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**COMPLIANCE COMMITTEE**

**CC/ERT/ARR/2010/25  
25 March 2010**

**Report of the individual review of the annual submission of Canada  
submitted in 2009**

**Note by the secretariat**

The report of the individual review of the annual submission of Canada submitted in 2009 was published on 1 March 2010. For purposes of rule 10, paragraph 2, of the rules of procedure of the Compliance Committee (annex to decision 4/CMP.2, as amended by decision 4/CMP.4), the report is considered received by the secretariat on the same date. This report, FCCC/ARR/2009/CAN, contained in the annex to this note, is being forwarded to the Compliance Committee in accordance with section VI, paragraph 3, of the annex to decision 27/CMP.1.





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**Report of the individual review of the annual submission of Canada  
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\* In the symbol for this document, 2009 refers to the year in which the inventory was submitted, and not to the year of publication.

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## I. Overview

### A. Introduction

1. This report covers the centralized review of the 2009 annual submission of Canada, coordinated by the UNFCCC secretariat, in accordance with decision 22/CMP.1. The review took place from 14 to 19 September 2009 in Bonn, Germany, and was conducted by the following team of nominated experts from the UNFCCC roster of experts: generalist – Ms. Katarina Mareckova (European Community); energy – Mr. Christo Christov (Bulgaria), Mr. Takeshi Enoki (Japan) and Mr. Norbert Nziramasanga (Zimbabwe); industrial processes – Mr. Riccardo De Lauretis (Italy) and Ms. Valentina Idrissova (Kazakhstan); agriculture – Mr. Jorge Alvarez (Peru) and Ms. Anna Romanovskaya (Russian Federation); land use, land-use change and forestry (LULUCF) – Mr. Emil Cienciala (Czech Republic) and Mr. Xiaoquan Zhang (China); and waste – Ms. Medea Inashvili (Georgia) and Mr. Seungdo Kim (Republic of Korea). Ms. Romanovskaya and Mr. Zhang were the lead reviewers. The review was coordinated by Ms. Ruta Bubniene (UNFCCC secretariat).
2. In accordance with the “Guidelines for review under Article 8 of the Kyoto Protocol” (decision 22/CMP.1), a draft version of this report was communicated to the Government of Canada, which provided comments that were considered and incorporated, as appropriate, into this final version of the report.

### B. Emission profiles and trends

3. In 2007, the main GHG in Canada was carbon dioxide (CO<sub>2</sub>), accounting for 79.0 per cent of total GHG emissions<sup>1</sup> expressed in CO<sub>2</sub> eq, followed by methane (CH<sub>4</sub>) (13.4 per cent) and nitrous oxide (N<sub>2</sub>O) (6.4 per cent). Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF<sub>6</sub>) collectively accounted for 1.2 per cent of the overall GHG emissions in the country. The energy sector accounted for 82.2 per cent of the total GHG emissions, followed by agriculture (8.0 per cent), industrial processes (6.9 per cent), waste (2.9 per cent) and solvent and other product use (0.04 per cent). Total GHG emissions amounted to 747,041.31 Gg CO<sub>2</sub> eq and increased by 26.2 per cent between the base year<sup>2</sup> and 2007. The long-term trends in the emissions from the different sectors fluctuated over the time series: total GHG emissions decreased by 3.0 per cent between 2003 and 2006, but increased by 4.0 per cent between 2006 and 2007. This variation in the emission trends has been reasonably well explained in the national inventory report (NIR).
4. Tables 1 and 2 show total GHG emissions by gas and by sector, respectively. Table 1 includes emissions from Annex A sources only and excludes emissions and removals from the LULUCF sector.

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<sup>1</sup> In this report, the term “total GHG emissions” refers to the aggregated national GHG emissions expressed in terms of CO<sub>2</sub> eq excluding LULUCF, unless otherwise specified.

<sup>2</sup> “Base year” refers to the base year under the Kyoto Protocol, which is 1990 for all gases. The base year emissions include emissions from Annex A sources only.

**Table 1. Total greenhouse gas emissions by gas, 1990–2007<sup>a</sup>**

Greenhouse gas	Gg CO <sub>2</sub> eq							Change base year–2007 (%)
	Base year <sup>b</sup>	1990	1995	2000	2005	2006	2007	
CO <sub>2</sub>	455 844.23	455 844.23	488 308.54	559 877.59	569 068.26	558 317.84	590 204.47	29.5
CH <sub>4</sub>	73 844.85	73 844.85	88 508.28	97 574.79	101 221.64	101 433.37	99 968.43	35.4
N <sub>2</sub> O	50 093.48	50 093.48	54 501.51	48 011.09	49 621.95	47 905.71	47 958.41	–4.3
HFCs	767.25	767.25	479.41	2 985.39	5 223.31	5 044.19	4 939.19	543.8
PFCs	6 538.83	6 538.83	5 489.59	4 311.08	3 313.31	2 580.17	2 188.69	–66.5
SF <sub>6</sub>	4 703.93	4 703.93	3 707.30	4 341.49	2 518.49	2 896.69	1 782.12	–62.1

<sup>a</sup> “Total greenhouse gas emissions” includes emissions from Annex A sources only (excludes emissions/removals from the LULUCF sector).

<sup>b</sup> “Base year” refers to the base year under the Kyoto Protocol, which is 1990 for all gases. The base year emissions includes emissions from Annex A sources only.

**Table 2. Greenhouse gas emissions by sector, 1990–2007**

Sector	Gg CO <sub>2</sub> eq							Change base year–2007 (%)
	Base year <sup>a</sup>	1990	1995	2000	2005	2006	2007	
Energy	469 467.68	469 467.68	509 831.24	586 941.87	593 053.47	580 805.19	614 266.39	30.8
Industrial processes	54 827.06	54 827.06	56 638.84	51 139.56	55 056.20	54 608.74	51 426.59	–6.2
Solvent and other product use	174.92	174.92	208.03	241.87	179.03	322.36	319.41	82.6
Agriculture	48 463.75	48 463.75	54 509.92	58 596.64	61 582.54	60 827.96	59 650.70	23.1
LULUCF	NA	–51 565.45	198 387.78	–80 320.51	41 413.22	41 367.47	45 453.28	NA
Waste	18 859.16	18 859.16	19 806.60	20 181.49	21 095.71	21 613.73	21 378.22	13.4
Other	NA	NA	NA	NA	NA	NA	NA	NA
<b>Total (with LULUCF)</b>	NA	540 227.12	839 382.41	636 780.92	772 380.17	759 545.45	792 494.59	NA
<b>Total (without LULUCF)</b>	591 792.58	591 792.58	640 994.63	717 101.43	730 966.96	718 177.98	747 041.31	26.2

*Abbreviations:* LULUCF = land use, land-use change and forestry, NA = not applicable.

<sup>a</sup> “Base year” refers to the base year under the Kyoto Protocol, which is 1990 for all gases. The base year emissions includes emissions from Annex A sources only.

### C. Annual submission and other sources of information

5. The 2009 annual inventory submission was submitted on 17 April 2009; it contains a complete set of common reporting format (CRF) tables for the period 1990–2007, and an NIR. Canada also submitted information required under Article 7, paragraph 1, of the Kyoto Protocol, including: information on activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, in the NIR only, and information on changes in the national system and in the national registry. Furthermore, the standard electronic format (SEF) tables were not submitted. In the NIR and in response to the standard independent assessment report (SIAR), Canada explained that since its national registry had not transferred or acquired any Kyoto Protocol units in 2008, no information has been reported with regard to the SEF tables. The annual submission was submitted in accordance with decision 15/CMP.1. The Party indicated that the 2009 submission is also its voluntary submission under the Kyoto Protocol.

6. In response to questions raised by the expert review team (ERT) during the review, on 26 October 2009 Canada submitted revised information on the completeness of its annual inventory submission (see para. 10 below). Where necessary, the ERT also used the previous years' submissions during the review.

7. In addition, the ERT used the SIAR, Parts I and II, to review information on the accounting of Kyoto Protocol units and on the national registry.<sup>3</sup>

8. During the review, Canada provided the ERT with additional information. The documents concerned are not part of the annual submission but are in many cases referenced in the NIR. The full list of materials used during the review is provided in the annex to this report.

#### Completeness of inventory

9. The inventory covers, in general, all source and sink categories for the period 1990–2007 and is complete in terms of years and geographical coverage. However, the ERT identified minor gaps in the reporting on the energy, industrial processes, agriculture, waste and LULUCF sectors. Canada has provided explanations for emissions reported as not estimated (“NE”) in CRF table 9(a).

10. In response to a question raised by the ERT, the Party indicated that it would, in its next annual submission, address the completeness of its inventory, in particular by: conducting a study to develop estimates for CH<sub>4</sub> and N<sub>2</sub>O emissions from the categories in the industrial processes sector (see para. 56 below); and assessing emissions from field burning of agricultural residues and examining other not-estimated categories in the agriculture sector (see para. 67 below) and in the waste sector (see para. 90 below). Canada indicated that once these analyses have been completed and reviewed, where appropriate, these potential categories will be included in its annual submission. Canada also provided an explanation for its choice of the country-specific emission factor (EF) used in the estimation of CH<sub>4</sub> emissions from wastewater (see para. 92 below).

11. The ERT recommends that Canada improve the completeness of its inventory by its next annual submission,<sup>4</sup> especially for those categories in which emissions are known to occur in the country and for

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<sup>3</sup> The SIAR, Parts I and II, is prepared by an independent assessor in line with decision 16/CP.10 (paragraphs 5(a), 6(c) and 6(k)), under the auspices of the international transaction log (ITL) administrator using procedures agreed in the Registry System Administrators Forum. Part I is a completeness check of the submitted information relating to the accounting of Kyoto Protocol units (including the SEF tables and their comparison report) and to national registries. Part II contains a substantive assessment of the submitted information and identifies any potential problem regarding information on the accounting of Kyoto Protocol units and the national registry. The SIAR is not publicly available.

<sup>4</sup> “Next annual submission” refers to the 2010 submission or subsequent submissions for which it is feasible to make the recommended changes.



which methodologies to estimate emissions are available in the Intergovernmental Panel on Climate Change (IPCC) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance) and the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines). The ERT also recommends that the Party, when reporting data on emissions for a given category for the first time, ensure that these data are provided for the entire time series and that the rationale for the choice of methods, EFs and other parameters is clearly explained in the NIR.

#### **D. Main findings**

12. The 2009 submission is generally of a high quality. In its 2009 submission, Canada's inventory continues to have been prepared and reported generally in line with the Revised 1996 IPCC Guidelines, the IPCC good practice guidance and the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF). However, the ERT found that Canada could improve the transparency of its inventory submission by providing better descriptions of methodologies and the rationale behind selected country-specific parameters; better documenting CO<sub>2</sub> emissions/removals from forest land and from forest land converted to cropland; and updating its uncertainty analysis, in particular for the LULUCF sector.

13. The ERT identified several instances in the energy, industrial processes, agriculture, waste and LULUCF sectors, where emissions/removals have been reported as "NE" (e.g. CH<sub>4</sub> from silicon carbide, carbon black, ethylene, dichloroethylene, styrene, methanol (see para. 56 below) ; CH<sub>4</sub> from enteric fermentation and manure management for mules and asses(see para. 71), N<sub>2</sub>O from manure management for anaerobic lagoon and from manure management for daily spread (see para 73 below), N<sub>2</sub>O from field burning of agriculture residues (see para. 76 below); CH<sub>4</sub> from unmanaged waste disposal sites, CH<sub>4</sub>, N<sub>2</sub>O from industrial wastewater, domestic and commercial wastewater/sludge, CH<sub>4</sub> from municipal waste burning (see para. 90 below). In response to questions raised by the ERT, Canada provided an explanation of the steps being taken to estimate these currently not-estimated emissions/removals for future submissions. Noting that there are no methodologies to estimate N<sub>2</sub>O emissions from industrial wastewater, N<sub>2</sub>O emissions from sludge from domestic and commercial wastewater or CH<sub>4</sub> from waste incineration provided in the Revised 1996 IPCC Guidelines or in the IPCC good practice guidance, the ERT recommends that Canada estimate emissions from those categories for which methodologies are available in these documents.

14. The Party has submitted, in part, on a voluntary basis supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol in accordance with Part I of the annex to decision 15/CMP.1 (information on activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, in the NIR only, and on changes in the national registry). According to the NIR and the response to the SIAR, since Canada's national registry did not transfer or acquire any Kyoto Protocol units in 2008, the SEF tables were not submitted. The Party has also not submitted on a voluntary basis information on adverse impacts under Article 3, paragraph 14, of the Kyoto Protocol.

15. Canada has reported that there are no changes to its national system. The national system continues to perform its required functions as set out in the annex to decision 19/CMP.1.

16. Canada reported changes to its national registry system. The national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 15/CMP.1, and continues to adhere to the technical standards for data exchange between registry systems in accordance with relevant Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP) decisions. However, at the time of review, the ERT identified that information on the national registry was not yet publicly available. During the review, Canada informed the ERT that this information will be made public as soon as the national registry goes live.

17. In the course of the review, the ERT formulated a number of recommendations relating to: both the consistency with the Revised 1996 IPCC Guidelines and the transparency of the reporting on the energy sector (see paras. 40, 41, 44, 45, 47 and 52 below); the completeness of the reporting on the industrial processes sector (see paras. 56 and 57 below); the completeness and transparency of the reporting on, and the uncertainty analysis for, the LULUCF sector (see paras. 81 and 85 below); and the transparency of the reporting on the waste sector (see para. 92 below).

18. The ERT acknowledges that Canada has implemented a number of the recommendations made in previous reviews, such as the improved implementation of its quality assurance/quality control (QA/QC) plan and the documentation of its identification of managed forests. However, the ERT noted that some recommendations made in previous reviews have not been followed up and recommends that Canada address these recommendations in its next annual submission. The ERT encourages Canada to continue structuring its reporting, in its next annual submission, following the annotated outline of the NIR, and the guidance contained therein, that can be found on the UNFCCC website.<sup>5</sup>

## **E. A description of the institutional arrangements for inventory preparation, including the legal and procedural arrangements for inventory planning, preparation and management**

### **1. Overview**

19. The ERT concluded that the national system continued to perform its required functions. The NIR described the national system and institutional arrangements for the preparation of the inventory. Environment Canada has overall responsibility for the national inventory. Other agencies and organizations are also involved in the preparation of the inventory (see para. 21 below). The NIR also reported that no change had been made to the national system since the previous annual submission (see chapter VII. B. of this report).

### **2. Inventory planning**

20. Environment Canada's GHG Division develops, reports and publishes the NIR and the CRF tables. It also ensures the quality of the inventory and the archiving systems; performs trend analyses; publishes fact sheets; and acts as a clearing house for information on GHGs and technical guidance on their quantification. The GHG Division also manages Canada's GHG Emissions Reporting program, which requires facilities emitting over 100 kt CO<sub>2</sub> eq/year to report their emissions annually. Furthermore, the GHG Division collaborates with the country's provincial and territorial governments on the collection of data on GHGs.

21. Other organizations are also involved in the preparation of the inventory as data providers. Canada's national statistical agency, Statistics Canada, provides Environment Canada with underlying activity data (AD) for use in the estimation of GHG emissions from the energy, industrial processes and agriculture sectors. Natural Resources Canada (NRCan) provides expertise on energy, and collects and provides AD on mineral production, ethanol consumption and wood residues. The Canadian Forest Service, NRCan and Agriculture and Agri-Food Canada are responsible for developing key parameters required for the reporting of GHG emissions and removals from the LULUCF and agriculture sectors. Individual divisions of Environment Canada also contribute data on waste and waste management. When required, consulting groups and universities conduct in-depth studies, for example on the updating of EFs. Furthermore, a bilateral agreement between industrial associations (Aluminium and Electricity Associations) has been concluded for the provision of supplementary data on the industrial processes sector.

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<sup>5</sup><[http://unfccc.int/files/national\\_reports/annex\\_i\\_ghg\\_inventories/reporting\\_requirements/application/pdf/annotated\\_nir\\_outline.pdf](http://unfccc.int/files/national_reports/annex_i_ghg_inventories/reporting_requirements/application/pdf/annotated_nir_outline.pdf)>.

### 3. Inventory preparation

#### Key categories

22. Canada has reported a key category tier 1 analysis, both level and trend assessment, as part of its 2009 submission. The key category analysis performed by the Party and that performed by the secretariat<sup>6</sup> produced different results, owing to the more detailed level of disaggregation used by Canada. Canada has included the LULUCF sector in its key category analysis, which was performed in accordance with the IPCC good practice guidance and the IPCC good practice guidance for LULUCF.

#### Uncertainties

23. The Party stated that information on uncertainty was not available for all subcategories. Canada has not performed an uncertainty analysis for the entire inventory since its 2003 inventory submission. For that analysis, a tier 2 approach was applied and the results have been transparently reported in the NIR. Since that entire inventory analysis, Canada has also conducted some category-specific uncertainty studies (e.g. on fugitive emissions, ammonia production and manure management). Canada uses the results of its uncertainty analyses to prioritize improvements to its inventory. The ERT noted that methods, EFs and AD had been updated for some categories and, in some cases, uncertainty parameters had been developed or reconfirmed based on the updated methodologies. Canada is also considering reassessing the applicability of, and/or updating, other existing uncertainty values, and the Party plans to perform uncertainty analyses on the up-to-date inventory data in the near future. The ERT recommends that Canada perform uncertainty analyses on the data in its most recent submission and present the results in its next annual submission.

#### Recalculations and time-series consistency

24. Recalculations have been performed and reported for the time series 1990–2006 in accordance with the IPCC good practice guidance. The recalculations have been sufficiently explained in the relevant sector chapters of the NIR (except for the LULUCF sector) and in CRF table 8(b). The recalculations were undertaken to take into account improvements in AD and EFs in all sectors, and they resulted in the improvement of the quality and time-series consistency of the inventory. The impact of recalculations to the total GHG emissions is minor: decreases by 0.08 per cent in 1990 and by 0.34 per cent in 2006.

25. As regards total GHG emissions including LULUCF, the recalculations resulted in a slight increase (by 1.0 per cent) in the emission estimate for 2006 and in a more significant increase for 1990 (by 11.2 per cent). The main reason for the increase in the estimated emissions for 1990 is the decrease in CO<sub>2</sub> removals from forest land (by 39.1 per cent) owing to the change in the methodology used to estimate the area of harvested forest (shifting from the use of area data to volume data as an input to the modelling environment). For 2006, the biggest changes in estimates as a result of recalculations were observed for CO<sub>2</sub> emissions/removals from forest land (increase by 105.7 per cent), from cropland (increase by 54.1 per cent) and from wetlands (increase by 32.6 per cent), but the impact of the recalculations on the estimates of total national emissions was minor.

#### Verification and quality assurance/quality control approaches

26. Information on the implementation of a QA/QC plan and on QA/QC procedures has been provided in the NIR in line with the “Guidelines for the preparation of national communications by Parties included

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<sup>6</sup> The secretariat identified, for each Party, the categories that are key categories in terms of their absolute level of emissions, applying the tier 1 level assessment as described in the IPCC good practice guidance for LULUCF. Key categories according to the tier 1 trend assessment were also identified for Parties that provided a full set of CRF tables for the base year or period. Where the Party performed a key category analysis, the key categories presented in this report follow the Party’s analysis. However, they are presented at the level of aggregation corresponding to a tier 1 key category assessment conducted by the secretariat.

in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories” (hereinafter referred to as the UNFCCC reporting guidelines). The Party has a QA/QC plan in place in accordance with decision 19/CMP.1 and the IPCC good practice guidance, and implements sector-specific controls.

27. Environment Canada’s GHG Division conducts QA/QC activities annually and is committed to improving the data and methods used for the inventory in collaboration with industrial plants, the country’s provincial and territorial administrations, academia and the international community. The compiled inventory is reviewed internally, while some components of the inventory are reviewed externally by experts, government agencies and provincial/territorial governments. Comments received as a result of these reviews are documented and, where appropriate, incorporated into the final version of the annual submission. However, the ERT noted that some country-specific parameters (e.g. the rate of CH<sub>4</sub> generation from anaerobic decomposition, and the net loss in soil carbon for forest land converted to cropland in western Canada) might require additional verification in order to ensure that the related emissions were not underestimated.

28. According to the information provided in the NIR, Canada’s QA/QC plan also includes a multi-year schedule for the implementation of its QA/QC activities in the future. Over a three-year cycle, all categories will undergo a tier 1 QC check. Some tier 2 QC, QA and verification activities should also be performed every year, based on a multi-year schedule, with the objective of achieving more comprehensive assessments of the quality of the entire inventory over a seven-year time frame. This multi-year schedule is expected to be implemented within the next few years. The ERT noted these planned improvement in the implementation of Canada’s QA/QC plan compared with the previous year’s submission and encourages Canada to continue its efforts to implement its multi-year QA/QC schedule within the next few years.

29. The ERT also noted minor inconsistencies in the reporting on agriculture sector in the NIR and recommends that Canada improve the accuracy of its reporting in its next annual submission (see para. 70 below).

#### Transparency

30. Canada’s inventory is generally transparent and the NIR includes information on key categories, methods, data sources, recalculations, trends, uncertainty estimates, QA/QC procedures and verification activities, which provides a good basis for the review of the inventory. However, the ERT noted that some additional information could further improve the transparency of the reporting, such as: data on auto producers provided separately under the energy sector; information on the type of waste incineration carried out and the consequent energy recovery; and an explanation for the high inter-annual variability in the removals from the LULUCF sector (see para. 77 below).

#### 4. Inventory management

31. Canada has a centralized archiving system at Environment Canada’s GHG Division, which includes the archiving of all information required for the inventory, including information on QA/QC procedures and their results. However, the ERT noted that the NIR does not include specific information about the characteristics of this archiving system and recommends that Canada include such information in the NIR of its next annual submission.

### **F. Follow-up to previous reviews**

32. The ERT acknowledges that Canada has implemented a number of the recommendations made in previous reviews, such as the improved implementation of its QA/QC plan, the provision of information on its commitment period reserve, and the documentation of its identification of managed forests. In addition, Canada incorporated new data into, and refined, the methodologies used to estimate emissions from the energy sector (more appropriate, provincially based natural gas CO<sub>2</sub> EFs and a refined methodology for

estimating fugitive emissions from natural gas extraction), the industrial processes sector (country-specific EFs for lime production), the agriculture sector (more representative data on animals) and the waste sector (revised estimates of landfill gas, based on updates to regionally defined parameters).

33. However, the ERT noted that some recommendations made in previous reviews have not been followed up and recommends that Canada address these recommendations in its next annual submission. The recommended improvements identified by the ERT are listed in paragraph 35 below.

## **G. Areas for further improvement**

### **1. Identified by the Party**

34. The 2009 NIR identifies several areas for improvement, which are based on the recommendations made both by national experts and in the previous review reports:

- (a) The development of a programme that will ensure Canada's ability to make incremental improvements to its uncertainty assessment on an annual basis, and the improvement of its uncertainty estimates for individual sectors;
- (b) The conduct of a study on the fuel parameters for coal (as indicated by Canada in response to a request made by the ERT during the review), the update of fuel parameters and EFs by updating region-specific factors, and the improvement of methods and AD used for selected categories;
- (c) The improvement of completeness and transparency of the reporting on the LULUCF sector (see paras. 81 and 84 below).

### **2. Identified by the expert review team.**

35. The ERT identifies the following cross-cutting issues for improvement:

- (a) The improvement of completeness by calculating estimates of all emissions that occur in the country (e.g. CH<sub>4</sub> emissions from chemical industry, and emissions/removals from grassland, other land, cropland converted to settlements and wetland converted to settlements);
- (b) The improvement of transparency by providing descriptions of the methodologies used and the rationale behind the selection of country-specific parameters, as well as better documentation of the CO<sub>2</sub> emissions/removals from forest land and from forest land converted to cropland;
- (c) The updating of the uncertainty analysis using the most recent inventory data, and the further development of uncertainty estimates for the LULUCF sector, particularly for forest land;
- (d) Structuring the reporting following the annotated outline of the NIR, in order to facilitate the review of the information required under the Kyoto Protocol in the next annual submission.

36. Recommended improvements relating to specific categories are presented in the relevant sector chapters of this report.

## II. Energy

### A. Sector overview

37. The energy sector is the main sector in the GHG inventory of Canada. In 2007, emissions from the energy sector amounted to 614,266.39 CO<sub>2</sub> eq, or 82.2 per cent of total GHG emissions. Since 1990, emissions have increased by 30.8 per cent. The key drivers for the rise in emissions are the increasing demand for electricity, the increasing use of fossil fuels in the energy generation mix, the increase in the total vehicle fleet, and a shift in the light-duty vehicles purchased from cars to trucks. Within the sector, 32.5 per cent of the emissions were from transport, followed by 31.9 per cent from energy industries, 13.2 per cent from other sectors and 11.8 per cent from manufacturing industries and construction. Fugitive emissions from oil and natural gas accounted for 10.4 per cent and fugitive emissions from solid fuels for 0.1 per cent.

38. In its 2009 submission, Canada has provided recalculations of its estimates in the energy sector for the period 1990–2006. These recalculations resulted in an overall decrease in the estimated sectoral emissions for 2006 by 0.39 per cent (from 583,099.57 to 580,805.19 Gg CO<sub>2</sub> eq). The largest decrease in the estimated emissions was observed for energy industries (by 0.83 per cent, from 184,845.26 to 183,317.05 Gg CO<sub>2</sub> eq), and this was due to the change in the methodology – the estimations of CO<sub>2</sub> emissions from combustion of natural gas were made first at provincial level and then summed up to the national level. Other changes resulting from the recalculations for 2006 estimates include a 1.46 per cent increase in the estimated emissions from manufacturing industries and construction (from 64,179.54 to 65,116.68 Gg CO<sub>2</sub> eq), a 0.36 per cent decrease in the estimated emissions from transport (from 192,124.73 to 191,432.48 Gg CO<sub>2</sub> eq) and a 1.60 per cent decrease in the estimate of fugitive emissions from oil and gas (from 66,151.83 to 65,090.98 Gg CO<sub>2</sub> eq).

39. Canada has submitted a complete GHG inventory and CRF tables. Emissions from some minor categories are reported as “NE”, such as the CH<sub>4</sub> and N<sub>2</sub>O emissions from other fuel (tires) combustion in the manufacture industries and construction. The ERT noted that Canada is making efforts to assess these emissions.

40. Canada’s fuel categories are based on the physical state of fuel that is not in line with the Revised 1996 IPCC Guidelines. The ERT reiterates the recommendation by previous review teams that Canada report the fuel categories following the headings and sub-headings in chapter 1.2, volume 1, of the Revised 1996 IPCC Guidelines.

41. Emissions associated with autoproduction under public electricity and heat production are reported under this category; this is inconsistent with the Revised 1996 IPCC Guidelines, which require the emissions to be reported under the specific categories of industry sector. During the review, Canada informed the ERT that Environment Canada is working towards a methodology to resolve this issue. The ERT recommends that Canada increase the transparency of the inventory for the autoproduction of electricity and report a separate estimation of emissions from autoproduction for the entire time series.

42. Tier 1 QC checks were performed for all categories in the energy sector, including conducting a review of the estimation model, AD, EFs, time-series consistency, transcription errors, reference material, conversion factors, and unit labelling, as well as calculating sample emission estimates. In addition, certain verification activities were performed during the preparation of the model for estimating emissions from road transportation, and QA measures were taken with regard to the estimations of fugitive emissions. As a result of these QC checks, one energy conversion factor for petroleum coke was revised. A detailed QA/QC checklist was submitted to the ERT in response to its request. The ERT recommends that Canada develop and apply sector-specific QA/QC procedures to improve the accuracy of its inventory in its next annual submission.

43. Improvement plans for all categories in the energy sector have been developed on the basis of recommendations made in both internal and external review processes, including the UNFCCC expert reviews, and from collaborative work between inventory sectoral experts and industry, other governmental agencies and academia. These improvements include a review of the coal EFs, the development of a tier 3 model to estimate emissions from civil aviation, the review of the residential biomass model, the review of the characteristics of fuel wood, and the revision of the model used to estimate fugitive emissions. The ERT recommends that Canada also take into consideration issues identified by previous ERTs, such as the substantiated allocation of navigational fuels to both domestic and international use (see paras. 46–47 below). Noting Canada's initiation of a study on fuel parameters, the ERT encourages Canada to continue updating the fuel parameters and EFs used by updating its region-specific factors.

## **B. Reference and sectoral approaches**

### **1. Comparison of the reference approach with the sectoral approach and international statistics**

44. Canada has presented a comparison of the emission estimates calculated using the reference and the sectoral approach. The NIR presents a more complete assessment than the CRF tables, with a difference between the estimates calculated using the two approaches of 1.4 per cent for 2007. The corresponding CRF table contains errors since non-energy use of fuels was not excluded from the calculations, resulting in a 5.1 per cent difference between the two approaches. The ERT recommends that Canada harmonize the information provided in the NIR with that in the CRF table, and follow the instructions contained in the Revised 1996 IPCC Guidelines to exclude non-energy use of fuels from the reference and sectoral approaches.

45. In CRF table 1.A(b), owing to the fact that stock changes have not been reported, the figures for jet kerosene in 2007 do not balance, with the figure for international bunkers being greater than that for net imports. Canada acknowledged this error during the review and intends to correct it in its next annual submission. The correction of the error in the carbon content of sub-bituminous coal following the recommendation of the previous ERT has not been explained. The ERT recommends that Canada explain these revisions in its next annual submission.

### **2. International bunker fuels**

46. The amount of fuel used in international aviation was estimated using a model based on the tonne-kilometre reported by Canadian airlines for both domestic and international flights. During the review, Canada informed the ERT that the accuracy of allocation of fuels in the model could be improved, given that the data is available in Canada. Canada also informed the ERT that it is now developing a new model that will enable the estimation of emissions from aviation applying a tier 3a method using high resolution flight data. The ERT welcomes these planned improvements and recommends their timely implementation.

47. The AD for international navigation were taken as the value of fuels sold to foreign marine vessels. The domestic/international allocation of the fuels was based on the flag of the vessel, which is not in line with the IPCC good practice guidance, as some Canadian vessels are involved in international navigation. The ERT reiterates the recommendation made in previous review reports that Canada make an effort to allocate these fuels to domestic and international navigation separately in accordance with the IPCC good practice guidance.

## **C. Key categories**

### **1. Stationary combustion: liquid, solid and gaseous fuels – CO<sub>2</sub>**

48. For this category, the EFs were estimated based on source-specific data on fuel quality. However, the parameters were based on studies that were carried out in or before 2000. The ERT encourages Canada to regularly check the validity and accuracy of the data used for its estimations.

49. AD on road transport were collected using both a top-down and a bottom-up approach. Data collected using the bottom-up approach were less accurate than those collected using the top-down approach as they were based on periodic surveys. Canada may wish to use the most accurate approach for data collection in its next annual submission.

50. The CO<sub>2</sub> implied emission factor (IEF) for petroleum refining (26.29–40.26 t CO<sub>2</sub>/TJ) is among the lowest of the reporting Parties (26.29–66.29 t CO<sub>2</sub>/TJ) for 1990–2007. During the review, Canada explained that this was due to the fact that emissions from petroleum refining with flaring had been subtracted from the total emissions. Fugitive emissions were subtracted from the estimated emissions for this category to avoid double-counting. However, the equivalent energy use was not subtracted, resulting in an artificially low CO<sub>2</sub> IEF. The ERT recommends that Canada correctly report the AD for this category in the CRF in its next annual submission.

### 2. Road transportation: liquid fuels – CH<sub>4</sub> and N<sub>2</sub>O

51. Emissions from road transportation were derived from a database that accounts for fuel allocation by vehicle type and vehicle technology. Estimates of fuel allocation were matched to total fuel consumption by including the data in the database in the Party's Mobile Greenhouse Gas Emission Model (MGEM), which matches calculated fuel consumption to reported fuel consumption. Some data on the composition and evolution of the vehicle fleet were available. In order to improve its fuel allocation and the emission estimates for this category, the ERT recommends that Canada develop a system to monitor the market penetration of vehicles by type; improve its use of data on the fuel consumption of on-road vehicles; and transparently document how the MGEM operates.

### 3. Railways: liquid fuels – CO<sub>2</sub>

52. Fuel combustion in railways includes biodiesel. Canada accounted for the fossil fuel component of the biodiesel in liquid fuels used for railway transport by splitting the relevant rows in CRF table 1.A.5. This allows for the use of a different EF for diesel burnt as biodiesel as for diesel burnt as diesel. The ERT recommends that Canada explain more in detail this split in its next annual submission.

## **D. Non-key categories**

### 1. Fugitive emissions: solid fuel transformation – CO<sub>2</sub> and CH<sub>4</sub>

53. The coke production process yields coke oven gas that is either recovered or flared and coal tars and liquids that are used as either fuel or feedstock. In CRF table 1.A(b), Canada has indicated that coke production does occur in the country, but the Party has not reported on the carbon stored from the use of coal tars and liquids or on the fugitive release or flaring of coke oven gas. In response to questions raised by the ERT, Canada indicated that coke production is integrated into steel production; hence, all by-products of coke production are used for energy. Therefore, if emissions from the combustion of the by-products of coke production have been reported under energy combustion, the emissions under solid fuel transformation should be reported as included elsewhere ("IE") instead of as "NE". The ERT encourages Canada, in its future submissions, to elaborate its reporting on coke production and the use of its by-products, and revise its use of the notation keys as described above.

### 2. Fugitive emissions: oil and natural gas – CO<sub>2</sub>

54. The ERT noted that Canada has provided information on the extended oil-recovery process that is used to store CO<sub>2</sub> underground. This is a new area and any information provided will help to improve the transparency of the applied methods. Therefore, the ERT encourages Canada, in its subsequent annual submissions, to continue to provide new information on this area as it becomes available.



### III. Industrial processes and solvent and other product use

#### A. Sector overview

55. In 2007, emissions from the industrial processes sector amounted to 51,426.59 Gg CO<sub>2</sub> eq, or 6.9 per cent of total GHG emissions, while emissions from solvent and other product use amounted to 319.41 Gg CO<sub>2</sub> eq, or 0.04 per cent of total GHG emissions. Since 1990, emissions from the industrial processes sector have decreased by 6.2 per cent and those from solvent and other product use have increased by 82.6 per cent, as a result of different trends in industrial production. In particular, N<sub>2</sub>O emissions from chemical industry have decreased by 77.6 per cent, whereas CO<sub>2</sub> emissions from the category other have increased by 63.1 per cent, from chemical industry – by 24.9 per cent, from metal production – by 13.9 and from mineral products – by 13.7 per cent. Within the industrial processes sector, 26.9 per cent of the emissions were from metal production, followed by 25.5 per cent from other, 18.3 per cent from mineral products, 17.2 per cent from chemical industry and 12.0 per cent from consumption of halocarbons and SF<sub>6</sub>.

56. Canada has reported CH<sub>4</sub> emissions from silicon carbide, carbon black, ethylene, dichloroethylene, styrene and methanol as “NE”. In its NIR, Canada has reported that it is planning a study to determine the level of CH<sub>4</sub> emissions from carbide and petrochemical production. In response to the question raised by the ERT, Canada indicated that a study to develop estimates of CH<sub>4</sub> and N<sub>2</sub>O emissions from the categories in the industrial processes sector that are not currently included in the inventory is under preparation. Terms of reference for the study have been developed and the proposals for the preparation of the study are expected to be received in autumn 2009. Once these studies have been completed and reviewed, where appropriate, Canada intends to include these potential emission sources in its inventory. The ERT recommends that Canada estimate CH<sub>4</sub> emissions from the currently not-estimated categories under chemical industry in its next annual submission.

57. Other source categories reported as “NE” include CO<sub>2</sub> emissions from asphalt roofing, road paving with asphalt, adipic acid production, and solvent and other product use of chemical products; CH<sub>4</sub> and N<sub>2</sub>O emissions from ammonia production and other sources in the industrial processes sector; N<sub>2</sub>O emissions from ethylene, fire extinguishers and aerosol cans; CH<sub>4</sub> emissions from ferroalloys and aluminium production; PFC emissions from aerosols; and HFC and PFC emissions from electrical equipment. No methodologies or EFs are provided in the Revised 1996 IPCC Guidelines for these emission categories. N<sub>2</sub>O emissions from aerosol cans should be reported under category 3.D.3, N<sub>2</sub>O from aerosol cans instead of under category 3.D.5g other (solvents and other product use).

58. Canada estimated emissions from the industrial processes sector in accordance with the Revised 1996 IPCC Guidelines and the IPCC good practice guidance. Following the recommendation of the previous ERT, Canada developed a country-specific EF for CO<sub>2</sub> emissions from lime production, and provided updated emission estimates using a tier 2 approach. The recalculations resulted in changes to the emission estimates for this category ranging between –0.6 and +0.7 per cent for the time series 1990–2006.

#### B. Key categories

##### 1. Cement production – CO<sub>2</sub>

59. Canada used the IPCC tier 2 approach and default EFs to estimate CO<sub>2</sub> emissions from cement production. A tier 2 QC check showed that the availability of country-specific information on cement kiln dust (CKD) and the calcium oxide content of clinker would improve the estimates. The NIR reports that a quality assurance programme carried out by the Cement Association of Canada is planned to determine the country-specific lime content of clinker and the CKD correction factor, which are expected to be available for the 2011 submission. The ERT recommends that Canada update its country-specific EFs using the information obtained from these planned activities.

## 2. Ammonia production – CO<sub>2</sub>

60. Canada used the method contained in the Revised 1996 IPCC Guidelines and a country-specific EF to estimate CO<sub>2</sub> emissions from ammonia production. Noting Canada's planned improvement to determine the amount of natural gas used by the plants in order to update the average national EF, the ERT recommends that Canada collect data on natural gas consumption from ammonia producers and review the estimation of the EF with a view to detecting possible changes over time.

61. In the CRF tables, under CO<sub>2</sub> recovered in ammonia production, Canada has reported the amount of CO<sub>2</sub> recovered and used to produce urea that is exported. In the NIR, however, no information has been provided on the assumptions, methodology and AD used to estimate the amount of CO<sub>2</sub> recovered. Canada explained that it did not use the amount of recovered CO<sub>2</sub> used to produce exported urea in the calculation of net CO<sub>2</sub> emissions, and that the CO<sub>2</sub> emissions reported in the CRF tables are the total emissions and not the net emissions from ammonia production. The ERT recommends that Canada report in the CRF tables only CO<sub>2</sub> emissions and recovery from ammonia production actually occurring and provide more transparent information on its estimates of CO<sub>2</sub> emissions from this category, including the amount of recovered CO<sub>2</sub> used to produce exported urea, in the NIR of its next annual submission.

## 3. Iron and steel production – CO<sub>2</sub>

62. Canada used the tier 2 method contained in the IPCC good practice guidance to estimate CO<sub>2</sub> emissions from iron and steel production. Default IPCC values were used for the carbon content of the ore and pig iron, and for the EF for carbon released by electric arc furnace electrodes. The emissions associated with the use of reducing agents, other than metallurgical coke, were estimated in the category other (industrial processes) and reported undifferentiated from other sources. Noting that Canada plans to develop country-specific values for the carbon content of steel and pig iron, and to report emissions from reducing agents other than coke under this category, the ERT encourages Canada to implement and report on this improvement plan in its next annual submissions.

## 4. Consumption of halocarbons and SF<sub>6</sub> – HFCs

63. One of the recommendations made during previous reviews was that Canada should use country-specific EFs for selected activities under this category and apply linear interpolation to replace missing values rather than using the data of one specific year. Canada reported its plans to develop country-specific EFs for the use of HFCs by carrying out a survey to acquire more detailed data from the relevant companies, and to provide currently missing AD using linear interpolation. The ERT recommends that Canada follow up this survey and take into account the results in its next annual submission.

### **C. Non-key categories**

#### Consumption of halocarbons and SF<sub>6</sub> – SF<sub>6</sub>

64. To estimate SF<sub>6</sub> emissions from electrical equipment, Canada assumed that all SF<sub>6</sub> purchased from gas distributors was used to replace the SF<sub>6</sub> released into the atmosphere through leakage. This method, which corresponds to a modified tier 1 approach, may be acceptable for the time being, since neither manufacturing nor disposal of equipment takes place in Canada, but may lead to an overestimation of emissions in the future, when disposal of this equipment will take place. Noting that Canada plans to develop a higher-tier method for its 2011 submission, the ERT recommends that the Party do so.

## **IV. Agriculture**

### **A. Sector overview**

65. In 2007, emissions from the agriculture sector amounted to 59,650.70 Gg CO<sub>2</sub> eq, or 8.0 per cent of total GHG emissions. Since the base year, emissions have increased by 23.1 per cent. The key drivers

for the rise in emissions are the increases in the number of non-dairy cattle, in milk production and in the use of synthetic fertilizers. Within the sector, 49.0 per cent of the emissions were from agricultural soils, followed by 37.9 per cent from enteric fermentation and 13.1 per cent from manure management.

66. Most of the categories and emissions in the agriculture sector have been reported in accordance with the IPCC good practice guidance, with exception of some minor subcategories that have been not estimated. Country-specific EFs were used to estimate emissions from agricultural soils, manure management and enteric fermentation. The ERT commends Canada for providing additional documentation during the review to improve the transparency of its reporting on this sector.

67. Appropriate QA/QC procedures were followed for the agriculture sector. Uncertainties were estimated at the category and subcategory levels. However, some minor subcategories have been reported as “NE” (see paras. 71 and 73 below).

68. In response to questions raised by the ERT during the review Canada noted that it is currently assessing the possibility of estimating emissions from field burning of agricultural residues; once a full assessment has been made, the estimates will be included in the inventory. Canada noted that it plans to provide estimates for these categories of the agriculture sector in its 2011 submission. The ERT recommends that Canada collect relevant data and report these emissions in its next annual submission.

69. The ERT noted that, except for emissions from cultivation of agricultural soils (histosols), updated information obtained from Canada’s 2006 Census of Agriculture<sup>7</sup> was used in the 2009 submission, including estimated N<sub>2</sub>O emissions from agricultural soils, and updated data on the mean body weight of cattle, nitrogen (N) excretion rates, milk production and fat content of milk. The recalculations resulted in a decrease in the total sectoral emissions by 2.1 per cent for 1990 and by 1.6 per cent for 2006.

70. The ERT identified some inconsistencies in the reporting on the agriculture sector, related to references provided in the NIR. For example, annex A3.3.5 to the NIR indicates that N<sub>2</sub>O emissions from animal waste management systems (AWMS) were estimated using equation A3-6 (in the NIR), whereas equation A3-9 was actually used; the description on page 321 of the NIR refers to table A3-17 as the table which summarizes the distribution of manure management systems in Canada by animal category, whereas table A3-17 actually presents CH<sub>4</sub> emission factors for enteric fermentation for cattle from 1990 to 2007. During the review Canada provided additional information and eliminated the inconsistencies. The ERT encourages Canada to strengthen the QA/QC procedures for the reporting on the agriculture sector in order to avoid such inconsistencies in its future annual submissions.

## **B. Key categories**

### **1. Enteric fermentation – CH<sub>4</sub>**

71. Canada estimated CH<sub>4</sub> emissions from enteric fermentation using an IPCC tier 2 method for cattle, whereas for buffalo, sheep, swine, goats, camels and llamas, and horses a tier 1 method and default EFs were used. The ERT notes that it is good practice to estimate emissions from key categories using higher-tier methods. The population of mules and asses was considered negligible by the Party and reported as “NE”. During the review, in response to the request made by the ERT, Canada informed the ERT that this information is neither collected nor reported since mules and asses are not raised for commercial purposes in Canada, and indicated its intention to report this subcategory as not occurring (“NO”) in its next annual submission.

72. For non-dairy cattle, the average gross energy intake estimated by the Party (195 MJ/head/day) is the highest of among the reporting Parties (100 to 189 MJ/head/day). Meanwhile, the average CH<sub>4</sub> conversion rate for non-dairy cattle (0.05 per cent) is one of the lowest of among the reporting Parties

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<sup>7</sup> Statistics Canada (2007a).

(0.058 to 8.36 per cent) and also lower than the IPCC default value (0.06) for developed countries. The ERT recommends that Canada review these values and explain the reasons for them in the NIR of its next annual submission.

## 2. Manure management – CH<sub>4</sub> and N<sub>2</sub>O

73. Some AWMS (anaerobic lagoons, daily spread and dry lot) have been reported as “NE”. The Party indicated that information on these AWMS was not available and that it had assumed that they were negligible as emission sources. However, Canada has reported that AWMS reported under the category other account for 0.1 per cent of AWMS. Being negligible, anaerobic lagoons, daily spread and dry lot should have made up less than 0.1 per cent of AWMS. Therefore, the ERT recommends that Canada reassess this issue, include developing estimates for this type of AWMS in its improvement plan, and report emissions from these sources in its next annual submission.

74. In the 2009 submission, the distributions for AWMS (liquid systems, solid storage, pastures and paddock, and other systems) were revised for all animals and for the entire time series. No explanation has been provided in the NIR, except for a reference to a study conducted by Marinier et al. (2004).<sup>8</sup> During the review, the ERT asked for clear explanations and documentation to support this new information, such as the relationship between table A3-22 of the NIR: Percentage of Manure Handled by AWMS for Canada, excluding British Columbia, and the information provided in CRF table 4.B. No response was provided by the Party. The ERT recommends that Canada provide, in its next annual submission, a detailed description of how AWMS are broken down by region.

## 3. Direct soil emissions – N<sub>2</sub>O

75. It was assumed that field under summer-fallow generated the same amount of emissions as field under summer cropping, and this amount was then adjusted to account for background emissions. The ERT reiterates the recommendation of the previous ERT that, given that this source of emissions is not identified in the IPCC good practice guidance, Canada provide the empirical basis for the estimation of these emissions in the NIR of its next annual submission.

## C. Non-key categories

### Field burning of agricultural residues – CH<sub>4</sub> and N<sub>2</sub>O

76. The Party has not reported the fraction of crop residue burned in CRF table 4.Ds2 for emissions from agricultural soils, although, according to CRF table 4.F, this activity did occur in Canada. The Party has indicated its intention to include these emissions in its 2010 annual submission. The ERT recommends that Canada report a value for FracBURN in its next annual submission.

## V. Land use, land-use change and forestry

### A. Sector overview

77. In 2007, the LULUCF sector in Canada was a net source of 45,453.28 Gg CO<sub>2</sub> eq, increasing national net emissions by about 6.1 per cent in 2007. Net GHG emissions by sources and removals by sinks in the LULUCF sector displayed high inter-annual variability and the LULUCF sector shifted between being a net sink and a net source of emissions throughout the time series. This high variability in emissions/removals is associated with the immediate impact of forest wildfires. Within the sector, 38,348.58 Gg CO<sub>2</sub> eq were from forest land, followed by 7,840.43 Gg CO<sub>2</sub> eq from settlements and

<sup>8</sup> Marinier M, Clark K, Wagner-Riddle C. 2004. *Improving Estimates of Methane Emissions Associated with Animal Waste Management Systems in Canada by Adopting an IPCC Tier-2 Methodology*. Final report submitted to the Greenhouse Gas Division, Environment Canada, by the Department of Land Resource Science, University of Guelph, Guelph, Ontario, Canada.

2,654.85 Gg CO<sub>2</sub> eq from wetlands. 3,390.58 Gg CO<sub>2</sub> eq were offset by removals from cropland. Emissions/removals from grassland, other land, cropland converted to settlements, and wetland converted to settlements have been reported as “NE”, “IE” or “NO”. Canada has indicated in its NIR that efforts are being made to improve the data on land-use changes for these categories.

78. The ERT notes that Canada is continuing with its multi-year effort to substantially improve its estimates for the LULUCF sector within the framework of its monitoring, accounting and reporting system (MARS) for LULUCF. IPCC tier 2 and 3 methods and country-specific parameters were applied when preparing the estimates for the LULUCF sector. For example, CO<sub>2</sub> emissions and removals from forest land were estimated on the basis of a carbon budget model, CBM-CFS3, while the CENTURY model was used to derive EFs for CO<sub>2</sub> emissions and removals from cropland. The ERT also notes that work within MARS for LULUCF is expected to continue for several years to come.

79. The uncertainty analysis was implemented for all categories in the LULUCF sector except for forest land. Tier 1 and tier 2 QA/QC procedures were applied to the estimations of all emissions by sources and removals by sinks reported. The ERT notes that an in-depth uncertainty analysis within the CBM-CFS3 modelling framework is under way and that Canada intends to report the results of this analysis in its future submissions.

80. Canada’s MARS for LULUCF uses a consistent spatial framework for the geographical referencing of all LULUCF estimates to ‘reporting zones’. This will be used to report estimates of afforestation, reforestation and deforestation under Article 3, paragraph 3, of the Kyoto Protocol, and to report on cropland management as elected by Canada under Article 3, paragraph 4, of the Kyoto Protocol. This framework is compliant with the method used to identify the lands using the IPCC tier 1 method by which multiple land units subject to afforestation, reforestation, deforestation or cropland management are encompassed within established geo-referenced boundaries (the reporting zones).

81. Within its MARS for LULUCF, Canada differentiates between a temporary loss of forest (owing to harvesting or forest disturbance) and deforestation through a system of visual interpretation of satellite imagery supported by ancillary data. The ERT noted that Canada plans, in its next inventory submission, to provide additional information in order to fulfil the requirements specific to LULUCF under the Kyoto Protocol, as detailed in the annex to decision 15/CMP.1.

## **B. Key categories**

### **1. Forest land remaining forest land**

82. There is a significant difference between the sectoral emissions/removals reported in the 2008 and 2009 submissions, mainly in the category forest land remaining forest land, owing to the data on harvest that was input into the model shifting from area to volume data, which is considered to improve the consistency between the harvest statistics and the emission estimates. This change resulted in a decrease in the estimate of CO<sub>2</sub> removals for the early years and an increase in the estimate of CO<sub>2</sub> emissions for the later years of the reporting period, but did not change the overall trend in emissions/removals. However, how this shift in data resulted in the significant above-mentioned changes in estimated emissions/removals has been poorly described in the NIR. The ERT recommends that Canada provide a transparent explanation in its next annual submission.

### **2. Cropland remaining cropland – CO<sub>2</sub>**

83. In 2007, cropland remaining cropland amounted to a net sink of 10,928.06 Gg CO<sub>2</sub>. Country-specific emission/removal factors derived from the CENTURY model and AD derived from Canada’s most recent Census of Agriculture, with a high degree of spatial disaggregation, were used to estimate CO<sub>2</sub> emissions/removals from mineral soils. The ERT notes that the Party is continuing to improve its emission/removal factors and AD for CO<sub>2</sub> emissions/removals from mineral soils. An IPCC

tier 1 method was used to estimate CO<sub>2</sub> emissions from cultivation of organic soils. As it is a good practice to use a higher tier methods for key categories, the ERT recommends that Canada use higher-tier methods to estimate emissions from this category.

### 3. Land converted to cropland – CO<sub>2</sub>

84. In 2007, land converted to cropland amounted to a net source of 7,283.40 Gg CO<sub>2</sub>, mainly from forest land converted to cropland. CO<sub>2</sub> emissions/removals from wetlands and settlements converted to cropland have been reported as “NE”. A combination of tier 2 and tier 3 methods was applied for the estimation of CO<sub>2</sub> emissions from forest land and grassland converted to cropland. It is assumed that no loss of soil organic carbon occurs upon conversion of forest land to cropland in western Canada. As reported in CRF table 5.B, the carbon stock in mineral soils increases for forest land converted to cropland in some areas of western Canada owing to conservation tillage after the land conversion, as clarified by Canada in response to questions raised by the ERT. The ERT recommends that Canada provide adequate justification for and verification of the above-mentioned assumption and transparently document it in the NIR of its next annual submission.

### 4. Land converted to settlements – CO<sub>2</sub>

85. In 2007, land converted to settlements was a net source of 6,795.02 Gg CO<sub>2</sub>, owing mainly to emissions from forest land converted to settlements. A tier 2 method and country-specific EFs were used to estimate CO<sub>2</sub> emissions/removals from land converted to settlements. While remote sensing is the core method to derive land areas converted to settlements, in the case of forest land conversion estimates were derived based on the fate of carbon in all pools in disturbed forest stands; for non-forest land, only the fate of carbon in the aboveground biomass pool is monitored. Emissions from cropland converted to settlements and from other land converted to settlements have been reported as “NE”, although the NIR indicates that the conversion of cropland to settlements is known to occur in the country. The ERT recommends that Canada estimate emissions from these two land-use conversions in its future annual submissions.

### 5. Land converted to wetlands – CO<sub>2</sub>

86. In 2007, land converted to wetlands was a net source of 766.00 Gg CO<sub>2</sub>, owing mainly to emissions from forest land converted to wetlands. A tier 2 method and country-specific EFs were used to estimate CO<sub>2</sub> emissions/removals owing to peat extraction and flooding. CO<sub>2</sub> emissions from cropland converted to wetlands and from grassland converted to wetlands have been reported as “NE”.

## C. Non-key categories

### Biomass burning – CH<sub>4</sub> and N<sub>2</sub>O

87. CH<sub>4</sub> and N<sub>2</sub>O emissions from wildfires on grassland remaining grassland have been reported as “NE”. Given that grassland is extensively managed in Canada, as described in the NIR, and emissions from wildfires may occur even if no net carbon gain or loss occurs, the ERT encourages Canada to include estimates of CH<sub>4</sub> and N<sub>2</sub>O emissions from wildfires on managed grassland in its future annual submissions.

## VI. Waste

### A. Sector overview

88. In 2007, emissions from the waste sector amounted to 21,378.22 Gg CO<sub>2</sub> eq, or 2.9 per cent of total GHG emissions. Over the period 1990–2007, emissions increased by 13.4 per cent, owing to the increase in Canada’s population. Within the sector, 94.5 per cent of the emissions were from solid waste disposal on land, followed by 4.3 per cent from wastewater handling and 1.2 per cent from waste incineration. Also over the period 1990–2007, emissions from solid waste disposal on land and those from

wastewater handling increased by 14.0 per cent and 26.0 per cent, respectively, while emissions from waste incineration decreased by 37.9 per cent, owing mainly to the closure of aging incinerators.

89. An increasing trend in GHG emissions is less significant in this sector than in terms of the national total, owing to a decrease in the rate of solid waste generation per capita and a steady increase in the recovery rate of CH<sub>4</sub> from landfills.

90. The CH<sub>4</sub> emissions from unmanaged waste disposal sites, CH<sub>4</sub> and N<sub>2</sub>O emissions from industrial wastewater, CH<sub>4</sub> and N<sub>2</sub>O emissions from sludge under domestic and commercial wastewater, and CH<sub>4</sub> emissions from municipal waste incineration have been reported as “NE”. During the review, in response to the questions raised the ERT, Canada indicated that it is examining how best to include these potential emission sources in its inventory in a timely manner. The ERT recommends that Canada estimate these currently not-estimated emissions from the categories for which methodologies are provided in the Revised 1996 IPCC Guidelines and in the IPCC good practice guidance, and report them in its next annual submission.

## B. Key categories

### Solid waste disposal on land – CH<sub>4</sub>

91. Canada applied the IPCC tier 2 methodology with a country-specific CH<sub>4</sub> generation potential and methane generation constant. Canada assumed, based on two studies, referenced in the NIR, that the provincial methane generation constants would be linearly dependent upon precipitation. As methane generation constant is typically expressed as a function of the waste types and temperatures, the ERT recommends that Canada, in its next annual submission, explain that precipitation is a dominant factor in determining the methane generation constant.

## C. Non-key categories

### 1. Wastewater handling – CH<sub>4</sub>

92. Canada applied a country-specific EF (4.015 kg CH<sub>4</sub>/person/day) to estimate CH<sub>4</sub> emissions from municipal wastewater treatment. The rate of CH<sub>4</sub> generation from the anaerobic decomposition of organic matter in wastewater (0.22 kg CH<sub>4</sub>/kg the five-day biochemical oxygen demand (BOD<sub>5</sub>) is lower than the IPCC default value (0.6 kg CH<sub>4</sub>/kg BOD) by a factor of almost three. During the review Canada provided the ERT with several relevant references<sup>9</sup> for the value but the ERT could not assess the content of these references and analyse if the chosen value is well substantiated. The ERT encourages Canada to verify this country-specific CH<sub>4</sub> generation rate and provide elaborated description on how the value has been obtained in its next annual submission.

### 2. Wastewater handling – N<sub>2</sub>O

93. Canada used the IPCC default method to estimate N<sub>2</sub>O emissions from human sewage, based on data on per capita protein intake obtained from Statistics Canada. N<sub>2</sub>O emissions from domestic and industrial wastewater treatment have been reported under the human sewage subcategory. The ERT recommends that Canada reprot as “IE” its N<sub>2</sub>O emissions from sludge in its next submission and indicate where these emissions are included.

<sup>9</sup> Thorneloe SA. 1993. *Methane from Wastewater Treatment*. United States Environmental Protection Agency, presented at the International IPCC Workshop ‘Methane and Nitrous Oxide’, the Netherlands, February 1993.  
Toprak H. 1992. Methane Emissions Originating from the Anaerobic Waste Stabilization Ponds Case Study: Izmir Wastewater Treatment System. *Chemosphere*. 26(1–4): pp.633–639.  
Parkin GF and Owen WF. 1986. Fundamentals of anaerobic digestion of wastewater sludge. *Journal of Environmental Engineering*. 112(5): pp. 867–920.

### 3. Waste incineration – CO<sub>2</sub>

94. Canada estimated CO<sub>2</sub> emissions from waste incineration in accordance with the IPCC good practice guidance. However, the ERT noted that Canada did not distinguish between CO<sub>2</sub> emissions from waste incineration with and without energy recovery. The ERT encourages Canada, in its next annual submission, to separate these CO<sub>2</sub> emissions and allocate the emissions with energy recovery to the energy sector.

## **VII. Supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol**

### **A. Information on Kyoto Protocol units**

#### 1. Standard electronic format and reports from the national registry

95. Canada has not reported information on its accounting of Kyoto Protocol units in the required SEF tables, as required by decisions 15/CMP.1 and 14/CMP.1. In the NIR and in response to the SIAR, Canada explained that since its national registry had not transferred or acquired any Kyoto Protocol units in 2008, no information has been reported with regard to the SEF tables. The ERT took note of the findings and recommendations included in the SIAR on the SEF tables. The SIAR was forwarded to the ERT prior to the review, pursuant to decision 16/CP.10.

#### 2. National registry

96. The ERT reiterated the main findings and recommendations contained in the SIAR that the reported information on the national registry is complete and was submitted in accordance with the annex to decision 15/CMP.1. The ERT further noted from the SIAR and its findings that the national registry continues to perform the functions set out in the annex to decision 5/CMP.1 and the annex to decision 13/CMP.1, and continues to adhere to the technical standards for data exchange between registry systems in accordance with decisions 16/CP.10 and 12/CMP.1. The national registry also has adequate security, data safeguard and disaster recovery measures in place and its operational performance is adequate.

97. The ERT noted from the SIAR that the information on the national registry is not currently publicly available. In response to the SIAR, the Party stated that the required information would be made publicly available but that the website is not currently accessible. The Party stated that this information would be made publicly available once Canada's national registry has begun live operations with the international transaction log (ITL). The ERT reiterates the recommendation in the SIAR that Canada provide through its registry the public information referred to in paragraphs 45 to 48 of the annex to decision 13/CMP.1, and report, in its next annual submission, on any changes to that public information.

#### 3. Calculation of commitment period reserve

98. Canada has reported its commitment period reserve in its 2009 annual submission. The Party reported that its commitment period reserve has not changed since the initial report review (2,512,613,494 t CO<sub>2</sub> eq) as it is based on the assigned amount and not on the most recently reviewed inventory. The ERT agrees with this figure.

### **B. Changes to the national system**

99. Canada reported that there is no change in its national system compared with the previous annual submission. The ERT concluded that the Party's national system continues to be in accordance with the requirements of national systems outlined in decision 19/CMP.1.



### **C. Changes to the national registry**

100. Canada reported on changes in its national registry compared with the previous annual submission. A description of the national registry and changes thereto (e.g. change of name or contact), where applicable, has been provided in annex 15.4 to the NIR. The ERT concluded that, taking into account information provided by Canada on its national registry and based on information provided in the SIAR, the Party's national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1.

## **VIII. Conclusions and recommendations**

101. Canada made its annual submission on 17 April 2009. The Party indicated that the 2009 annual submission is a voluntary submission under the Kyoto Protocol. The annual submission contains the GHG inventory (CRF tables and NIR) and some supplementary information, provided on voluntary basis, under Article 7, paragraph 1, of the Kyoto Protocol. This is in line with decision 15/CMP.1.

102. The ERT concludes that the inventory submission of Canada has been prepared and reported in accordance with the UNFCCC reporting guidelines. The inventory submission is in general complete in terms of geographical coverage, years, sectors and gases. The Party has submitted a complete set of CRF tables for the years 1990–2007. Some of the categories have been reported as “NE”, particularly in the industrial processes and LULUCF sectors, although methodologies to estimate emissions from these categories are available in the Revised 1996 IPCC Guidelines, the IPCC good practice guidance or the IPCC good practice guidance for LULUCF. The ERT recommends that the Party provide estimates for these categories in its next annual submission, in order to improve completeness. In response to the questions raised the ERT during the review, Canada provided descriptions of the steps being taken to estimate emissions and removals from these currently not-estimated categories.

103. The submission on a voluntary basis of information required under Article 7, paragraph 1, of the Kyoto Protocol has been prepared and reported in accordance with decision 15/CMP.1. Canada did not report on a voluntary basis information on the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol. However, the Party voluntarily provided information under Article 3, paragraphs 3 and 4, of the Kyoto Protocol in its NIR, and plans to enhance this information in its next annual submission.

104. The Party's inventory is generally in line with the UNFCCC reporting guidelines, the Revised 1996 IPCC Guidelines, the IPCC good practice guidance and the IPCC good practice guidance for LULUCF, with exception of some cases in energy sector (see paras. 40, 41 and 47).

105. Canada reported in its 2009 submission that there had been no change in its national system since the previous annual submission. The national system continues to perform its required functions as set out in the annex to decision 19/CMP.1.

106. Canada has reported in its NIR and in its response to the SIAR that since Canada's national registry had not transferred or acquired any Kyoto Protocol units in 2008, no information has been reported with regard to the SEF tables.

107. Canada reported a change in its national registry in accordance with section I.G of the annex to decision 15/CMP.1. The national registry continues to perform the functions set out in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1, and continues to adhere to the technical standards for data exchange between registry systems in accordance with relevant CMP decisions.

108. In the course of the review, the ERT formulated a number of recommendations<sup>10</sup> relating to: both the consistency with the Revised 1996 IPCC Guidelines and the transparency of the reporting on the energy sector; the completeness of the reporting on the industrial processes sector (chemical industry); the completeness of the uncertainty analysis for, and the transparency of, the LULUCF sector; and the transparency of the reporting on the waste sector (solid waste disposal on land). The key recommendations are that Canada:

- (a) Ensure, to the extent possible, the inclusion in its next annual submission of emissions from categories currently reported as “NE” and for which methods for estimating emissions are available in the Revised 1996 IPCC Guidelines and/or in the IPCC good practice guidance, and where emissions cannot be estimated for any category then the Party is to provide sufficient explanation for this in its NIR;
- (b) Report emissions following IPCC methodologies, in particular for auto production and international navigation in the energy sector;
- (c) Improve the transparency of its NIR by providing better descriptions of the methodologies, AD and EFs, including the rationale behind the selection of country-specific parameters, and by explaining in more detail the effects of recalculations on the estimates for forest land;
- (d) Improve verification, QC checks and documentation of country-specific factors, such as the rate of CH<sub>4</sub> generation from anaerobic decomposition, and the soil carbon stock change in forest land converted to cropland;
- (e) Update the uncertainty analyses for the latest reported inventory year, and further develop and document formal uncertainty estimates for forest land;
- (f) Continue structuring its reporting in its next annual submission, as proposed in the annotated outline of the NIR in order to facilitate the review of the information provided under Article 7, paragraph 1, of the Kyoto Protocol.

## **IX. Questions of implementation**

109. No questions of implementation were identified by the ERT during the review.

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<sup>10</sup> For a complete list of recommendations, the relevant chapters of this report should be consulted.

Annex I**Documents and information used during the review****A. Reference documents**

Intergovernmental Panel on Climate Change. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Available at <<http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm>>.

Intergovernmental Panel on Climate Change. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. Available at <<http://www.ipcc-nggip.iges.or.jp/public/gp/english/>>.

Intergovernmental Panel on Climate Change. Good Practice Guidance for Land Use, Land-Use Change and Forestry. Available at <<http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm>>.

“Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories”. FCCC/SBSTA/2006/9. Available at <<http://unfccc.int/resource/docs/2006/sbsta/eng/09.pdf>>.

“Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention”. FCCC/CP/2002/8. Available at <<http://unfccc.int/resource/docs/cop8/08.pdf>>.

“Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol”. Decision 19/CMP.1. Available at <<http://unfccc.int/resource/docs/2005/cmp1/eng/08a03.pdf#page=14>>.

“Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol”. Decision 15/CMP.1. Available at <<http://unfccc.int/resource/docs/2005/cmp1/eng/08a02.pdf#page=54>>.

“Guidelines for review under Article 8 of the Kyoto Protocol”. Decision 22/CMP.1. Available at <<http://unfccc.int/resource/docs/2005/cmp1/eng/08a03.pdf#page=51>>.

Status report for Canada 2009. Available at <<http://unfccc.int/resource/docs/2009/asr/can.pdf>>.

Synthesis and assessment report on the greenhouse gas inventories submitted in 2009. Available at <<http://unfccc.int/resource/webdocs/sai/2009.pdf>>.

FCCC/ARR/2008/CAN. Report of the individual review of the greenhouse gas inventories of Canada submitted in 2007 and 2008. Available at <<http://unfccc.int/resource/docs/2009/arr/can.pdf>>.

UNFCCC. *Standard Independent Assessment Report*, Parts I and II. Unpublished document.

**B. Additional information provided by the Party**

Responses to questions during the review were received from Mr. Art Jaques (Greenhouse Gas Division, Environment Canada), including additional material on the methodology and assumptions used.

Annex II**Acronyms and abbreviations**

AD	activity data	IPCC	Intergovernmental Panel on Climate Change
AWMS	animal waste management systems	kg	kilogram (1 kg = 1 thousand grams)
CH <sub>4</sub>	methane	LULUCF	land use, land-use change and forestry
CKD	cement kiln dust	N	nitrogen
CMP	Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol	NA	not applicable
CP	Conference of the Parties	NE	not estimated
CO <sub>2</sub>	carbon dioxide	N <sub>2</sub> O	nitrous oxide
CO <sub>2</sub> eq	carbon dioxide equivalent	NIR	national inventory report
CRF	common reporting format	NO	not occurring
EF	emission factor	PFCs	perfluorocarbons
ERT	expert review team	PJ	petajoule (1 PJ = 10 <sup>15</sup> joule)
GHG	greenhouse gas; unless indicated otherwise, GHG emissions are the sum of CO <sub>2</sub> , CH <sub>4</sub> , N <sub>2</sub> O, HFCs, PFCs and SF <sub>6</sub> , without GHG emissions and removals from LULUCF	QA/QC	quality assurance/quality control
HFCs	hydrofluorocarbons	SEF	standard electronic format
IE	included elsewhere	SF <sub>6</sub>	sulphur hexafluoride
ITL	International transaction log	SIAR	standard independent assessment report
		TJ	terajoule (1 TJ = 10 <sup>12</sup> joule)
		UNFCCC	United Nations Framework Convention on Climate Change

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