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Human Activity and the Environment

Waste management in Canada

2012 — Updated

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User information

Symbols

The following standard symbols are used in Statistics Canada publications:

.	not available for any reference period
..	not available for a specific reference period
...	not applicable
0	true zero or a value rounded to zero
0s	value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
p	preliminary
r	revised
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
E	use with caution
F	too unreliable to be published
*	significantly different from reference category ($p < 0.05$)

Note to readers

Corrections have been made to this product.

The publication has been reloaded on September 14, 2012

Please take note of the following changes:

The 2009 data on industrial wastewater have been corrected in the following sections:
Highlights
Canada's waste generation – the big picture
Industrial wastewater

The following chart and tables have been changed:
Chart 2.2 – "Major wastewater discharges, 2009"
Table 4.1 – "Wastewater discharge from manufacturing, mineral extraction and thermal-electric power industries, 2009"
Table 4.2 – "Water costs for manufacturing, mineral extraction and thermal-electric power industries, 2009"

We regret any inconvenience this may have caused.

For more information please *contact us*.

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Table of contents

Highlights

Human Activity and the Environment 2012: Waste management in Canada gathers together a variety of statistics describing the generation and management of different types of waste. The report starts with an overview of waste generation in Canada. The remaining sections cover solid waste, wastewater discharges, and air emissions in greater detail.

Solid waste

- From 2002 to 2008, municipal solid waste disposal increased slightly from 769 kilograms to 777 kilograms per capita. During the same time period, solid waste diversion increased from 212 kilograms to 254 kilograms per capita.
- The average diversion rate—the amount of waste diverted as a proportion of waste generated—has increased from 22% in 2002 to 25% in 2008.
- By weight, organic materials accounted for the largest proportion of waste diversion in 2008, with 2,439,223 tonnes diverted, 29% of total waste diversion, followed by cardboard and boxboard (17%) and newsprint (13%).
- Of the 58% of households that had batteries to dispose of in 2009, 42% discarded them in the garbage.
- From 2001 to 2008, waste generation from mining activities increased by 55%.

Wastewater discharges

- In 2009, 82% of households lived in dwellings connected to municipal sewer systems, while 13% used private septic systems and 1% used communal septic systems.
- Wastewater discharge for manufacturing, mineral extraction (excluding oil and gas extraction) and thermal-electric power generation was 29.9 billion cubic metres in 2009.
- Industrial wastewater treatment and discharge costs were $532.2 million, approximately 37% of total industrial water costs in 2009.

Air emissions

- In 2009, criteria air contaminants made up nearly 99% of air pollutants emitted by industrial facilities according to the National Pollutant Release Inventory.
- From 1985 to 2009, emissions of sulphur oxides decreased 60%, emissions of carbon monoxide decreased 43% and emissions of nitrogen oxides decreased 18%.
- In 2008, the majority of capital investments for pollution prevention and abatement and control were targeted at the prevention or reduction of air pollutants. Almost $1.4 billion was invested in pollution abatement and control processes and technologies to reduce air emissions, while capital expenditures on pollution prevention processes and technologies totalled $422.2 million.
- Canada’s greenhouse gas emissions reached 690 megatonnes in 2009, a 17% increase since 1990.

Related products

Selected publications from Statistics Canada

11-526-X	Households and the Environment
16-001-M	Environment Accounts and Statistics Analytical and Technical Paper Series
16-002-X	EnviroStats
16-201-S	Human Activity and the Environment: Detailed Statistics
16-257-X	Environment Accounts and Statistics Product Catalogue
16-401-X	Industrial Water Use
16F0006X	Environmental Protection Expenditures in the Business Sector
16F0023X	Waste Management Industry Survey: Business and Government Sectors

Selected technical and analytical products from Statistics Canada

16-001-M2010013	Recycling by Canadian Households, 2007
16-002-X200700110174	Recycling in Canada
16-002-X200800110539	Disposal of household special wastes
16-002-X200800110540	Is composting organic waste spreading?
16-002-X200800210623	Canadian industry's expenditures to reduce greenhouse gas emissions
16-002-X200800210624	The Canadian Environmental Sustainability Indicators: On population-weighted ground-level ozone
16-002-X200800410749	Greenhouse gas emissions: a focus on Canadian households
16-002-X200800410751	A geographical profile of livestock manure production in Canada, 2006
16-002-X200800410752	Households' use of water and wastewater services
16-002-X200900110821	Production of nitrogen and phosphorus from livestock manure, 2006
16-002-X200900210890	Targeting environmental protection expenditures in the manufacturing sector
16-002-X201100411600	Consumption-related greenhouse gas emissions in Canada, the United States and China

16-002-X201100411601	Use and disposal of compact fluorescent lights by Canadian households

Selected CANSIM tables from Statistics Canada

153-0040	Manure production, Canada, major drainage areas and sub-drainage areas, every 5 years
153-0041	Disposal of waste, by source, Canada, provinces and territories, biennial
153-0042	Materials diverted, by source, Canada, provinces and territories, biennial
153-0043	Materials diverted, by type, Canada, provinces and territories, biennial
153-0044	Business sector characteristics of the waste management industry, Canada, provinces and territories, biennial
153-0045	Local government characteristics of the waste management industry, Canada, provinces and territories, biennial
153-0046	Direct and indirect household energy use and household greenhouse gas emissions, annual
153-0047	Water use parameters in manufacturing industries, by North American Industry Classification System (NAICS), biennial
153-0048	Water use parameters in manufacturing industries, by provinces, territories and drainage regions, biennial
153-0079	Water use parameters in mineral extraction and thermal-electric power generation industries, by region, biennial

Selected surveys from Statistics Canada

1736	Waste Management Industry Survey: Government Sector
1903	Survey of Environmental Protection Expenditures
2009	Waste Management Industry Survey: Business Sector
3881	Households and the Environment Survey
5120	Industrial Water Survey

Selected summary tables from Statistics Canada

- *Waste disposal by source, province and territory*
- *Disposal and diversion of waste, by province and territory*
- *Capital expenditures on pollution abatement and control (end-of-pipe) by medium and industry*
- *Capital expenditures on pollution prevention by medium and industry*
- *Expenditures on environmental protection by industry and activity*
- *Water use parameters in manufacturing industries, by industry group, Canada*

Section 1

Introduction

Most human activities generate some form of waste byproduct or residual in a solid, liquid or gaseous state. Waste generation starts with simple processes such as living, eating and breathing. Large-scale waste production began during the industrial revolution in the 19th century and continues today, as an increasing number of people and businesses produce and consume an ever-widening range of goods and services. Managing waste and minimizing associated environmental impacts have become more challenging as worldwide populations and economies continue to grow.

The statistics and analysis contained in this volume of ***Human Activity and the Environment 2012: Waste management in Canada*** are organized around concepts that were developed as part of the ***United Nations*** (UN) ***System of Environmental and Economic Accounts***.[1] The working definition of waste comes from the latest volume of the UN handbook:

> Residuals are flows of solid, liquid and gaseous materials, and energy that are discarded, discharged or emitted by establishments and households through processes of production, consumption or accumulation.[2]

Human Activity and the Environment 2012: Waste management in Canada gathers together a variety of statistics describing the generation and management of different types of waste. Not all waste residuals are included in this report, particularly those that are self-managed by producers. The report starts with an overview of waste generation in Canada (Section 2). The remaining sections cover solid waste (Section 3), wastewater discharges (Section 4), and air emissions (Section 5) in greater detail.[3]

1. United Nations Statistics Division, 2010, *Handbook of National Accounting: Integrated Environmental and Economic Accounting 2003 (SEEA)*, *http://unstats.un.org/unsd/envaccounting/seea.asp* (accessed April 28, 2010).
2. United Nations Statistics Division, 2012, *Revision of the System of Environmental – Economic Accounting (SEEA)*, *http://unstats.un.org/unsd/envaccounting/seearev/* (accessed April 11, 2012).
3. A glossary of terms used in the publication is available in Appendix A.

Section 2

Canada's waste generation – the big picture

Waste is generated in various forms and concentrations from all sectors of Canadian society. Solid waste, wastewater, organic waste and emissions to air are all examples of waste produced by households, businesses and industry. It is beyond the scope of this report to address the environmental impacts of all waste residuals, because these are dependent on the quantity and type of substance produced, the local environmental conditions and how the waste residuals are managed after release. In order to provide a relative comparison of the magnitude of various categories of waste produced in Canada, quantities for selected major waste categories are shown in charts 1 through 3.

As a resource producer and processor, Canada generates a significant amount of waste[1] that is solid or semi-solid. Canada's oil sands industry is the largest solid waste producer in Canada and generated 645 million tonnes of tailings from surface mining operations in 2008 including 547 million tonnes of sand tailings and 98 million tonnes of fluid tailings, which are composed of water, sand, silt, clay and bitumen (Chart 2.1). Oil sands tailings are stored in situ close to where they were extracted.

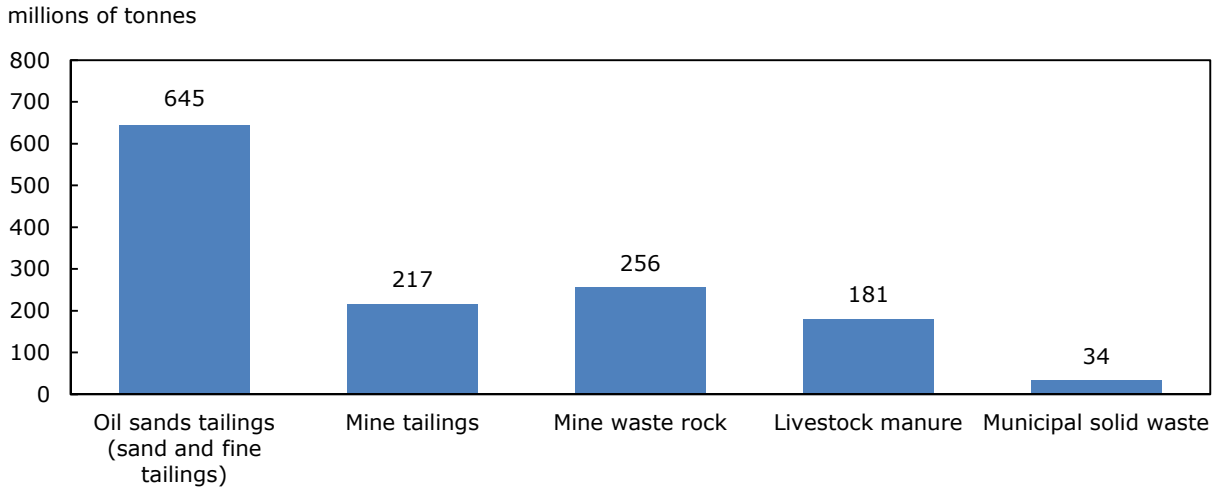
The domestic mining industry (metal and non-metal mineral extraction), produced 473 million tonnes of waste rock and tailings[2] in 2008. Livestock manure amounted to 181 million tonnes in 2006, while households, businesses, institutions and industry generated 34 million tonnes of municipal solid waste in 2008.[3] (For more detail on solid waste see Section 3.)

Wastewater discharges are by far the largest emission into the Canadian environment by weight. Municipalities released 6.4 billion tonnes of wastewater in 2006 and together the manufacturing, mineral extraction and thermal-electric power generation industries released 29.9 billion tonnes of wastewater in 2009 (Chart 2.2). (See Section 4 for more detail on wastewater.)

Air emissions are highly mobile and are easily dispersed and transported by the surrounding atmosphere. These emissions can have impacts locally and globally depending on the type of emission. Over 540 million tonnes of carbon dioxide (CO_2), a greenhouse gas, were emitted in 2009 (Chart 2.3). Most CO_2 emissions result from burning fossil fuels. In 2009, 25.2 million tonnes of volatile organic compounds and 18.6 million tonnes of particulate matter were emitted to air. (See Section 5 for more information on air emissions.)

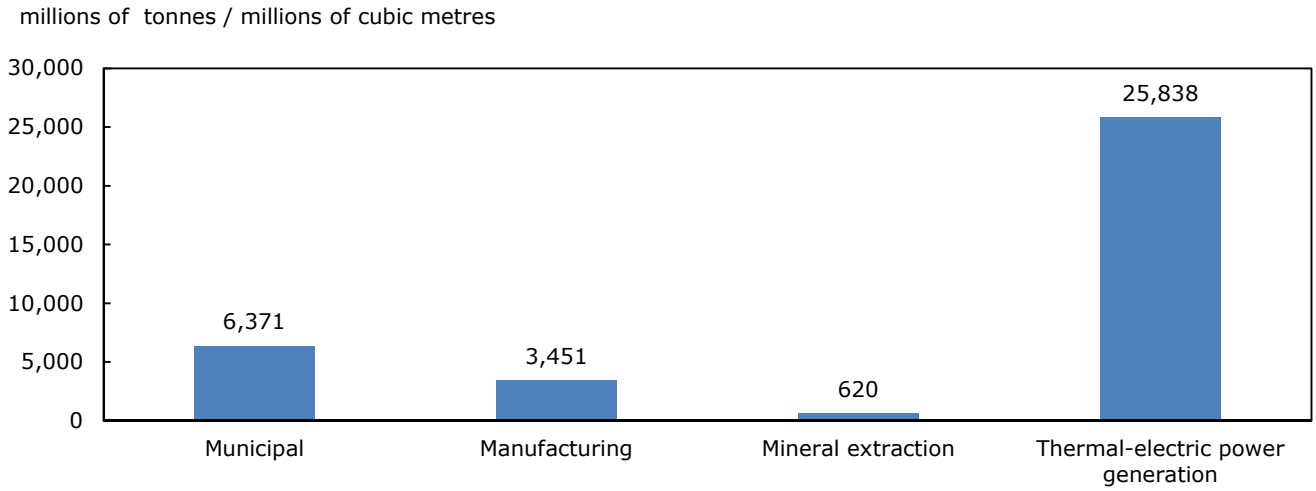
1. These different categories of mineral waste are not systematically measured and estimates are not available for all mineral waste categories. For example, blasting done in road construction projects results in "waste" that is similar to the waste rock from mining, yet it generally does not get counted since it is typically crushed up and used as fill. Waste rock resulting from mining often does not have an application of this kind close by and therefore gets counted as waste rock.
2. Waste rock is mined material that has not been processed to recover valuable materials and typically carries little or no risk to health or the environment. Tailings are a residual following the processing of materials and are subject to ongoing management regimes.
3. This estimate does not cover waste managed on-site by companies or households (for example, backyard composting) or materials that are transported directly to secondary processors. See textbox "**Waste Management Industry Survey: Coverage**" in Section 3 for further details.

Chart 2.1
Major categories of solid waste, various years



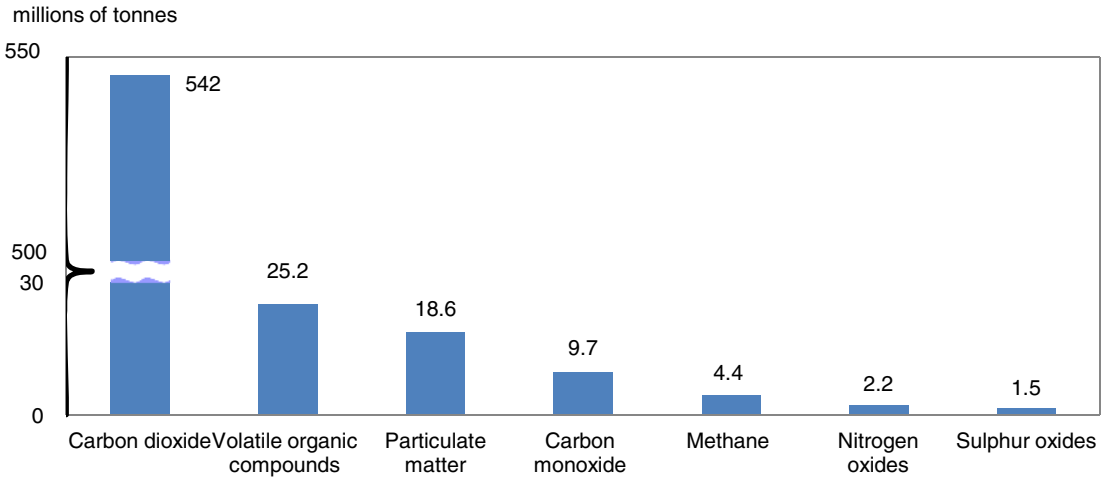
Note(s): This chart shows waste generation from various sources and does not address the subsequent disposition of these waste residuals. A significant portion of these waste residuals are recycled, stored in permitted sites, used as inputs or converted to other products (for example, road building materials or fertilizers). Data for oil sands and mines are from 2008. Data for livestock manure are from 2006 and include both urine and feces. Municipal solid waste data are for 2008. Business and household waste generation does not cover any waste that is managed on-site by a company or household or that is transported directly to secondary processors.
Source(s): Statistics Canada, CANSIM tables 153-0041 and 153-0043 (accessed October 7, 2011). Government of Alberta, 2009, *Environmental Management of Alberta's Oil Sands, http://environment.gov.ab.ca/info/library/8042.pdf (accessed May 23, 2012).* Government of Alberta, 2011, *talk about oil sands,* www.energy.alberta.ca/OilSands/pdfs/FactSheet_OilSands.pdf (accessed October 7, 2011). Energy Resources Conservation Boards, 2008, *ST98-2008: Alberta's Energy Reserves 2007 and Supply/Demand Outlook 2008-2017, www.ercb.ca (accessed October 24, 2011).* Natural Resources Canada, Annual Census of Mines, Quarries and Sandpits, 2008. N. Hofmann, 2008, "A geographical profile of livestock manure production in Canada, 2006," *EnviroStats,* Vol. 2, no. 4, Statistics Canada Catalogue no. 16-002-X200800410751.

Chart 2.2
Major wastewater discharges, 2009



Note(s): Mineral extraction - Excluding sand, gravel, clay, and ceramic and refractory minerals mining and quarrying and oil and gas. **Thermal-electric power generation** - Defined as fossil-fuel electric power generation and nuclear electric power generation. Much of the wastewater from both municipalities and industries is treated before release. Data for municipal wastewater are from 2006 and data for industrial wastewater are from 2009.
Source(s): Statistics Canada, CANSIM tables 153-0047 and 153-0079 (accessed September 7, 2012). Environment Canada, 2010, *2010 Municipal Water Use Report: Municipal Water Use, 2006 Statistics*, www.ec.gc.ca/Publications/default.asp?lang=En&xml=596A7EDF-471D-444C-BCEC-2CB9E730FFF9 (accessed October 7, 2011).

Chart 2.3
Major air emissions, 2009



Note(s): Data for all categories are from 2009.
Source(s): Environment Canada, 2011, *National Inventory Report 1990-2009: Greenhouse Gas Sources and Sinks in Canada*, Catalogue no. En81-4/2009E-PDF. Environment Canada, Pollutant Inventories and Reporting Division, 2011, *National Pollutant Release Inventory (NPRI) Downloadable Datasets,* www.ec.gc.ca/inrp-npri/default.asp?lang=en&n=0EC58C98- (accessed October 4, 2011).

Section 3

Solid waste

Solid waste can be hazardous or non-hazardous and is generated by many sources including residential, commercial, institutional and industrial. Municipal solid waste is regulated by the provinces and territories and managed by the waste management industry under contract to municipal or regional authorities. In contrast, solid waste from industrial processes can be handled directly by the producer and disposed of either on land or in water.

3.1 Municipal solid waste

Used packaging, food scraps, old computers and newspapers generated by business and household activities are all examples of municipal solid waste. Residential waste is generated by households and can be picked up by the municipality, private waste management companies or transported by households to collection, recycling and disposal facilities. Non-residential waste includes non-hazardous waste generated by industrial, commercial and institutional sources as well as waste generated by construction and demolition activities.

Municipal solid waste can be managed through disposal in landfills or incinerators or can be diverted from disposal through recycling or composting. Waste diversion can reduce the demand for energy and new resources by re-using materials that have already been produced (for example, aluminum, glass, plastics and paper). As a result, it can also reduce greenhouse gas emissions.

From 2002 to 2008, municipal solid waste disposal increased slightly from 769 kilograms to 777 kilograms per capita. During the same time period, solid waste diversion increased from 212 kilograms to 254 kilograms per capita (see Textbox: **Waste Management Industry Survey: Coverage**).

1. Statistics Canada, *Waste Management Industry Survey: Business and Government Sectors*, Catalogue no. 16F0023X, various issues.

Solid waste can impact the environment in various ways, depending on how it is managed. For example, waste disposal may contribute to soil and water contamination, while methane gas produced at landfills contributes to greenhouse gas emissions (see Textbox: **Landfills and incineration**).

Waste Management Industry Survey: Coverage

Unless otherwise indicated, *Section 3.1 Municipal solid waste* uses data from the Waste Management Industry Survey: Business and Government Sectors.[1]

The estimates presented in this section refer only to waste that is processed by firms or local governments that are part of the waste management industry as classified by the North American Industry Classification System (NAICS). Waste that bypasses the waste management industry is not included in survey coverage.

For example, estimates do not include waste managed on-site by companies or households. While the majority of residential waste is handled by municipalities or private businesses, a significant quantity of non-residential waste is managed on-site by industrial generators or is transported directly to secondary processors such as pulp and paper mills.

The estimates also do not include materials that were processed for reuse and resale (for example, wholesaling of scrap metal or used clothing) or materials that were collected through deposit-return systems (for example, food and beverage containers and tires).

Agricultural waste is not covered by these surveys. This waste is typically managed on-farm or by specialized firms that are not classified as part of the waste management industry under NAICS.

3.1.1 The waste management industry in Canada

A range of services are provided by the waste management industry: collection and transportation of waste and materials for disposal and diversion (recycling and composting); operation of non-hazardous and hazardous waste disposal facilities; operation of transfer stations; operation of

recycling and composting facilities; and treatment of hazardous waste.

Waste management services are provided by one of two sources: public bodies, such as local governments or waste management boards or commissions, and private firms that enter into contracts with local governments or businesses to provide waste management services. In 2008, there were 31,344 full-time workers employed in the waste management industry, 81% working in the business sector and the remainder employed by government.

Total current expenditures on solid waste management by local governments were $2.6 billion in 2008, a $1.1 billion increase over 2002. Of this, 42% went to collection and transportation, while operation of disposal facilities accounted for 18% and tipping fees accounted for 14% (Chart 3.1).

3.1.2 Disposal

With few exceptions, materials thrown in the garbage are destined for waste disposal facilities where they are either landfilled or incinerated (see Textbox: **Landfills and incineration** and Textbox: **Energy from waste**).

In 2008, Canadians sent 25,871,310 tonnes of solid waste for disposal (777 kilograms per capita), a 7% increase over 2002 (Table 3.1). At a provincial level, the largest increases were seen in Alberta (39%) and New Brunswick (16%). Nova Scotia was the only province that experienced a decrease in waste disposal (-9%).

Residential solid waste made up a third of total waste disposal in 2008, although this proportion varied by province. In Newfoundland and Labrador, residential sources accounted for 53% of waste disposal, compared to 24% in Alberta.

From 2002 to 2008, residential solid waste disposal remained nearly stable, increasing by 1%, from 8,446,766 tonnes to 8,536,891 tonnes (Table 3.1). However, on a per capita basis, it decreased 5% to 256 kilograms. Per capita residential solid waste disposal was highest in Newfoundland and Labrador (429 kilograms) and lowest in Nova Scotia (158 kilograms) in 2008 (Chart 3.2).

Landfills and incineration

Landfills are used as the primary means for the disposal of waste materials in Canada. The main environmental concerns related to landfills are leachate and landfill gas.

As liquid moves through the landfill, it picks up a variety of toxic and polluting components in large or trace amounts forming leachate, which can potentially contaminate ground and surface water. Sanitary landfills control the types and quantities of incoming waste and use liners and leachate collection and treatment systems to prevent water and soil contamination.

Landfill gas is formed as organic material decomposes in landfills. This gas is composed mainly of methane, a greenhouse gas (GHG) 21 times more potent than carbon dioxide (CO_2) in terms of its global warming potential.[2] It also includes CO_2, small amounts of nitrogen and oxygen, and trace amounts of a wide range of other gases. Concerns about landfill gas include fires, explosions, vegetation damage and unpleasant odours.[3] In 2009, emissions of methane from landfills accounted for 22% of national methane emissions and 3% of total GHG emissions.[4] Landfill gas can be captured and flared, converting the methane to CO_2 and reducing odour, or used to generate electricity or provide fuel substitutes.[5] In 2009, 349 kilotonnes of methane were captured and combusted, half of which was used in energy applications while the rest was flared.[6]

Incineration includes a range of practices, from low-tech open burning to controlled combustion processes using mass burn systems and other types of modern incinerators using pollution control devices that burn waste at temperatures between 900 and 1,100°C.[7] Less than 5% of municipal solid waste disposal goes to incineration in Canada.[8]

One of the benefits of incineration is the reduction of the amount of waste for disposal. However, incineration creates gaseous waste and ash and can contribute to air pollution. In 2009, municipal incineration released 677 tonnes of particulate matter (PM) (0.004% of total emissions of PM), 350 tonnes of sulphur oxides (SO_x) (0.02% of total emissions of SO_x), 1,364 tonnes of nitrogen oxides (NO_x) (0.06% of total emissions of NO_x), 602 tonnes of volatile organic compounds (VOCs) (0.002% of total emissions of VOCs), 1,330 tonnes of carbon monoxide (CO) (0.01% of total emissions of CO) and 19 tonnes of ammonia (NH_3) (0.004% of total emissions of NH_3) into the atmosphere.[9]

Dioxins and furans, which are persistent organic pollutants, are potential contaminants from incineration. These toxic, bioaccumulative chemicals can result from incomplete combustion due to inadequate technology or improper incinerator operation.[10]

Mercury is another potential bioaccumulative contaminant that can be emitted when items containing mercury are placed into the incinerator. Limiting the amount of mercury in waste as well as the use of specialized air pollution control equipment reduces releases of mercury.[11]

Non-residential waste made up two-thirds of total solid waste disposal in 2008. From 2002 to 2008, non-residential solid waste disposal increased by 11%, from 15,634,606 tonnes to 17,334,419 tonnes (Table 3.1). The largest increases were seen in Alberta (52%) and Newfoundland and Labrador (21%).

2. Environment Canada, 2010, *Municipal Solid Waste and Greenhouse Gases*, *www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=6F92E701-1* (accessed September 30, 2011).
3. El-Fadel, M., A.N. Findikakis and J.O. Leckie, 1997, "Environmental Impacts of Solid Waste Landfilling,"*Journal of Environmental Management*, Vol. 50, no. 1, pages 1 to 25.
4. Environment Canada, 2011, *National Inventory Report 1990-2009: Greenhouse Gas Sources and Sinks in Canada*, Catalogue no. En81-4/2009E-PDF.
5. Landfill Gas Industry Alliance, n.d. (no date), *What is Landfill Gas?,www.lfgindustry.org/Landfill.asp* (accessed September 30, 2011).
6. Environment Canada, 2011, *National Inventory Report 1990-2009: Greenhouse Gas Sources and Sinks in Canada - Executive Summary*, Catalogue no. En81-4/1-2009E-PDF.
7. Citizens' Clearinghouse on Waste Management, 2003, *Overview of Municipal Waste Incineration*, *www.citizenswasteinfo.org/A559CA/ccwm.nsf/5155d8f53ce25d2785256cc300567828/844d66e71f3e8b7685256cf50065bb7b?OpenDocument* (accessed October 6, 2011).
8. Statistics Canada, 2005, "Solid waste in Canada,"*Human Activity and the Environment*, Catalogue no. 16-201-X.
9. Environment Canada, Pollutant Inventories and Reporting Division, 2011, *National Pollutant Release Inventory (NPRI) Downloadable Datasets*, *www.ec.gc.ca/inrp-npri/default.asp?lang=en&n=0EC58C98-* (accessed December 6, 2011).
10. Environment Canada, 2010, *Technical Document for Batch Waste Incineration*, *www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=B8DA5596-1* (accessed October 6, 2011).
11. Environment Canada, 2010, *Technical Document for Batch Waste Incineration*, *www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=B8DA5596-1* (accessed October 6, 2011).

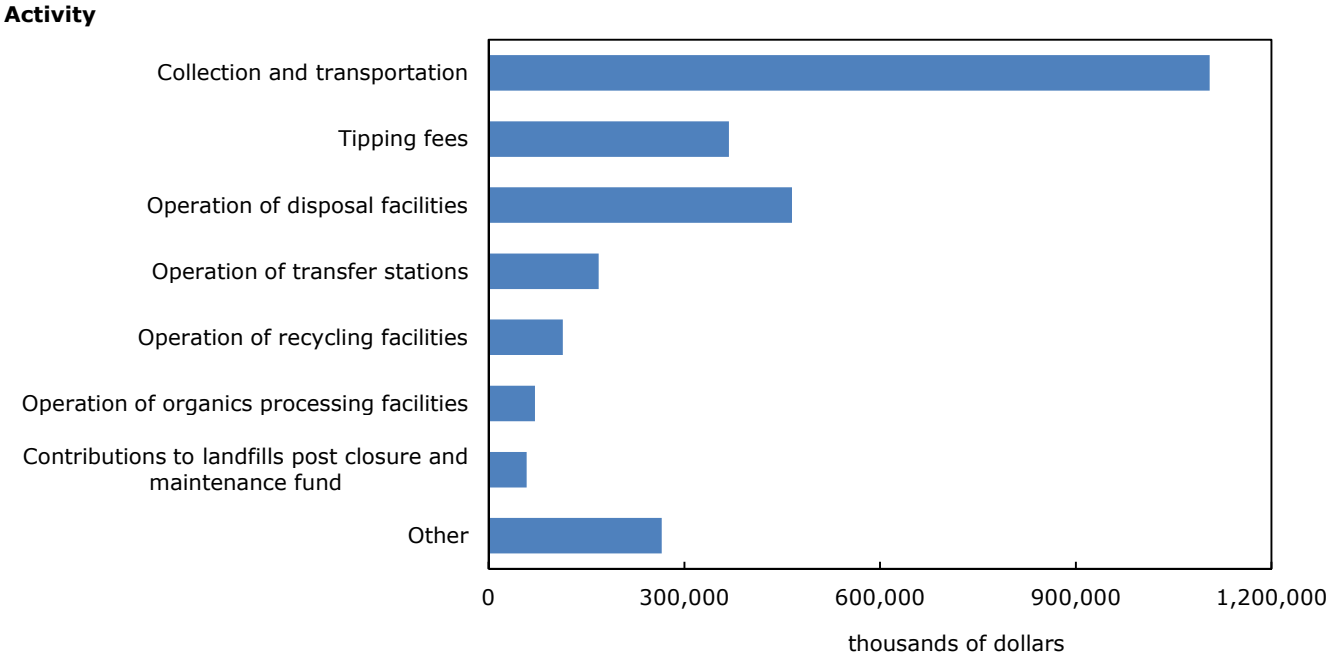
Energy from waste

Energy from waste facilities are highly efficient power plants that produce heat and electricity using municipal solid waste as fuel, thereby replacing the energy produced by conventional power plants that use fossil fuels, such as coal, oil, or natural gas.

Of the seven municipal incineration plants located across Canada, five generate energy, burning approximately 763,000 tonnes of municipal solid waste. Approximately 3% of disposed waste was incinerated at energy from waste facilities in 2006.[12]

12. Canadian Energy-From-Waste-Coalition, 2010, *The State of EFW in Canada: An Overview of Policy Options and Political Challenges*, Presentation to the Waste-To-Energy Research & Technology Council Bi-Annual Meeting, Columbia University, New York, October 7 and 8, 2010, *www.seas.columbia.edu/earth/wtert/meet2010/Proceedings/presentations/FODEN.pdf* (accessed January 19, 2012).

Chart 3.1
Current expenditures by local government on waste management by activity, 2008



Source(s): Statistics Canada, CANSIM table 153-0045 (accessed October 5, 2011).

Table 3.1
Disposal of waste, by source, Canada, provinces and territories, 2002 and 2008

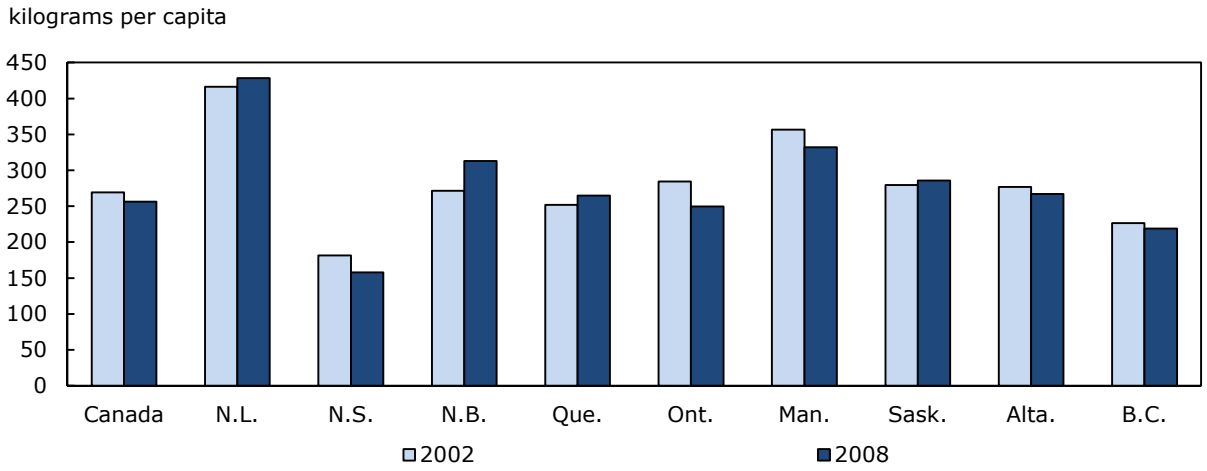
	Residential sources [1]		Non-residential sources [2]		Total waste disposal	
	2002	2008	2002	2008	2002	2008
	tonnes					
Canada	**8,446,766**	**8,536,891**	**15,634,606**	**17,334,419**	**24,081,371**	**25,871,310**
Newfoundland and Labrador	216,218	216,992	160,376	193,598	376,594	410,590
Prince Edward Island	x	x	x	x	x	x
Nova Scotia	169,649	148,060	219,546	206,171	389,194	354,231
New Brunswick	203,506	233,703	210,100	245,758	413,606	479,461
Quebec [3]	1,875,235	2,052,182	3,971,225	4,105,970	5,846,459	6,158,152
Ontario	3,438,408	3,231,399	6,207,225	6,400,160	9,645,633	9,631,559
Manitoba	412,612	400,297	483,944	565,902	896,556	966,199
Saskatchewan	278,692	289,760	516,432	613,182	795,124	902,943
Alberta	866,398	958,539	2,023,896	3,070,895	2,890,294	4,029,435
British Columbia	929,101	960,472	1,758,781	1,851,097	2,687,882	2,811,568
Yukon, Northwest Territories and Nunavut	x	x	x	x	x	x

1. Residential non-hazardous waste disposal includes solid waste produced by residences that is picked up by the municipality using its own staff or through contracting firms or that is self-hauled to depots, transfer stations and disposal facilities.
2. Non-residential non-hazardous waste disposal includes solid waste produced by the Industrial, Commercial, and Institutional (IC and I) sector and the Construction, Renovation and Demolition (CRD) sector. IC and I waste materials are generated by manufacturing, primary and secondary industries; commercial operations, such as, shopping centres, restaurants, offices, and others; and institutional facilities, such as, schools, hospitals, government facilities, seniors homes, universities, and others. CRD waste generally includes materials, such as, wood, drywall, certain metals, cardboard, doors, windows, wiring, and others, but excludes asphalt, concrete, bricks and clean sand or gravel and materials from clearing previously undeveloped land.
3. Waste disposal data for 2002 were derived from a survey administered by RECYC-QUÉBEC.

Note(s): Total amount of non-hazardous waste disposal in public and private waste disposal facilities includes waste that is exported out of the source province or out of the country for disposal. This does not include waste disposal in hazardous waste disposal facilities or waste managed by the waste generator on site.

Source(s): Statistics Canada, CANSIM table 153-0041 (accessed July 18, 2011).

Chart 3.2
Per capita disposal of residential solid waste, Canada and provinces, 2002 and 2008



Note(s): Quebec - The waste disposal data prior to 2006 were derived from a survey administered by RECYC-QUÉBEC. Residential non-hazardous waste disposal includes solid waste produced by all residences and includes waste that is picked up by the municipality (either using its own staff or through contracting firms), and waste from residential sources that is self-hauled to depots, transfer stations and disposal facilities.

Source(s): Statistics Canada, CANSIM tables 051-0001 and 153-0041 (accessed September 28, 2011).

3.1.3 Diversion

Waste can be diverted from disposal facilities and processed at recycling or composting facilities (see Textbox: **Recycling and composting**).

The average diversion rate—the amount of waste diverted as a proportion of waste generated—has increased from 22% in 2002 to 25% in 2008. In 2008, Nova Scotia had the highest provincial diversion rate at 45%.

In 2008, 8,473,257 tonnes of solid waste were diverted for recycling or composting, a 28% increase from 2002 (Table 3.2). Over this period, the largest increases were seen in New Brunswick (105%) and Nova Scotia (51%) while Manitoba saw a 21% decline.

Table 3.2
Diversion of waste, by source, Canada, provinces and territories, 2002 and 2008

	Residential sources [1]		Non-residential sources [2]		Total diversion	
	2002	2008	2002	2008	2002	2008
	tonnes					
Canada	**2,789,669**	**4,360,505**	**3,851,879**	**4,112,752**	**6,641,546**	**8,473,257**
Newfoundland and Labrador	25,993	x	4,393	x	30,386	x
Prince Edward Island	x	x	x	x	x	x
Nova Scotia	122,707	149,961	69,299	139,989	192,006	289,950
New Brunswick	57,192	62,076	73,536	205,391	130,728	267,467
Quebec [3]	595,000	1,046,000	1,148,376	1,417,600	1,743,376	2,463,600
Ontario	1,029,042	1,878,899	1,236,927	932,001	2,265,968	2,810,900
Manitoba	79,923	74,168	135,892	96,209	215,815	170,377
Saskatchewan	39,345	78,381	76,951	71,238	116,296	149,619
Alberta	320,536	391,709	369,981	336,827	690,517	728,536
British Columbia	496,751	614,204	721,724	890,908	1,218,475	1,505,112
Yukon, Northwest Territories and Nunavut	x	x	x	x	x	x

1. Residential non-hazardous recyclable materials include solid materials produced by residences that are picked up by the municipality using its own staff or through contracting firms or that are self-hauled to depots, transfer stations and disposal facilities.
2. Non-residential sources include solid non-hazardous recyclable material from the Industrial, Commercial, and Institutional (IC and I) sector as well as the Construction, Renovation and Demolition sector (CRD). Materials are those generated by all IC and I and CRD sources in a municipality, and are excluded from the residential waste stream.
3. Waste diversion data are derived from a survey administered by RECYC-QUÉBEC.

Note(s): This information covers only those companies and local waste management organizations that reported non-hazardous recyclable material preparation activities and refers only to that material entering the waste stream and does not cover any waste that may be managed on-site by a company or household. Additionally, these data do not include those materials transported by the generator directly to secondary processors, such as, pulp and paper mills while bypassing entirely any firm or local government involved in waste management activities.

Source(s): Statistics Canada, CANSIM tables 153-0042 and 153-0043 (accessed July 18, 2011).

In 2008, 254 kilograms of solid waste were diverted for each Canadian, a 20% increase from 2002. New Brunswick and British Columbia had the highest per capita solid waste diversion at 358 kilograms and 343 kilograms respectively.

In 2008, residential sources accounted for 51% of solid waste diversion in Canada, while non-residential sources accounted for the remainder. This proportion differed by province: residential sources made up two-thirds of solid waste diversion in Ontario, while non-residential waste made up more than three-quarters of solid waste diversion in New Brunswick.

From 2002 to 2008, diversion of solid waste from residential sources increased from 2,789,669 tonnes to 4,360,505 tonnes, a 56% increase. Diversion of solid waste from non-residential sources increased by 7%, from 3,851,879 tonnes to 4,112,752 tonnes (Table 3.2).

Recycling and composting

Recycling is the process whereby materials such as glass, metal, plastic or paper are diverted from the waste stream and remanufactured into new products or used as raw material substitutes.

Composting is a process in which organic material is broken down into simpler substances by microorganisms such as bacteria and fungi. The end product is a stable humus-like product called compost that can be used for landscaping, gardening or other purposes. Examples of organic waste that can be composted include food scraps, yard waste, agricultural crop residues, paper products, sewage sludge and wood.[13]

Recycling and composting divert waste from disposal. In addition, recycling can provide an alternative source of materials to the extraction and production of virgin resources.[14]

3.1.3.1 Diversion, by type of waste

By weight, organic materials[15] accounted for the largest proportion of waste diversion in 2008, with 2,439,223 tonnes diverted, 29% of total waste diversion, followed by cardboard and boxboard (17%) and newsprint (13%) (Table 3.3 and Chart 3.3).

13. Compost Council of Canada, 2010, *25 Questions and Answers about Composting*, *www.compost.org/English/qna.html#section1* (accessed September 30, 2011).
14. Federation of Canadian Municipalities, 2009, *Getting to 50% and Beyond: Waste Diversion Success Stories from Canadian Municipalities*, *www.fcm.ca/gmf* (accessed July 18, 2011).
15. Organic materials includes waste managed at centralized facilities and does not include backyard composting.

Table 3.3
Materials prepared for recycling by type and by province and territory, 2008

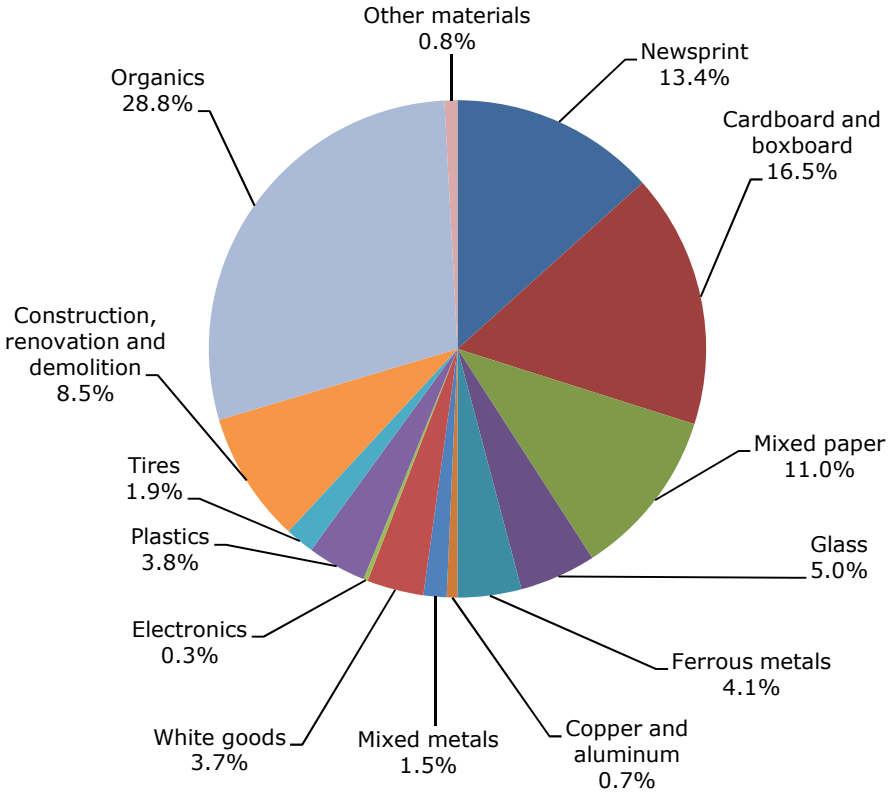
	Canada	Newfoundland and Labrador	Prince Edward Island	Nova Scotia	New Brunswick	Quebec[1]	Ontario	Manitoba	Saskat-chewan	Alberta	British Columbia	Yukon, Northwest Territories and Nunavut
	tonnes											
All materials diverted	**8,473,257**	**x**	**x**	**289,950**	**267,467**	**2,463,600**	**2,810,900**	**170,377**	**149,619**	**728,536**	**1,505,112**	**x**
Newsprint	1,132,398	x	x	34,771	12,287	310,000	494,116	45,638	18,796	84,239	124,979	x
Cardboard and boxboard	1,400,907	x	x	27,271	15,111	456,000	419,690	38,249	39,332	115,789	260,478	x
Mixed paper	931,358	x	0	7,399	x	376,000	210,720	10,263	8,158	86,941	x	x
Glass	421,007	x	x	1,222	x	103,000	143,780	7,361	x	x	x	x
Ferrous metals	350,370	0	0	4,244	1,499	134,400	110,467	x	x	20,685	34,193	x
Copper and aluminum	58,950	x	x	581	x	19,200	17,363	4,146	x	6,814	x	x
Mixed metals	127,033	x	x	1,462	3,540	0	22,364	4,052	1,143	20,266	73,471	x
White goods	312,988	0	0	x	x	270,000	12,376	x	2,743	x	12,192	x
Electronics	24,367	0	0	x	x	7,000	4,419	99	x	5,429	x	0
Plastics	325,868	x	x	6,303	1,518	113,000	98,594	9,247	4,863	26,342	64,864	x
Tires	158,336	0	x	x	298	73,000	8,087	1,499	x	3,392	x	667
Construction, renovation and demolition	720,076	0	0	40,368	x	211,000	209,628	2,331	x	54,056	198,480	0
Organics	2,439,223	0	x	158,419	225,081	384,000	1,029,510	x	12,190	231,544	343,586	x
Other materials	70,375	x	x	2,400	954	7,000	29,786	703	1,009	10,111	9,101	x

1. Waste diversion data are derived from a survey administered by RECYC-QUÉBEC.

Note(s): This information covers only those companies and local waste management organizations that reported non-hazardous recyclable material preparation activities and refers only to that material entering the waste stream and does not cover any waste that may be managed on-site by a company or household. Additionally, these data do not include those materials transported by the generator directly to secondary processors, such as, pulp and paper mills while bypassing entirely any firm or local government involved in waste management activities.

Source(s): Statistics Canada, CANSIM table 153-0043 (accessed October 7, 2011).

Chart 3.3
Material prepared for recycling, by weight, 2008



Note(s): This information covers only those companies and local waste management organizations that reported non-hazardous recyclable material preparation activities and refers only to that material entering the waste stream and does not cover any waste that may be managed on-site by a company or household. Additionally, these data do not include those materials transported by the generator directly to secondary processors, such as, pulp and paper mills while bypassing entirely any firm or local government involved in waste management activities.
Source(s): Statistics Canada, CANSIM table 153-0043 (accessed July 18, 2011).

Diversion of organic materials increased by 1,128,433 tonnes from 2002 to 2008—an 86% increase. Rapid growth was also experienced in the diversion of plastics (126%) although this material accounts for a much smaller proportion of diversion overall.

3.2 Hazardous waste

Hazardous waste is that which cannot be handled by the normal waste and recycling programs, usually because it is environmentally harmful or because it poses a health hazard to collection and processing staff. Hazardous waste materials may exhibit characteristics such as flammability, corrosiveness or toxicity and require special treatment before disposal or recycling.

3.2.1 Household hazardous waste

Household hazardous waste can include compact fluorescent lights (CFLs) and fluorescent tubes, both

of which contain mercury; batteries that contain acids and heavy metals such as cadmium and lithium; electronics such as cell phones and televisions; paints and solvents; and medication. These materials should be taken to hazardous waste depots, drop-off centres or returned to suppliers or retailers for safe treatment and disposal.

Of the 58% of households that had batteries[16] to dispose of in 2009, 42% discarded them in the garbage (Table 3.4). Households also frequently had medication, paint or solvents that they wished to dispose of, but the majority returned these materials safely to suppliers or waste depots and drop-off centres.

16. Not including car batteries.

Table 3.4
Household hazardous waste, 2009

	Had the identified hazardous waste item to dispose of	Had the identified hazardous waste item to dispose of						
		Put them in the garbage	Took or sent them to a depot or drop-off centre	Returned them to a supplier or retailer	Poured them down the drain, dwer, ground, toilet or sink	Donated them or gave them away	Still had them	Other
	percent							
Medication	39	22	6	57	8	…	15	1 E
Paint or solvents	39	4	62	8	…	…	31	2
Unwated engine oil or anti-freeze	15	1 E	61	19	…	…	18	4
Dead or unwanted car batteries	12	F	46	31	…	…	20	5 E
Other dead or unwanted batteries	58	42	35	7	…	…	18	4
Unwanted electronic devices	36	11	45	5	…	22	28	2
Dead or unwanted compact fluorescent lights (CFLs)	22	56	24	…	…	4	13	3

Source(s): Statistics Canada, 2011, *Households and the Environment, 2009*, Catalogue no. 11-526-X.

3.2.1.1 E-waste

With the rapid increase in the popularity of cellular phones, computers, televisions and other electronic devices, it is increasingly important to ensure that this electronic equipment waste or e-waste undergoes environmentally sound management at the end of its useful life. In 2009, 77% of households had at least one cellular telephone, 82% had at least one home computer and 99% had at least one colour television.[17] Many of these products contain copper, aluminum and gold, as well as metals, such as lead, mercury and cadmium.

Electronics recycling programs help keep electronic devices out of landfills and recover useful resources.[18] Electronics recycling programs currently exist in British Columbia (start date 2007), Alberta (2005), Saskatchewan (2007), Ontario (2009), Nova Scotia (2007) and Prince Edward Island (2010). These programs have diverted over 172,000 tonnes of end-of-life electronics from landfills since 2004.[19]

In 2009, 36% of households reported having electronic devices they wished to dispose of (Table 3.5). These households most frequently used a depot or drop-off centre for e-waste disposal (45%), while 22% donated unwanted electronic products or gave them away. Twenty-eight percent of households still had their unwanted electronic devices at home.

Households in Saskatchewan were most likely to use a depot or drop-off centre (69%) for e-waste disposal. Households in Newfoundland and Labrador (36%), Prince Edward Island (35%) and New Brunswick (34%) were most likely to still have unwanted electronic devices.

17. Statistics Canada, 2010, *Spending Patterns in Canada, 2009*, Catalogue no. 62-202-X.
18. Encorp Pacific, 2011, *Electronics Recycling FAQ's for Consumers*, *www.return-it.ca/electronics/faqs/elec-consumer/* (accessed September 30, 2011).
19. Electronics Product Stewardship Canada, n.d. (no date), *Electronics Product Stewardship Canada*, *www.epsc.ca/* (accessed September 30, 2011).

Table 3.5
Household e-waste disposal, Canada and provinces, 2009

	Had unwanted electronic devices to dispose of	Had unwanted electronic devices to dispose of					
		Put them in the garbage	Took or sent them to a depot or drop-off centre	Returned them to a supplier or retailer	Donated them or gave them away	Still had them	Other
	percent						
Canada	**36**	**11**	**45**	**5**	**22**	**28**	**2**
Newfoundland and Labrador	18	F	34	F	F	36 E	F
Prince Edward Island	36	F	51	F	F	35 E	F
Nova Scotia	41	F	61	F	11 E	30	F
New Brunswick	30	28	28	F	F	34	F
Quebec	30	13	29	9 E	31	29	3 E
Ontario	35	13	41	3 E	22	28	2 E
Manitoba	45	11 E	41	F	28 E	29 E	F
Saskatchewan	40	10 E	69	F	20	23	F
Alberta	46	5 E	63	F	16	29	F
British Columbia	43	10 E	57	F	19	26	F

Source(s): Statistics Canada, 2011, *Households and the Environment, 2009*, Catalogue no. 11-526-X.

3.2.2 Radioactive waste

Managing radioactive waste poses a unique challenge because of the long-term toxicity of some of the byproducts. Highly radioactive waste such as spent nuclear fuels poses the greatest risk. These materials are highly regulated, monitored and contained. Middle and lower-level radioactive waste from research labs or radium contaminated soils is less toxic, but still requires monitoring.

Radioactive waste has been produced in Canada since the 1930s. Radium was the first radioactive material to be processed and was used in medicine and as a luminescence agent in engineering applications. Today, radioactive waste in Canada comes primarily from uranium mining, milling, refining and conversion; nuclear fuel fabrication; nuclear reactor operations; nuclear research; and radioisotope manufacture and use.

Most of the accumulated inventory of low-level radioactive waste in Canada was produced many years ago by mining and processing activities. The amount of low-level waste in storage is now expected to increase only moderately by 2050. Most intermediate-level radioactive waste is generated by nuclear research and development activities. In 2007, this waste was accumulating at a rate of 890 cubic metres a year and the inventory of this waste is expected to increase to 79,000 cubic metres by 2050. The amount of higher level radio-active waste from nuclear power generation is also expected to more than double over the period (Table 3.6).[20]

20. Information on Canada's radioactive waste is gathered by the Low-Level Radioactive Waste Management Office and other agencies. Data for the radioactive waste inventory is grouped into three broad categories: nuclear fuel waste, low- and intermediate-level radioactive waste, and uranium mining and milling waste. For planning purposes the Low-Level Radioactive Waste Management Office also projects waste inventories where possible.

Table 3.6
Radioactive waste in Canada

	Accumulation rates in 2007	Radioactive waste inventory 2007	Projected radioactive waste inventory 2050
	cubic metres per year	cubic metres	
Nuclear fuel waste	311	8,130	21,300
Intermediate-level radioactive waste	890	30,350	79,000
Low-level radioactive waste	4,560	2,330,000	2,570,000
	millions of tonnes per year	millions of tonnes	
Uranium mine tailings	0.7	216	..
Waste rock	..	175	..

Note(s): In order to assess the future requirements for the management of radioactive waste, the Low-Level Radioactive Waste Management Office projects the inventory to 2050. The year 2050 is selected as a future reference date because it was forecasted as the end of operation for the last constructed power reactors (Darlington Generating Station). This projection assumes that no new nuclear generating stations will be commissioned before the year 2050 and that all current operating reactors will have ceased operations by this time.

Source(s): Low-Level Radioactive Waste Management Office, 2009, *Inventory of Radioactive Waste in Canada*, *www.llrwmo.org/en/programs/ongoing/index.html* (accessed December 19, 2011).

3.2.3 Imports and exports of hazardous waste

The *Canadian Environmental Protection Act 1999* (CEPA 1999) enables regulations governing the export and import of hazardous waste, including hazardous recyclable materials.

In 2010, 358,236 tonnes of hazardous waste were imported into Canada (Table 3.7), the vast majority from the United States. Hazardous waste imported for disposal included solid waste no longer suitable for metal recovery, industrial residues and other environmentally hazardous substances. Recyclable materials made up 59% of total hazardous waste imports and included batteries, metal-bearing waste, liquors from metallurgical processes, lubricating oil and manufacturing residues.[21]

In 2010, 425,334 tonnes of hazardous waste were exported out of Canada, of which 83% was recyclable (Table 3.7). The majority of hazardous recyclable materials were sent to authorized facilities located in the northeastern and central United States.[22]

21. Environment Canada, 2012, Canadian Environmental Protection Act, 1999 *Annual Report for April 2010 to March 2011*, Catalogue no. En81-3/2011E, *www.ec.gc.ca/ceparegistry* (accessed March 16, 2012).
22. Environment Canada, 2012, Canadian Environmental Protection Act, 1999 *Annual Report for April 2010 to March 2011*, Catalogue no. En81-3/2011E, *www.ec.gc.ca/ceparegistry* (accessed March 16, 2012).

Table 3.7
Imports and exports of hazardous waste and hazardous recyclable material, 2002 to 2010

	Imports								
	2002	2003	2004	2005	2006	2007	2008	2009	2010
	tonnes								
Recyclables	193,318	189,110	200,097	174,983	164,903	220,377	247,763	215,648	212,053
Total imports	423,067	417,368	416,136	476,416	408,839	470,136	509,501	478,651	358,236
	Exports								
	2002	2003	2004	2005	2006	2007	2008	2009	2010
	tonnes								
Recyclables	238,597	205,356	187,986	226,380	374,024	352,933	354,722	316,172	355,003
Total exports	340,261	321,294	308,357	327,746	474,538	452,396	457,806	431,921	425,334

Source(s): Environment Canada, 2012, Canadian Environmental Protection Act, 1999 *Annual Report for April 2010 to March 2011*, Catalogue no. En81-3/2011E, *www.ec.gc.ca/ceparegistry* (accessed March 16, 2012).

3.3 Natural resource residuals

Natural resource residuals are byproducts from extraction and production processes associated with natural resources such as waste rock from mining.

From 2001 to 2008, waste generation from mining activities increased by 55% (Table 3.8). Increased crude bitumen processing at oil sands projects accounted for the bulk of the increase in waste—solid and fluid tailings generated by the oil sands sector grew by 78%. However, waste production increased for most mineral extraction activities over the same period.

The rise in waste from mining can be partly explained by a rise in demand for minerals. From 2003 to 2008, the value of mineral assets grew significantly as a result of increased world prices. Mineral production and associated waste generation are very much tied to world prices—as prices for minerals fall or rise so too does production.

Table 3.8
Mineral extraction waste from select mining industries, 2001 and 2008

	2001	2008	2001 to 2008
	millions of tonnes		percent change
Total	**720**	**1,118**	**55**
Gold mining and processing	73	79	8
Miscellaneous metal mines, mining and processing	178	249	40
Iron mining and processing	71	107	51
Miscellaneous non-metals mining and processing, including salt, gypsum, potash asbestos	34	38	12
Oilsands mining and processing (sand)	308	547	78
Oilsands mining and processing (fine tailings)	55	98	78

Note(s): Mineral extraction wastes include waste rock and overburden, rejected mineral ores and mine tailings. Figures may not add up to totals due to rounding.
Source(s): Government of Alberta, 2009, *Environmental Management of Alberta's Oil Sands*, *http://environment.gov.ab.ca/info/library/8042.pdf* (accessed May 23, 2012). Government of Alberta, 2011, *talk about oil sands*, *www.energy.alberta.ca/OilSands/pdfs/FactSheet_OilSands.pdf* (accessed October 7, 2011). Energy Resources Conservation Boards, 2008, *ST98-2008: Alberta's Energy Reserves 2007 and Supply/Demand Outlook 2008-2017*, www.ercb.ca (accessed October 24, 2011). Natural Resources Canada, Annual Census of Mines, Quarries and Sandpits, 2008. Statistics Canada, Environment Accounts and Statistics Division, 2011, special tabulation.

3.4 Livestock manure

Livestock manure[23] provides nutrients essential to plant growth, such as nitrogen and phosphorus and is a source of organic matter, which can help reduce soil erosion and improve soil's water-holding capacity. However, it can also be a source of pollution with impacts on the environment and human health.

In 2006, Canadian livestock produced over 180 million tonnes of manure, a 16% increase since 1981 (Table 3.9). Beef cattle were responsible for the largest proportion of manure (38%), followed by milk cows (12%), calves (12%) and heifers (12%).

23. For the purposes of this article, manure consists of livestock feces and urine.

Table 3.9
Manure production by livestock type, 1981 and 2006

	1981	2006	Difference	Change
	thousands of tonnes			percent
Total	**156,265**	**180,960**	**24,694**	**16**
Beef cows	47,195	68,153	20,958	44
Heifers	12,852	21,975	9,123	71
Calves	16,819	22,305	5,486	33
Pigs	10,582	15,793	5,211	49
Horses	2,991	3,789	798	27
Poultry	3,929	4,688	758	19
Sheep	536	750	214	40
Steers	16,961	17,101	141	1
Goats	85	168	83	97
Bulls	4,104	3,775	-329	-8
Milk cows	40,212	22,463	-17,749	-44

Source(s): Agriculture and Agri-Food Canada and Statistics Canada, special tabulation, Census of Agriculture, Census Geographic Component Base, 2006.

3.5 Disposal at sea

Environment Canada issues permits for the disposal at sea of excavated earth, material dredged from waterways, fish processing waste, retired vessels and organic matter. Each permit is subject to a technical review and public notice. No permit is issued if practical alternatives to disposal at sea are available.

Between April 2000 and March 2011, 1,026 permits for disposal at sea were issued in Canada (Table 3.10), for disposal of 43,380,716 tonnes of waste. About 76% of this waste was dredged material waste. The Pacific and Yukon region accounted for close to two-thirds of permits by weight, allowing 28,442,422 tonnes of waste for disposal in their waters. Most of the permits issued in the Atlantic region were for fish waste.

Table 3.10
Disposal at sea, permits issued and quantities permitted, April 2000 to March 2011

	Atlantic		Quebec		Pacific and Yukon		Prairie and Northern	
	Quantities permitted	Permits issued	Quantities permitted	Permits issued	Quantities permitted	Permits issued	Quantities permitted	Permits issued
	tonnes	number	tonnes	number	tonnes	number	tonnes	number
Material								
Dredged material	11,586,790	123	2,200,900	122	18,818,270	205	392,600	2
Geological matter	0	0	0	0	9,605,700	52	60	1
Fisheries waste	732,770	459	22,520	40	2,800	1	0	0
Vessels	1,054	4	0	0	15,652	9	0	0
Organic matter	0	0	0	0	0	0	1,600	8

Source(s): Environment Canada, Canadian Environmental Protection Act, 1999, *Annual Report*, various issues, *www.ec.gc.ca/ceparegistry* (accessed March 19, 2012).

3.6 Industrial pollutant releases to land

The National Pollutant Release Inventory (NPRI) measures the volume of pollutants released and disposed of by over 8,000 industrial facilities. Releases to land are pollutants released to the soil as a result of production and consumption processes in the economy. Some releases to soil may eventually enter the water system.[24]

24. United Nations Statistics Division, 2010, *Handbook of National Accounting: Integrated Environmental and Economic Accounting 2003 (SEEA)*, *http://unstats.un.org/unsd/envaccounting/seea.asp* (accessed April 28, 2010).

The most common substances released and disposed of to land include hydrogen sulphide (639,425 tonnes), manganese (198,121 tonnes) and phosphorus (108,763 tonnes) (Table 3.11). The top ten substances account for over 93% of pollutants released and disposed of by industrial facilities to land in 2009.

Table 3.11
Top ten substances released and disposed of to land according to the National Pollutant Release Inventory, 2009

	Releases to land [1]	On-site disposal [2]	Off-site disposal [3]	Total	Share of total
	tonnes				percent
Hydrogen sulphide	0	186,832	452,593	639,425	48.9
Manganese (and its compounds)	230	192,873	5,018	198,121	15.1
Phosphorus (total)	591	97,273	10,899	108,763	8.3
Zinc (and its compounds)	363	65,689	8,645	74,697	5.7
Copper (and its compounds)	316	63,173	2,499	65,988	5.0
Nickel (and its compounds)	0	36,991	1,485	38,476	2.9
Lead (and its compounds)	164	31,028	2,878	34,070	2.6
Asbestos (friable form)	390	18,251	5,466	24,107	1.8
Methanol	32	13,376	6,082	19,489	1.5
Arsenic (and its compounds)	1	16,760	287	17,048	1.3

1. Includes leaks, spills and other releases.
2. Includes the following on-site disposals: containment (landfill), land treatment (farm), underground injection, tailings management and waste rock management.
3. Includes the following off-site disposals: containment (landfill), land treatment (farm), underground injection, containment (other storage), tailings management and waste rock management.

Source(s): Environment Canada, Pollutant Inventories and Reporting Division, 2011, *National Pollutant Release Inventory (NPRI) Downloadable Datasets*, *www.ec.gc.ca/inrp-npri/default.asp?lang=en&n=0EC58C98-* (accessed February 14, 2012).

Section 4

Wastewater discharges

Canada has one of the largest renewable water supplies in the world, an average of 3,472 km^3 per year.[1] Rivers, lakes and marine areas are used to dispose of wastewater and industrial waste, which can have a negative impact on water quality. This section will examine discharges of municipal and industrial wastewater.

Water discharged into drains or sewers, water received by water treatment plants or water discharged directly to the environment is all considered wastewater. Wastewater includes all return flows of water to the environment, regardless of quality.[2]

4.1 Municipal wastewater

Municipal wastewater is liquid waste and can be divided into two categories:

- sanitary sewage from homes, businesses, institutions and industries;
- stormwater from rain or melting snow that drains off rooftops, lawns, roads, and other urban surfaces.

Wastewater is collected by sewer systems and in most cases is treated before being released to the environment (see Textbox: **Municipal wastewater**).[3]

Most households in Canada are connected to a municipal sewer system. In 2009, 82% of households lived in dwellings connected to municipal sewer systems, while 13% used private septic systems and 1% used communal septic systems.[4]

Municipal wastewater

Municipal wastewater can contain grit, debris, suspended solids, disease-causing pathogens, decaying organic waste, nutrients and about 200 different identified chemicals. It is a leading source of suspended solids, nutrients, organic chemicals and metals discharged into Canadian waters.[5]

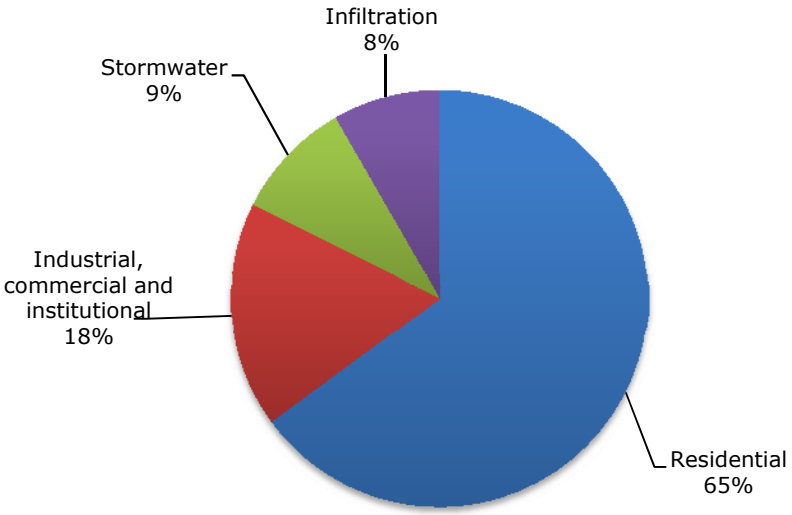
When discharged, municipal wastewater can cause aesthetic problems such as odours and discolouration. Disease-causing pathogens such as bacteria and viruses can make water unfit for human use. Excess nutrients can overstimulate the growth of aquatic plants. Decaying organic waste can use up dissolved oxygen and threaten the survival of aquatic life. Toxic chemicals can harm aquatic organisms. Additionally, excessive sedimentation[6] can smother fish feeding and spawning grounds.

Contaminant levels can be high in untreated sewage, stormwater, and combined sewer[7] overflows. Even treated sewage may still contain some harmful substances, although in smaller quantities than in raw sewage.

In 2006, municipalities across the country generated a daily average of 668 L of wastewater per person served by sanitary sewers.[8] Residential sources accounted for close to two-thirds of the flow into municipal sewer systems, while the industrial, commercial, and institutional sector produced 18% of municipal wastewater flows. Stormwater accounted for 9% of sewer flows and the remainder (8%) was the result of groundwater infiltration into sewer systems (Chart 4.1).

1. Statistics Canada, 2010, "Freshwater supply and demand in Canada,"*Human Activity and the Environment*, Catalogue no. 16-201-X.
2. Wastewater also includes reused water which is wastewater supplied to a user for further use with or without treatment. Wastewater that is recycled within the same firm is not recorded.
3. Environment Canada, 2009, *Wastewater Management,www.ec.gc.ca/eu-ww/default.asp?lang=en&n=0FB32EFD-1* (accessed February 2, 2012).
4. Statistics Canada, 2011, *Households and the Environment, 2009*, Catalogue no. 11-526-X.
5. Environment Canada, 2001, *The state of municipal wastewater effluents in Canada*, Catalogue no. En1-11/96E, Ottawa.
6. Sedimentation is the process whereby particles suspended in a water body settle to the bottom and accumulate in layers.
7. Combined sewer systems collect both sanitary sewage and stormwater.
8. Environment Canada, 2010, *2010 Municipal Water Use Report: Municipal Water Use, 2006 Statistics*, Catalogue no. En11-2/2006E-PDF, *www.ec.gc.ca/Publications/default.asp?lang=En&xml=596A7EDF-471D-444C-BCEC-2CB9E730FFF9* (accessed August 2, 2011).

Chart 4.1
Wastewater sewer flows, by source, 2006



Source(s): Environment Canada, 2010, *2010 Municipal Water Use Report: Municipal Water Use, 2006 Statistics*, www.ec.gc.ca/Publications/default.asp?lang=En&xml=596A7EDF-471D-444C-BCEC-2CB9E730FFF9 (accessed August 2, 2011).

In smaller communities, wastewater is primarily produced by the residential sector, whereas in larger communities their share decreases. For example, in communities of less than 1,000 people, 71% of wastewater flow was from residential sources, whereas in those communities with 50,000 to 500,000 people, only 53% was produced by the residential sector in 2006.

4.1.1 Municipal wastewater treatment and discharge destination

Municipal wastewater can be treated to various degrees before release to the environment. Secondary mechanical treatment is considered the conventional treatment process in Canada (see Textbox: **Wastewater treatment levels**). Of Canadians served by sanitary wastewater collection systems in 2006, wastewater was treated at the secondary level or better for 79% of the population. Almost 2% were not served by wastewater treatment facilities at all.[9]

Surface freshwater was the main destination for 91% of municipal wastewater discharge in 2006, while 6% was discharged into marine water and 3% was disposed of using other methods, including infiltration, irrigation, and evaporation processes. Smaller municipalities were more likely to use these alternative discharge methods.

Wastewater treatment levels

Municipal wastewater can be treated to various levels, each of which includes specific activities or technologies as described below:

Primary treatment removes insoluble matter only.

Secondary treatment removes biological impurities from water treated at the primary level.

Advanced or tertiary treatment removes nutrients and chemical contaminants remaining after the secondary treatment.

Local governments across Canada spent $3.9 billion for sewage collection and disposal in 2006.[10]

9. Environment Canada, 2010, *2010 Municipal Water Use Report: Municipal Water Use, 2006 Statistics*, Catalogue no. En11-2/2006E-PDF, *www.ec.gc.ca/Publications/default.asp?lang=En&xml=596A7EDF-471D-444C-BCEC-2CB9E730FFF9* (accessed August 2, 2011).

10. Statistics Canada, CANSIM table 385-0003 (accessed January 17, 2012).

4.2 Industrial wastewater

Industrial wastewater is liquid waste discharged from industrial activities such as manufacturing, mining and power generation (see Textbox: **Industrial Water Use Survey: Coverage**).

11. Statistics Canada, 2012, *Industrial Water Use, 2009*, Catalogue no. 16-401-X.
12. Does not include oil and gas extraction.

Industrial Water Use Survey: Coverage

Unless otherwise specified, *Section 4.2 Industrial wastewater* uses data from the Industrial Water Use Survey.[11] The target population covered manufacturing and thermal-electric power generation as well as selected mining industries (coal, metal ore, and non-metallic mineral mining). The survey did not include wastewater from oil and gas extraction activities or support activities for mining and oil and gas extraction.

Wastewater discharge for manufacturing, mineral extraction[12] and thermal-electric power generation was 29.9 billion cubic metres in 2009. Thermal-electric power producers accounted for 86% of wastewater discharge, followed by manufacturing industries (12%) and mining industries (2%) (Table 4.1).

Table 4.1
Wastewater discharge from manufacturing, mineral extraction and thermal-electric power industries, 2009

	Manufacturing	Mineral extraction [1]	Thermal-electric power [2]
	millions of cubic metres		
Canada	**3,450.6**	**620.4**	**25,838.4**
Atlantic provinces	334.1 [3]	247.1	1,355.5
Quebec	925.0	151.4	x
Ontario	1,328.8	62.7	x
Prairie provinces	287.7	43.1	1,769.1
British Columbia and territories	537.9	116.1	106.4

1. Excluding sand, gravel, clay, and ceramic and refractory minerals mining and quarrying and oil and gas.
2. Defined as fossil-fuel electric power generation and nuclear electric power generation.
3. Does not include Newfoundland and Labrador and Prince Edward Island.

Note(s): Figures may not add up to totals due to rounding.
Source(s): Statistics Canada, CANSIM tables 153-0047, 153-0048 and 153-0079 (accessed September 7, 2012).

4.2.1 Industrial wastewater treatment and discharge costs

Industrial wastewater treatment and discharge costs were $532.2 million, approximately 37% of total industrial water costs in 2009 (Table 4.2).

Manufacturing industries spent $452.2 million on wastewater treatment and discharge, 41% of their total water costs (Table 4.2). The paper industry accounted for the largest share of this total at $189.3 million, while the food manufacturing industry spent $91.7 million, the chemical manufacturing industry spent $72.7 million and the primary metals manufacturing industry spent $49.3 million on wastewater treatment and discharge.

Mineral extraction industries spent $70.6 million on wastewater treatment and discharge, 43% of their total expenditure on water.

Thermal-electric power producers use large quantities of water for cooling, condensing and steam. The industry spent relatively little ($9.5 million or 6%) on water treatment and discharge as a proportion of their total water costs in 2009.

Table 4.2
Water costs for manufacturing, mineral extraction and thermal-electric power industries, 2009

	Manufacturing			Mineral extraction [1]			Thermal-electric power [2]		
	Total water costs	Water discharge treatment costs	Water discharge treatment costs as a share of total water costs	Total water costs	Water discharge treatment costs	Water discharge treatment costs as a share of total water costs	Total water costs	Water discharge treatment costs	Water discharge treatment costs as a share of total water costs
	thousands of dollars		percent	thousands of dollars		percent	thousands of dollars		percent
Canada	**1,097,663**	**452,165**	**41**	**165,695**	**70,584**	**43**	**160,977**	**9,495**	**6**
Atlantic provinces	70,473 [3]	22,554 [4]	..	19,185	5,976	31	18,274	x	..
Quebec	251,931	127,576	51	47,227	29,552	63	2,390	x	..
Ontario	448,699	155,138	35	14,094	F	..	100,617	5,729	6
Prairie provinces	223,745	90,765	41	29,856	12,173	41	35,920	612	2
British Columbia and territories	89,853	42,259 [5]	..	55,334	15,575	28	3,776	x	..

1. Excluding sand, gravel, clay, and ceramic and refractory minerals mining and quarrying and oil and gas.
2. Defined as fossil-fuel electric power generation and nuclear electric power generation.
3. Does not include Newfoundland and Labrador and Prince Edward Island.
4. Does not include Newfoundland and Labrador, Prince Edward Island and Nova Scotia.
5. Does not include Yukon, Northwest Territories and Nunavut.

Note(s): Figures may not add up to totals due to rounding. Total water costs include acquisition, intake treatment, recirculation and discharge treatment costs.
Source(s): Statistics Canada, CANSIM tables 153-0076, 153-0077 and 153-0097 (accessed September 7, 2012).

4.2.2 Industrial wastewater discharge destination and treatment

Manufacturing industries discharged most of their wastewater (75%) to surface freshwater bodies, tidewater (11%) and to public and municipal sewers (10%). The balance was discharged to groundwater or other points. Of the water discharged by manufacturers, 38% was not treated before being released. Seventeen percent of the total discharge received primary treatment, 37% underwent secondary or biological treatment and 8% underwent tertiary or advanced treatment.

Mining industries discharged most of their wastewater (73%) to surface freshwater, while discharging another 11% to tailing ponds and 9% to groundwater. Metal mines accounted for the largest proportion of wastewater discharged to tailing ponds. Of the total water discharged by mining operations, 60% was not treated before discharge, 31% underwent primary or mechanical treatment and 9% underwent tertiary or advanced treatments.

Thermal-electric power generation industries discharged 95% of their wastewater to surface freshwater bodies. Almost 59% of this water was not treated before being discharged.

4.2.3 Industrial water recirculation

Water recirculation is defined as the process of using the same water more than once in a system. The water must leave the system and re-enter it again or be used in a different system. Water recirculation reduces the need for industries to take in new water.[13]

In 2009, 7,770.9 million cubic metres of water was recirculated by the manufacturing, mining and thermal electric power generation industries. The recirculation rate, defined as the amount of recirculated water as a percent of water intake, was 25%.

Manufacturing industries recirculated 2,003.3 million cubic metres of water, 53% of their total water intake. The primary metal manufacturing industry had a recirculation rate of 98%.

Mining industries reported the use of 1,547.7 million cubic metres of recirculated water in 2009, a recirculation rate of 311%. Almost all of the recirculated water (98%) was used for process activities by the mining industry.

Thermal-electric power producers recirculated 4,220.0 million cubic metres of water, resulting in a recirculation rate of 16%.

13. Statistics Canada, 2010, *Industrial Water Use, 2007*, Catalogue no. 16-401-X.

4.2.4 Industrial water pollutant discharges

Ammonia and nitrate made up 90% of the total tonnage of substances released into water by industrial facilities in Canada in 2009 according to the NPRI database (Table 4.3).

Table 4.3
Top ten substances released to water according to the National Pollutant Release Inventory, 2009

	Releases to water [1]	Share of total
	tonnes	percent
Nitrate (ion in solution at pH >= 6.0)	55,724	47.1
Ammonia (total) [2]	51,210	43.3
Phosphorus (total)	6,053	5.1
Methanol	1,544	1.3
Manganese (and its compounds)	1,256	1.1
Ethylene glycol	762	0.6
Chlorine	303	0.3
Zinc (and its compounds)	219	0.2
Total Reduced Sulphur (TRS)	195	0.2
Benzene	136	0.1

1. Includes direct discharges, spills and leaks.
2. Refers to the total of both ammonia (NH_3) and ammonium ion (NH_4+) in solution.

Source(s): Environment Canada, Pollutant Inventories and Reporting Division, 2011, *National Pollutant Release Inventory (NPRI) Downloadable Datasets*, *www.ec.gc.ca/inrp-npri/default.asp?lang=en&n=0EC58C98-* (accessed February 14, 2012).

In 2008, $114.7 million in capital expenditures was invested in pollution abatement and control processes and technologies to reduce emissions to surface water, while capital expenditures on pollution prevention processes and technologies totalled $178.8 million (Table 4.4).

The paper manufacturing industry spent the greatest portion (34%) of their total capital expenditures on pollution abatement and control to reduce emissions to surface water, followed by the food manufacturing (19%) and chemical manufacturing (17%) industries. The mining and quarrying industry spent the greatest portion (62%) of their total capital expenditures on pollution prevention to reduce emissions to surface water.

Table 4.4
Distribution of capital expenditures on pollution abatement and control (end-of-pipe) and pollution prevention by industry, 2008

	Pollution abatement and control (end-of-pipe)		Pollution prevention	
	Total	Surface water	Total	Surface water
	millions of dollars			
Total, all industries	**1,682.2**	**114.7**	**959.1**	**178.8**
Logging	F	F	F	F
Oil and gas extraction	790.0	18.3	118.1	F
Mining and quarrying	119.1	x	134.2	83.6
Electric power generation, transmission and distribution	197.6	20.9	276.3	21.3
Natural gas distribution	x	0.0	x	0.1
Food	19.2	3.6	42.3	8.3
Beverage and tobacco products	x	x	x	1.4
Wood products	3.4	F	6.8	0.6
Paper manufacturing	13.0	4.4	30.5	x
Petroleum and coal products	122.9	x	42.5	x
Chemicals	27.8	4.6	47.4	4.0
Non-metallic mineral products	39.2	0.5	38.2	2.7
Primary metals	290.5	8.3	72.6	5.7
Fabricated metal products	F	0.1	14.3	1.7
Transportation equipment	26.3	x	14.6	F
Other manufacturing	19.5	F	F	F

Note(s): Figures may not add up to totals due to rounding.
Source(s): Statistics Canada, CANSIM table 153-0054 (accessed February 1, 2012).

Section 5

Air emissions

Air emissions can have a wide range of effects. For example, traffic emissions affect urban air quality; industrial emissions of sulphur oxides and nitrogen oxides can lead to acid rain; chlorofluorocarbons, hydrochlorofluorocarbons and other substances deplete the ozone layer; and carbon dioxide, methane and nitrous oxide contribute to climate change. Air pollutants have a negative impact on the air we breathe and can also have an effect on soil and water systems through acid deposition. Effects can be local, regional or global, as pollution can travel long distances with prevailing winds.

5.1 Criteria air contaminants

Criteria air contaminants (CACs) are those pollutants for which ambient air quality standards have been established by government and include sulphur oxides, carbon monoxide, nitrogen oxides, volatile organic compounds, particulate matter and ammonia. CACs contribute to air quality issues such as smog and acid rain.[1]

5.1.1 Particulate matter

Particulate matter is a broad category of air pollutants that includes a range of small solid or liquid particles varying in size and chemical composition. Total particulate matter (TPM) refers to all particles with a diameter less than 100 micrometres. Particulate matter less than or equal to 10 micrometres (PM_{10}) is a subset of TPM and particulate matter less than or equal to 2.5 micrometres ($PM_{2.5}$) is a subset of PM_{10}.[2] $PM_{2.5}$ poses the greatest threat to human health because it can travel deepest into the lungs.[3]

Emissions of TPM increased 45% from 1985 to 2009 while emissions of PM_{10} increased 19% and emissions of $PM_{2.5}$ decreased 13% (Chart 5.1). Open sources such as paved and unpaved roads, construction, agriculture and forest fires were responsible for 96% of emissions of TPM, 93% of PM_{10} and 72% of $PM_{2.5}$ in 2009 (Table 5.1). Industrial sources were the second highest emitters of $PM_{10,}$ with mining and rock quarrying in particular responsible for a quarter of industrial emissions. Non-industrial sources, residential fuel wood combustion in particular, were the second highest emitters of $PM_{2.5}$ (see **5.1.7 Air emissions from residential wood consumption**).

5.1.2 Sulphur oxides (SO_x)

Sulphur oxides (SO_x) are a group of gases, consisting mainly of sulphur dioxide (SO_2). The combustion of fossil fuels and the smelting of ore are primary sources.[4] SO_2 dissolves in water vapour in the air to form acids, and interacts with other gases and particles in the air to form sulphates.[5]

Emissions of SO_x decreased 60% from 1985 to 2009 (Chart 5.2). Industrial sources were responsible for more than 64% of emissions of SO_x in 2009, with the non-ferrous smelting and refining industry and the upstream petroleum industry responsible for close to three-quarters of industrial emissions (Table 5.1). Electric power generation accounted for 26% of total emissions of SO_x in 2009.

5.1.3 Nitrogen oxides (NO_x)

Nitrogen oxides are air pollutants that consist primarily of nitric oxide (NO) and nitrogen dioxide (NO_2) produced by the reaction of nitrogen (N_2) and oxygen (O_2) in air at high temperatures in internal combustion

1. Environment Canada, 2011, *Criteria Air Contaminants and Related Pollutants*, www.ec.gc.ca/Air/default.asp?lang=En&n=7C43740B-1 (accessed October 4, 2011).
2. Environment Canada, 2011, *Particulate Matter*, www.ec.gc.ca/air/default.asp?lang=En&n=2C68B45C-1 (accessed October 4, 2011).
3. Health Canada, 2006, *Let's Talk About Health and Air Quality*, www.hc-sc.gc.ca/ewh-semt/air/out-ext/effe/talk-a_propos-eng.php#airborne (accessed March 21, 2012).
4. Environment Canada, 2011, *Pollution and Waste – Glossary*, www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=9264E929-1#v (accessed March 22, 2012).
5. Environment Canada, 2011, *Sulphur Oxides – SO_x*, www.ec.gc.ca/air/default.asp?lang=En&n=BBB2123F-1 (accessed October 4, 2011).

engines and furnaces. Nitrogen oxides contribute to the formation of ground-level ozone, the production of particulate matter and acid deposition (including acid rain).

Emissions of NO_x decreased 18% from 1985 to 2009 (Chart 5.2). Transportation was the highest emitter of nitrogen oxides, responsible for more than half of emissions in 2009. Industrial sources were the second highest emitters (Table 5.1).

5.1.4 Volatile organic compounds (VOCs)

Volatile organic compounds (VOCs) include those that participate in atmospheric photochemical reactions and exclude methane, ethane, acetone, methylene chloride, methyl chloroform and several chlorinated organics.[6,7] VOCs are carbon-containing compounds that have a high propensity to pass from the solid or liquid state to the vapour state under typical environmental conditions. Such compounds contribute to the formation of ground-level ozone, a component of smog as well as the formation of $PM_{2.5}$.[8]

Emissions of VOCs (excluding natural sources) decreased 26% from 1985 to 2009 (Chart 5.2). Natural sources were responsible for 92% of emissions of VOCs in 2009 while industrial sources and transportation were responsible for the second and third highest emissions (Table 5.1).

5.1.5 Carbon monoxide (CO)

Carbon monoxide is a toxic, colourless, odourless gas generated primarily from the incomplete combustion of fossil fuels.[9]

Emissions of CO decreased 43% from 1985 to 2009 (Chart 5.1). Transportation was responsible for the highest emissions of CO in 2009 (Table 5.1).

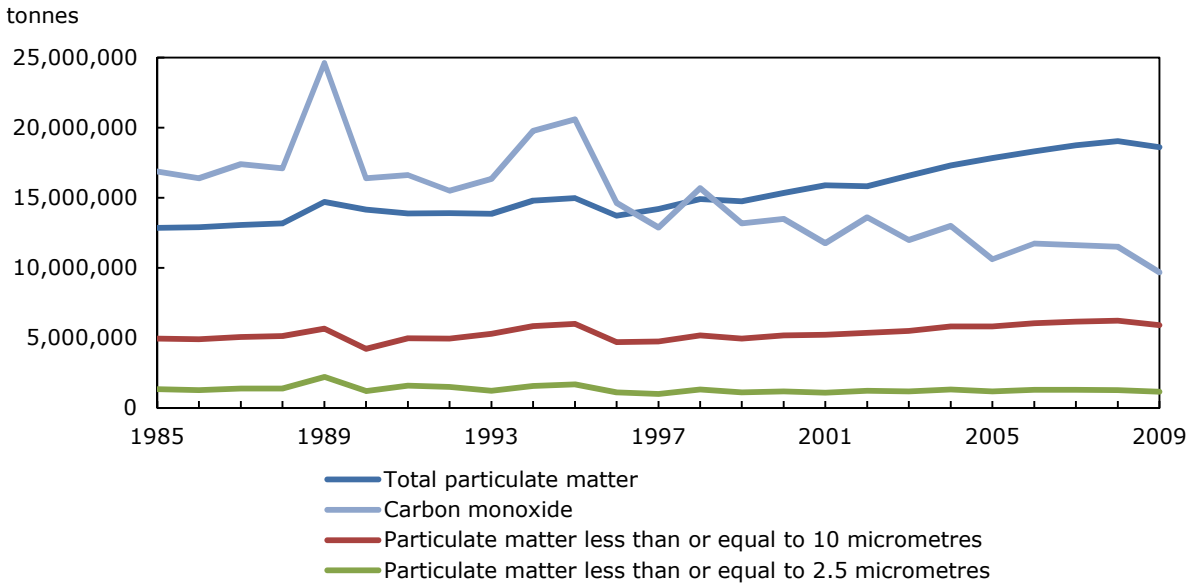
5.1.6 Ammonia (NH_3)

Ammonia (NH_3) is a colourless gas, generated primarily from livestock waste management and fertilizer production. It combines with sulphates and nitrates to form $PM_{2.5}$ and can also contribute to the nitrification and eutrophication of aquatic systems.[10]

Emissions of NH_3 increased 13% from 1985 to 2009 (Chart 5.2). Open sources, agriculture in particular, were responsible for almost 90% of emissions of NH_3 in 2009 (Table 5.1).

6. Environment Canada, 2011, *Pollution and Waste – Glossary*, *www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=9264E929-1#v* (accessed March 22, 2012).
7. As defined in the List of Toxic Substances in Schedule 1 of the *Canadian Environmental Protection Act, 1999* (CEPA 1999). See Environment Canada, 2012, *Toxic Substances List – Schedule 1*, *www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=0DA2924D-1&wsdoc=4ABEFFC8-5BEC-B57A-F4BF-11069545E434* (accessed April 19, 2012).
8. Environment Canada, 2011, *Volatile Organic Compounds (VOCs)*, *www.ec.gc.ca/air/default.asp?lang=En&n=15B9B65A-1* (accessed October 4, 2011).
9. Environment Canada, 2011, *Carbon Monoxide (CO)*, *www.ec.gc.ca/air/default.asp?lang=En&n=139689AB-1* (accessed October 4, 2011).
10. Environment Canada, 2011, *Ammonia*, *www.ec.gc.ca/air/default.asp?lang=En&n=27A52116-1* (accessed October 4, 2011).

Chart 5.1
Emissions of particulate matter and carbon monoxide, Canada, 1985 to 2009



Source(s): Environment Canada, 2011, *National Pollutant Release Inventory (NPRI) Downloadable Datasets,* www.ec.gc.ca/inrp-npri/default.asp?lang=en&n=0EC58C98- (accessed October 4, 2011).

Table 5.1
Criteria air contaminant emissions, 2009

	Particulate matter			SO_x [4]	NO_x [5]	VOC [6]	CO	NH_3
	Total [1]	PM_{10} [2]	$PM_{2.5}$ [3]					
	tonnes							
Total	**18,607,112**	**5,915,509**	**1,180,253**	**1,480,547**	**2,175,349**	**25,164,130**	**9,696,616**	**464,702**
Industrial sources	**412,162**	**139,879**	**68,057**	**948,343**	**605,309**	**642,576**	**1,425,090**	**18,362**
Abrasives manufacture	11	9	4			23		
Aluminum industry	9,818	6,279	5,019	64,153	1,535	1,455	389,028	
Asbestos industry	104	23	9	162	54		4	
Asphalt paving industry	38,273	7,608	1,491	761	1,127	4,489	4,199	
Bakeries	2	2	2	0	0	9,040	0	
Cement and concrete industry	50,516	16,651	7,860	24,577	31,310	263	11,874	237
Chemicals industry	4,123	2,886	1,354	13,816	22,116	11,059	13,492	10,117
Mineral products industry	1,292	1,001	799	1,506	457	194	3,395	203
Foundries	6,391	5,964	5,421	50	151	378	51,245	
Grain industries	48,513	12,382	2,256	582	1,006	2,818	487	10
Iron and steel industries	4,698	2,388	1,600	21,789	8,680	644	19,607	85
Iron ore mining industry	8,956	3,739	1,285	10,992	9,982	40	17,822	
Mining and rock quarrying	171,930	35,641	10,444	4,720	18,149	1,982	9,259	1,209
Non-ferrous smelting and refining industry	4,803	3,019	1,835	401,307	2,052	54	9,136	356
Pulp and paper industry	17,723	12,720	9,073	29,346	30,443	15,789	52,945	1,464
Wood industry	20,411	11,077	6,149	1,938	10,312	55,251	322,227	1,291
Upstream petroleum industry	13,748	10,932	8,288	295,086	411,293	454,047	477,590	3,038
Downstream petroleum industry	4,665	3,415	2,225	71,050	24,123	42,347	20,497	75
Petroleum product transportation and distribution	138	135	134	1,295	27,219	175	14,719	
Other industries	6,048	4,005	2,809	5,214	5,299	42,526	7,564	278

See notes at the end of the table.

Table 5.1 – continued

Criteria air contaminant emissions, 2009

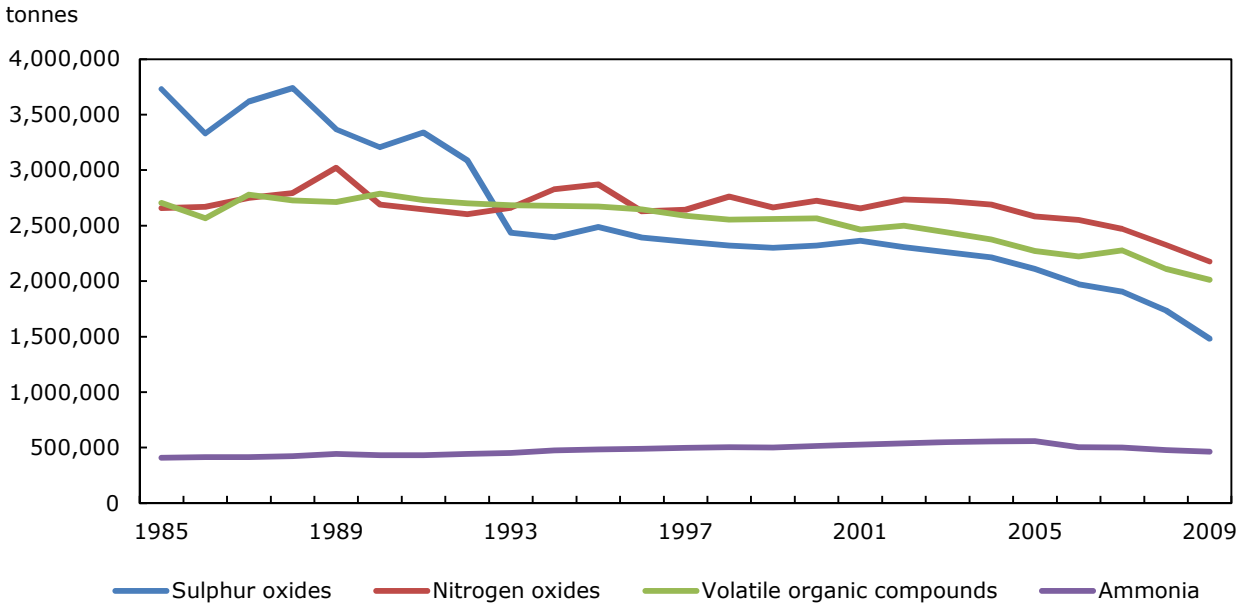
	Particulate matter			SO_x [4]	NO_x [5]	VOC [6]	CO	NH_3
	Total [1]	PM_{10} [2]	$PM_{2.5}$ [3]					
	tonnes							
Non-industrial sources	**143,366**	**123,712**	**117,890**	**433,052**	**284,052**	**157,808**	**764,570**	**2,162**
Commercial fuel combustion	5,299	3,947	2,991	39,383	35,182	1,498	19,685	416
Electric power generation (utilities)	22,987	11,501	7,013	384,897	205,348	2,719	40,816	464
Residential fuel combustion	3,758	2,864	2,616	7,307	33,261	1,770	13,226	358
Residential fuel wood combustion	111,321	105,399	105,271	1,466	10,261	151,821	690,843	923
Transportation	**68,760**	**68,227**	**61,151**	**95,355**	**1,132,079**	**509,575**	**6,605,699**	**22,600**
Air transportation	1,102	1,102	1,075	5,287	74,377	11,950	65,801	39
Heavy-duty diesel vehicles	4,697	4,697	4,325	569	207,885	8,573	44,246	635
Heavy-duty gasoline trucks	305	296	250	85	20,357	6,855	83,663	258
Light-duty diesel trucks	336	336	309	40	3,960	1,830	3,297	26
Light-duty diesel vehicles	101	101	93	9	1,017	359	1,583	12
Light-duty gasoline trucks	612	595	503	712	96,715	100,126	1,853,697	8,962
Light-duty gasoline vehicles	520	505	468	663	82,945	99,615	1,767,964	11,762
Marine transportation	11,089	10,658	9,773	82,766	119,368	3,941	9,982	127
Motorcycles	26	25	17	3	1,435	3,364	20,482	14
Off-road use of diesel	32,026	32,026	30,906	2,875	388,803	36,274	208,168	574
Off-road use of gasoline/LPG/CNG	8,670	8,670	7,992	106	36,386	233,867	2,530,752	91
Rail transportation	3,895	3,895	3,583	2,241	98,831	2,822	16,063	99
Tire wear and brake lining	5,381	5,321	1,855					
Incineration	**1,016**	**583**	**497**	**2,535**	**2,417**	**1,386**	**5,179**	**138**
Crematorium	6	6	6	12	20	2	17	
Industrial and commercial incineration	115	75	32	525	639	637	1,899	72
Municipal incineration	677	480	443	350	1,364	602	1,330	19
Other incineration and utilities	218	22	16	1,648	394	144	1,933	47
Miscellaneous	**9,431**	**9,311**	**9,238**	**0**	**33**	**425,843**	**3,720**	**1,713**
Cigarette smoking	479	479	479			8	2,264	86
Dry cleaning	2	2	2			300		
General solvent use						253,539		
Marine cargo handling industry	201	82	30			16		
Meat cooking	8,473	8,473	8,473					
Refined petroleum products retail						51,128		
Printing	16	15	14	0	33	43,189	6	0
Structural fires	261	261	242			266	1,451	15
Surface coatings						77,397		
Human perspiration								567
Other miscellaneous								1,045
Open sources	**17,866,946**	**5,484,178**	**849,618**	**1,197**	**5,369**	**275,169**	**24,100**	**417,866**
Agriculture	1,717,015	879,405	48,140			257,381		413,765
Construction operations	3,685,768	1,100,422	218,012	661	2,080	24	342	38
Dust from paved roads	3,444,827	660,259	157,964					
Dust from unpaved roads	8,979,137	2,837,591	421,565					
Waste	5,658	2,521	2,338	532	3,085	17,190	13,936	4,046
Mine tailings	32,966	2,637	659					
Prescribed burning	1,574	1,343	940	4	205	574	9,823	17
Natural sources	**105,431**	**89,620**	**73,802**	**65**	**146,090**	**23,151,774**	**868,257**	**1,861**

1. Total particulate matter is made up of solid and liquid particles under 100 micrometres in diameter that are released into the atmosphere.
2. $PM_{10}$is the fraction of total particulate matter that is less than or equal to 10 micrometres in diameter.
3. $PM_{2.5}$is the fraction of total particulate matter that is less than or equal to 2.5 micrometres in diameter.
4. $SO_x$is made up of gaseous oxides of sulphur, mainly sulphur dioxide (SO_2). In some cases, emissions may contain small amounts of sulphur trioxide (SO_3) and sulphurous and sulphuric acid vapour.
5. $NO_x$is made up of gaseous nitric oxide (NO) and nitrogen dioxide (NO_2).
6. Volatile organic compounds (VOCs) are made up of photochemically reactive hydrocarbon compounds (those that participate in chemical reactions when exposed to sunlight). They are major contributors to smog in urban areas.

Note(s): Figures may not add up to totals due to rounding. A blank cell indicates that no emissions data is available or applicable. "0" indicates that the value was approximated to zero, as the value was very small in the context of the sector and pollutant.

Source(s): Environment Canada, Pollutant Inventories and Reporting Division, 2011, *National Pollutant Release Inventory (NPRI) Downloadable Datasets*, *www.ec.gc.ca/inrp-npri/default.asp?lang=en&n=0EC58C98-* (accessed October 4, 2011).

Chart 5.2
Emissions of sulphur oxides, nitrogen oxides, volatile organic compounds and ammonia, Canada, 1985 to 2009



Note(s): The category 'volatile organic compounds' does not include natural sources.
Source(s): Environment Canada, 2011, *National Pollutant Release Inventory (NPRI) Downloadable Datasets,* www.ec.gc.ca/inrp-npri/default.asp?lang=en&n=0EC58C98- (accessed October 4, 2011).

5.1.7 Air emissions from residential wood consumption

A number of pollutants can be generated from burning wood including particulate matter, nitrogen oxides, carbon monoxide, volatile organic compounds, dioxins and furans, and polycyclic aromatic hydrocarbons.[11]

In 2009, residential fuel wood combustion was responsible for 9% of emissions of $PM_{2.5}$, the largest contributor after open sources (Table 5.1). Residential fuel wood combustion was also the source of 7% of carbon monoxide emissions in 2009.

The efficiency of wood heating depends greatly on the type of wood fireplace or stove used. Fireplaces tend to use wood inefficiently. Fireplace inserts and airtight wood stoves and heaters are more efficient. In 2007, wood and wood pellets accounted for 13% of total energy used by Canadian households (Table 5.2).

Table 5.2
Household wood consumption, by province, 2007

	Wood and wood pellets	
	terajoules of energy used	percent of total energy use
Canada	**176,107**	**13**
Newfoundland and Labrador	5,746 E	25 E
Prince Edward Island	1,890 E	28 E
Nova Scotia	12,864	29
New Brunswick	10,729	31
Quebec	84,996	27
Ontario	35,411	7
Manitoba	3,370 E	7 E
Saskatchewan	F	F
Alberta	5,738 E	3 E
British Columbia	13,750	8

Source(s): Statistics Canada, 2010, *Households and the Environment Survey: Energy Use, 2007*, Catalogue no. 11-526-S.

11. Environment Canada, 2011, *Residential Wood Heating*, *www.ec.gc.ca/residentiel-residential/default.asp?lang=En&n=E9FE1750-1* (accessed December 12, 2011).

5.1.8 Industrial air pollutant emissions

In 2009, criteria air contaminants made up nearly 99% of air pollutants emitted by industrial facilities according to the National Pollutant Release Inventory (Table 5.3).

The most common substances released to air include sulphur dioxide (1,308,230 tonnes), carbon monoxide (866,724 tonnes) and nitrogen oxides (698,015 tonnes).

Table 5.3
Top ten substances released to air according to the National Pollutant Release Inventory, 2009

	Releases to air [1]	Share of total
	tonnes	percent
Sulphur dioxide	1,308,230	38.6
Carbon monoxide	866,724	25.6
Nitrogen oxides (expressed as NO_2)	698,015	20.6
Volatile organic compounds (VOCs)	243,923	7.2
Total particulate matter (TPM)	161,365	4.8
Ammonia (total) [2]	18,943	0.6
Total Reduced Sulphur (TRS)	16,256	0.5
Methanol	11,780	0.3
Carbonyl sulphide	6,977	0.2
Hydrochloric acid	6,390	0.2

1. Includes stack or point, storage or handling, fugitive, spills and other non-point releases.
2. Refers to the total of both ammonia (NH_3) and ammonium ion (NH_4+) in solution.

Source(s): Environment Canada, Pollutant Inventories and Reporting Division, 2011, *National Pollutant Release Inventory (NPRI) Downloadable Datasets*, *www.ec.gc.ca/inrp-npri/default.asp?lang=en&n=0EC58C98-* (accessed February 14, 2012).

In 2008, the majority of capital investments for pollution prevention and abatement and control were targeted at the prevention or reduction of air pollutants. Almost $1.4 billion was invested in pollution abatement and control processes and technologies to reduce air emissions, while capital expenditures on pollution prevention processes and technologies totalled $422.2 million (Table 5.4).

The non-metallic mineral product industry (97%) and the primary metal industry (94%) spent the largest share of their total investments for pollution abatement and control on emissions to air. These two industries also spent the largest share of their total investments for pollution prevention on emissions to air, at 81% and 83% respectively.

Table 5.4
Distribution of capital expenditures on pollution abatement and control (end-of-pipe) and pollution prevention by industry, 2008

	Pollution abatement and control (end-of-pipe)		Pollution prevention	
	Total	Air	Total	Air
	millions of dollars			
Total, all industries	**1,682.2**	**1,361.0**	**959.1**	**422.2**
Logging	F	F	F	F
Oil and gas extraction	790.0	711.4	118.1	F
Mining and quarrying	119.1	F	134.2	18.9
Electric power generation, transmission and distribution	197.6	149.7	276.3	81.3
Natural gas distribution	x	x	x	x
Food	19.2	9.9	42.3	10.8
Beverage and tobacco products	x	0.7	x	1.4
Wood products	3.4	3.0	6.8	3.1
Paper manufacturing	13.0	8.0	30.5	20.9
Petroleum and coal products	122.9	96.9	42.5	26.8
Chemicals	27.8	11.7	47.4	23.9
Non-metallic mineral products	39.2	37.9	38.2	30.9
Primary metals	290.5	272.9	72.6	60.5
Fabricated metal products	F	F	14.3	7.5
Transportation equipment	26.3	15.3	14.6	x
Other manufacturing	19.5	16.8	F	F

Note(s): Figures may not add up to totals due to rounding.
Source(s): Statistics Canada, CANSIM table 153-0054 (accessed February 1, 2012).

5.2 Greenhouse gases

Canada's greenhouse gas (GHG) emissions reached 690 megatonnes in 2009, a 17% increase since 1990 (Table 5.5). The increase was driven by growth in emissions from energy, transportation, including road transportation in particular, and mining and oil and gas extraction. GHG emissions declined for the manufacturing industries, industrial processes and the chemical industry over the period. Carbon dioxide (CO_2) is by far the most common GHG emitted (Chart 5.3).

Table 5.5
Greenhouse gas (GHG) emissions by source and sink category

	Carbon dioxide (CO_2)		Methane (CH_4)		Nitrous oxide (N_2O)		CO_2 equivalents [1]		
	1990	2009	1990	2009	1990	2009	1990	2009	Percentage change 1990 to 2009
	kilotonnes								percent
Total [2]	**458,000**	**542,000**	**3,400.00**	**4,400.00**	**160.00**	**150.00**	**590,000**	**690,000**	**16.9**
Energy	**424,000**	**507,000**	**1,700.00**	**2,300.00**	**30.00**	**30.00**	**468,000**	**566,000**	**20.9**
Stationary combustion sources	**273,000**	**308,000**	**200.00**	**200.00**	**7.00**	**8.00**	**279,000**	**315,000**	**12.9**
Electricity and heat generation	91,000	97,200	1.80	4.90	2.00	2.00	91,600	97,900	6.9
Fossil fuel industries	49,600	61,400	80.00	90.00	0.90	1.00	51,000	64,000	25.5
Petroleum refining and upgrading	18,000	20,000	0.30	0.30	0.10	0.08	18,000	20,000	11.1
Fossil fuel production	31,900	41,500	80.00	90.00	0.80	0.90	34,000	44,000	29.4
Mining and oil and gas extraction	6,610	31,100	0.10	0.60	0.10	0.70	6,650	31,300	370.7
Manufacturing industries	55,400	41,900	2.00	2.00	2.00	2.00	56,000	42,600	-23.9
Iron and steel	5,210	3,980	0.20	0.20	0.20	0.10	5,270	4,030	-23.5
Non ferrous metals	3,240	3,110	0.07	0.07	0.05	0.04	3,260	3,120	-4.3
Chemical	8,170	7,520	0.17	0.15	0.10	0.10	8,220	7,570	-7.9
Pulp and paper	14,100	4,120	1.00	2.00	1.00	1.00	14,400	4,510	-68.7
Cement	3,810	3,610	0.07	0.07	0.04	0.02	3,820	3,610	-5.5
Other manufacturing	20,900	19,600	0.40	0.40	0.40	0.40	21,000	19,700	-6.2
Construction	1,850	1,070	0.03	0.02	0.05	0.03	1,870	1,080	-42.2
Commercial and institutional	25,500	35,800	0.50	0.60	0.50	0.70	25,700	36,000	40.1
Residential	40,900	37,900	100.00	100.00	2.00	2.00	43,000	41,000	-4.7
Agriculture and forestry	2,370	2,040	0.04	0.04	0.05	0.06	2,390	2,050	-14.2

See notes at the end of the table.

Table 5.5 – continued

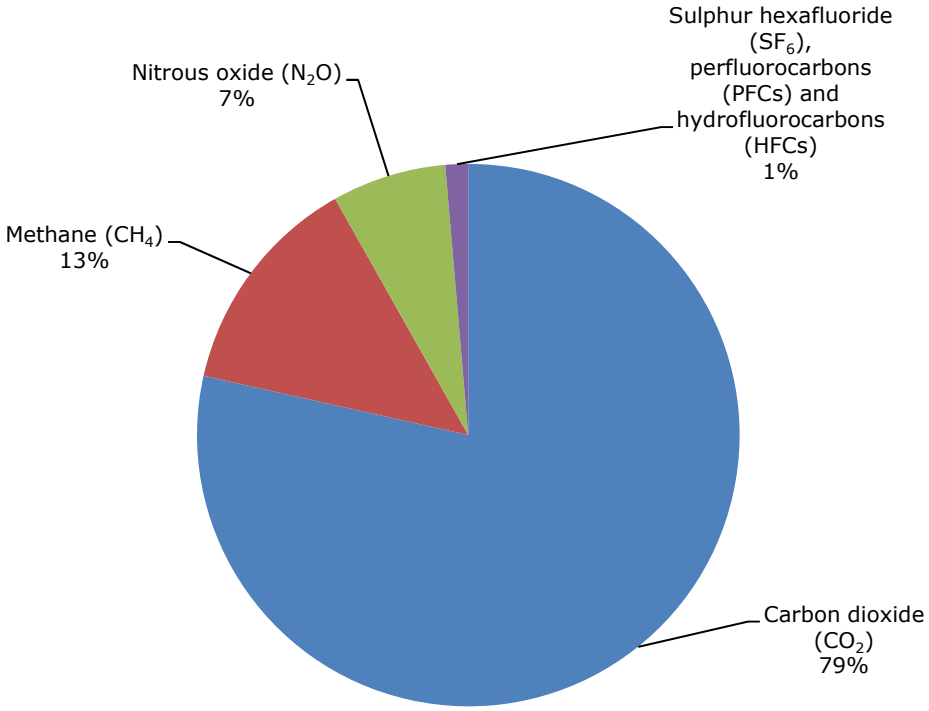
Greenhouse gas (GHG) emissions by source and sink category

	Carbon dioxide (CO_2)		Methane (CH_4)		Nitrous oxide (N_2O)		CO_2 equivalents [1]		
	1990	2009	1990	2009	1990	2009	1990	2009	Percentage change 1990 to 2009
	kilotonnes								percent
Transport [3]	**139,000**	**182,000**	**30.00**	**30.00**	**20.00**	**30.00**	**146,000**	**190,000**	**30.1**
Domestic aviation	7,150	7,080	0.50	0.40	0.20	0.20	7,200	7,200	0.0
Road transportation	93,200	128,000	14.00	10.00	10.00	12.00	96,700	131,000	35.5
Light-duty gasoline vehicles	43,400	39,900	7.70	3.80	6.20	4.60	45,500	41,400	-9.0
Light-duty gasoline trucks	19,200	39,800	3.00	3.80	3.20	4.70	20,300	41,300	103.4
Heavy-duty gasoline vehicles	7,350	6,810	1.20	0.30	0.21	0.53	7,440	6,990	-6.0
Motorcycles	148	242	0.15	0.10	0.00	0.00	152	245	61.2
Light-duty diesel vehicles	458	647	0.01	0.01	0.03	0.05	469	663	41.4
Light-duty diesel trucks	686	1,890	0.02	0.05	0.05	0.20	702	1,940	176.4
Heavy-duty diesel vehicles	19,800	37,500	1.00	2.00	0.60	2.00	20,000	38,200	91.0
Propane and natural gas vehicles	2,170	764	1.00	0.70	0.04	0.02	2,200	780	-64.5
Railways	6,160	6,110	0.30	0.30	3.00	3.00	7,000	7,000	0.0
Domestic marine	4,690	4,770	0.30	0.40	1.00	0.90	5,000	5,100	2.0
Other Transportation	28,000	36,000	20.00	20.00	6.00	10.00	30,000	40,000	33.3
Off-road gasoline	7,600	7,400	9.00	9.00	0.20	0.20	7,800	7,600	-2.6
Off-road diesel	14,000	23,000	0.80	1.00	6.00	9.00	16,000	26,000	62.5
Pipelines	6,650	6,140	6.70	6.20	0.20	0.20	6,850	6,320	-7.7
Fugitive sources	**11,000**	**17,000**	**1,500.00**	**2,100.00**	**0.10**	**0.10**	**42,100**	**60,700**	**44.2**
Coal mining	...	...	90.00	30.00	...	...	2,000	700	-65.0
Oil and natural gas	11,500	16,700	1,370.00	2,060.00	0.10	0.10	40,200	60,000	49.3
Oil	95	200	193.00	252.00	0.10	0.10	4,190	5,530	32.0
Natural gas	23	67	543.00	920.00	...	...	11,400	19,400	70.2
Venting	6,990	10,200	627.00	881.00	...	0.01	20,200	28,700	42.1
Flaring	4,400	6,300	2.60	4.20	0.00	0.03	4,400	6,400	45.5
Industrial processes	**34,000**	**35,000**	**4.70**	**2.60**	**37.90**	**5.87**	**56,800**	**46,300**	**-18.5**
Mineral products	**8,300**	**6,800**	**...**	**...**	**...**	**...**	**8,300**	**6,800**	**-18.1**
Cement production	5,400	5,100	...	...	...	...	5,400	5,100	-5.6
Lime production	1,800	1,200	...	...	...	...	1,800	1,200	-33.3
Mineral product use [4]	1,090	449	...	...	...	...	1,090	449	-58.8
Chemical industry	**5,000**	**6,200**	**4.70**	**2.60**	**37.90**	**5.87**	**17,000**	**8,100**	**-52.4**
Ammonia production	5,000	6,200	...	...	...	...	5,000	6,200	24.0
Nitric acid production	...	...	...	...	3.27	3.71	1,010	1,150	13.9
Adipic acid production	...	...	...	...	35.00	2.10	11,000	660	-94.0
Petrochemical production [5]	...	...	4.70	2.60	0.03	0.02	110	63	-42.7
Metal production	**12,900**	**12,700**	**...**	**...**	**...**	**...**	**22,600**	**15,000**	**-33.6**
Iron and steel production	10,200	7,650	...	...	...	...	10,200	7,650	-25.0
Aluminum production	2,700	5,000	...	...	...	...	9,300	7,200	-22.6
SF_6 used in magnesium smelters and casters	...	...	...	...	...	...	3,110	193	-93.8
Production and consumption of halocarbons and SF_6 [6]	**...**	...	**...**	**...**	**...**	**...**	**990**	**7,000**	**607.1**
Other and undifferentiated production	**8,000**	**9,400**	**...**	**...**	**...**	**...**	**8,000**	**9,400**	**17.5**
Solvent and other product use	**...**	**...**	**...**	**...**	**0.58**	**0.84**	**180**	**260**	**44.4**
Agriculture	**...**	**...**	**900.00**	**1,000.00**	**90.00**	**110.00**	**47,000**	**56,000**	**19.1**
Enteric fermentation	...	...	780.00	920.00	...	...	16,000	19,000	18.8
Manure management	...	...	120.00	130.00	10.00	**13.00**	5,700	6,600	15.8
Agricultural soils	...	...	...	...	80.00	97.00	25,000	30,000	20.0
Direct sources	...	...	...	...	44.00	52.00	14,000	16,000	14.3
Pasture, range and paddock manure	...	...	...	...	7.10	9.70	2,200	3,000	36.4
Indirect sources	...	...	...	...	30.00	40.00	9,000	10,000	11.1
Field burning of agricultural residues	...	...	7.10	1.50	0.18	0.04	210	45	-78.6
Waste	**270**	**200**	**870.00**	**980.00**	**2.00**	2.00	**19,000**	**22,000**	**15.8**
Solid waste disposal on land	...	...	850.00	970.00	...	...	18,000	20,000	11.1
Wastewater handling	...	...	13.00	16.00	2.00	2.00	780	1,000	28.2
Waste incineration	270	200	0.40	0.08	0.40	0.20	400	260	-35.0
Land use, land use-change and forestry	**-73,000**	**-22,000**	**160.00**	**280.00**	**6.60**	**12.00**	**-67,000**	**-12,000**	**82.1**
Forest land	-98,000	-26,000	140.00	270.00	5.90	11.00	-93,000	-17,000	81.7
Cropland	11,000	-7,100	10.00	5.00	0.50	0.20	11,000	-6,900	-162.7
Grassland	...	...	...	...	...	...	...	...	...
Wetlands	5,000	2,000	0.30	0.00	0.01	0.00	5,000	2,000	-60.0
Settlements	9,000	9,000	5.00	6.00	0.20	0.20	9,000	9,000	0.0

1. CO_2 equivalent emissions are the weighted sum of all greenhouse gas emissions. The following global warming potentials are used as the weights: CO_2 = 1; CH_4 = 21; N_2O = 310; HFCs = 140 to 11,700; PFCs = 6,500 to 9,200; SF_6 = 23,900. Not all HFC, PFC and SF_6 data are presented in this table.
2. National totals exclude all GHGs from the Land use, land-use change and forestry sector.
3. Emissions from fuel ethanol are reported within the gasoline transportation sub-categories.
4. The category 'Mineral product use' includes CO_2 emissions coming from the use of limestone & dolomite, soda ash, and magnesite.
5. The category 'Petrochemical Production' includes emissions coming from production of silicon/calcium carbides, carbon black, ethylene, methanol, ethylene dichloride, and styrene.
6. Production of HFCs (HCFC-22 exclusively) only occurred in Canada from 1990-1992. HFC consumption began in 1995.

Note(s): Figures may not add up to totals due to rounding.
Source(s): Environment Canada, 2011, *National Inventory Report 1990-2009: Greenhouse Gas Sources and Sinks in Canada*, Catalogue no. En81-4/2009E-PDF.

Chart 5.3
Composition of Canadian greenhouse gas emissions expressed as carbon dioxide equivalents, 2009

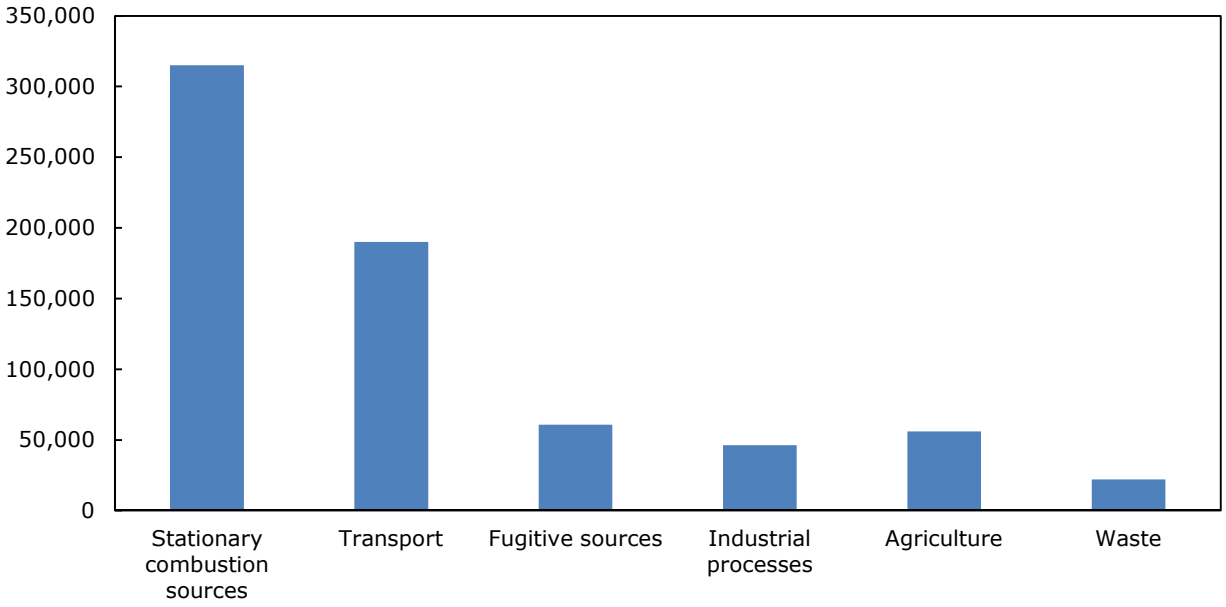


Source(s): Environment Canada, 2011, *National Inventory Report 1990-2009: Greenhouse Gas Sources and Sinks in Canada*, Catalogue no. En81-4/2009E-PDF.

In 2009, the largest source of GHG emissions was energy production and consumption activities including direct emissions from fossil fuel combustion, as well as fugitive emissions from coal mining and oil and natural gas activities (Chart 5.4).

Chart 5.4
Greenhouse gas emissions by source, 2009

kilotonnes of carbon dioxide equivalent



Source(s): Environment Canada, 2011, *National Inventory Report 1990-2009: Greenhouse Gas Sources and Sinks in Canada,* Catalogue no. En81-4/2009E-PDF.

Appendix A

Glossary

Ammonia (NH_3) is a colourless gas, generated primarily from livestock waste management and fertilizer production. It combines with sulphates and nitrates to form particulate matter less than or equal to 2.5 micrometres ($PM_{2.5}$) and can also contribute to the nitrification and eutrophication of aquatic systems.

Carbon monoxide (CO) is a toxic, colourless, odourless gas generated primarily from the incomplete combustion of fossil fuels.

Composting is an aerobic biological treatment process used most frequently in Canada at this time for management of biodegradable residential waste, such as leaf and yard or food wastes.

Construction and demolition waste includes waste generated by construction, renovation and demolition activities. It generally includes materials such as wood, drywall, certain metals, cardboard, doors, windows, wiring, etc. It excludes materials from land-clearing on areas not previously developed, as well as materials such as asphalt, concrete, bricks and clean sand or gravel.

Diversion rate refers to the amount of waste diverted as a proportion of waste generated.

E-waste refers to electronic equipment waste such as cellular phones, computers, televisions and other electronic devices.

Greenhouse gases (GHGs) are the group of chemical compounds that are responsible for the so-called greenhouse effect. The most important greenhouse gases produced by economic activity are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and chlorofluorocarbons (CFCs).

Hazardous waste includes all materials designated as hazardous, due to their nature or quantity, and requiring special handling techniques as specified by legislation or regulation.

Incineration, in the context of waste, refers to the burning of waste. Most jurisdictions in Canada consider incineration to be disposal.

Industrial, commercial and institutional (IC and I) waste is the waste generated by all non-residential sources in a municipality, and is excluded from the residential waste stream. This includes:

- industrial waste, which is generated by manufacturing, primary and secondary industries, and is managed off-site from the manufacturing operation, and is generally picked up under contract by the private sector;
- commercial waste is generated by commercial operations such as shopping centres, restaurants, offices, etc. Some commercial waste (from small street-front stores, etc.) may be picked up by the municipal collection system along with residential waste;
- institutional waste is generated by institutional facilities such as schools, hospitals, government facilities, seniors homes, universities, etc. This waste is generally picked up under contract with the private sector.

Mine tailings are waste rock rejected after most of the recoverable valuable minerals have been extracted.

Municipal wastewater is effluent discharged from municipal wastewater treatment plants, combined sewer overflows, and stormwater discharges.

Natural resource residuals refers to byproducts from extraction and production processes associated with natural resources such as waste rock from mining.

Nitrogen oxides (NO_x) are air pollutants that consist primarily of nitric oxide (NO) and nitrogen dioxide (NO_2) produced by the reaction of nitrogen (N_2) and oxygen (O_2) in air at high temperatures in internal combustion engines and furnaces. Nitrogen oxides contribute to the formation of ground-level ozone, the production of particulate matter and acid deposition (including acid rain).

Non-residential waste includes municipal solid non-hazardous waste generated by industrial, commercial and institutional sources as well as waste generated by construction and demolition activities.

Particulate matter is a broad category of air pollutants that includes a range of small solid or liquid particles varying in size and chemical composition. Total particulate matter (TPM) refers to all particles with a diameter less than 100 micrometres. Particulate matter less than or equal to 10 micrometres (PM_{10}) is a subset of TPM and particulate matter less than or equal to 2.5 micrometres ($PM_{2.5}$) is a subset of PM_{10}.

Pollution abatement and control processes refers to separately identifiable processes whose sole purpose is to abate undesirable substances emitted during normal production activities, without any impact on the production process itself.

Pollution prevention is the minimization or elimination of pollutants before they are created rather than after they are created.

Recirculation rate is the amount of recirculated water as a percentage of water intake.

Recycling is the process whereby a material (for example, glass, metal, plastic, paper) is diverted from the waste stream and remanufactured into a new product or is used as a raw material substitute.

Radioactive waste refers to waste products generated from: uranium mining, milling, refining and conversion; nuclear fuel fabrication; nuclear reactor operations; nuclear research; and radioisotope manufacture and use.

Residential waste includes solid waste from residential sources (households), and includes waste that is picked up by the municipality (either using its own staff or through contracting firms), or residential waste that is taken by the generator to depots, transfer stations and disposal facilities.

Residuals are flows of solid, liquid and gaseous materials, and energy that are discarded, discharged or emitted by establishments and households through processes of production, consumption or accumulation.

Solid waste generation is the sum of total non-hazardous residential and non-residential solid waste disposed of in an off-site disposal facility and the total materials processed for recycling at an off-site recycling facility.

Stormwater is water from rain or snowmelt that accumulates prior to entering a water body or filtering into soils.

Sulphur oxides (SO_x) are a group of gases—mainly sulphur dioxide (SO_2)—produced by the combustion of fossil fuels and by natural sources such as volcanoes. SO_2 dissolves in water vapour in the air to form acids, and interacts with other gases and particles in the air to form sulphates.

Volatile organic compounds (VOCs) include those that participate in atmospheric photochemical reactions and exclude compounds such as methane, ethane, acetone, methylene, chloride, methyl chloroform and several chlorinated organics. VOCs are carbon-containing compounds that have a high propensity to pass from the solid or liquid state to the vapour state under typical environmental conditions. Such compounds contribute to the formation of ground-level ozone, a component of smog as well as the formation of $PM_{2.5}$.

There have been several definitions of **waste** proposed in recent years. One common thread among these definitions is the concept that waste is a material that is unwanted by its producer. The unwanted materials may be by-products of a production process—fly ash from a furnace, for example. Alternatively they might be products, the inherent value of which has been consumed from the perspective of the current holder. For example, a newspaper that has been read, a package that has been opened and emptied of its contents, or an apple eaten to the core, are all similar insofar as they have lost their original inherent value from the consumer's perspective.

Waste disposal refers to all materials not wanted by their generator and which are discarded for management at waste disposal facilities (excludes materials destined for recycling and composting).

Waste diversion represents the quantity of materials diverted from disposal facilities and represents the sum of all materials processed for recycling at an off-site recycling or composting facility.

The **waste management industry** includes all firms and public bodies operating in Canada that provide the services of collection, transportation, diversion, treatment or disposal of waste or recyclable materials.

Wastewater refers to water that is returned to the environment after being used during some activity or process, and it may be treated or untreated at the location of use prior to being discharged.

Water recirculation refers to the process of using water more than once in an industrial establishment. It applies mainly to industrial cooling and processing activities.