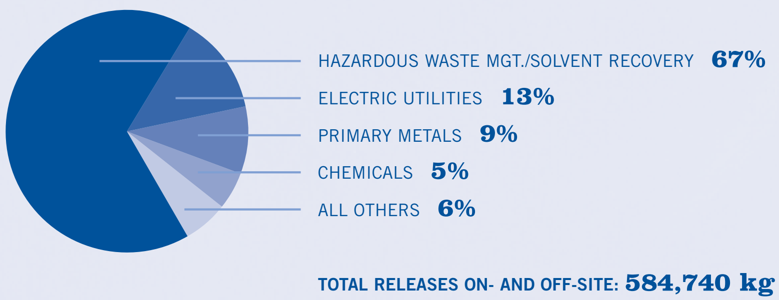
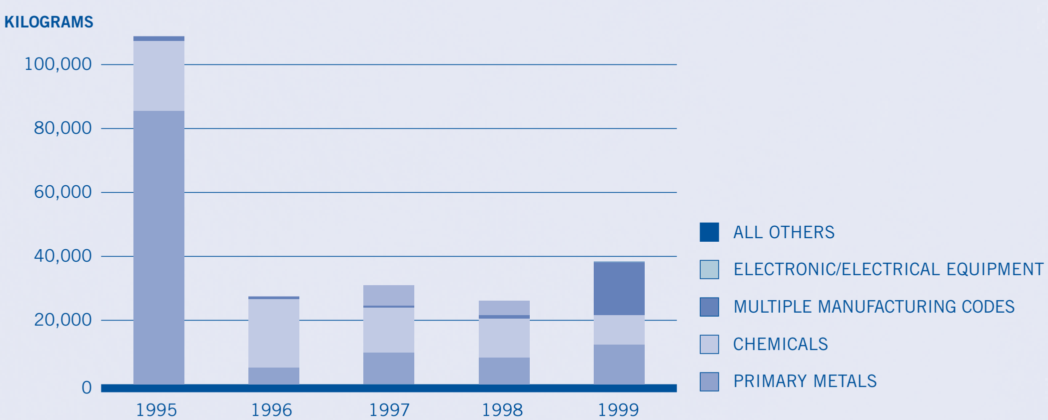


FIGURE 14. Total Releases (On- and Off-site) of Mercury and its Compounds (1995-1999 Matched Data Set)



- Organic mercury (usually called methylmercury)—a compound formed when elemental mercury combines with carbon and hydrogen in nature. Airborne mercury can be deposited into water where it can be converted into methylmercury and accumulated into fish and wildlife.

Elemental mercury is a persistent, bioaccumulative toxicant that can remain in the atmosphere for one year and readily convert to other forms. A variety of health effects have been found from mercury exposure, with the severity of effects varying with the amount and timing of exposure. Health effects include damage to the stomach and large intestine, permanent damage to the brain and kidneys, lung damage, increased blood pressure and heart rate and permanent damage to unborn children (US EPA 2002b). Other routes of mercury exposure in children include consumer products such as broken thermometers, dental fillings, *in utero* exposures, breast milk and proximity to a source of mercury, such as certain hazardous waste facilities, utilities, smelters, mines and steel mills.

Inorganic mercury salts also cause health problems, especially kidney failure and gastrointestinal damage. Highly irritating, they can cause blisters and ulcers on the lips and tongue, or rashes, excessive sweating, irritability, muscle twitching, and high blood pressure (Health Canada 2003).

Children are primarily exposed to the most toxic form of mercury, methylmercury, from food, mainly fish, where it can bioaccumulate to levels up to 100,000 times greater than in the surrounding water (Health Canada 2003).

Releases of mercury to the air from industrial and combustion sources contribute to levels of mercury in fish. Methylmercury is both a developmental toxicant and a neurotoxicant. When pregnant women eat fish contaminated with mercury, the methylmercury can cross the placenta and distribute throughout the body of the developing child. It readily accumulates in the brain. Depending on how much is absorbed, infants suffering from methylmercury poisoning can appear normal at birth but later show reduced attention, focus, fine motor function, language, drawing ability and memory. These children may struggle to keep up at school, require special education or remedial classes (National Academy of Science 2000, Goldman and Shannon 2001).

What can PRTR data tell us about releases and transfers of mercury?

Mercury has historically been emitted in large quantities from chloralkali plants (factories that make chlorine), Portland cement production, incineration of medical and municipal wastes and fossil fuel (especially coal) combustion in utility boilers (US EPA 1997a).

PRTR data provide information on one source of mercury to the environment, i.e., certain industrial and combustion sources. PRTR data can help identify potential areas, facilities and sectors that may be important starting points for reducing mercury exposure to children. However, because many municipal incinerators do not report to TRI, the matched NPRI and TRI data does not include municipal incinerators, which are often a significant source of mercury emissions.

TABLE 16. Summary of Total Reported Releases and Transfers of Mercury and its Compounds (2000 Matched Data Set)

	North America (kg)	Canadian NPRI (kg)	United States TRI (kg)
*Total On-site Releases**	*151,870*	*8,372*	*143,498*
Air	74,150	5,510	68,640
Surface Water	1,103	67	1,037
Underground Injection	1,090	26	1,064
Land	75,527	2,770	72,757
Total Off-site Releases	*432,870*	*25,495*	*407,375*
Total Releases On- and Off-site	*584,740*	*33,867*	*550,873*
Transfers to Recycling	*113,616*	*30,546*	*83,070*
Other Transfers Off-site for Further Management	*0*	*0*	*0*
Total Reported Amounts of Releases and Transfers of Mercury and its Compounds	**698,356**	**64,413**	**633,943**

Note: Canada and US data only. Mexico data not available for 2000. Data include chemicals common to both NPRI and TRI lists from selected industrial and other sources. The data reflect estimates of releases and transfers of chemicals, not exposures of the public to those chemicals. In combination with other information, these data can be used as a starting point in evaluating exposures that may result from releases and other management activities which involve these chemicals.

** The sum of air, surface water, underground injection and land releases in NPRI does not equal the total on-site releases because in NPRI on-site releases of less than 1 tonne may be reported as an aggregate amount.*

In North America in 2000, over 698,000 kg of mercury were released and transferred from matched TRI and NPRI facilities. About 74,000 kg were released to the air from facilities, and 1,000 kg to the water. Large amounts of mercury (over 430,000 kg) were sent off site for disposal **(Table 16)**.

Most mercury was released by three sectors **(Figure 13)**:

- Hazardous waste management/solvent recovery (389,500 kg)
- Electric utilities (75,500 kg)
- Primary metals (53,500 kg)

Several facilities in North America released large amounts of mercury to the air in 2000 **(Table 17)**. These are:

- Atofina Petrochemicals Inc., Total Fina Elf, in Port Arthur, Texas (1,717 kg)
- ASARCO Inc., in East Helena, Montana (1,484 kg)
- Hudson Bay Mining And Smelting Co. Ltd., in Flin Flon, Manitoba (1,266 kg)

The amount of mercury released on- and off-site decreased by 65 percent from 1995 to 1999 **(Figure 14)**. While this seems encouraging, most of this decrease happened in one year,

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TABLE 17. Facilities with the Largest On-Site Air Releases of Mercury and its Compounds
(2000 Matched Data Set)

Rank	Facility	City, State/Province	SIC CODE Canada	SIC CODE US	On-site Air Emissions (kg)
	Canada				
1	Hudson Bay Mining and Smelting Company Ltd., HBM&S Co., Ltd., Anglo American PLC	Flin Flon, MB	29	33	1,266
2	Safety-Kleen Ltd., Lambton Facility	Corunna, ON	37	28	407
3	Osram Sylvania Ltée	Drummondville, QC	33	36	400
4	Noranda Inc., Fonderie Horne	Rouyn-Noranda, QC	29	33	330
5	TransAlta Corporation, Sundance Thermal Generation Plant	Duffield, AB	49	49	283
	United States				
1	Atofina Petrochemicals Inc., Port Arthur Refy., Total Fina Elf	Port Arthur, TX		29	1,717
2	ASARCO Inc.	East Helena, MT		33	1,484
3	Calaveras Cement Co., Lehigh Portland Cement Co.	Tehachapi, CA		32	1,170
4	Alcoa World Alumina Atlantic, Alcoa	Point Comfort, TX		28	932
5	Mt. Storm Power Station, Dominion Resources Inc.	Mount Storm, WV		495/491	862

Note: Canada and US data only. Mexican data not available for 2000. Data include chemicals common to both NPRI and TRI lists from selected industrial and other sources. The data reflect estimates of releases and transfers of chemicals, not exposure of the public to those chemicals. In combination with other information, these data can be used as a starting point in evaluating exposures that may result from releases and other management activities which involve these chemicals. Some facilities may have reduced or increased releases and transfers since 2000.

from 1995 to 1996, when total releases of mercury fell from approximately 109,000 kg to 28,000 kg. However, since 1996, releases of mercury have been slowly increasing to about 38,000 kg in 1999.

Most of the initial decrease has been driven by TRI facilities, as NPRI facilities have reported a tripling of mercury releases. This increase in mercury releases in NPRI is mainly driven by the primary metals sector **(Table 18)**. These trends are based on industries commonly reported over this time period, thus electric utilities, hazardous waste/solvent recovery facilities and transfers to recycling are not included.

Mercury levels and exposures in North America

In northern Canada, the Inuit have been affected by mercury and other contaminants. Due to a diet of fish and mammals, the Inuit had mercury in their blood at levels known to cause developmental toxicity for developing children (Muckle 2001, Dewailly *et al.* 2001). In Ontario, over 95 percent of surveyed lakes had levels of mercury that exceeded the WHO guideline of 0.5–1.0 mg/kg fish body weight resulting in fish consumption warnings (Environment Canada 2000).

Limited information exists about Mexican children's exposure to mercury. Drinking water studies found mercury in 42 percent of the samples in Sonora (Wyatt *et al.* 1998a). A mercury inventory is under development in Mexico, which will help identify sources of mercury to the environment. Preliminary results indicate the total amount of mercury air emissions is about 40 tonnes per year, mainly from gold mining and refining (11 tonnes/year), mercury mining and refining (10 tonnes/year), medical waste incinerators (seven tonnes/year), and chlor-alkali plants (five tonnes/year) (CEC 2001).

The CEC's Sound Management of Chemicals program has developed a Phase I and Phase II North American Regional Action Plan to facilitate coordination among the three countries in addressing the measurement, monitoring,

TABLE 18. Summary of Total Reported Releases and Transfers of Mercury and its Compounds
(1995–1999 Matched Data Set)

US SIC Code	Industry	TOTAL RELEASES AND TRANSFERS 1995 (kg)	1996 (kg)	1997 (kg)	1998 (kg)	1999 (kg)	Change 1995–1999 (kg)	(%)
20	Food Products	0	0	0	0	0	0	—
26	Paper Products	3	3	0	0	0	-3	-100
28	Chemicals	21,826	21,391	14,091	12,141	9,218	-12,607	-58
29	Petroleum and Coal Products	34	10	5	7	7	-27	-80
30	Rubber and Plastics Products	0	116	0	0	0	7	—
33	Primary Metals	85,589	5,263	9,811	8,347	12,422	-73,167	-85
34	Fabricated Metals Products	7	9	7	7	13	6	88
36	Electronic/Electrical Equipment	13	9	6,359	4,433	251	238	1,807
37	Transportation Equipment	0	0	0	0	68	68	—
38	Measurement/Photographic Instruments	0	5	0	0	0	0	—
39	Misc. Manufacturing Industries	0	0	0	0	28	28	—
—	Multiple codes 20–39*	1,404	778	718	1,123	16,305	14,901	1,061
	Total	**108,876**	**27,583**	**30,990**	**26,060**	**38,312**	**-70,564**	**-65**
	Total Releases On- and Off-site, NPRI, 1995–1999							
26	Paper Products	3	3	0	0	0	-3	-100
28	Chemicals	32	32	238	358	1	-31	-97
29	Petroleum and Coal Products	12	0	0	0	0	-12	-100
33	Primary Metals	2	2	6	156	1,533	1,531	76,550
34	Fabricated Metals Products	0	0	0	0	6	6	—
	Total	**49**	**37**	**244**	**514**	**1,540**	**1,491**	**3,043**
	Total Releases On- and Off-site, TRI, 1995–1999							
20	Food Products	0	0	0	2	0	0	—
28	Chemicals	21,794	21,359	13,853	11,783	9,217	-12,576	-58
29	Petroleum and Coal Products	22	10	5	7	7	-15	-69
30	Rubber and Plastics Products	0	116	0	0	0	0	—
33	Primary Metals	85,587	5,261	9,805	8,191	10,889	-74,698	-87
34	Fabricated Metals Products	7	9	7	7	7	0	0
36	Electronic/Electrical Equipment	13	9	6,359	4,433	251	238	1,807
37	Transportation Equipment	0	0	0	0	68	68	—
38	Measurement/Photographic Instruments	0	5	0	0	0	0	—
39	Misc. Manufacturing Industries	0	0	0	0	28	28	—
—	Multiple codes 20–39*	1,404	778	718	1,123	16,305	14,901	1,061
	Total	**108,827**	**27,546**	**30,746**	**25,546**	**36,772**	**-72,055**	**-66**

Note: Canada and US data only. Mexican data not available for 1995–1999. Data include chemicals common to both NPRI and TRI lists from selected industrial and other sources. The data reflect estimates of releases and transfers of chemicals, not exposure of the public to those chemicals. In combination with other information, these data can be used as a starting point in evaluating exposures that may result from releases and other management activities which involve these chemicals. Some facilities may have reduced or increased releases and transfers since 2000.

** Multiple codes reported in TRI only.*

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Health Effects of PCBs

LINGER LONG AFTER EXPOSURE

One of the most compelling illustrations of the subtle and long-lasting effects of PCB exposure in children comes from a series of studies of children born to mothers who ate PCB-contaminated fish from Lake Michigan.

Infants, whose mothers ate these fish during pregnancy, were somewhat smaller for their gestational age, had shortened gestation, smaller head circumference and were of lower birth weight (Jacobsen and Jacobsen 1993).

As they grew, the children most highly exposed to PCBs prenatally showed delayed or reduced psychomotor development and poorer performance on a visual recognition memory test (Jacobsen and Jacobsen 1996).

After 11 years, these PCB-exposed children still showed lower IQ scores. The most highly exposed children were more than three times as likely to perform poorly on IQ and attention span tests, and twice as likely to be at least two years behind in reading. These children had trouble focusing for sustained periods of time, and suffered learning and neurodevelopmental delays (Jacobsen and Jacobsen 1997).

Other studies of PCB-exposed children in North Carolina demonstrate similar associations with lower scores on psychomotor tests at 6 and 12 months (Jacobsen and Jacobsen 1996).

modeling, research and assessment of the effects of this toxic substance. The goal of this action plan is to significantly reduce mercury in the North American environment to levels attributable to naturally occurring sources. See <http://www.cec.org/programs_projects/ pollutants_health/smoc/smoc-rap.cfm?varlan=english>.

PCBs

Uses of PCBs

Polychlorinated biphenyls (PCBs) are a mixture of persistent chlorinated chemicals that are no longer produced in North America but still are found in the environment. They formerly had many industrial uses—especially as heat transfer fluids in transformers, capacitors and fluorescent lamp ballasts. A variety of other uses included industrial applications as plasticizers, hydraulic fluids, vacuum pump and compressor fluids and in the manufacture of inks, lubricants, flame-retardants, special adhesives and carbonless paper. The estimated cumulative production of PCBs in the US from 1930 to 1975 was 700,000 metric tonnes (ATSDR 2000). About 44,000 tonnes of PCBs were imported into Canada and 10,000 tonnes into Mexico.

Health effects of PCBs

PCBs are highly persistent, bioaccumulative and toxic chemicals with subtle yet pervasive health effects that linger long after exposure. They can deleteriously affect birth weight, memory, coordination, IQ and attention span, and the effects are more pronounced when exposure takes place at younger ages (Longnecker *et al.* 1997).

What can PRTR data tell us about releases and transfers of PCBs?
PRTR data provide information on one source of PCBs to the environment: certain industrial and combustion sources. PRTR data can help identify potential areas, facilities and sectors that may be starting points for reducing PCB exposure to children.

Using TRI data, the total amount of PCBs released on- and off-site from industrial facilities has decreased over time, from over 187 tonnes in 1988 to less than 5 tonnes in 1999 (US EPA 2002c).

In 2000, the reporting threshold was lowered to 10 pounds, or 4.5 kilograms, which resulted in several facilities newly reporting PCBs released to the air. Hazardous waste facilities landfilled large quantities of PCBs (over 648 tonnes) in 2000. Two Chemical Waste Management facilities (one in Emelle, Alabama, and one in Model City, New York) accounted for 467 tonnes. TRI facilities sent 130 tonnes of PCBs off-site for treatment in 2000.

PCBs are not reported to NPRI. According to the most recent 1996 PCB inventory, over 2,800 sites across Canada had PCBs in storage awaiting destruction. One facility, Swan Hills in Alberta, destroyed over 10,000 tonnes of PCBs in 1996 (Environment Canada 2001).

Mexico had approximately 8,800 tonnes of PCBs in storage and in transformers in 1995 (CEC 1996).

PCB levels and exposure in North America
Children's exposure to PCBs can come from a variety of sources, including fish, other food, accidental spills, light ballasts, *in utero*, breast milk and/or proximity to a contaminated site or hazardous waste facility.

Canada has monitored levels of a number of persistent organic pollutants in breast milk over the years and has generally found a downward trend. However, it is estimated that exclusively breastfed infants under 6 months of age in the Great Lakes region are likely be exposed to 81 percent of the Health Canada Provisional Tolerable Daily Intake (PTDI) for PCBs of 1 mg/kg body weight/day. By comparison, the average adult takes in only two percent of the PTDI for PCBs (Haines *et al.* 1998a; Haines *et al.* 1998b). The concentration of PCBs in breast milk is considered an indicator of population exposure to these contaminants by Health Canada and is also relevant to determining the exposure of breastfed infants. Compared to other Ontarians and Canadians, the general population in the Great Lakes basin is more exposed to PCBs. The Inuit of northern Quebec are exceptional, however, in that their exposure is the highest of all Canadians and among the highest globally (Haines *et al.* 1998a; Haines *et al.* 1998b).

Little is known about PCB exposures to children in Mexico. Albert and Aldana (1982) determined the content of PCBs in Mexican cereals and in packaging materials. They concluded that the main source of PCBs in cereals is the transfer from recycled paperboard used for the packaging.

Our experiences with PCBs can teach us many lessons. PRTR data demonstrate the decline in releases of PCBs over time, reflecting the utility of bans and phase-outs on uses and production. However, large amounts of PCBs still remain in waste storage sites across North America, in selected uses, and in the large amounts that are sent to landfills and to treatment every year.

PCBs are still commonly found in soil, sediment, fish and people in North America. Because of the highly persistent, bioaccumulative nature of PCBs, it can take many decades for concentrations in the environment to decrease. For some children, such as those in the Arctic, those whose parents eat a lot of contaminated fish, or those who eat contaminated fish themselves, PCBs remain a health threat. Bans and phase-outs work to reduce environmental releases, but many children will still be exposed to harmful levels of PCBs during the time lag between phase-out and reduction in environmental concentrations. This suggests that bans and phase-outs of chemicals identified to be of concern should not be delayed.

The CEC's Sound Management of Chemicals program has developed a North American Regional Action Plan to facilitate coordination among the three countries in addressing the measurement, uses, storage, shipment, and waste reduction and recycling of these toxic substances. See <http://www.cec.org/programs_projects/pollutants_health/smoc/pcb.cfm?varlan=english>.

Dioxins and Furans

Sources of dioxins and furans

Dioxins and furans are a family of chemical compounds unintentionally created from a variety of processes, such as incineration, backyard burning, pulp and paper mills, smelters and electric utilities. Dioxins and furans can also be contaminants in some pesticides and chlorinated solvents. Other sources of dioxins include natural sources, such as forest fires and volcanoes, contaminated soils and sediments, and long-range transboundary air pollution.

Health effects of dioxins and furans

Each member of the dioxin and furan family has a different toxicity, with 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) generally being considered the most toxic. Some members of the dioxin family are considered carcinogens, suspected neurotoxicants, developmental toxicants and endocrine disruptors. Dioxins and furans are considered to be persistent, bioaccumulative and toxic compounds.

What can PRTR data tell us about releases and transfers of dioxins and furans?

PRTR data provide information on one source of dioxin and furans to the environment, from some industrial and combustion sources. PRTR data can help identify potential areas, facilities and sectors that may be starting points for reducing dioxin and furan exposure to children.

Facilities began reporting dioxins and furans to both TRI and NPRI with the 2000 reporting year. This milestone provided an improved picture of releases and transfers from some of the sources of dioxins and furans. However, methods for reporting dioxins and furans differ between NPRI and TRI. The TRI and NPRI numbers are not comparable because: they are in different units that are not readily convertible, they are reported from different industries and the reporting thresholds are different. Evaluation of the trend in releases of dioxins and furans will only become possible with subsequent reporting years, since 2000 is the first year.

Because dioxins and furans are found at small concentrations, in complex mixtures, with differing toxicity, scientists have assigned toxic equivalency factors (i-TEF) to each dioxin/furan family member, which reflects its toxicity. For NPRI reporting, this specific toxic equivalency factor is then multiplied by the concentration of each individual dioxin member in the mixture. The sum of the toxicity equivalents concentrations for the individual dioxin members then gives the toxicity equivalent (i-TEQ) concentration for the mixture. TRI does not currently report using i-TEQs; rather, the amount of each dioxin and furan member in grams is summed, and the total dioxin/furan content of the mixture is reported in grams.

NPRI identifies specific types of facilities that must report dioxins and furans, often regardless of the number of employees. TRI has a different approach, requiring all facilities that report to TRI to also report dioxins and furans. These different national approaches to dioxin reporting mean that different types of facilities will report dioxins and furans in NPRI and TRI.

NPRI data on dioxins and furans

In 2000, 210.25 grams of dioxins and furans, expressed as toxicity equivalents (i-TEQ), were released on-site from certain Canadian NPRI facilities. This was greater than the amount of dioxins and furans released off-site (148.83 grams i-TEQ), and much greater than the amounts sent for treatment (17.35 grams i-TEQ) and transfers for further management (20.26 grams iTEQ).

Of particular concern are the 103.92 grams of dioxins and furans (i-TEQ) released into the air in 2000. The five sectors that released the largest amounts into the air in 2000 were:

- Air, water, solid waste management (includes municipal incinerators, 50.98 grams i-TEQ)
- Primary metals (23.80 grams i-TEQ)
- Paper products (14.13 grams i-TEQ)
- Hazardous waste management/solvent recovery facilities (5.65 grams i-TEQ)
- Electric utilities facilities (5.61 grams i-TEQ).

NPRI facilities that reported the largest amounts of releases of dioxins and furans to the air in 2000 were **(Table 19)**:

- Skeena Cellulose Inc., Skeena Pulp Operations, in Port Edward, British Columbia (9.17 grams i-TEQ)

Protecting ARCTIC CHILDREN

The image of a clean, untouched wilderness many of us associate with the Arctic areas in North America is not completely accurate. Unfortunately, the Arctic and Arctic children are on the receiving end of emissions from sources often far to the south.

Elevated concentrations of many persistent organic contaminants, such as PCBs, mercury, and some pesticides, have been found in such traditional food sources as fish and marine mammals. Arctic mothers also show high levels of some contaminants such as PCBs and mercury from eating this traditional food, as do their children, being nourished by breast milk and from other sources. According to the recent Canadian Arctic Contaminants Assessment Report II: "Ten percent of mothers in Baffin region and 16 percent of Nunavik mothers have mercury blood levels that fall within Health Canada's 'increasing risk' category. Nearly 80 percent of Nunavik mothers and 68 percent of Baffin mothers have mercury blood levels that exceed a new guideline based on United States studies. Mercury levels in Yukon First Nations, Dene, Métis, and Inuit from Kivalliq and Kitikmeot regions are much lower and fall within Health Canada's 'acceptable' range."

To help protect the children in the Arctic, a series of remedial measures have been undertaken, including improved monitoring and testing, community education, and reduction of emissions from local, national and international sources.

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TABLE 19. NPRI Facilities with the Largest On-Site Air Releases of Dioxins and Furans (2000 Matched Data Set)

Rank	Facility	City, Province	SIC CODES Canada	SIC CODES US	Air (grams TEQ)
1	Skeena Cellulose Inc., Skeena Pulp Operations	Port Edward, BC	27	26	9.17
2	Exploits Regional Services Board, Solid Waste Disposal Site	Grand Falls-Windsor, NF	83	95	8.01
3	Conception Bay North Incinerator Association	Harbour Grace, NF	83	95	7.17
4	Stelco Inc., Hilton Works	Hamilton, ON	29	33	6.25
5	Canadian Waste Services Inc., Swaru Incinerator	Hamilton, ON	49	73	5.49
6	Ispat Sidbec Inc., Aciérie, Ispat International Ltd.	Contrecoeur, QC	29	33	3.69
7	Town of Wabush	Wabush, NF	83	95	3.52
8	Town of Marystown, Waste Disposal Site Jean-de-Baie	Marystown, NF	83	95	3.26
9	Town of Holyrood Incinerator	Holyrood, NF	83	95	2.58
10	Town of Deer Lake	Deer Lake, NF	83	95	2.56
	Subtotal				**51.70**
	% of Total				**50**
	Total				**103.92**

Note: The data reflect estimates of releases of chemicals, not exposure of the public to those chemicals. In combination with other information, these data can be used as a starting point in evaluating exposures that may result from releases and other management activities which involve these chemicals. Some facilities may have reduced or increased releases since 2000.

- Exploits Regional Services Board, Solid Waste Disposal Site, in Grand Falls-Windsor, Newfoundland (8.01 grams i-TEQ)
- Conception Bay North Incinerator Association, in Harbour Grace, Newfoundland (7.17 grams i-TEQ).

TRI data on dioxins and furans

TRI facilities released 45,916 grams of dioxins and furans on-site in 2000. This was similar to the amount of dioxins released off-site (53,941 grams), and sent to treatment (58,504 grams).

Of particular concern are the 5,218 grams of dioxins and furans released into the air.

The four sectors that released the largest amounts of dioxins and furans into the air in 2000 were:

- Chemicals manufacturers (1,254 grams)
- Electric utilities (1,151 grams)
- Manufacturing facilities reporting more than one 2-digit standard industrial classification code (1,067 grams)
- Primary metals (945 grams)

Three facilities in the US reported the largest releases of dioxins and furans to the air in 2000 **(Table 20)**:

- Southwire Co., in Carrollton, Georgia (965 grams)
- Solutia Inc., in Decatur, Alabama (807 grams)
- Magnesium Corporation of America, Renco Group Inc., in Rowley, Utah (623 grams)

Data for dioxins and furans in both TRI and NPRI demonstrate that a handful of facilities are responsible for the majority of air releases. In NPRI, the top ten facilities are responsible for almost half of the total dioxins and furans released to the air, and in TRI the top ten facilities are responsible for over two-thirds of the total air releases. PRTR data can therefore be useful as a starting point for targeting actions to reduce releases.

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TABLE 20. TRI Facilities with the Largest On-Site Air Releases of Dioxins and Furans (2000 Matched Data Set)

Rank	Facility	City, State	US SIC Code	Air (grams)
1	Southwire Co.	Carrollton, GA	Mult.	965.00
2	Solutia Inc.	Decatur, AL	28	807.39
3	Magnesium Corp. of America, Renco Group Inc.	Rowley, UT	33	623.00
4	City of Fremont Department of Utilities, Lon D. Wright Power, City of Fremont Dep	Fremont, NE	49	429.00
5	TXI Ops., L.P. Hunter Cement Plant	New Braunfels, TX	32	145.51
6	Dow Chemical Co., Freeport	Freeport, TX	28	139.64
7	Waupaca Fndy. Inc., Plant 5, Budd Co.	Tell City, IN	33	106.70
8	Boswell Oil Co.	Dravosburg, PA	57	102.80
9	Occidental Chemical Corp., Occidental Petroleum Corp.	Gregory, TX	28	99.70
10	Cogentrix of Richmond Inc., Cogentrix Energy Inc.	Richmond, VA	49	80.00
	Subtotal			**3,498.74**
	% of Total			**67**
	Total			**5,217.77**

Note: *The data reflect estimates of releases of chemicals, not exposure of the public to those chemicals. In combination with other information, these data can be used as a starting point in evaluating exposures that may result from releases and other management activities which involve these chemicals. Some facilities may have reduced or increased releases since 2000.*

Levels of dioxins and furans and exposures in North America

Children's exposure to dioxins can come from a variety of sources, including food, such as fish, *in utero* exposure or via breast milk, and from proximity to a contaminated site or hazardous waste facility. Foods that are high in fats, such as beef, pork, dairy products, fish and breast milk, tend to have higher concentrations of dioxins and furans.

Canadian exposure estimates indicate that breastfed infants under six months of age in the Great Lakes region are likely to be exposed to almost six times the Tolerable Daily Intake (TDI) of dioxins (10 picograms i-TEQ/kg of body weight/day for dioxins) (World Health Organization 1998). By comparison, the average adult 20 years of age or older takes in only 12 percent of the TDI for dioxin (Haines 1998a). It is important to note that international scientists recently agreed on revising the TDI for dioxins downward to a range of between 1 to 4 picogram/kg of body weight/day (WHO 1998).

Canada has monitored breast milk levels of a number of persistent organic pollutants over the years and has generally found a downward trend. The concentration of dioxins in breast milk is considered an indicator of population exposure to these contaminants by Health Canada (Health Canada 1998a) and is also relevant to determining the exposure of breast-fed infants. Breast milk levels of dioxins and furans indicate that exposure is relatively uniform geographically for the general Canadian population.

A draft North American Regional Action Plan on these toxic substances has been released for public comment. See <http://www.cec.org/pubs_docs/documents/index.cfm?varlan=english&ID=1220>.

CHAPTER 4

What's Being Done to Protect Children's Health from Toxic Chemicals?

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Across North America, numerous regulations, programs and actions are underway which will help protect children's health from toxic chemicals. The following section provides an overview of some of the types of activities being undertaken at different governmental levels.

MUNICIPAL Activities

- Restrictions on use of pesticides
- Emission standards/permits
- Sewer bylaws
- Transportation and land use policies

Some municipalities are restricting the use of pesticides. For example, in Canada, a recent Supreme Court decision upheld a bylaw passed by the town of Hudson, Quebec, which banned the cosmetic use of pesticides within municipal boundaries, including on private property. At least fifty communities across Canada have bylaws that reduce or restrict the use of pesticides on public and private property.

NATIONAL AND PROVINCIAL/STATE Activities

Each nation has a number of activities that occur on the national and/or state/provincial levels that will help to protect children's health from toxic chemicals. These fall roughly into four types:

1. Activities to reduce releases of toxic chemicals
   - Pollution prevention programs
   - Emission standards
   - Voluntary reductions
   - Regulations and programs to reduce chemical emissions or use by chemical, by regional area, or for certain industrial sectors
   - Bans and phase-outs
2. Activities to reduce exposure of children to toxic chemicals
   - Soil replacement programs in lead contaminated communities
   - Minimizing exposures to leaded paint and pottery

Each nation has a number of activities that occur on the national and/or state/provincial levels that will help to protect children's health from toxic chemicals.

- Education and outreach
- Recalls of contaminated food, consumer products (recalls of the latter not available in Canada)
- Warnings on fish consumption, consumer products and drinking water safety
- Prenatal counseling and education

3. Activities to improve monitoring and surveillance of children's health
   - Health surveys
   - Disease and disability tracking databases
   - Physician/health worker training/education
   - Community outreach
   - Improved chemical screening
4. Activities to improve monitoring of chemicals in the environment and in humans
   - Chemical reporting (PRTRs, etc.)
   - Environmental monitoring and surveys
   - Biomonitoring

For more information about national activities, please see:

- Environment Canada at <www.ec.gc.ca>
- Semarnat at <www.semarnat.gob.mx>
- Environmental Protection Agency at <www.epa.gov>

International Action on PERSISTENT ORGANIC POLLUTANTS

Some chemicals are slow to break down in the environment. These chemicals are known as persistent organic pollutants (POPs). POPs know no boundaries because they can travel long distances from their sources. Levels of some of these chemicals, such as DDT, PCBs, and dioxins and furans, can be found in all of our bodies. The chemicals can be passed from one generation to the next through breast milk. Several of these chemicals are neurotoxicants and suspected endocrine disruptors.

Faced with the widespread, persistent and toxic nature of these chemicals, over 150 countries, including Canada, Mexico and the US, have signed the Stockholm Convention on POPs. The Convention seeks the elimination or phase out of POPs, with an initial focus on 12 chemicals: aldrin, chlordane, dieldrin, endrin, hepatachlor, hexachlorobenzene, mirex, toxaphene, PCBs, DDT, and dioxins and furans. For more information on POPs, see <www.chem.unep.ch/pops/>.

INTERNATIONAL Activities

In the past decade, children's environmental health has become increasingly more prominent on the international agenda. Several important conventions and agreements have been signed, such as the UN Convention on the Rights of the Child (1989), Declaration of the Environment Leaders of the Eight on Children's Environmental Health (G7 countries and Russia, 1997), and the Declaration of the Third European Ministerial Conference on Environment and Health (1999, WHO European Delegation).

The reduction of toxic chemicals into the environment has also become the subject of several international agreements: the Basel Convention on the Transboundary Movement of Hazardous Wastes and their Disposal, the Montreal Protocol on Ozone-depleting Chemicals, the Convention on Long-range Transboundary Air Pollution and the Stockholm Convention on Persistent Organic Pollutants.

Trilateral Action in North America to Reduce Toxic Chemicals and Protect Children's Health

Canada, Mexico and the US, through the CEC's Sound Management of Chemicals (SMOC) initiative, have developed North American Regional Action Plans (NARAPs) for a series of chemicals important to children's health (examples mentioned above concern mercury, PCBs, and dioxins and furans). Through NARAPs, the three countries have committed themselves to taking specific concrete steps that will reduce these chemicals in the North American environment. In addition to the new NARAP for dioxins, furans and hexachlorobenzene that has recently been drafted, lindane and lead are under consideration for future action under SMOC.

The CEC has developed a trilateral community of people interested in the linkages between children's health and the environment. As part of this initiative, a background document, entitled *Making the Environment Healthier for Our Kids: An Overview of Environmental Challenges to the Health of North America's Children* (CEC 2002), has been developed.

This document formed part of the discussions leading up to the CEC Council's adoption of the Cooperative Agenda for Children's Environmental Health in 2002 (Council Resolution 02-06). The initial focus of the agenda is on asthma and other respiratory diseases, the effects of lead, and the effects of exposure to other toxic chemicals.

Contaminants emitted by cars and trucks are one of the areas investigated by the CEC's Air Quality Program. Emissions of particulates and other contaminants from diesel trucks and cars is being reviewed, particularly emissions at congested border crossings.

CHAPTER 5

What Needs to be done to Protect Children's Health from Toxic Chemicals

We have made some important progress over recent decades to recognize, reduce and prevent children's exposure to toxic chemicals, as illustrated by PRTR data. Releases of many carcinogens, neurotoxicants and developmental toxicants to the air decreased from 1995 to 2000 from industrial sources, and some facilities have continued to make reductions since 2000. Emissions of lead, a carcinogen, neurotoxicant and development toxicant, from industrial facilities decreased by 29 percent from 1995 to 2000. Lead has been phased out of gasoline in Canada, Mexico and the US. This has significantly reduced the lead levels in children's blood. In addition to reductions in emissions, some pesticides such as DDT and chlordane have been banned or severely restricted.

And yet…more of our children have asthma, brain cancers and certain types of leukemia than ever before. Concerns are increasing about our children who seem to be struggling with a wide range of learning, behavioral and developmental disabilities. Certainly there are many factors that may interact to cause these health effects. Exposure to toxic chemicals is one of these.

The challenge before us is to intervene whenever possible to reduce or prevent these health effects.

The challenge before us is to intervene whenever possible to reduce or prevent these health effects. While some factors may be less amenable to intervention, exposure to toxic chemicals is an area where we can make improvements.

Actions to Reduce CHILDREN'S EXPOSURE to Toxic Chemicals

Reducing children's exposure to toxic chemicals requires activities to:

1. Reduce releases of toxic chemicals
2. Reduce pathways/exposures
3. Monitor children's health
4. Monitor releases
5. Increase awareness of the role of toxic chemicals in children's health

Activities to Reduce Releases of Toxic Chemicals

Preventing or reducing toxic contamination at the source is a first step in stemming the impacts that toxic chemicals can have on children's health. Reducing releases has the potential to reduce contaminants that children receive from the air, water, soil, breast milk, food or *in utero*. A broad range of programs, regulations and actions are underway to reduce releases of chemicals. Traditionally these programs have either focused on reducing emissions from a specific chemical, from a specific source or to a specific regional area. For an overview of some of these programs, please see Environment Canada's web site at <http://www.ec.gc.ca/>, Semarnat's web site at <www.semarnat.gob.mx> and the US EPA's web site at <www.epa.gov/ttn/airtoxics>.

PRTRs provide information on specific chemicals, industrial sectors and industrial facilities that could be targeted for further reductions of releases. For example, the carcinogens styrene, dichloromethane, formaldehyde, acetaldehyde and trichloroethylene are released into the air in large quantities in North America, often from the chemical manufacturing, primary metals and electronics sectors. Developmental toxicants and neurotoxicants such as methanol, toluene, hydrogen fluoride and xylenes are released to the air from chemical manufacturing and primary metals. Three jurisdictions, Texas, Ontario and Ohio, release large amounts of carcinogens, developmental toxicants and neurotoxicants. Often a handful of facilities are responsible for the lion's share of the releases of carcinogens, developmental toxicants and neurotoxicants. These jurisdictions and facilities could consider actions to reduce releases, especially of carcinogens, developmental toxicants and neurotoxicants. Some of these facilities have made reductions since 2000.

PRTR data can also be helpful in identifying specific sectors and facilities that could be targeted for reductions of a specific chemical of concern to children's health. For example, three facilities in North America, all smelters, released large amounts of lead into the air in 2000. While some facilities have made progress in reducing these emissions, others have not.

PRTR data are good at identifying sectors, facilities and chemicals for action. However, they are only part of the picture. The PRTR data need to be combined with other data to provide a more complete picture of children's exposure to chemicals from mobile sources, area sources and natural sources. Regulations and programs requiring nonleaded gasoline and cleaner cars have helped to reduce releases of toxics from vehicles. Reducing releases from mobile sources remains a major challenge in many parts of North America.

Many municipalities, schools and homeowners have reduced the use of pesticides. Given the associations between pesticide use and some childhood cancers, further reduction in use may be warranted.

With the increasing economic and social ties among the three North American countries, we have an opportunity to increase shared actions to reduce releases of chemicals.

Activities to Reduce Exposure to Toxic Chemicals

Often, reducing ongoing releases of chemicals from industrial, mobile and other sources will reduce children's exposure to chemicals. A second challenge is to reduce levels of contamination already existing in the environment. For chemicals such as persistent, bioaccumulative toxics, historical contamination can re-enter the environment from the soil and sediment of even long-controlled sources.

Determining the relative importance of the numerous exposures of children to toxic chemicals is not an easy task. Risk assessments have often been used to help answer these questions and can often identify knowledge gaps, missing information and critical pathways.

Efforts such as the US 1996 National Air Toxics Assessment have used estimates of releases of 32 hazardous air pollutants from industrial, mobile, area and other sources to model ambient concentrations, human exposure and estimated risk. The results showed that the greatest national cancer risk came from three chemicals: benzene, chromium and formaldehyde (diesel emissions and dioxins/furans not included). The greatest contributor to non-cancer hazards was acrolein. More than 200 million people in the US live in census tracts where the combined lifetime cancer risk (based on human data) from these compounds exceeded 10-in-one million (US EPA 2002a). These efforts are an important step in pulling together data from industrial, mobile, area and natural sources to answer questions about exposure and risk. The next reassessment, based on 1999 data, is expected in 2003.

Approaches to reducing risks to children from environmental exposures in North America need to take into account the diversity of environments in which children find themselves across the continent. For example, the use of biomass fuels for home heating and cooking is exposing children in many homes in Mexico to unacceptable levels of indoor air pollution, including dioxins. Across the continent, children of

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Native American/Aboriginal/Indigenous origin may be at greater risk because of traditional practices like fishing from areas that have now become contaminated, sometimes from persistent compounds from far away.

We are faced with the triple challenges of reducing ongoing releases, reducing contributions from historical sources, and recognizing the unique exposures in North America. Where do we need to focus? Generally exposure assessments point to the need to protect the quality of *in utero* and newborn development, to ensure a clean and safe food supply, to ensure good air quality— both indoor and outdoor, and to minimize contamination from consumer products.

Activities to Improve Monitoring and Surveillance of Children's Health

Across North America, there is a need to increase the information on hazards and exposures and to increase our capacities for assessing environmental risks to children. This is especially true in Mexico, which has the greatest need for capacity building and a large number of children exposed to a wider range of environmental threats. Currently, it is difficult to compare disease and mortality in children across North America. Collection methods and time frames differ. Without a comprehensive disease-tracking system, it is difficult to explore the connections between diseases and environmental exposures.

It is also difficult to put together the scanty data on levels of contaminants in human cord blood, breast milk and children's bodies. This makes it difficult to get a picture of current levels of contaminant burdens in children in North America, and thus makes difficult exploring the connections between contaminant burdens, sources and diseases.

An important step in this direction is the development of international children's health research networks. Binational and international activities, including those of the International Joint Commission, the CEC, the G-8, WHO, UNEP and OECD, as well as hundreds of nongovernmental groups, are increasingly working on children's environmental health and coordinating their efforts in new and promising partnerships.

One new, growing trilateral partnership is the Pediatric Environmental Health Specialty Units (PEHSU). The PEHSU aims to provide information, education and medical services to health professionals and the general population on children's environmental health related problems. Starting with a network of clinics in the US, PEHSU clinics have grown to Canada and Mexico. The Pediatric Environmental Health Clinic at the Misericordia Centre in Edmonton has joined the network of PEHSU clinics. The US EPA funded a PEHSU in Cuernavaca, Mexico, in partnership with Mexico's *Instituto Nacional de Salud Pública* and the *Hospital del Niño Morelense.* The PEHSU could be expanded to other areas in Canada and Mexico, particularly around the Canada-US-Mexico borders.

NEW KNOWLEDGE on the Horizon

The US is designing a major study of children's environmental health and safety called the "National Children's Study." As currently proposed, the study would enroll 100,000 children while still *in utero*, and would assess short- and long-term impacts of prenatal and early childhood risk factors. Health Canada has been in discussions to be involved in this study. Extending this study to Mexico is also under discussion. The CEC is involved in facilitating such linkages among the three countries, with the long-term vision of coordinating studies in all three North American countries. The US National Children's Study could potentially serve as a basis or starting point for continent-wide, coordinated research.

The US has largely taken the lead in research efforts in children's environmental health. It has established a number of Centers of Excellence in Children's Environmental Health and Disease Prevention Research, funded by the National Institute of Environmental Health Sciences and the US EPA. These centers are producing important research that will help inform decisions about reducing children's risks in the future. The US CDC National Center for Environmental Health has begun a process to track levels of chemicals in people over time. On an annual basis, they will publish the *National Report on Human Exposure to Environmental Chemicals*. Knowledge of levels should provide better information about preventing and reducing children's exposure.

The US EPA has entered into a voluntary agreement with US industry to test chemicals for risks to children, the Voluntary Children's Chemical Evaluation Program (VCCEP). While this effort is in a preliminary pilot phase, it shows promise of filling many of the gaps in hazard knowledge that are needed for risk assessment. The US National Toxicology Program has begun a process of formally assessing the potential for hazard to children, the Center for the Evaluation of Risks to Human Reproduction. To date, this Center has evaluated risks of phthalates (seven with major industrial uses) and methanol.

In addition, the EPA, under the Food Quality Protection Act of 1996, has developed a number of new policies for determining what types of hazard data are needed for assessment of risks to children and how to do cumulative (multiple pesticides that act by the same mode of action) and aggregate (multiple routes of exposure to the same pesticide) assessments of risk.

Canada has established the National Children's Agenda through Health Canada, which takes a broad approach to child health and well being, including environmental health (see <http://unionsociale.gc.ca/nca_e.html>). This agenda has included support for the Canadian Centres of Excellence for the Children's Well-Being. An inventory of research on children's health has been compiled by the Canadian Institutes for Health Research, with the objective of developing a research agenda.

In Mexico, several cohort studies of children are underway, funded by the US National Institute of Health and the Mexican government, under the leadership of Mexico's *Instituto Nacional de Salud Pública* (INSP). Potentially, these studies could be expanded to provide comparable methods to the National Children's Study, resulting in the first trilateral assessment of children's health.

Under NAFTA, there is increasing harmonization of pesticide reviews and joint reviews. Canada has revised its national pesticide law and the new legislation contains a number of measures that may help to protect children's health.

Many of the research efforts could be undertaken on a regional, bilateral or trilateral basis. This would help to fill in the existing lack of comparable data among the three countries. We need to build on existing efforts to provide a more North American picture of children's environmental health.

Activities to Improve Monitoring of Chemicals in the Environment

It is currently difficult to compile comparable information on chemical releases, transfers or ambient concentrations in Canada, Mexico and the US. Often data are missing, are not available to the public or are not directly comparable. In addition, data collected using different methods, time periods or estimation methods are often difficult to compare. PRTR data can offer an opportunity to help bridge some of these gaps, especially as reporting under the Mexican program comes online. Other chemical inventories are also being compiled on mercury, dioxins and furans, which will help answer some questions about children's potential exposures. Regional criteria air contaminant inventories in Mexico are increasing in number, and permit a greater understanding of children's potential exposures to chemicals associated with smog and respiratory diseases. Putting together these national and regional inventories will help provide a better picture of releases of chemicals.

Traditionally, ambient air monitoring networks have measured criteria air contaminants. Monitoring for toxic air contaminants needs to be increased across North America.

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Working Towards an Improved Picture of NORTH AMERICAN CONTAMINANTS

The three national governments have committed themselves to work together to increase the comparability of PRTR data, which will result in an improved picture of contaminants in North America. In June 2002, the CEC Council adopted an *Action Plan to Enhance the Comparability Among Pollutant Release and Transfer Registers in North America* to further this aim (Council Resolution 02-05). To date, collaboration among the three countries has increased the amount of matched PRTR data (NPRI-TRI) by about 40 to 60 percent.

Therefore, there are opportunities for expanding knowledge about pollutant releases of concern to children through:

- Expanding the PRTR efforts in Canada and the US to give a fuller picture of sources and amounts;
- Continuing to implement PRTR reporting in Mexico, with mandatory reporting on a broad range of chemicals and making the information publicly accessible;
- Expanding efforts to put together inventories of criteria air contaminants and toxic contaminants into a trilateral picture;
- Increasing the amount of publicly available information about pesticide sales, use, concentrations, poisonings and exposure; and
- Increasing the monitoring of toxic contaminants in ambient air, water and soil in North America, and increasing the coordination of these results.

Activities to Improve Awareness

Parents, teachers, relatives, and neighbors have the ability to reduce a child's exposure to toxic chemicals. The first step is increasing their awareness of possible sources and pathways of chemicals to children, and the potential for chemicals to harm children. The second step is taking practical actions to reduce potential exposures to chemicals. The third step is to watch and monitor for health effects or changes in the environment, which may increase exposure.

A number of organizations can provide detailed information on these steps.

STEP ONE: For information about releases and transfers of chemicals from industrial and other facilities in your neighborhood, as reported to PRTRs:

Canada

- Search for industrial facilities in your community using the National Pollutant Release Inventory at <www.ec.gc.ca/pdb>.
- Search by postal code, view maps, query databases of information about chemicals and health effects or to send a letter see the PollutionWatch site at <http://www.pollutionwatch.org/>.

Mexico

- English-language information on emissions of some contaminants from industrial sectors is available from the *Registro de Emisiones y Transferencia de Contaminantes* (RETC), see: <http://sat.semarnat.gob.mx/dggia/retc/ingles/ingles.html>.

US

- Search for industrial facilities in your community using zip codes, states or national overviews of the Toxics Release Inventory at <www.epa.gov/tri/>.
- Search for industrial facilities by zip codes, for additional health information and maps, to send an email to a facility about their releases, or to join a discussion group about a chemical or facility, try the Scorecard site at <www.scorecard.org>.

North America

- Search for information on releases and transfers of chemicals common to both TRI and NPRI using the CEC's *Taking Stock Online* web site at <www.cec.org/takingstock>.

For information about emissions from mobile, area and other sources in your community see:

Canada

- Environment Canada's emission inventories at <http://www.ec.gc.ca/pdb/ape/cape_home_e.cfm>
- or general information at <http://www.ec.gc.ca/pdb/npri/npri_links_e.cfm - ECInv>.

Mexico

- National information at <www.semarnat.gob.mx>.
- Mexico City emission inventories at <www.sma.df.gob.mx/menu.htm>.

US

- For air toxics, see the National Air Toxics Assessment at <http://www.epa.gov/ttn/atw/nata/>.
- For criteria air contaminants, see the National Emission Inventory at: <http://www.epa.gov/ttn/chief/eiinformation.html>.

STEP TWO: For information about practical steps to reduce your child's exposure to chemicals, see:

- Children's Health Environmental Coalition. 2002. The State of Children's Health and Environment 2002. See especially chapter 6: Guidelines for parents and those who manage children's environments, available at <http://www.checnet.org/prodres_sche_enews.asp>.
- Philip J. Landrigan, MD; Herbert L. Needleman, MD; and Mary M. Landrigan, MPA. Raising Healthy Children in a Toxic World:101 Smart Solutions for Every Family. Rodale Press. See: <http://www.rodalestore.com/webapp/wcs/stores/servlet/ProductDisplay?catalogId=10002&storeId=10051&productId=11697&langId=-1>.
- A variety of suggestions from the Children's Health Environmental Coalition Healthy House including "How to Create Better Breathing Space for Asthmatics": <http://www.checnet.org/healthehouse/education/top10-detail.asp?Top10_Cat_ID=14>.
- D.T. Wigle. In press. Child Health and the Environment. Oxford University Press.
- American Academy of Pediatrics. 1999. Handbook of Pediatric Environmental Health. See: <http://www.aap.org/bst/showdetl.cfm?&DID=15&Product_ID=1697&CatID=132>.

STEP THREE: For information about how to watch and monitor for health effects or changes in the environment which could increase exposure:

- You can subscribe to the Children's Health Environmental Coalition (CHEC) Health-eNews, which is sent twice a month, by signing up at: <http://checnet.forms.soceco. org/47/>.
- You can learn about emerging research from the Children's Environmental Health Network at: <http://www.cehn.org/cehn/About.html-listserv>.

For general information about children's environmental health, see:

Canada

- Environment Canada at <www.ec.gc.ca>.
- Health Canada's Environmental Health Program at <http://www.hc-sc.gc.ca/english/protection/environment.html>.
- Health Canada's First Nations and Inuit Health Branch: Your Environmental Health Program at <http://www.hc-sc.gc.ca/fnihb/bpm/hfa/transfer_publications/environmental_health_program.htm>.
- The Children's Health project at Canadian Environmental Law Association at <http://www.cela.ca/>.

- The Canadian Institute of Child Health at <http://www.cich.ca/>.
- Canadian Partnership for Children's Health and Environment at <www.healthyenvironmentforkids.ca>.
- Pollution Probe at <www.pollutionprobe.org/>.
- For general health information and links, see the Canadian Health Network <http://www.canadian-health-network.ca/>.

US

- Environmental Protection Agency at <www.epa.gov>.
- Physicians for Social Responsibility at <www.psr.org/>.
- Children's Health Environmental Coalition at <www.checnet.org>.
- Children's Environmental Health Network at <http://www.cehn.org/>.
- Learning Disabilities Association of America at <http://www.LDAAmerica.org/>.
- The Center for Children's Health and the Environment at <www.Childenvironment.org>.
- Partnership for Children's Health and the Environment at <http://www.partnersforchildren.org/>.

For an online directory of children's environment organisations and links, see:

Canada

- The Canadian Institute of Child Health at <http://www.cich.ca/>.

US

- The Resource Guide on Children's Environmental Health at: <http://www.cehn.org/cehn/resourceguide/organizations.html>.

To become involved in promoting improvements in children's environmental health:

- Consider joining a children's health environmental organization such as those listed above.
- Consider participating in municipal, provincial or national children's health programs.
- Consider participating in trilateral programs such as the CEC's Sound Management of Chemicals Program, the North American PRTR Program, Children's Health and the Environment, and the Air Quality Program, see <http://www.cec.org/>.

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APPENDIX A. Number of Children in North America

Country	Number of Children under 18 years old (2001)	Age of Children 0–5 years	Total Population in 2001	Children as a Percent of Total Population	0–5 years as Percent of Total Population	Urbanized Rate[1]	Estimated Number of Urban Children	Children's "Relative" Poverty Rate[2]	Estimated Number of Children in "Relative" Poverty
Canada	7,087,000	1,766,000	31,015,000	22.8	5.7	79	5,598,730	16	1,259,200
Mexico	38,933,000	11,126,000	100,368,000	38.8	11.1	75	29,978,410	26	5,914,700
US	73,767,000	19,834,000	285,926,000	25.8	6.9	77	56,800,00	22	16,228,000
Total	**119,787,000**	**32,726,000**	**417,309,000**				**30,035,210**		**23,401,900**

Sources:

(1) UNICEF. 2003. State of the World's Children, <www.Unicef.org>

(2) UNICEF. 2000. A League Table of Child Poverty in Rich Nations. Innocenti Report Card No.1 UNICEF Innocenti Research Centre, Florence, 2000. Relative Poverty = living in a household where the income is less than half the national median.

APPENDIX B. List of Chemicals Reported to both TRI and NPRI that are Known or Suspected Carcinogens, Developmental Toxicants, and/or Neurotoxicants (Matched TRI-NPRI Data Set 2000 or 1995–2000)

Known or Suspected Carcinogens	Known or Suspected Developmental Toxicants	Suspected Neuro-toxicants	* = not in 1995-2000 data set	CAS Number	Chemical
■	■	■		75-07-0	Acetaldehyde
	■	■		75-05-8	Acetonitrile
		■	*	107-02-8	Acrolein
■		■		79-06-1	Acrylamide
■	■	■		107-13-1	Acrylonitrile
	■	■		107-18-6	Allyl alcohol
		■		107-05-1	Allyl chloride
		■		7429-90-5	Aluminum (fume or dust)
		■		1344-28-1	Aluminum oxide (fibrous forms)
	■	■		62-53-3	Aniline
		■		–	Antimony (and its compounds)
■	■	■		–	Arsenic (and its compounds)

APPENDIX B (continued). **List of Chemicals Reported to both TRI and NPRI that are Known or Suspected Carcinogens, Developmental Toxicants, and/or Neurotoxicants** (Matched TRI-NPRI Data Set 2000 or 1995–2000)

Known or Suspected Carcinogens	Known or Suspected Developmental Toxicants	Suspected Neuro-toxicants	* = not in 1995-2000 data set	CAS Number	Chemical
■				1332-21-4	Asbestos (friable)
■	■	■		71-43-2	Benzene
	■			98-88-4	Benzoyl chloride
■	■	■		100-44-7	Benzyl chloride
	■	■		92-52-4	Biphenyl
		■	*	7637-07-2	Boron trifluoride
	■	■	*	7726-95-6	Bromine
		■	*	353-59-3	Bromochlorodifluoromethane (Halon 1211)
	■	■		74-83-9	Bromomethane
		■	*	75-63-8	Bromotrifluoromethane (Halon 1301)
■	■	■		106-99-0	1,3-Butadiene
	■	■		75-65-0	tert-Butyl alcohol
■				106-88-7	1,2-Butylene oxide
■	■	■		–	Cadmium (and its compounds)
	■	■		75-15-0	Carbon disulfide
■	■	■		56-23-5	Carbon tetrachloride
■		■		120-80-9	Catechol
■			*	115-28-6	Chlorendic acid
		■		7782-50-5	Chlorine
	■			10049-04-4	Chlorine dioxide
	■	■		108-90-7	Chlorobenzene
	■	■	*	75-45-6	Chlorodifluoromethane (HCFC-22)
	■	■		75-00-3	Chloroethane
■	■	■		67-66-3	Chloroform
	■	■		74-87-3	Chloromethane
■			*	563-47-3	3-Chloro-2-methyl-1-propene
		■	*	542-76-7	3-Chloropropionitrile
		■	*	75-72-9	Chlorotrifluoromethane (CFC-13)
■				–	Chromium (and its compounds)
■		■		–	Cobalt (and its compounds)
	■			–	Copper (and its compounds)
		■		108-39-4	m-Cresol
		■		95-48-7	o-Cresol
		■		106-44-5	p-Cresol
		■		1319-77-3	Cresol (mixed isomers)

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APPENDIX B (continued). List of Chemicals Reported to both TRI and NPRI that are Known or Suspected Carcinogens, Developmental Toxicants, and/or Neurotoxicants (Matched TRI-NPRI Data Set 2000 or 1995–2000)

Known or Suspected Carcinogens	Known or Suspected Developmental Toxicants	Suspected Neuro-toxicants	* = not in 1995-2000 data set	CAS Number	Chemical
		■		98-82-8	Cumene
	■	■		–	Cyanides
		■		110-82-7	Cyclohexane
		■	*	108-93-0	Cyclohexanol
	■			1163-19-5	Decabromodiphenyl oxide
■	■			95-80-7	2,4-Diaminotoluene
	■	■		84-74-2	Dibutyl phthalate
		■		95-50-1	1,2-Dichlorobenzene
■	■	■		106-46-7	1,4-Dichlorobenzene
■			*	612-83-9	3,3'-Dichlorobenzidine dihydrochloride
		■	*	75-71-8	Dichlorodifluoromethane (CFC-12)
■	■	■		107-06-2	1,2-Dichloroethane
		■	*	1717-00-6	1,1-Dichloro-1-fluoroethane (HCFC-141b)
■		■		75-09-2	Dichloromethane
		■		78-87-5	1,2-Dichloropropane
		■	*	76-14-2	Dichlorotetrafluoroethane (CFC-114)
		■	*	77-73-6	Dicyclopentadiene
		■		111-42-2	Diethanolamine
■	■			117-81-7	Di(2-ethylhexyl) phthalate
■				64-67-5	Diethyl sulfate
		■	*	124-40-3	Dimethylamine
		■		121-69-7	N,N-Dimethylaniline
		■		131-11-3	Dimethyl phthalate
■		■		77-78-1	Dimethyl sulfate
		■		534-52-1	4,6-Dinitro-o-cresol
■		■		121-14-2	2,4-Dinitrotoluene
■		■		606-20-2	2,6-Dinitrotoluene
		■		25321-14-6	Dinitrotoluene (mixed isomers)
■		■		123-91-1	1,4-Dioxane
		■	*	122-39-4	Diphenylamine
■		■		106-89-8	Epichlorohydrin
	■	■		110-80-5	2-Ethoxyethanol
■	■	■		140-88-5	Ethyl acrylate
■	■	■		100-41-4	Ethylbenzene
		■		74-85-1	Ethylene
	■	■		107-21-1	Ethylene glycol
■	■	■		75-21-8	Ethylene oxide
■	■			96-45-7	Ethylene thiourea
■		■		50-00-0	Formaldehyde
		■	*	64-18-6	Formic acid
	■	■		77-47-4	Hexachlorocyclopentadiene
■	■	■		67-72-1	Hexachloroethane

APPENDIX B (continued). List of Chemicals Reported to both TRI and NPRI that are Known or Suspected Carcinogens, Developmental Toxicants, and/or Neurotoxicants (Matched TRI-NPRI Data Set 2000 or 1995–2000)

Known or Suspected Carcinogens	Known or Suspected Developmental Toxicants	Suspected Neuro-toxicants	* = not in 1995-2000 data set	CAS Number	Chemical
	■	■	*	70-30-4	Hexachlorophene
	■	■	*	110-54-3	n-Hexane
■	■	■		302-01-2	Hydrazine
		■		74-90-8	Hydrogen cyanide
	■	■		7664-39-3	Hydrogen fluoride
		■		123-31-9	Hydroquinone
		■	*	13463-40-6	Iron pentacarbonyl
		■		80-05-7	4,4'-Isopropylidenediphenol
■	■	■		–	Lead (and its compounds)
	■	■	*	554-13-2	Lithium carbonate
		■		–	Manganese (and its compounds)
		■	*	149-30-4	2-Mercaptobenzothiazole
	■	■	*	–	Mercury (and its compounds)
	■	■		67-56-1	Methanol
	■	■		109-86-4	2-Methoxyethanol
		■		96-33-3	Methyl acrylate
	■	■		1634-04-4	Methyl tert-butyl ether
■		■		101-14-4	4,4'-Methylenebis(2-chloroaniline)
■		■		101-77-9	4,4'-Methylenedianiline
	■	■		78-93-3	Methyl ethyl ketone
		■		74-88-4	Methyl iodide
	■	■		108-10-1	Methyl isobutyl ketone
	■	■		80-62-6	Methyl methacrylate
		■	*	924-42-5	N-Methylolacrylamide
		■	*	109-06-8	2-Methylpyridine
	■	■	*	872-50-4	N-Methyl-2-pyrrolidone
■				90-94-8	Michler's ketone
		■		1313-27-5	Molybdenum trioxide
		■	*	76-15-3	Monochloropentafluoroethane (CFC-115)
	■	■		91-20-3	Naphthalene
■	■	■		–	Nickel (and its compounds)
■				139-13-9	Nitrilotriacetic acid
		■	*	100-01-6	p-Nitroaniline
■		■		98-95-3	Nitrobenzene
		■		55-63-0	Nitroglycerin
		■		100-02-7	4-Nitrophenol
■	■	■		79-46-9	2-Nitropropane
		■	*	123-63-7	Paraldehyde
		■	*	76-01-7	Pentachloroethane
	■	■		108-95-2	Phenol
		■		106-50-3	p-Phenylenediamine
	■	■		90-43-7	2-Phenylphenol

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APPENDIX B (continued). List of Chemicals Reported to both TRI and NPRI that are Known or Suspected Carcinogens, Developmental Toxicants, and/or Neurotoxicants (Matched TRI-NPRI Data Set 2000 or 1995–2000)

Known or Suspected Carcinogens	Known or Suspected Developmental Toxicants	Suspected Neuro-toxicants	* = not in 1995-2000 data set	CAS Number	Chemical
		■		7723-14-0	Phosphorus (yellow or white)
		■		85-44-9	Phthalic anhydride
■			*	–	Polychlorinated alkanes (C10 to C13)
■			*	7758-01-2	Potassium bromate
		■	*	107-19-7	Propargyl alcohol
		■		123-38-6	Propionaldehyde
■	■	■		75-56-9	Propylene oxide
		■		110-86-1	Pyridine
		■		91-22-5	Quinoline
		■		106-51-4	Quinone
■		■		94-59-7	Safrole
	■	■		–	Selenium (and its compounds)
	■	■	*	7632-00-0	Sodium nitrite
■	■	■		100-42-5	Styrene
■	■	■		96-09-3	Styrene oxide
	■	■		79-34-5	1,1,2,2-Tetrachloroethane
■	■	■		127-18-4	Tetrachloroethylene
	■		*	64-75-5	Tetracycline hydrochloride
■	■			62-56-6	Thiourea
	■	■		108-88-3	Toluene
■		■		584-84-9	Toluene-2,4-diisocyanate
■				91-08-7	Toluene-2,6-diisocyanate
■		■		26471-62-5	Toluenediisocyanate (mixed isomers)
	■	■		120-82-1	1,2,4-Trichlorobenzene
		■		79-00-5	1,1,2-Trichloroethane
■	■	■		79-01-6	Trichloroethylene
		■	*	75-69-4	Trichlorofluoromethane (CFC-11)
		■	*	121-44-8	Triethylamine
		■		95-63-6	1,2,4-Trimethylbenzene
■		■		108-05-4	Vinyl acetate
■	■	■		75-01-4	Vinyl chloride
	■	■		75-35-4	Vinylidene chloride
	■	■		–	Xylenes
	■	■		–	Zinc (and its compounds)
58	**74**	**144**	**165**		**Total Number of Chemicals**