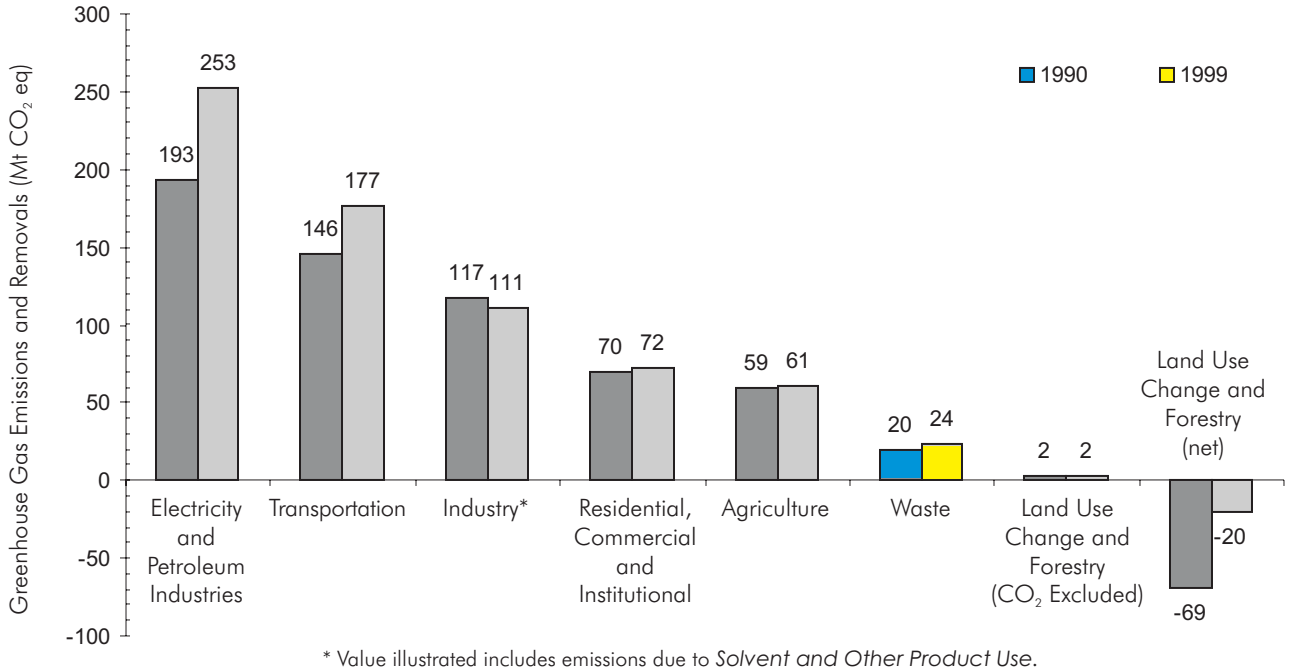
Waste: 1990-1999

The Waste sector of the Canadian Greenhouse Gas Inventory (CGHGI) includes the contribution to greenhouse gas emissions from solid waste disposal on land, wastewater handling and waste incineration.

- *In 1999,* greenhouse gas emissions from the Waste sector totalled nearly 24 megatonnes of carbon dioxide equivalent* (Mt CO_2 eq), representing 3.4% of Canada's total emissions (699 Mt) in 1999. The primary source of emissions is from solid waste disposal on land, which contributed 93% of the total sector emissions, with much smaller contributions from wastewater handling and waste incineration (5.7% and 1.5%, respectively). The majority of emissions were methane (CH_4), at 22.3 Mt, with the remainder being composed of nitrous oxide (N_2O) (1 Mt) and carbon dioxide (0.3 Mt).
- *Between 1990 and 1999,* waste-related emissions rose by over 17%, of which 95% of the increase is attributable to a rise in landfill emissions. Waste incineration and wastewater handling emissions increased 9% and 10%, respectively, and generally follow the national population trend. Although emissions from solid waste disposal on land rose nearly 18%, increasing landfill gas capture reduced the rate of emission growth from landfills in the early to middle 1990s.

**Unless otherwise indicated, all emissions are reported in Mt CO_2 eq. For brevity, this has been shortened to Mt. This concept provides a relative measure of the impacts of different greenhouse gases on global warming, with the effect of carbon dioxide being equal to one.*

Figure 1. Canadian Greenhouse Gas Emissions and Removals 1990 and 1999



* Value illustrated includes emissions due to *Solvent and Other Product Use.*

Canada's Waste Sector

The major sources of greenhouse gas emissions in the Waste Sector are solid waste disposal in landfills, wastewater handling and waste incineration. These emissions consist almost completely of methane; in fact, methane emissions comprised 95% of the total emissions in this sector in 1999.

Much of the waste treated or disposed is biomass or biomass-based. The carbon dioxide emissions attributable to such wastes are not included in the national inventory totals, but are in theory accounted for when measuring changes in carbon in agricultural soils. In theory, there are no net emissions if the biomass is sustainably produced and consumed. This assumes that on an annual basis, the carbon dioxide emitted from the decomposition of food is consumed in growing the next year's crop. With respect to forest products, if biomass is harvested at an unsustainable rate (for example, faster than the annual re-growth), net carbon dioxide emissions will be accounted for as a loss of biomass stocks in the Land-Use Change and Forestry sector.

The Greenhouse Gas Inventory allocates emissions from the Waste sector within the following three categories:

1. Solid Waste Disposal on Land
2. Wastewater Handling
3. Waste Incineration

The Canadian Greenhouse Gas Inventory (CGHGI)

The Canadian Greenhouse Gas Inventory is developed, compiled, and reported annually by the Greenhouse Gas Division of Environment Canada, and utilizes methods and models developed in-house by engineering and scientific staff, as well as published data, data developed by industry, or methods developed by the Intergovernmental Panel on Climate Change (IPCC, 1997).

The greenhouse gases that have been estimated in the national inventory are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), perfluorocarbons (PFCs), and hydro fluorocarbons (HFCs).

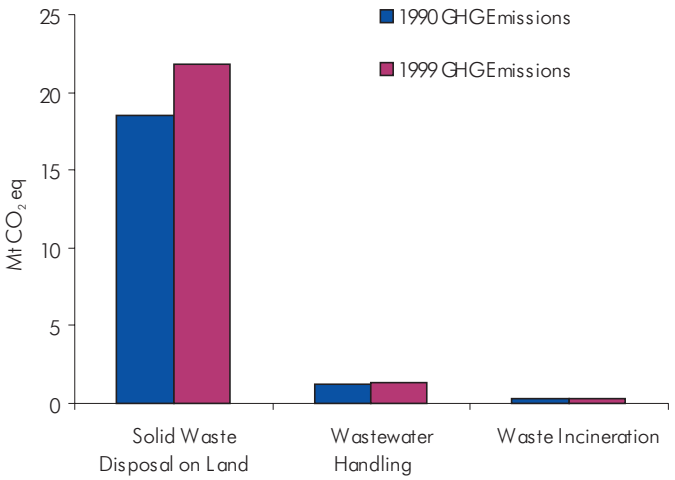
The inventory uses an internationally agreed to reporting format that groups emissions and removals into the following six sectors: Energy, Industrial Processes, Solvent and Other Product Use, Agriculture, Land-Use Change and Forestry, and Waste. The 1999 Trends Fact Sheet Series, while presenting the latest information on Canadian greenhouse gas emissions and removals derived from the latest national inventory, use a modified sector approach to facilitate the use of information by the public.

Waste Sector Emission Trends: 1990 to 1999

Greenhouse gas emissions from the Waste sector totaled nearly 24 Mt, representing 3.4% of Canada's total emissions in 1999. Waste-related emissions rose by over 17% since 1990; 95% of this increase is attributable to increases in landfill emissions. Figure 2 compares the changes in emissions among the Waste sector categories for 1990 and 1999.

In 1999, Solid Waste Disposal on Land accounted for almost 93% of the emissions in this sector, while municipal wastewater and incinerated material derived from fossil-fuel products are minor contributing categories (5.7% and 1.5%, respectively). Of the total sector's 24 Mt of emissions, 22.3 Mt were composed of methane.

Figure 2. Greenhouse Gas Emission Trends in the Waste Sector by Subcategory, 1990 and 1999



Solid Waste Disposal on Land

The emissions from Solid Waste Disposal on Land were 21.9 Mt in 1999, an increase of almost 18% since 1990. Emissions are estimated for two types of landfills in Canada, municipal solid waste (MSW) landfills and wood waste (WW) landfills.

In Canada, most waste disposal on land occurs in municipally managed or privately owned landfills. Very few, if any, unmanaged waste disposal sites exist; therefore, it has been assumed that all waste is disposed of in managed facilities. Residential, institutional, commercial, industrial, construction and demolition wastes are disposed of in MSW landfills.

Wood waste landfills are privately owned and operated by forest industries, such as saw mills and pulp and paper mills. These industries use the landfills to dispose of surplus wood residue such as sawdust, wood shavings, bark and sludges.

Although emissions from MSW landfills increased by nearly 18% between 1990 and 1999, landfill gas capture increased by almost 40% since 1990 (Table 1). As a result, this practice reduced the rate of emissions growth in the early and middle 1990s. Emissions from WW landfills increased by over 20% since 1990, though they are a minor source compared to MSW landfills. Landfill gas capture is not practised at WW landfills; therefore, it has had no reduction effect on emissions from this source.

Landfill gas, which is composed mainly of methane and carbon dioxide, is produced by the anaerobic decomposition of organic wastes. The first phase of this process typically begins after waste has been in a landfill for 10 to 50 days. Although the majority of methane and carbon dioxide is generated within 20 years of landfilling, emissions can continue for 100 years or more (Levelton, 1991).

Landfill Sites in Canada

In Canada, there are well over 10,000 landfill sites[1]. The generation of methane from landfills has increased since 1990; however, more landfill gas is now being captured and combusted.

[1] Levelton, 1991.

Wastewater Handling

Emissions from wastewater handling totaled 1.4 Mt in 1999, an increase of 10% since 1990. The emissions have essentially followed the same trend as Canada's population during this period.

Municipal wastewater can be aerobically or anaerobically treated. When wastewater is treated anaerobically, methane is produced. Emissions from aerobic systems are assumed to be negligible. Both types of systems generate nitrous oxide through the nitrification and denitrification of sewage nitrogen (IPCC, 1997). Carbon dioxide is also generated by both types of treatment but, as discussed earlier, carbon dioxide emissions originating from the decomposition of food are not inventoried.

Table 1. Methane Emissions Trends from Landfills, 1990 to 1999 (Mt CO_2 eq)

	Municipal Solid Waste Landfills			Wood Waste Landfills	
Year	Generated	Captured*	Emitted	Emissions	Total Emissions
1990	21.5	4.4	17.0	1.5	18.5
1991	22.1	4.5	17.6	1.6	19.2
1992	22.7	4.7	18.0	1.6	19.6
1993	23.2	4.8	18.4	1.7	20.1
1994	23.7	5.1	18.6	1.7	20.3
1995	24.2	5.6	18.6	1.8	20.4
1996	24.7	6.1	18.6	1.8	20.4
1997	25.2	6.1	19.0	1.9	20.9
1998	25.7	6.1	19.5	1.9	21.4
1999	26.2	6.1	20.0	1.8	21.9

* 1998 and 1999 data were not available; hence, emissions were assumed constant from 1997

Waste Incineration

Emissions from both MSW and sewage sludge incineration are included in the inventory. While emissions from waste incineration were a minor source of greenhouse gases in 1999 (0.35 Mt) emissions from this category have increased by nearly 9% since 1990, the majority from MSW incineration. In common with emissions from wastewater handling, waste incineration emissions mirror the trends in population growth in Canada.

Several municipalities in Canada utilize incinerators to reduce the quantity of MSW sent to landfills and to reduce the amount of sewage sludge requiring land application. The greenhouse gas emissions from incinerators depend on factors such as: the amount of waste incinerated, the composition of the waste, the carbon content of the non-biomass waste, and the facilities' operating conditions.

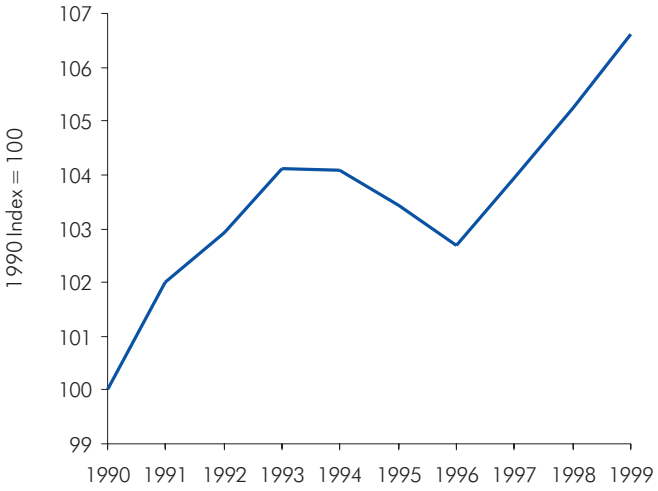
Waste Emissions Per Capita

Waste emissions per capita increased 6.6% from 1990 to 1999, primarily due to the increasing emissions from landfills (Figure 3). Growth in emissions exceeds population increases during this period because material that was landfilled in past decades is still contributing to methane production today. The decline in per capita growth in emissions observed in the mid-1990s is directly attributable to methane capture programs at landfills.

Table 2. Greenhouse Gas Emission Trends for Wastewater Treatment, 1990 to 1999 (Mt CO_2 eq)

Year	CH_4	N_2O	Total
1990	0.36	0.87	1.22
1991	0.36	0.88	1.24
1992	0.36	0.89	1.25
1993	0.37	0.90	1.27
1994	0.37	0.91	1.28
1995	0.38	0.92	1.30
1996	0.38	0.93	1.31
1997	0.39	0.94	1.33
1998	0.39	0.95	1.34
1999	0.40	0.95	1.35

Figure 3. Per Capita Greenhouse Gas Emissions Trend for Waste, 1990 to 1999



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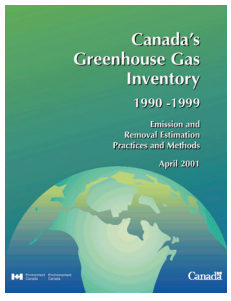

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