



# INFORMATION ON GREENHOUSE GAS SOURCES AND SINKS

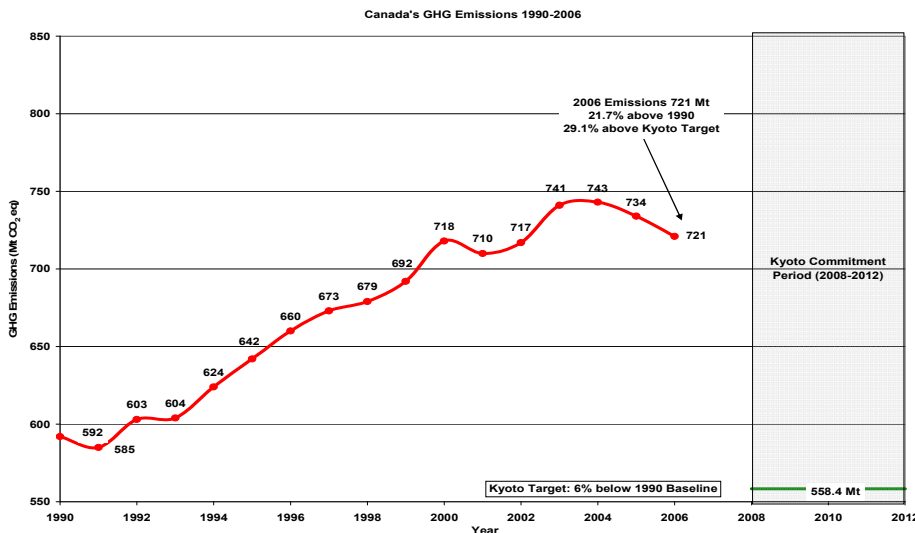
## Canada's 2006 Greenhouse Gas Inventory - A Summary of Trends

### 2006 Greenhouse Gas Emission Trends

Every year, Canada prepares a national inventory of human-induced greenhouse gas emissions from sources (eg. fuel combustion, industrial processes) and removals by sinks (e.g. growing plants and trees).

Total greenhouse gas emissions in Canada in 2006 were 721 megatonnes of carbon dioxide equivalent<sup>1</sup> (Mt of CO<sub>2</sub> eq), a decrease of 1.9% from 2005 levels, and 2.8% from 2003 levels. Overall, the long-term trend indicates that emissions in 2006 were about 22% above the 1990 total of 592 Mt. This trend shows a level 29.1% above Canada's Kyoto target of 558.4 Mt.

The overall decrease in emissions since 2003 is due primarily to a change in the mix of sources used for electricity production (reduced coal and increased hydro and nuclear generation), lower emissions from fossil fuel production (as a result of fuel switching and a smaller volume of oil refined) and reduced demand for heating fuels because of warmer winters in 2004, 2005 and 2006.



### National Inventory

As an Annex I Party (Developed Countries) to the United Nations Framework Convention on Climate Change (UNFCCC), Canada is required on an annual basis to prepare and submit a national inventory of human induced greenhouse gas emissions from sources (e.g. fuel combustion, industrial processes) and removals by sinks (e.g. growing plants and trees) in the form of a National Inventory Report (NIR) and a set of Common Reporting Format (CRF) tables. The National Inventory must meet international reporting guidelines and quality standards, and is reviewed annually by a UN Expert Review Team.

In addition, Annex I Parties are required to continuously improve the quality of their national greenhouse gas (GHG) inventory. As new information and data become available and more accurate methods are developed, previous estimates are updated to provide a consistent and comparable trend in emissions and removals.

This year's inventory covers the period from 1990 to 2006 and incorporates updates to previous years' submissions, based in large part on recommendations provided by the UN Expert Review Team that undertook an in-depth review of last year's submission in November 2007.

<sup>1</sup> Each greenhouse gas has a different potential to contribute to warming. We call it the Global Warming Potential (GWP). Scientists assign each gas a global warming potential, based on the gas' ability to contribute to climate change. Carbon dioxide is set as the baseline with a global warming potential of 1 (for example, the GWP for methane (CH<sub>4</sub>) is 21).

## Short-Term Comparisons: 2003–2006

Since 2003, total Canadian greenhouse gas emissions have decreased more than 20 Mt (2.8%). Although there were some large increases in areas such as road transportation and, to a smaller extent, the industrial processes sector, these were offset by larger declines from electricity and heat generation and a reduction in emissions from the fossil fuel industries, both of which are reversals of the long-term trend. Residential and commercial/institutional emissions fell significantly as well.

- Between 2003 and 2006, greenhouse gas emissions from electricity and heat generation fell by 18 Mt (13%). This drop is a result of reduced coal and oil generation, which was replaced by increased electricity from hydro, nuclear and, to some extent, wind power sources. Indeed, hydroelectric power generation increased throughout Canada as a result of higher water levels (precipitation in each of 2004, 2005 and 2006 was greater than the 30-year average). Overall, coal power generation in Canada fell by 6% between 2003 and 2006, its lowest level since 1997.
- The fossil fuel industries,<sup>2</sup> consisting of oil, gas and coal production, refining and transmission, showed a 4-Mt decrease in greenhouse gas emissions between 2003 and 2006. During the same period, the price of crude oil rose 75%. Although crude oil production increased by 6%, crude oil exports rose much more quickly (15%). Total domestic energy consumption fell by 1.3%.
- Emissions associated with oil refining alone fell by 3.2 Mt (17%). Although this was accompanied by a 2.5% reduction in the amount of crude oil refined in Canada, a switch in fuel consumption at refineries, from coke to less carbon-intensive natural gas, appears to have made the largest impact on emissions reductions in this sector.
- On average, Canadian homes and businesses have required lower amounts of energy for heating each successive year since 2003 because of generally milder winter temperatures. In 2006, heating degree days, an indicator of the necessity for space heating in reaction to the severity of cold weather, were down almost 13% from 2003 on a national basis. This fact almost certainly had an impact on fossil fuel consumption, specifically in the residential and commercial/institutional sectors where emissions declined by a total of 9.6 Mt or 12% since 2003.
- **Trends in Emissions and Emissions Intensities for Selected Years (1990–2006)**

	1990	1995	2000	2002	2003	2004	2005	2006
<b>Total GHG<sup>3</sup> (Mt)</b>	<b>592</b>	<b>642</b>	<b>718</b>	<b>717</b>	<b>741</b>	<b>743</b>	<b>734</b>	<b>721</b>
<i>Change Since 1990 (%)</i>	<i>N/A</i>	8.3	21.2	21.0	25.1	25.4	24.0	21.7
<i>Annual Change (%)</i>	<i>N/A</i>	2.8	3.7	0.9	3.4	0.2	-1.1	-1.9
<b>GDP (Billions 1997\$)</b>	<b>707</b>	<b>772</b>	<b>943</b>	<b>982</b>	<b>1001</b>	<b>1032</b>	<b>1061</b>	<b>1090</b>
<i>Change Since 1990 (%)</i>	<i>N/A</i>	9.3	33.4	38.8	41.6	46.0	50.0	54.2
<i>Annual Change (%)</i>	<i>N/A</i>	2.6	5.3	2.6	2.0	3.1	2.8	2.8
<b>GHG Intensity (Mt/\$B GDP)</b>	<b>0.84</b>	<b>0.83</b>	<b>0.76</b>	<b>0.73</b>	<b>0.74</b>	<b>0.72</b>	<b>0.69</b>	<b>0.66</b>
<i>Change Since 1990 (%)</i>	<i>N/A</i>	-0.9	-9.2	-12.9	-11.6	-14.1	-17.3	-21.1
<i>Annual Change (%)</i>	<i>N/A</i>	0.2	-1.5	-1.7	1.4	-2.8	-3.8	-4.6

Industrial Sector GDP by NAICS Code (1990–1996: Constant 1997\$; 1997–2006: Chained 1997\$) (millions), Statistics Canada 2008

<sup>2</sup> Sum of oil and gas industries, pipelines (Transportation) and fugitive releases.

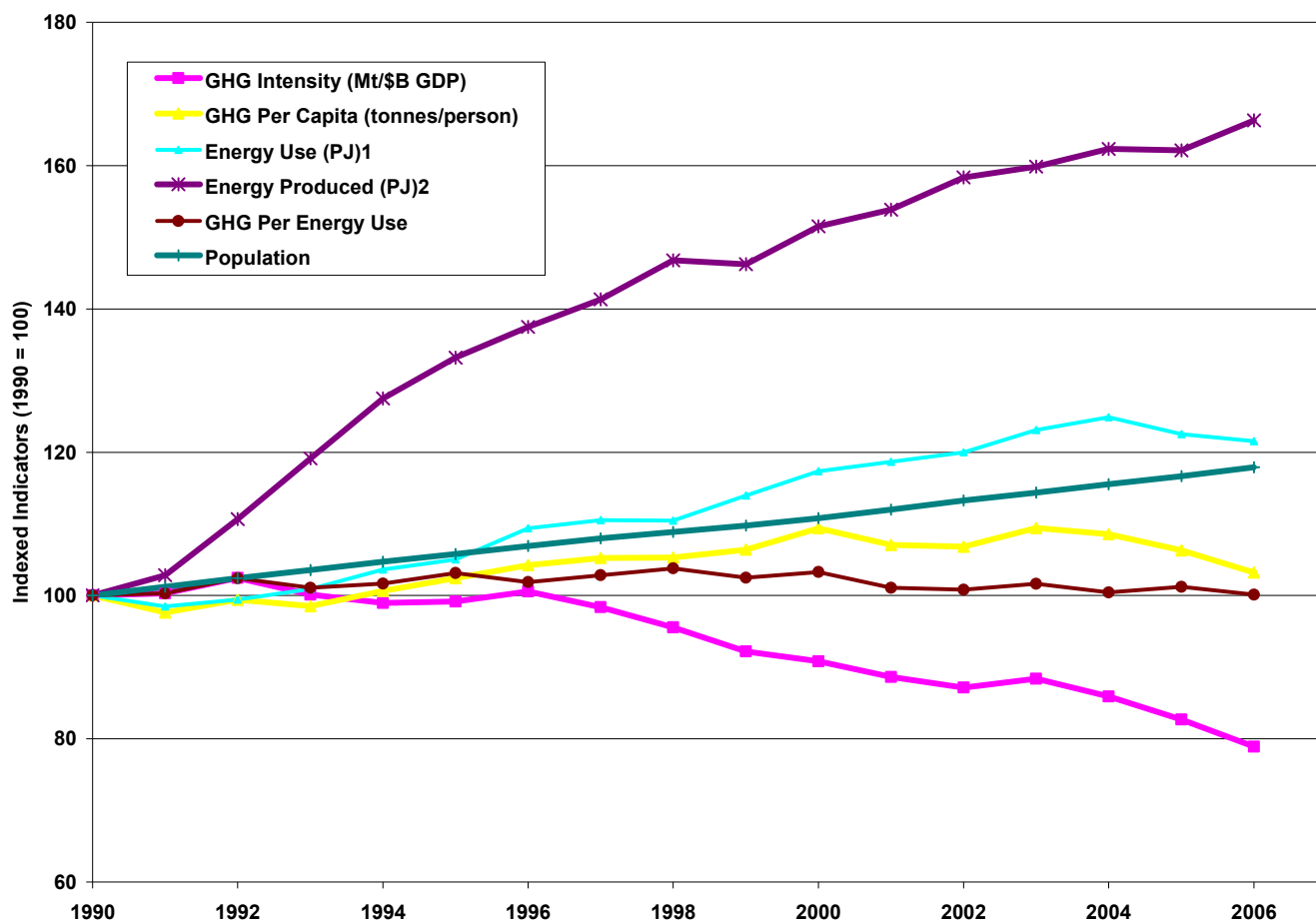
<sup>3</sup> Greenhouse Gases



## Long-Term Comparisons by Sector: 1990–2006

### Sector Trends

- Between 1990 and 2006, the net increase in Canada's annual greenhouse gas emissions totaled about 128 Mt.



<sup>1</sup> Statistics Canada's *Report on Energy Supply-Demand In Canada 2006* (57-003), Table S, Line 2 (Availability – Total Primary)

<sup>2</sup> Statistics Canada's *Report on Energy Supply-Demand In Canada 2006* (57-003), Natural Gas and Crude Oil

- Within the two energy sub-sectors, the greatest contributors to the overall increase were the 116% increase from light-duty gasoline trucks, the 23% increase from electricity and heat generation and the 91% increase from heavy-duty diesel vehicles. Much of the increase in the petroleum industries sector is attributable to the rapid growth in crude oil and natural gas exports over the period.
- The industrial processes, agriculture and waste sectors contributed to changes in emissions levels; they showed a 0.4 Mt decrease, a 12.4 Mt increase and a 2.8 Mt increase, respectively, since 1990.

### *Energy Industries*

- Emissions from energy industries (including electricity and heat generation, fossil fuel industries, combustion emissions from pipelines and fugitive releases) rose by about 65 Mt between 1990 and 2006. About two thirds of that increase (43.1 Mt) was in fossil fuel industries, pipelines and fugitive releases, a product of the 66% increase in oil and gas production over the period. The other third of the increase in the energy industries (21.6 Mt) was in electricity and heat generation, a result of greater electricity demand coupled with continuing increases in the use of coal-fired power generation since 1990.
- Fugitive releases (e.g. venting and flaring from oil production, methane leaks from pipelines) by themselves contributed to greenhouse gas emissions. The current estimates show an increase of 24.1 Mt between 1990 and 2006, a growth of about 57%. Much of this increase is the result of higher crude oil and natural gas exports.

### *Transportation Sector*

- Emissions in the transportation sector rose by about 44 Mt, or 31.7% from 1990 to 2006. Of particular note in this sector is a 24.1 Mt increase – more than 116% – in the emissions from light-duty gasoline trucks, reflecting the growing popularity of sport utility vehicles.
- Emissions from heavy-duty diesel vehicles increased 18.8 Mt over the period, indicative of greater heavy truck transport. Offsetting these increases were reductions of 6.9 Mt from gasoline-fueled cars and 1.4 Mt from alternatively fueled cars.

### *Residential Sector*

- Residential emissions were down by 3.2 Mt (8.5%) in 2006 as compared to 1990. Here, the impact of the long-term trend of improved energy standards for homes and the adoption of higher efficiency furnaces and other improved appliances has served to reduce emissions.

### *Industrial Processes Sector*

- Emissions in the industrial processes sector witnessed an overall decrease of 0.4 Mt, or 0.7% from 1990 to 2006. Although some sub-sectors within this group did show significant increases (e.g. emissions from use of hydrofluorocarbons in refrigeration and air conditioning, substitutes to ozone-depleting substances, grew by 4.7 Mt since 1995 – a 1000% increase), there were some significant reductions to make up for them.
- Emissions of nitrous oxide (N<sub>2</sub>O) – a greenhouse gas – from Canada's sole adipic acid manufacturing plant decreased by 9.5 Mt after the installation of N<sub>2</sub>O abatement technology. Also, process emissions from the aluminium industry decreased by 1.7 Mt, or 18.1% from 1990 to 2006, because of, in part, improved perfluorocarbon emission control technologies.

### *Agriculture Sector*

- In the agriculture sector, the expansion of the beef cattle, swine and poultry industries, along with increases in the application of synthetic nitrogen fertilizer in the Prairies, resulted in a long-term greenhouse gas emission growth of 12.4 Mt. This 25% increase for the agriculture sector contributed the equivalent of 8.6% to the overall national increase.

### *Waste Sector*

- From 1990 to 2006, greenhouse gas emissions from the waste sector increased by about 2.8 Mt, or 15.2% – slightly lower than the population growth of approximately 18%. This appears largely due to the generation of increasing amounts of waste in landfills. This increase would have been larger had landfill gas recovery projects and waste diversion programs (composting and recycling) not been implemented in Canada.

### *Land Use, Land-Use Change and Forestry Sector (not included in national totals)*

- The trend in emissions from sources and removals by sinks in land use, land-use change and forestry (i.e., agricultural soils, managed forests, wetlands and urban areas) suggests that the whole sector can turn from a sink to a source, which means that this whole sector tends to emit emissions overall instead of removing carbon dioxide (CO<sub>2</sub>) from the atmosphere. In 2006, this sector amounted to a net source of emissions of 31.3 Mt. Trends in the sector are primarily driven by changes occurring in the forests. Changes are dominated by the erratic pattern of forest fires, which can hide smaller human associated activities, such as the harvesting of wood. For example, between 1990 and 1998 the amount of carbon removed in harvested wood biomass increased by 50%; it has since stabilized at an annual average of around 42 Mt of carbon, corresponding to annual emissions of 155 Mt of carbon dioxide (CO<sub>2</sub>). Nevertheless, the impact of major forest disturbances in recent years, notably the mountain pine beetle infestation in Western Canada and large areas burned by wildfires in 1995, 1998, 2002, 2003 and 2004, undoubtedly dominate.
- The cropland subcategory includes the effect of agricultural practices on carbon dioxide emissions and removals from arable soils (soils suitable for growing crops) and the impact of converting forest and grassland to cropland. In 2006, carbon sequestration in arable soils more than made up for emissions from lands converted to cropland; there was a net reduction of 1.4 Mt. The continued adoption of no-till and reduced-tillage practices and the reduction of summer fallow have resulted in a steadily increasing ability of cultivated soils to behave like sinks (sinks remove carbon dioxide from the atmosphere).
- Forest land converted to cropland, wetlands and settlements amount to additional emissions of about 19 Mt in 2006, down from 27 Mt in 1990 for the same land-use changes. Looking at the conversion of forest and grassland to cropland alone shows a steady decrease in GHG emissions from 15 Mt in 1990 to 8 Mt in 2006.

### ***Provincial/Territorial Greenhouse Gas Emissions***

It is important to note that Canada's greenhouse gas emissions vary from region to region. This is linked to the distribution of natural resources and heavy industry within the country. While the use of natural resources and industrial products benefits all of North America, emissions from producing them tend to be concentrated in particular geographic regions. Thus, certain areas of Canada tend to produce more emissions because of their economic and industrial structure and their relative dependence on fossil fuels for producing energy.

## Sectoral Greenhouse Gas Emission Summary

Source Categories	1990	2003	2005	2006	2003 to 2006		1990 to 2006	
					Change	Change	Change	Change
	kt CO <sub>2</sub> eq				Absolute	Percent	Absolute	Percent
<b>TOTAL</b>	<b>592,000</b>	<b>741,000</b>	<b>734,000</b>	<b>721,000</b>	<b>-20,403</b>	<b>-2.8%</b>	<b>128,350</b>	<b>21.7%</b>
<b>ENERGY</b>	<b>470,000</b>	<b>609,000</b>	<b>596,000</b>	<b>583,000</b>	<b>-25,702</b>	<b>-4.2%</b>	<b>113,463</b>	<b>24.2%</b>
<b>a. Stationary Sources</b>	<b>282,000</b>	<b>360,000</b>	<b>338,000</b>	<b>324,000</b>	<b>-35,704</b>	<b>-9.9%</b>	<b>42,595</b>	<b>15.1%</b>
Electricity and Heat Generation	95,400	135,000	125,000	117,000	-18,000	-13.3%	21,578	22.6%
Fossil Fuel Industries	52,000	74,000	69,000	68,000	-5,657	-7.7%	16,224	31.4%
Mining	6,190	15,700	15,600	16,500	828	5.3%	10,352	167.3%
Iron and Steel	6,500	6,380	6,480	6,380	-2	0.0%	-121	-1.9%
Non Ferrous Metals	3,190	3,200	3,270	3,050	-158	-4.9%	-143	-4.5%
Chemical	7,100	5,810	6,340	6,490	680	11.7%	-608	-8.6%
Pulp and Paper	13,700	9,060	7,180	5,950	-3,104	-34.3%	-7,786	-56.7%
Cement	3,690	4,080	4,590	4,850	772	18.9%	1,158	31.3%
Other Manufacturing	20,700	20,800	19,400	19,600	-1,216	-5.8%	-1,037	-5.0%
Construction	1,870	1,300	1,360	1,300	8	0.6%	-566	-30.3%
Commercial & Institutional	25,700	37,800	36,700	33,400	-4,319	-11.4%	7,735	30.1%
Residential	44,000	45,000	42,000	40,000	-5,253	-11.7%	-3,718	-8.5%
Agriculture & Forestry	2,390	2,200	1,980	1,920	-282	-12.8%	-473	-19.8%
<b>b. Transportation</b>	<b>150,000</b>	<b>180,000</b>	<b>190,000</b>	<b>190,000</b>	<b>9,220</b>	<b>5.0%</b>	<b>46,730</b>	<b>32.1%</b>
Domestic Aviation	6,400	7,200	8,600	8,400	1,205	16.7%	2,067	32.5%
Light Duty Gasoline Vehicle	45,800	41,400	39,900	38,900	-2,489	-6.0%	-6,918	-15.1%
Light Duty Gasoline Trucks	20,700	40,500	43,100	44,800	4,311	10.7%	24,083	116.4%
Heavy Duty Gasoline Vehicles	7,810	6,050	6,300	6,280	230	3.8%	-1,536	-19.7%
Motorcycles	146	226	251	259	33	14.6%	113	76.9%
Light Duty Diesel Vehicles	355	398	432	433	35	8.8%	79	22.2%
Light Duty Diesel Trucks	707	1,880	2,130	2,330	445	23.6%	1,620	229.2%
Heavy Duty Diesel Vehicles	20,700	34,100	37,900	39,400	5,338	15.6%	18,767	90.7%
Propane & Natural Gas Vehicles	2,200	820	720	800	-11	-1.3%	-1,410	-63.7%
Railways	7,000	6,000	6,000	6,000	591	10.2%	-568	-8.2%
Domestic Marine	5,000	6,100	6,400	5,800	-392	-6.4%	715	14.2%
Off Road Gasoline	7,000	8,000	7,000	7,000	-1,073	-13.8%	20	0.3%
Off Road Diesel	20,000	20,000	20,000	20,000	438	2.0%	6,938	46.1%
Pipelines	6,900	9,100	10,100	9,660	558	6.1%	2,762	40.0%
<b>c. Fugitives</b>	<b>42,700</b>	<b>66,000</b>	<b>65,500</b>	<b>66,800</b>	<b>783</b>	<b>1.2%</b>	<b>24,138</b>	<b>56.6%</b>
Coal Mining	2,000	900	700	600	-236	-27.0%	-1,274	-66.6%
Oil	4,180	5,770	5,650	5,710	-60	-1.0%	1,533	36.7%
Natural Gas	12,900	20,100	20,800	21,300	1,291	6.4%	8,452	65.5%
Venting	19,300	33,700	32,800	33,100	-563	-1.7%	13,861	72.0%
Flaring	4,400	5,600	5,500	6,000	351	6.3%	1,567	35.6%
<b>INDUSTRIAL PROCESSES</b>	<b>54,800</b>	<b>51,200</b>	<b>54,800</b>	<b>54,400</b>	<b>3,238</b>	<b>6.3%</b>	<b>-376</b>	<b>-0.7%</b>
<b>a. Mineral Production</b>	<b>8,300</b>	<b>9,100</b>	<b>9,500</b>	<b>9,600</b>	<b>482</b>	<b>5.3%</b>	<b>1,282</b>	<b>15.5%</b>
<b>b. Chemical Industry</b>	<b>17,000</b>	<b>8,500</b>	<b>10,000</b>	<b>9,000</b>	<b>540</b>	<b>6.4%</b>	<b>-7,707</b>	<b>-46.1%</b>
<b>c. Metal Production</b>	<b>19,500</b>	<b>17,200</b>	<b>16,200</b>	<b>16,800</b>	<b>-405</b>	<b>-2.4%</b>	<b>-2,700</b>	<b>-13.9%</b>
<b>d. Consumption of Halocarbons and SF<sub>6</sub></b>	<b>2,300</b>	<b>6,000</b>	<b>6,400</b>	<b>6,600</b>	<b>611</b>	<b>10.2%</b>	<b>4,325</b>	<b>187.5%</b>
<b>e. Other &amp; Undifferentiated Production</b>	<b>8,000</b>	<b>10,000</b>	<b>12,000</b>	<b>12,000</b>	<b>2,010</b>	<b>19.2%</b>	<b>4,424</b>	<b>55.1%</b>
<b>SOLVENT &amp; OTHER PRODUCT USE</b>	<b>170</b>	<b>220</b>	<b>180</b>	<b>320</b>	<b>101</b>	<b>45.9%</b>	<b>147</b>	<b>84.3%</b>
<b>AGRICULTURE</b>	<b>49,000</b>	<b>61,000</b>	<b>63,000</b>	<b>62,000</b>	<b>1,148</b>	<b>1.9%</b>	<b>12,352</b>	<b>25.0%</b>
<b>a. Enteric Fermentation</b>	<b>18,000</b>	<b>23,000</b>	<b>25,000</b>	<b>24,000</b>	<b>673</b>	<b>2.9%</b>	<b>6,179</b>	<b>34.4%</b>
<b>b. Manure Management</b>	<b>6,100</b>	<b>7,900</b>	<b>8,200</b>	<b>8,000</b>	<b>110</b>	<b>1.4%</b>	<b>1,965</b>	<b>32.4%</b>
<b>c. Agriculture Soils</b>	<b>25,000</b>	<b>29,000</b>	<b>29,000</b>	<b>30,000</b>	<b>365</b>	<b>1.2%</b>	<b>4,209</b>	<b>16.5%</b>
<b>WASTE</b>	<b>18,000</b>	<b>20,000</b>	<b>21,000</b>	<b>21,000</b>	<b>811</b>	<b>4.0%</b>	<b>2,764</b>	<b>15.2%</b>
<b>a. Solid Waste Disposal on Land</b>	<b>17,000</b>	<b>19,000</b>	<b>19,000</b>	<b>20,000</b>	<b>780</b>	<b>4.1%</b>	<b>2,773</b>	<b>16.3%</b>
<b>b. Wastewater Handling</b>	<b>780</b>	<b>910</b>	<b>940</b>	<b>930</b>	<b>15</b>	<b>1.7%</b>	<b>149</b>	<b>19.1%</b>
<b>c. Waste Incineration</b>	<b>400</b>	<b>230</b>	<b>240</b>	<b>240</b>	<b>16</b>	<b>7.1%</b>	<b>-158</b>	<b>-39.4%</b>
<b>LAND USE, LAND-USE CHANGE AND FORESTRY</b>	<b>-110,000</b>	<b>12,000</b>	<b>-8,400</b>	<b>31,000</b>	<b>19,833</b>	<b>172.3%</b>	<b>137,796</b>	<b>129.4%</b>
<b>a. Forest Land</b>	<b>-130,000</b>	<b>500</b>	<b>-18,000</b>	<b>23,000</b>	<b>22,225</b>	<b>4462.1%</b>	<b>156,360</b>	<b>117.0%</b>
<b>b. Cropland</b>	<b>14,000</b>	<b>640</b>	<b>-860</b>	<b>-1,400</b>	<b>-2,045</b>	<b>-321.4%</b>	<b>-15,065</b>	<b>-110.3%</b>
<b>c. Grassland</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>
<b>d. Wetlands</b>	<b>4,000</b>	<b>2,000</b>	<b>2,000</b>	<b>2,000</b>	<b>-289</b>	<b>-11.9%</b>	<b>-2,232</b>	<b>-51.1%</b>
<b>e. Settlements</b>	<b>9,000</b>	<b>8,000</b>	<b>8,000</b>	<b>8,000</b>	<b>-58</b>	<b>-0.7%</b>	<b>-1,268</b>	<b>-13.8%</b>

Notes:

<sup>1</sup>National totals exclude all GHGs from the Land Use, Land-use Change and Forestry sector.

<sup>2</sup> Absolute and percent changes shown are based on UNROUNDED values..

<sup>3</sup> Due to rounding, totals may not add up.