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**Report of the individual review of the annual submission of
Canada submitted in 2010***

* In the symbol for this document, 2010 refers to the year in which the inventory was submitted, and not to the year of publication.

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I. Introduction and summary

A. Overview

1. This report covers the centralized review of the 2010 annual submission of Canada, coordinated by the UNFCCC secretariat, in accordance with decision 22/CMP.1. The review took place from 30 August to 4 September 2010 in Bonn, Germany, and was conducted by the following team of nominated experts from the UNFCCC roster of experts: generalists – Ms. Erasmia Kitou (European Union) and Ms. Anna Romanovskaya (Russian Federation); energy – Mr. Leonidas Osvaldo Girardin (Argentina), Mr. Leif Hockstad (United States of America), Ms. Ayse Yasemin Orucu (Turkey) and Mr. Hristo Vassilev (Bulgaria); industrial processes – Ms. Valentina Idrissova (Kazakhstan) and Ms. Sina Wartmann (Germany); agriculture – Mr. Bernard Hyde (Ireland) and Ms. Batima Punsalmaa (Mongolia); land use, land-use change and forestry (LULUCF) – Ms. Marina Shvangiradze (Georgia), Ms. Marina Vitullo (Italy) and Mr. Richard Volz (Switzerland); and waste – Ms. Kyoko Miwa (Japan) and Ms. Tatiana Tugui (Republic of Moldova). Mr. Hockstad and Ms. Tugui were the lead reviewers. The review was coordinated by Ms. Inkar Kadyrzhanova and Mr. Javier Hanna (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 2008, the main greenhouse gas (GHG) in Canada was carbon dioxide (CO₂), accounting for 78.1 per cent of total GHG emissions¹ expressed in CO₂ eq, followed by methane (CH₄) (13.4 per cent) and nitrous oxide (N₂O) (7.1 per cent). Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆) collectively accounted for 1.4 per cent of the overall GHG emissions in the country. The energy sector accounted for 81.3 per cent of total GHG emissions, followed by the agriculture sector (8.5 per cent), the industrial processes sector (7.2 per cent), the waste sector (2.9 per cent) and the solvent and other product use sector (0.04 per cent). Total GHG emissions amounted to 734,566.32 Gg CO₂ eq and increased by 24.1 per cent between the base year² and 2008.

4. Tables 1 and 2 show GHG emissions from Annex A sources and emissions and removals from activities under Article 3, paragraph 3, and, if any, Article 3, paragraph 4, of the Kyoto Protocol (KP-LULUCF), by gas and by sector, respectively. In addition, table 2 shows emissions and removals from the LULUCF sector under the Convention. In table 1 CO₂, CH₄ and N₂O emissions included in the rows under Annex A sources do not include emissions and removals from the LULUCF sector.

5. Table 3 provides information on the most important emissions and removals and accounting parameters that will be included in the compilation and accounting database.

¹ In this report, the term “total GHG emissions” refers to the aggregated national GHG emissions expressed in terms of CO₂ eq excluding LULUCF, unless otherwise specified.

² “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
Greenhouse gas emissions from Annex A sources and emissions/removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, by gas, base year to 2008^a

	Greenhouse gas	Gg CO ₂ eq								Change	
		Base year	1990	1995	2000	2005	2006	2007	2008	Base year–2008 (%)	
Annex A sources	CO ₂	455 844.23	455 844.23	488 308.54	559 877.59	569 068.26	558 317.84	591 397.83	573 707.56	25.9	
	CH ₄	73 994.89	73 994.89	88 632.29	97 663.38	101 256.33	101 472.51	100 040.48	98 730.63	33.4	
	N ₂ O	50 022.76	50 022.76	54 521.70	47 977.39	49 610.28	47 890.52	49 534.81	52 138.30	4.2	
	HFCs	767.25	767.25	479.41	2 985.39	5 223.31	5 044.19	5 431.70	5 506.75	617.7	
	PFCs	6 538.83	6 538.83	5 489.59	4 311.08	3 313.31	2 580.17	2 188.69	2 245.69	–65.7	
	SF ₆	4 703.93	4 703.93	3 707.30	4 341.49	2 518.49	2 896.69	1 821.27	2 237.38	–52.4	
KP-LULUCF	Article 3.3 ^b	CO ₂							13 522.61		
		CH ₄							236.81		
		N ₂ O							146.34		
	Article 3.4 ^c	CO ₂	4 257.53	4 257.53						–11 504.10	–370.2
		CH ₄	NE, NO	NE, NO						NE, NO	NA
		N ₂ O	13.87	13.87						0.77	–94.4

Abbreviations: KP-LULUCF = land use, land-use change and forestry emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, NA = not applicable, NO = not occurring, NE = not estimated.

^a “Base year” for Annex A sources refers to the base year under the Kyoto Protocol, which is 1990 for all gases. The “base year” for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol is 1990.

^b Activities under Article 3, paragraph 3, of the Kyoto Protocol, namely afforestation and reforestation, and deforestation. Only the inventory years of the commitment period must be reported.

^c Elected activities under Article 3, paragraph 4 of the Kyoto Protocol, including forest management, cropland management, grazing land management and revegetation. For cropland management, grazing land management and revegetation the base year and the inventory years of the commitment period must be reported.

Table 2

Greenhouse gas emissions by sector and activity, base year to 2008

		<i>Gg CO₂ eq</i>								<i>Change</i>	
		<i>Base year^a</i>	<i>1990</i>	<i>1995</i>	<i>2000</i>	<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>Base year– 2008 (%)</i>	
	<i>Sector</i>										
Annex A	Energy	469 467.68	469 467.68	509 831.24	586 941.87	593 053.47	580 805.19	614 247.22	597 527.56	27.3	
	Industrial processes	54 827.06	54 827.06	56 638.84	51 139.56	55 056.20	54 608.74	53 229.24	52 586.44	–4.1	
	Solvent and other product use	174.92	174.92	208.03	241.87	179.03	322.36	319.41	330.06	88.7	
	Agriculture	48 541.52	48 541.52	54 651.40	58 648.51	61 600.54	60 844.74	61 234.65	62 457.78	28.7	
	Waste	18 860.70	18 860.70	19 809.31	20 184.51	21 100.74	21 620.90	21 384.25	21 664.48	14.9	
	Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	LULUCF	NA	–51 565.45	198 387.78	–80 320.51	41 413.22	41 367.47	45 453.28	–12 826.60	NA	
Total (with LULUCF)		NA	540 306.44	839 526.60	636 835.82	772 403.21	759 569.40	795 868.06	721 739.72	NA	
Total (without LULUCF)		591 871.89	591 871.89	641 138.82	717 156.33	730 989.99	718 201.93	750 414.78	734 566.32	24.1	
KP-LULUCF	Article 3.3 ^b	Afforestation & reforestation							–737.97		
		Deforestation							14 643.73		
		Total (3.3)							13 905.77		
	Article 3.4 ^c	Forest management								NA	
		Cropland management	4 271.40							–11 503.33	–369.3
		Grazing land management	NA							NA	NA
		Revegetation	NA							NA	NA
Total (3.4)		4 271.40							–11 503.33	–369.3	

Abbreviations: LULUCF = land use, land-use change and forestry; KP-LULUCF = LULUCF emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, NA = not applicable.

^a “Base year” for Annex A sources refers to the base year under the Kyoto Protocol, which is 1990 for all gases. The “base year” for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol is 1990.

^b Activities under Article 3, paragraph 3, of the Kyoto Protocol, namely afforestation and reforestation, and deforestation. Only the inventory years of the commitment period must be reported.

^c Elected activities under Article 3, paragraph 4, of the Kyoto Protocol, including forest management, cropland management, grazing land management and revegetation. For cropland management, grazing land management and revegetation the base year and the inventory years of the commitment period must be reported.

Table 3
Information to be included in the compilation and accounting database in t CO₂ eq

	<i>As reported</i>	<i>Adjustment^a</i>	<i>Final^b</i>	<i>Accounting quantity^c</i>
Commitment period reserve	2 512 613 494		2 512 613 494	
Annex A emissions for current inventory year				
CO ₂	573 707 564		573 707 564	
CH ₄	98 571 457		98 730 634	
N ₂ O	52 150 859		52 138 304	
HFCs	5 506 745		5 506 745	
PFCs	2 245 690		2 245 690	
SF ₆	2 237 383		2 237 383	
Total Annex A sources	734 419 698		734 566 320	
Activities under Article 3, paragraph 3, for current inventory year				
3.3 Afforestation and reforestation on non-harvested land for current year of commitment period as reported	-737 966		-737 966	
3.3 Afforestation and reforestation on harvested land for current year of commitment period as reported	NA		NA	
3.3 Deforestation for current year of commitment period as reported	14 643 732		14 643 732	
Activities under Article 3, paragraph 4, for current inventory year^d				
3.4 Forest management for current year of commitment period				
3.4 Cropland management for current year of commitment period	-11 503 326		-11 503 326	
3.4 Cropland management for base year	4 271 405		4 271 405	
3.4 Grazing land management for current year of commitment period				
3.4 Grazing land management for base year				
3.4 Revegetation for current year of commitment period				
3.4 Revegetation in base year				

Abbreviation: NA = not applicable.

^a "Adjustment" is relevant only for Parties for which the ERT has calculated one or more adjustment(s).

^b "Final" includes revised estimates, if any, and/or adjustments, if any.

^c "Accounting quantity" is included in this table only for Parties that chose annual accounting for activities under Article 3, paragraph 3 and elected activities under Article 3, paragraph 4, if any.

^d Activities under Article 3, paragraph 4, are relevant only for Parties that elected one or more such activities.

II. Technical assessment of the annual submission

A. Overview

1. Annual submission and other sources of information

6. The 2010 annual inventory submission was submitted on 15 April 2010; it contains a complete set of common reporting format (CRF) tables for the period 1990–2008 and a national inventory report (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, accounting of Kyoto Protocol units, changes in the national system and in the national registry, and minimization of adverse impacts under Article 3, paragraph 14, of the Kyoto Protocol. 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 because its national registry had not transferred or acquired any Kyoto Protocol units in 2009, no information has been reported with regard to the SEF tables. The annual submission was submitted in accordance with decision 15/CMP.1.

7. Canada officially submitted new and revised emission estimates on 18 October 2010 in response to the list of potential problems and further questions raised by the expert review team (ERT) during the course of the centralized review (see paras. 46, 81, and 98 below). The overall impact of these revised estimates is an increase of 146.62 Gg CO₂ eq (or 0.02 per cent) in 2008 and an increase of 79.31 Gg CO₂ eq (0.01 per cent) in 1990. Where necessary, the ERT also used the previous year's submission during the review.

8. 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.³

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

Completeness of inventory

10. The inventory covers, in general, all source and sink categories for the period 1990–2008 and is complete in terms of gases, years and geographical coverage. However, the ERT noted that, in the NIR and CRF tables, Canada has identified incomplete reporting of 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). The ERT noted that for most of these categories methodologies to estimate emissions are not available in the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines), 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 IPCC *Good Practice Guidance for Land Use,*

³ The SIAR, parts I and II, is prepared by an independent assessor in line with decision 16/CP.10 (paras. 5(a), 6(c) and 6(k)), under the auspices of the international transaction log 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.

Land-Use Change and Forestry (hereinafter referred to as the IPCC good practice guidance for LULUCF).

11. Canada also explained in the NIR that the exclusion of some emissions typically relates to the unavailability of comprehensive activity data (AD) for certain subcategories of a category that are minor by nature. In some cases, the lack of appropriate and cost-effective methodologies has been the reason for the exclusion of a minor category. In the NIR, Canada states that, in the energy sector, completeness improvements could be further achieved through the study of non-conventional fuels used in the manufacturing industry and non-CO₂ emission factors (EFs) for waste tyres. The NIR also notes that since 2008 the energy sector has included biodiesel in transport, as recommended in the 2007 review report. The ERT commends the Party for this improvement. However, it notes that N₂O emissions from natural gas flaring are reported as "NE", although these emissions are actually reported under category 1.A.1.c. The ERT recommends that Canada use the appropriate notation key "IE" for N₂O emissions from gas flaring and reconsider their allocation. However, as stated in para. 48 below, transparency of reporting could be improved. The NIR reports that, in the industrial processes sector, emissions of CH₄ from process sources are being investigated. The ERT notes in para. 51 below that for some categories default EFs are provided in the Revised 1996 IPCC Guidelines thus until the results of the investigation undertaken to develop country-specific EFs for Canada become available emission estimates should be based on those default EFs. In the agriculture sector, efforts have been made to establish a consistent time series of AD on crop residue burning in Canada through expert consultations. In the LULUCF sector, significant improvements have been implemented starting in 2006, but completeness has not yet been fully met as a result of data limitations. The NIR reports that, for the waste sector, CH₄ emissions from unmanaged landfills are reported as "NE", but the ERT notes, that Canada has taken a conservative approach in including all waste on managed disposal sites and so this would not lead to an underestimation (see para. 92 below). The NIR also reports that CH₄ emissions from industrial wastewater treatment and municipal solid waste (MSW) incineration will be the subject of further research (see para. 100 below).

12. Canada reported CH₄ and N₂O emissions from field burning of agricultural residues as "NE" in its 2010 submission. In response to the list of potential problems and further questions raised by the ERT during the centralized review, Canada provided CH₄ and N₂O emission estimates for this category (see para. 81 below). The ERT agreed with these emission estimates. In addition, the Party reported CH₄ emissions from industrial wastewater as "NE". In response to the list of potential problems and further questions raised by the ERT during the centralized review, Canada provided CH₄ emission estimates for this category (see para. 98 below). The ERT agreed with these emission estimates.

13. The ERT reiterates the recommendation of the previous review report that Canada improve the completeness of its inventory in its next annual submission, especially for those categories for which emissions are known to occur in the country and that are identified in this report. The ERT also recommends that Canada improve its use of notation keys in line with the CRF table reporting requirements. The ERT also recommends that, when reporting data on emissions for a given category for the first time, Canada ensure that these data are provided for the entire time series and that the rationale for the choice of methods, EFs and other parameters are clearly explained in the NIR.

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

Overview

14. The ERT concluded that the national system continued to perform its required functions.

15. Canada reported that there had been no changes in its national system since its previous annual submission.

Inventory planning

16. The NIR described the national system for the preparation of the inventory in the country. The GHG Division of Environment Canada 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 programme, which requires facilities emitting over a certain threshold to report their emissions annually. The reporting threshold was 100 kt CO₂ eq per year from 2004–2008 and the threshold was decreased to 50 kt CO₂ eq per year starting with 2009. Furthermore, the GHG Division collaborates with the country's provincial and territorial governments on the collection of data on GHGs.

17. 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 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 with 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 (e.g. the aluminium and electricity associations) has been concluded for the provision of supplementary data on the industrial processes sector.

18. Canada has developed a quality assurance/quality control (QA/QC) plan that uses an integrated approach to managing the inventory quality and works towards achieving continuously improved emission and removal estimates. It is designed so that QA/QC procedures are implemented throughout the entire inventory development process, from initial data collection through development of emission and removal estimates to publication.

19. The ERT considers that Canada's legal, procedural and institutional arrangements for estimating and reporting GHG emissions are in line with the general and specific functions of the national system defined in the annex to decision 19/CMP.1.

Inventory preparation

Key categories

20. Canada has reported a key category tier 1 analysis, both level and trend assessment, as part of its 2010 submission. The key category analysis performed by Canada and that

performed by the secretariat⁴ produced similar results, with Canada's key category analysis provide further disaggregation of subcategories. 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

21. Although in some cases Canada applies a more complex tier 2 method to develop uncertainty estimates at the sectoral or category level, for the inventory as a whole these uncertainties were combined with the simple tier 1 error propagation method. Separate analyses were conducted for the inventory as a whole with and without LULUCF. The calculation of trend uncertainties was only performed without the LULUCF sector. Uncertainty estimates for each source/sink category were either: retained from the previous studies; or improved upon on the basis of these studies; or derived for the first time, as was the case for the LULUCF sector.

22. Canada states in its NIR that planned improvements for the uncertainty analysis include the development of a programme to provide incremental improvements to its uncertainty assessment on an annual basis. Canada reports that it will probably build its analysis on previous methods and databases, including making use of the Monte Carlo simulation data and methods performed in 2003–2004, while ensuring that any new methodological changes and refinements consider the impact on uncertainties prior to implementation. In addition, many sectors have plans to improve their uncertainty estimates. In its NIR, Canada notes that its longer-term vision with respect to performing uncertainty assessments is consistent with recommendations received in past review reports. The ERT encourages Canada to continue implementing these planned improvements.

Recalculations and time-series consistency

23. Recalculations have been performed and reported in accordance with the IPCC good practice guidance. In the 2010 submission, there were no recalculations for the years 1990–2006. Recalculations for the 2007 inventory year are primarily based on revisions to AD received from Statistics Canada, which affected the energy, industrial process and agriculture sectors. There were no recalculations in the LULUCF sector, and the waste sector recorded a recalculation of negligible impact in 2007 based on a revision to population data. However, Canada has identified planned improvements which, when implemented, will impact the inventory time series from 1990 onwards. The magnitude of the impact of recalculations is an increase in total GHG emissions in 2007 of 0.4 per cent and a resulting upward change on the trend from 1990–2007 of 0.8 per cent. The rationale for these recalculations is provided in the NIR and in CRF table 8(b).

24. The time series were generally found to be consistent, although the ERT was not always able to assess this due to a lack of transparency, as in the case of the industrial processes sector. The ERT encourages Canada to improve time-series consistency and comparability by using a single method for all years and for all plants under a category, wherever possible.

⁴ 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.

Verification and quality assurance/quality control approaches

25. Information on the implementation of the 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 in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories” (hereinafter referred to as the UNFCCC reporting guidelines). Canada has a QA/QC plan in place in accordance with decision 19/CMP.1 and the IPCC good practice guidance, and implements category-specific tier 2 QC procedures. Canada has also reported in its NIR on recalculations due to errors identified as part of its QA/QC procedures as well as on additional inventory-related activities stipulated by its QA/QC plan.

26. The GHG Division of Environment Canada conducts 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, and some sections of the inventory are reviewed externally by experts, government agencies and provincial and 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 CH₄ generation from anaerobic decomposition in landfills 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 emissions are in accordance with the IPCC good practice guidance.

Transparency

27. 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 – for example, an improved explanation in the NIR about the calculations provided at the provincial level, which form the basis for some category calculations (see para. 42 below), and the manner in which these calculations are collected for use in the final national totals. Canada’s use of notation keys (see example in para. 97 below) is not fully transparent, as “NE” is used in some categories where, upon the ERT’s review of the NIR, “IE” would be more appropriate (such as unmanaged solid waste disposal sites).

Inventory management

28. As reported in the NIR, Canada has a centralized archiving system at the GHG Division of Environment Canada, which includes the archiving of all information required for the inventory, including information on QA/QC procedures and their results. The ERT considers that this is in line with requirements of decision 19/CMP.1.

3. Follow-up to previous reviews

29. The ERT commends Canada for its provision of category-specific information in relation to uncertainties and time-series consistency in response to recommendations of the previous review report and encourages Canada to continue providing this information in its future annual submissions. However, the ERT noted that some recommendations are yet to be addressed by Canada in its next annual submission, in particular related to completeness of its inventory, harmonization of the information provided in the annexes to the NIR with the data reported in the CRF tables, improvement of allocation of fuels to domestic and international navigation, updating of country-specific EFs in the energy sector,

development of country-specific EFs and the collection of more accurate AD in the industrial processes sector, strengthening its QC procedures for the reporting of methodologies and emissions in the agriculture sector, and completeness of information in the NIR given for other direct N₂O emissions (summer fallow, no-till and reduced tillage and irrigation).

4. Areas for further improvement

Identified by the Party

30. The 2010 NIR identifies several areas for improvement which are based on the recommendations made both by national experts and in the previous review reports, including improvement activities to further refine and increase the transparency, completeness, accuracy, consistency and comparability of the submission. Planned improvements for the uncertainty analysis include the development of a programme to provide incremental improvements to Canada's uncertainty assessment on an annual basis. Some efforts at capacity building have been undertaken and applied in the short term. Canada plans to build on previous methods and databases in its the uncertainty analysis.

Identified by the expert review team

31. The ERT identified the following cross-cutting issues for improvement:

(a) Providing estimates of all missing emission source categories that are known to occur in the country and for which IPCC methodologies exist.

(b) Providing descriptions of the methodologies used for the energy sector and the rationale behind the selection of country-specific parameters, as well as updating the country-specific EFs currently use for fuel combustion categories;

(c) Providing descriptions of the methodologies used for the LULUCF sector and the rationale behind the selection of country-specific parameters, as well as better documentation of the CO₂ emissions and removals from forest land and from forest land converted to cropland categories;

(d) Continuing the update and improvement of uncertainty analyses using the most recent inventory data available and further development of uncertainty estimates for the LULUCF sector;

(e) Increasing the transparency of the use of references in CRF tables to sections of the agriculture chapter and annex 3 to the NIR and also to the equations used in emission estimates;

(f) Correcting inconsistencies between the NIR and CRF tables with respect to animal weights, nitrogen (N) excretion (N_{ex}) values and other livestock production information and strengthening QA/QC procedures for the reporting of methodologies and parameters in order to avoid inconsistencies and transparency issues;

(g) Improving the consistency of the classification of managed and unmanaged lands in the land matrix used for the LULUCF sector estimates.

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

B. Energy

1. Sector overview

33. The energy sector is the main sector in the GHG inventory of Canada. In 2008, emissions from the energy sector amounted to 597,527.56 Gg CO₂ eq, or 81.3 per cent of total GHG emissions. Since 1990, emissions have increased by 27.3 per cent. The key driver for the rise in emissions is a growth in electricity and heat generation, fossil fuel based industries and transportation. Within the sector, fuel combustion was the largest contributor (89.3 per cent), with 33.2 per cent of the sector emissions coming from transport, followed by 31.3 per cent from energy industries, 13.4 per cent from other sectors and 11.5 per cent from manufacturing industries and construction. Fugitive emissions from oil and natural gas accounted for 10.6 per cent. The remaining 0.1 per cent of emissions were from fugitive emissions from solid fuels.

34. The energy sector reporting is generally complete. In general, emissions reported as “NE” are the CO₂ and CH₄ from fugitive emission categories which do not have default EFs provided by the IPCC. However, the ERT notes that N₂O emissions from natural gas flaring are reported as “NE.” In response to the draft findings of the ERT, Canada has indicated that N₂O emissions from flaring activities are reported in category 1.A.1.c Manufacturing of Solid Fuels and Other Energy Industries. The ERT recommends that Canada use the appropriate “IE” notation key and to provide explanations for this reporting to increase the transparency of the CRF for this category in its next annual submission.

35. Recalculations were performed by Canada for 2007 emissions due to updated energy statistics published by Statistics Canada. No other years in the time series were recalculated for the energy sector. The recalculations resulted in a minor decrease in overall emissions from the sector of 0.003 per cent, with the primary differences seen in the manufacturing industries and construction categories with an increase of 1.9 per cent, followed by decreases in other sectors by 0.4 per cent, energy industries by 0.3 per cent and transport by 0.2 per cent.

2. Reference and sectoral approaches

Comparison of the reference approach with the sectoral approach and international statistics

36. Canada has reported a comparison of the emission estimates calculated using the reference and the sectoral approaches for all years of the time series. Annex 4 to the NIR presents a fairly transparent assessment of the methodology used to present the data from the two approaches in the CRF tables, including the specific adjustments made to exclude non-energy uses of fuels from the apparent consumption calculated using the reference approach. In CRF table 1.A(c) the reported difference between the CO₂ estimates calculated using the two approaches is 5.34 per cent for 2008. Canada states in the NIR that the corresponding CRF table does not properly exclude non-energy use of fuels in its calculations and reports a difference of -1.35 per cent between the CO₂ emissions calculated using the two approaches. The ERT reiterates the recommendation from the previous review report that Canada improve the harmonization of the information provided in the annex 4 to the NIR with the data reported in the CRF tables, namely to follow the recommendations of the Revised 1996 IPCC Guidelines to exclude non-energy use of fuels from the reference approach. Comparisons with international statistics are generally consistent, and Canada provided further explanations during earlier stages of the review.

International bunker fuels

37. The amount of fuel used in international aviation was estimated based on fuel-use data reported as sold to foreign airlines and using a model based on the tonne-kilometre

flown reported by Canadian airlines for both domestic and international flights, which appears to be in line with the IPCC good practice guidance. The NIR noted the uncertainties associated with this approach. During the centralized review, Canada informed the ERT that a new tier 3a model, based on high-resolution flight data which will more clearly differentiate between domestic and international flights, will be used in the next submission. The ERT welcomes these planned improvements and recommends that Canada report transparently on the new model and the recalculations for the complete time series resulting from the use of this new model in its next annual submission.

38. The amount of fuel used for international marine bunkers is based upon data of fuels sold to foreign marine vessels, which may result in an underestimate of international marine bunkers by not fully including foreign trips by Canadian vessels. During the centralized review, Canada informed the ERT that once the new international aviation model is finalized, Canada will make efforts to improve its method for international marine bunkers. Noting that Canada's current approach does not adequately follow the IPCC good practice guidance, the ERT reiterates recommendations made in previous review reports that Canada make further efforts to allocate these fuels to domestic and international navigation separately, in accordance with the IPCC good practice guidance.

Feedstocks and non-energy use of fuels

39. In the sectoral approach, the non-energy use of fuels is accounted for in the industrial processes sector and is in line with the Revised 1996 IPCC Guidelines. The reporting of feedstocks and non-energy use of fuels in the reference approach is generally in line with the Revised 1996 IPCC Guidelines although, as noted in paragraph 36 above, improvement could be made to ensure transparency between the description in annex 4 of the NIR and the data reported in the CRF tables.

Country-specific issues

40. Canada has reported emissions using a country-specific methodology for "unconventional oil production" in CRF table 1.B.2 to account for oil sands and the heavy oil upgrading industry. This country-specific methodology, as explained in the NIR, is not completely transparent nor are the data that form the source of the calculations. In response to questions raised by the ERT during the centralized review, Canada stated that calculations are based on data publications and facility-specific information. The ERT recommends that Canada: increase the transparency of its next annual submission; be more specific in methodological descriptions about the availability of facility-level data in the given time periods in annex 2 of the NIR; and provide clear references to all data used for its estimates using this country-specific methodology.

3. Key categories

Stationary combustion: liquid, solid and gaseous fuels – CO₂

41. Canada used a tier 2 sectoral approach from the Revised 1996 IPCC Guidelines to estimate emissions from fuel combustion based on country-specific EFs and category-level data on quantity of fuel consumed. Canada provided details on the country-specific EFs used in its calculations in the annexes of the NIR. These country-specific EFs are based on two studies, McCann (2000)⁵ and Jaques (1992),⁶ and generally grouped into two distinct

⁵ McCann TJ. 2000. 1998 Fossil Fuel and Derivative Factors. Report prepared by T.J. McCann and Associates for Environment Canada.

⁶ Jaques AP. 1992. Canada's Greenhouse Gas Emissions: Estimates for 1990. Environmental Protection, Conservation and Protection, Environment Canada. Report No. EPS 5/AP/4.

time series for application: 1990–1999 and 2000–2008. In response to questions raised by the ERT during the centralized review, Canada described its EF improvement activities, including a study of coal EFs, the results of which will be included in the 2011 submission and will affect the entire time-series (1990–2009), and an analysis of fuels with variable carbon contents such as still gas from upgraders and refineries. The comprehensive study of coal EFs will determine the development of an approach to assessing EFs for other fuels. Non-variable carbon content fuels, such as gasoline, natural gas and diesel, will be considered as part of future improvement activities. Previous review reports have noted Canada's planned improvements to update EFs, which have been ongoing and not yet implemented. The ERT welcomes the statement that updated country-specific EFs will be incorporated in the next annual submission and encourages Canada to provide, in the annexes to the NIR of its next annual submission, sufficient explanatory details in the recalculations section of the energy sector, including details of the resulting changes and updated information on these EFs.

Road transportation: liquid fuels – CO₂ and N₂O

42. Canada calculated emissions from road transportation using the Mobile Greenhouse Gas Emission Model (MGEM) using data on the vehicle fleet class and age. Canada provided further information in annex 2 to the NIR, including the application of “typical technology splits” and EFs. However, the ERT noted that this information is not fully transparent, for example the NIR does not clearly identify how provincial fleets are modelled according to the specific fleet compositions for that year. In response to questions raised by the ERT during the centralized review, Canada clarified that, in general, provincial data and EFs are available, and they are calculated at the provincial level and then aggregated to the national level. The ERT recommends that, in its next annual submission, Canada improve the transparency of reporting and provide more specific information in the annex to the NIR with methodological descriptions, in particular identifying more clearly how provincial fleets are modelled.

43. Additionally, for road transportation, Canada applies the vehicle-kilometres travelled (VKT) data from Ontario and extrapolates these data to other provinces and territories in Canada, including vehicle classes and vehicle ages. During the centralized review, in response to a question raised by the ERT about the appropriateness of applying the data of inspection and maintenance from one province across all provinces and territories, Canada stated that the Ontario VKT is the best VKT data available in Canada because they are verified and consistently recorded. Canada further noted that vehicle fleet composition does vary by province, and its model takes into consideration each provincial fleet to derive a specific fleet average VKT for all provinces. In addition, Canada is working to obtain a new set of data from the Ontario programme and additional data from the province of British Columbia. As the ERT notes in Canada's response, the bottom-up approach fuel use estimate has correlated better with the Statistics Canada fuel consumption data, so the ERT does find this approach reasonable. The ERT recommends that Canada include additional information in the uncertainty section of the transport section of the energy chapter of the NIR, highlighting the advantages of this approach and how it has reduced uncertainty.

44. During the review week, the ERT identified that the numbers of heavy duty vehicles, as stated in the NIR, were only available from the 2007 Canadian Vehicle Survey of Statistics Canada, whereas the 2008 vehicle numbers do not have a specific reference. During the centralized review, in response to a question raised on this issue by the ERT, Canada noted that a 2008 publication was available which was not identified in the NIR. The ERT recommends that Canada correct the NIR of its next annual submission and apply appropriate QC procedures for its references in its future annual submissions.

Oil and natural gas – CH₄

45. Canada reported fugitive CH₄ emissions from distribution (natural gas) using provincial EFs and the length of the natural gas pipeline used for natural gas distribution. The NIR states that the most current pipeline length data available from Statistics Canada was for 2006, and updated pipeline length data were unavailable for 2007 and 2008. Canada used the 2006 value of the natural gas pipeline length for the 2008 emissions calculation, and did not provide additional detail in the NIR on why the use of this older data was appropriate or justified. The ERT noted that the use of the 2006 pipeline length to calculate 2008 fugitive CH₄ emissions from natural gas distribution results in an underestimate. During the centralized review, the ERT recommended that Canada estimate emissions of CH₄ from distribution (natural gas) using updated pipeline data either based on a new report from Statistics Canada with the 2008 pipeline length or based on an extrapolation of recent trends in the growth of pipeline length.

46. After the centralized review, in response to the list of potential problems and further questions raised by the ERT, Canada provided revised estimates for this category using updated natural gas distribution pipeline lengths for 2007 and 2008 obtained from Statistics Canada. The impact of the revised estimates is an increase of 119.10 Gg CO₂ eq or 0.2 percent of emissions in this category. The ERT agrees with these estimates and welcomes this effort by Canada to use the specific data for each year, and recommends that Canada continue to collect these data and include corresponding estimates in its next annual submission.

47. Additionally, the ERT recommends that Canada improve its use of notation keys for this category, such as the use of “NE” for other leakage for residential and commercial for which the information in the NIR indicates might more correctly be reported as “included elsewhere” (“IE”). In response to the draft review report, Canada indicated that it will improve its use of the “NE” and “IE” notation keys in the next annual submission.

4. Non-key categories

Road transportation: other liquid fuels – CO₂

48. Under this category, Canada has reported emissions from the fossil portion of biodiesel (assumed to be 5 per cent by volume) using the option for other liquid fuels categorization available in the CRF tables. For railways and navigation, the fossil portion of biodiesel is reported under other fuels. In the summations of fuels for the transport category and for overall fuel combustion, the AD and CO₂ emissions (and other GHGs) from the fossil portion of biodiesel used in road transportation are aggregated into liquid fuels, while for the fossil portion of biodiesel used in railways and navigation these emissions are aggregated into other fuels. The ERT notes that this creates an inconsistency in the manner in which the same fuel is reported for different categories. The ERT encourages Canada to examine alternative allocation of these fuels so that it is easier to review the use of fossil fuels and the associated calculations.

C. Industrial processes and solvent and other product use

1. Sector overview

49. In 2008, emissions from the industrial processes sector amounted to 52,586.44 Gg CO₂ eq, or 7.2 per cent of total GHG emissions, and emissions from the solvent and other product use sector amounted to 330.06 Gg CO₂ eq, or 0.04 per cent of total GHG emissions. Since 1990, emissions have decreased by 4.1 per cent in the industrial processes sector and increased by 88.7 per cent in the solvent and other product use sector, including

N₂O emissions from anaesthesia and from aerosol cans. This relatively stable trend in the industrial processes sector includes increasing as well as decreasing trends of particular categories, as follows: N₂O emissions from the chemical industry category have decreased by 69.0 per cent, whereas CO₂ emissions from this category have increased by 34.0 per cent, and CO₂ emissions from metal production have increased by 29.0 per cent and from other increased by 38.6 per cent. At the same time, emissions of PFCs and SF₆ in metal production decreased by 65.7 per cent and 85.3 per cent, respectively. Total emissions from HFCs increased by 671.7 per cent. Within the industrial processes sector 29.1 per cent of the emissions were from metal production, followed by 21.2 per cent from other, 19.6 per cent from chemical industry, 16.2 per cent from mineral products and 13.9 per cent from consumption of halocarbons and SF₆. The emission trends in the solvent and other product sector use are explained by an increase in the domestic demand for N₂O for anaesthetic or propellant purposes.

50. In the Party's 2010 submission, only 2007 emissions were recalculated for a number of categories (cement production, lime production, limestone and dolomite use, soda ash use, other (magnesite use), iron and steel production, consumption of halocarbons and SF₆ (HFCs and SF₆ from electrical equipment), due to the availability of updated AD. The recalculations led to an increase of overall emissions in the industrial processes sector of 3.5 per cent.

51. Canada has reported CH₄ emissions from silicon carbide, carbon black, ethylene, dichloroethylene, styrene and methanol as "NE". Further categories reported as "NE" are PFCs from aerosols and metered dose inhalers. In the NIR, Canada reported that a study aiming to close existing gaps in the inventory is currently being carried out and that results are expected to be available by the fourth quarter of 2010, enabling the Party to include the missing categories in its 2011 submission. The ERT strongly recommends that Canada estimate emissions from these categories in its next annual submission. In addition, the ERT recommends that Canada investigate whether aerosols and metered dose inhalers used in Canada contain PFCs and, if so, include PFC estimates from this category in its next annual submission, in line with the IPCC good practice guidance, or, if not occurring, to use appropriate notation key "NO" in its CRF tables. The ERT further recommends that, in the next annual submission, Canada update the use of notation keys for these categories, depending upon the outcomes of its study.

52. The ERT noted that a number of recommendations from the 2009 review report have not been implemented, although the Party had indicated that implementation was planned. These recommendations were, for the most part, addressing the improvement of accuracy in the estimation of emissions by the development of country-specific EFs and the collection of more accurate AD, for example, for the estimation of SF₆ emissions from the category consumption of halocarbons and SF₆ (see para. 59 below).

53. The ERT strongly recommends that Canada implement previous and current recommendations related to the issues indicated in paragraph 52 above, in its future annual submissions.

2. Key categories

Cement production – CO₂

54. Canada estimates emissions from cement production using a tier 2 approach from the IPCC good practice guidance (using clinker production) and the default EFs for clinker from the Revised 1996 IPCC Guidelines and the cement kiln dust (CKD) default factor from the IPCC good practice guidance. The AD for 1990–1996 stem from industry reports and for 1997–2008 statistical data are used. In response to the draft findings of the ERT, Canada clarified that the Cement Association of Canada (CAC) stated that no plant-specific

AD could be made available from industry directly to Environment Canada. The ERT encourages Canada to consider moving from the default EF to a country-specific EF when data become available from the Cement Association of Canada (CAC) as a result of the QA process started in 2009.

Limestone and dolomite use – CO₂

55. Emissions are estimated using the approach from the Revised 1996 IPCC Guidelines, with amounts of limestone and dolomite as AD and stoichiometric EFs corrected for purity. This correction is based on national assumptions on purity and composition. The AD are taken from national statistics. For 2008, only the overall limestone and dolomite use data were available, with no data available for the subcategories. Canada therefore allocated emissions to the subcategories based on the distribution in 2007. While this does not change overall emissions from this category, the ERT notes that it could lead to inaccuracies in the estimates of single subcategories. The ERT encourages Canada to recalculate 2008 emissions for the subcategories as soon as more detailed data becomes available.

Ammonia production – CO₂

56. Canada estimates emissions from ammonia (NH₃) production based on the tier 1b approach (using ammonia production) from the Revised 1996 IPCC Guidelines. The EF used is country-specific. The AD were partly taken from reports by plants (2005–2008) and partly estimated by the inventory compilers based on data of plant capacities and statistical data (1990–2004). If the approach based on ammonia production continues to be used, the ERT recommends that Canada assess whether the country-specific EF of 1.56 t CO₂/t NH₃ (stemming from 1992) is still representative for ammonia production in Canada. However, as the NIR indicates that information on natural gas use for ammonia production is available, the ERT recommends that Canada use the tier 1a approach from the Revised 1996 IPCC Guidelines in its future annual submissions, as this is the most accurate method of estimation.

Iron and steel production – CO₂

57. For estimates of emissions in this category a tier 2 approach (mass balance) is used together with default EFs from the IPCC good practice guidance, except for the EF for the main reductant, coke, where a country-specific value of 2.479 kt CO₂/kt of coke is used. The AD are taken from national statistics. CO₂ emissions from reductants other than coke (such as natural gas, heavy fuel oil and coal) are reported under the category other (under non-energy use of hydrocarbons). In order to allow a more accurate estimation of emissions, the ERT encourages Canada to develop country-specific EFs for the carbon contents in ores, pig iron and steel. In order to increase consistency, the ERT recommends that Canada report other reductants under the iron and steel production category instead of the category other.

Aluminium production – CO₂ and PFCs

58. In the NIR, Canada reports that emission estimates for aluminium production were directly obtained from the Aluminum Association of Canada (AAC). The NIR states that AAC provides information on the smelter-specific emission estimates, the methodologies used by the aluminium producers to calculate CO₂, PFC, and SF₆ emissions. The ERT found that the NIR does not describe transparently the use of these approaches over the time series. In response to the draft review report, Canada stated that it had contacted AAC in the past (in 2007) to better understand which approaches have been used for which years of the time series. Canada said that the response obtained at the time was that one of the

three companies has only used Tier 3 method to develop its estimates for the whole time series, whereas the other two companies have used default parameter values for estimates of some historical years (i.e. before 2006, the establishment of the MOU between Environment Canada and AAC). The default parameter values are presented in the NIR in Tables 4-3 and 4-4. Canada stated further that a response from one of the three companies (covering most of the plants in Canada) stated that “to identify which plants utilized default values for which years would require a very significant amount of work which would take quite a bit of time.” The ERT recommends that Canada increase transparency by stating more clearly which approaches have been used and for which years of the time series. In response to the draft review report, Canada said that it will engage in efforts to follow up with the company again regarding the question on methodology used for historical years, and will include any new information, if made available, in its future annual submissions.

Consumption of halocarbons and SF₆ – HFCs

59. A two-step approach was used for the estimation of HFCs emissions. Canada reports that emissions of HFCs only started in 1995 and for this year a simplified tier 2 approach from the Revised 1996 IPCC Guidelines was used, taking into account only the consumed amounts of HFCs and using conservative assumptions on EFs (e.g. 100 per cent emission for mobile air-conditioning equipment). For 1996–2008, a tier 2 approach was applied, which does consider the lifetime of equipment and emissions during use and at disposal (if applicable). Leakage rates and lifetimes stem from the Revised 1996 IPCC Guidelines. The AD (such as imports, exports and sales data) were collected by industry through surveys and voluntary reporting. Gaps were closed by using assumptions such as stable growth rates. Given that the importance of emissions of HFCs for the Canadian inventory is increasing over time, the ERT recommends that Canada use more accurate emission estimations by developing country-specific factors such as leakage rates and life times for HFCs in its future annual submissions. Furthermore, the ERT encourages Canada to further elaborate on the issue of time series consistency with its approach to estimate 1995 HFC emissions and its separate approach to estimate 1996–2008 emissions in the NIR.

3. Non-key categories

Other – CO₂

60. There is no IPCC methodology available for estimating emissions from magnesite use reported under the category other (mineral products). Canada estimated CO₂ emissions based on amounts of magnesite used and a stoichiometric EF corrected for the purity of the magnesite. The value of the purity stems from a publication by one of the three Canadian plants in 2004. No information is available for the other plants, so this value is used to correct the stoichiometric EF for the purity for the remaining plants. The ERT notes that the EF used might not be representative for all plants over time. The ERT therefore encourages Canada to develop a country-specific EF for magnesite, possibly in cooperation with industry and taking into account the possible changes in purity and the technologies used over time.

Aluminium production – SF₆

61. In the NIR, SF₆ emissions from aluminium foundries (which are estimated using SF₆ consumption) are considered under aluminium production, instead of under the category SF₆ used in aluminium and magnesium foundries. However, SF₆ emissions are reported under the category SF₆ used in aluminium and magnesium foundries. The ERT encourages Canada to explore the option of reporting SF₆ under the category of SF₆ used in aluminium and magnesium foundries in the NIR, consistent with the reporting in the CRF tables.

Consumption of halocarbons and SF₆ – SF₆

62. Emissions are calculated based on a tier 1a methodology from the Revised 1996 IPCC Guidelines, assuming SF₆ purchase is equal to leakage of SF₆ (not including SF₆ purchased by equipment manufacturers, as this is assumed to be filled into new equipment). In order to increase the accuracy of the approach, the ERT recommends that Canada establish contacts with the users of SF₆ to obtain more accurate data (i.e. amounts used for refill, excluding recycled amounts), and report on this in its next annual submission.

D. Agriculture**1. Sector overview**

63. In 2008, emissions from the agriculture sector amounted to 62,457.78 Gg CO₂ eq, or 8.5 per cent of total GHG emissions. Since 1990, emissions have increased by 28.7 per cent. The key drivers for the rise in emissions are increases in the populations of dairy cattle and other cattle, in milk production and in the use of synthetic nitrogen fertilizers. Within the sector, 51.9 per cent of the emissions were from agricultural soils, followed by 36.0 per cent from enteric fermentation, 12.0 per cent from manure management and 0.1 per cent from field burning from agricultural residues. N₂O emissions accounted for 59.4 per cent of sector emissions and CH₄ accounted for 40.6 per cent.

64. The ERT commends Canada for providing in the NIR specific information in relation to uncertainties and time-series consistency at the subcategory level, and encourages Canada to continue providing such information in its future annual submissions.

65. The agriculture sector is complete in terms of gases, categories, years and geographical coverage. However, during the centralized review the ERT noted that Canada had reported field burning of agricultural residues as “NE”. After the centralized review, in response to the list of potential problems and further questions from the ERT, Canada provided estimates for this category (see paras. 80 and 81 below).

66. The majority of the category emission estimates have been reported in accordance with the IPCC good practice guidance. Country-specific EFs have been used to estimate emissions from enteric fermentation, manure management and agricultural soils. The ERT commends Canada for providing, in response to questions raised by the ERT, additional information during the centralized review which improved the transparency of its reporting for this sector. However, the ERT recommends that, in its next annual submission, Canada improve the description of the animal waste management systems (AWMS) used in the country by providing a detailed description of how AWMS are broken down by region, in line with a recommendation in the 2009 review report.

67. The ERT identified a large number of issues with respect to the transparent use of references to sections of the agriculture chapter and annex 3 of the NIR, to data in the CRF tables and also to the equations used in emission estimates. The ERT also identified instances of inconsistencies between the NIR and CRF tables with respect to animal weights, Nex values and other livestock production information. In response to questions raised during the centralized review, Canada stated that it would correct these inconsistencies in its next annual submission. The ERT reiterates the recommendations of the previous review report that Canada strengthen its QC procedures for the reporting of methodologies and emissions in order to avoid such inconsistencies and transparency issues in its future annual submissions.

68. The ERT also notes that Canada identified in the NIR an inconsistency in the time series with respect to estimates of CH₄ from enteric fermentation, in particular in relation to the implementation of equations 4.3a and 4.4b of the IPCC good practice guidance on net

energy for growth and due to weight loss, which were corrected for the year 2008 only. The ERT notes that Canada is forthcoming in identifying such time-series inconsistencies, and recommends that Canada undertake to correct the inconsistencies for the whole time series and provide recalculated estimates in its next annual submission.

69. The ERT commends Canada for providing in the NIR information on a number of planned improvements for the agriculture sector, namely the correction of time-series inconsistencies outlined in paragraph 68 above, the development of a time series for feed digestibility and an update of tier 2 uncertainties taking into consideration the improvements in methods and new data sources. The ERT encourages Canada to make every effort to implement these planned improvements for its next annual submission.

2. Key categories

Enteric fermentation – CH₄

70. Emissions of CH₄ from enteric fermentation for dairy cattle and other cattle are estimated using the IPCC tier 2 approach, and the tier 1 approach is used for all other animal categories. This is in line with the IPCC good practice guidance. The ERT noted that Canada identified in the NIR time-series inconsistencies with respect to data for milk fat for the province of Quebec in addition to the inconsistencies indicated in paragraph 68 above. The ERT also noted that Canada corrected these issues for the year 2008 and lists under planned improvements that it will correct these time-series inconsistencies for the remainder of the time series (1990–2007) for its next annual submission. The ERT recommends that Canada implement its improvement plans and correct these time-series inconsistencies for its next annual submission.

71. Canada reports in its CRF table 4.A an average gross energy intake estimate of 181.40 MJ/head/day for non-dairy cattle, which is within the range of those reported by Parties (100–189 MJ/head/day). However, Canada still uses an average CH₄ conversion rate of 5.00 per cent, which is one of the lowest of reporting Parties (5.00 to 8.36 per cent) and also lower than the IPCC value of 6.00 per cent. In response to a question raised by the ERT during the centralized review, Canada stated that the average CH₄ conversion rate reported in the CRF is the un-weighted average of the lowest conversion rate of 0.04 for feedlot heifers and steers and the rate for all other cattle (0.06 for other cattle). The ERT noted that, in the calculation that Canada used to produce the CH₄ estimate for 2008, feedlot cattle only represent 16 per cent of all cattle in Canada and therefore the weighted CH₄ conversion factor would be 0.057 based on the relative proportion of the population occupied by feedlot cattle. The ERT recommends that Canada provide a clearer description of the use of these values in its next annual submission.

Manure management – CH₄ and N₂O

72. To estimate emissions of CH₄ from management of manure, Canada used a tier 2 approach. For all other livestock categories a tier 1 approach was used. A tier 1 methodology was used to estimate emissions of N₂O from manure management. The ERT considers this to be in line with the IPCC good practice guidance. During the centralized review, Canada supplied the ERT with additional information in relation to the estimation of CH₄ emissions from manure management that improved the understanding of the ERT on the method used. The ERT also notes that, in its 2010 submission, Canada makes use of the updated methane conversion factors (MCF) for cattle from the *2006 IPCC Guidelines for National Greenhouse Gas inventories* (hereinafter referred to as the 2006 IPCC Guidelines). The ERT encourages Canada to further elaborate in its next annual submission the methodological approach used to estimate CH₄ emissions from manure management

and provide further information in relation to the applicability of the MCF values from the 2006 IPCC Guidelines to the circumstances which exist in Canada.

73. The time-series inconsistencies identified in the estimation of CH₄ emissions from enteric fermentation from cattle with respect to volatile solids (VS) excretion (see para. 70 above) also have an effect on the estimation of CH₄ emissions from manure management. As a consequence, time-series inconsistencies also exist in this category. The ERT reiterates its recommendation that the Party clarify the use of parameters for calculating emissions from enteric fermentation, and furthermore, for manure management, and recommends that Canada correct these time-series inconsistencies for its next annual submission.

74. The ERT noted that, in the estimation of N₂O emissions from manure management, Canada uses the average annual Nex rates for domestic animals from table 10.19 from the 2006 IPCC Guidelines and the default EFs for a developed country with a cool climate from the 2006 IPCC Guidelines. The ERT encourages Canada to further elaborate in the NIR of its next annual submission the rationale for the use of these annual Nex rates and default EFs from the 2006 IPCC Guidelines.

75. The ERT noted that in CRF table 4.B(b) the multiplication of animal population with average Nex (in kg N/head/year) do not exactly match the sum of AWMS for the following animal categories: dairy cows, sheep, poultry, goats, horses and lambs. During the centralized review, in response to a question raised by the ERT, Canada stated that this discrepancy occurs due to the use of average values in CRF table 4.B(b), as opposed to weighted averages which take into account region-specific and subcategory information. The ERT recommends that Canada address this issue in its next annual submission by reporting in the CRF weighted average values that take into account region-specific and subcategory-specific information.

76. Some AWMS (anaerobic lagoons, daily spread and dry lot) have been reported as "NE". In the previous review report, Canada stated that these AWMS were negligible sources of emissions and that information on these AWMS was not available. In response to a question raised by the ERT during the centralized review, Canada stated that the lagoons present in the country do not meet the criteria for anaerobic lagoons as stated in the IPCC good practice guidance. The ERT strongly recommends that Canada review its use of the notation key "NE" for the AWMS identified above and that it use the appropriate notation keys in CRF table 4.B(b) with respect to the AWMS anaerobic lagoons, daily spread and dry lot in its future annual submissions.

Agricultural soils – N₂O

77. The ERT commends Canada for the use of country-specific methodologies for the subcategories synthetic fertilizers, animal manure applied to soils, crop residue and for the use of a country-specific methodology for the category other direct emissions. Tier 1 methodologies are employed for all other categories.

78. The ERT commends Canada for recalculating the emissions associated with synthetic fertilizer application as a result of updated AD. The ERT notes that the resulting overall increase of emissions (by 1,551.56 Gg CO₂ eq in 2007) had a significant impact on the long-term trend for emission estimates from synthetic fertilizer application.

79. Canada reports in its NIR that, in the calculation of N₂O emissions from the cultivation of histosols the AD used (i.e. area of cultivated organic soils) remain constant throughout the time series. Further information was supplied to the ERT during the centralized review outlining the Party's approach. The ERT deems the approach taken to be conservative and in line with IPCC good practice guidance. The ERT encourages Canada to

include information on the AD used for this category, as was provided to the ERT during the review week, in the NIR in its next annual submission.

3. Non-key categories

Field burning of agricultural residues – CH₄ and N₂O

80. In its 2010 submission, Canada reported the fraction of crop residue burned in CRF table 4.D as “NE” for emissions from agricultural soils, although, according to CRF table 4.F, this activity did occur in Canada. In the NIR, Canada indicated its intention to include these emissions in its 2011 annual submission. However, during the centralized review the ERT noted that this issue results in a potential underestimate of Canada’s 2008 emissions and recommended that Canada estimate emissions of CH₄ and N₂O from field burning of agricultural residues using the country-specific methodology as presented to the ERT during the review week.

81. After the centralized review, in response to the list of potential problems and further questions raised by the ERT, Canada provided estimates of CH₄ and N₂O emissions for this category, which were deemed appropriate by the ERT. The impact of the new estimates in 2008 is an increase of 45.18 Gg CO₂ eq in this category; however it also represents a decrease of 25.06 Gg CO₂ eq in the agricultural soils category, due to accounting for the fraction of crop residue burned. Overall, the impact of the new estimates is an increase by 20.12 Gg CO₂ eq or 0.03 per cent for the agriculture sector. For 1990, the new estimates are 205.33 Gg CO₂ eq for this category with a decrease of 127.55 Gg CO₂ eq in the agricultural soils category and an overall increase of 77.77 Gg CO₂ eq or 0.02 per cent for the agriculture sector. The ERT recommends that, in its next annual submission, Canada document in full the estimation methodology provided to the ERT in its response and continue to report estimates for this category.

E. Land use, land-use change and forestry

1. Sector overview

82. In 2008, net removals from the LULUCF sector amounted to 12,826.60 Gg CO₂ eq. Since 1990, net annual emissions or removals have fluctuated; the net removals in 2008 were 75.1 per cent lower than in 1990. The key driver for the fall in net removals are changes in emissions/removals from forest land, caused by a high inter-annual variability due to occurrence and severity of fires and of forest disturbance caused by insect epidemics. The ERT noted that cropland changed from being a net source of emissions (of 12,666.80 Gg CO₂ eq) in 1990 to a net sink (of 4,427.58 Gg CO₂ eq) in 2008. In 2008, within the sector, 18,247.23 Gg CO₂ eq net removals were from forest land, followed by 4,427.58 Gg CO₂ eq from cropland. Settlements accounted for 7,350.74 Gg CO₂ eq net emissions (mainly due to the conversion of forest land to settlements) and wetlands accounted for 2,497.46 Gg CO₂ eq. CO₂ emissions/removals from grassland remaining grassland were reported as “IE” and “NE”, and land converted to grassland as “NE” and “NO”. Land converted to other land was reported as “NE” and “NO”. Cropland, wetlands and other land converted to settlements have been reported as “NE”. Estimates are provided for N₂O emissions from disturbance associated with land-use conversion to cropland (CRF table 5(III)), for CO₂ emissions from lime application (CRF table 5(IV)) and biomass burning (table 5(V)), but some subcategories are reported as “IE”, “NE” or “NO”. N₂O emissions from N fertilization (CRF table 5(I)) are reported as “IE” and non-CO₂ emissions from drainage of soils and wetlands (CRF table 5(II)) are reported as “NO”. Canada has indicated in its NIR that efforts are being made to update estimates on areas converted to

and from forest land using new series of remote sensing data. The net removals of the LULUCF sector offset 1.7 per cent of the total GHG emissions in 2008.

83. Canada applies the IPCC tier 2 and 3 methods and country-specific parameters to prepare the estimates for the LULUCF sector. The methods used to represent areas of land comply with approach 2 of the IPCC good practice guidance for LULUCF. The Monitoring, Accounting and Reporting System (MARS) is used by Canada for ensuring the highest consistency and spatial integrity of the GHG inventory. Canada uses a hierarchical spatial framework which, in the case of managed forest land, consists of 542 analysis units. The National Soil Database of the Canadian Soil Information System is the basis for the data used for estimates of the cropland category. The ERT notes that Canada is continuing its efforts to improve AD and its estimates for the LULUCF sector. Detailed information on the uncertainty analysis and QA/QC procedures is provided in the NIR. The uncertainty analysis was implemented in 2010 for all categories in the LULUCF sector except for land converted to forest land, wetlands and settlements, due to resource limitations. The ERT encourages Canada to complete the NIR by providing this uncertainty estimate. Tier 1 QA/QC and tier 2 QC procedures were applied to the estimations of all emissions by sources and removals by sinks reported in the sector.

84. From the total area of Canada of 996,357 kha, estimates are reported for 279,884 kha. The rest of the area is considered by Canada as unmanaged and therefore not reported. Land once managed does not become unmanaged again; even though management has stopped or land is abandoned and no new management is established, Canada continues to report such land under the former land-use category. Managed agricultural grasslands are only found within the Prairie regions of Canada; their extent is estimated based on census statistics for unimproved pasture. Canada argues that no information is available on management changes on such land and therefore no net change of the carbon pools in these lands are to be expected. Managed areas of grassland (i.e. cut for hay or green feed or improved pastures) are included under cropland. In the NIR, Canada provided a land-use change matrix for managed land and a table with total area, areas of managed forests and areas of cropland for 2007, which provide comparable estimates. During the centralized review, Canada informed the ERT that it will re-examine its land-use change matrix for the 2011 submission. The ERT welcomes the Party's efforts leading to increased consistency of the information about land use and land-use change areas and all improvements undertaken and encourages Canada to implement them in its next annual submission.

2. Key categories

Forest land remaining forest land – CO₂

85. The AD used for preparing estimates in this category are prepared by the National Forest Carbon Monitoring, Accounting and Reporting System (NFCMARS). The system integrates forest inventory data, yield curves and reference AD. The CBM-CFS3 model computes data of growth, litter fall, tree mortality and decomposition as well as the effects of natural disturbances and management activities, and produces estimates of emissions and removals of this category. Updated AD and methodological changes were performed in 2010, but were implemented for the year 2008 only. Therefore, there is an inconsistency in the time-series of the estimates. The ERT notes that Canada reported in the NIR that it will implement the improvements for the entire time series in its next annual submission. The ERT welcomes these efforts and recommends Canada to provide an updated time series in its next annual submission.

Cropland remaining cropland – CO₂

86. Estimates reported for this category include emissions and removals from mineral soils, lime application, cultivation of organic soils and changes in woody biomass of perennial crops. Canada uses a well-calibrated and validated model (CENTURY) to estimate changes in soil organic carbon. The model takes account of changes of areas of annual and perennial crops, areas of summer fallows and of tillage regimes. Lime application is estimated using the default tier 1 approach of the IPCC good practice guidance for LULUCF. Carbon stock changes in living biomass are only estimated for perennial crops with woody biomass. Cropland with woody biomass remaining cropland with woody biomass is assumed to have no net increase or decrease in carbon stock. Vineyards, fruit orchards and Christmas trees are considered as crops. Changes were estimated only in cases where an additional area of perennial crops with woody biomass is established or when such crops are removed and not replaced. The ERT welcomes the ongoing efforts by Canada to update the time series and to reduce uncertainties.

Land converted to cropland – CO₂

87. In Canada, land converted to cropland is converted from forest land and from grassland. The conversion rate from forest land to cropland was updated for 2008, but it has not yet been updated for the entire time series. The ERT notes that Canada reported in the NIR that it will provide updated time-series estimates in its next annual submission and welcomes this effort.

Land converted to wetlands – CO₂

88. Under this category, Canada reports emissions from peatlands drained for peat extraction and flooded land. Peat extraction is used for horticultural application only. For flooded land a conversion time of 10 years is applied, afterwards emissions from the decay of cleared forest biomass are reported under wetlands remaining wetlands. In its 2010 submission, Canada implemented improvements to the carbon transfer parameters for forest clearing before flooding for 2008 only. The ERT notes that Canada reported in the NIR that it will implement improvements and correct inconsistencies in the entire time series in its next annual submission. The ERT further notes that Canada plans to reassess the emission curve used to determine the emissions from the surface of flooded land and invites Canada to apply these improvements in its next submissions.

3. Non-key categories

Land converted to forest land – CO₂

89. Only the forest plantations that mainly occur on abandoned farmland are included under this category. Natural vegetation re-growing on abandoned farmland is not included in this category, as the land is still considered cropland until a full forest cover is established. Updated AD and methodological changes were implemented for 2008 estimates only. The ERT notes that Canada reported in the NIR that it will update the entire time-series estimates in its next submission. The ERT recommends the Party to introduce these improvements.

Biomass burning – CO₂, CH₄ and N₂O

90. The NIR reports that Canada performed investigations in fieldwork and experimental burns to improve EFs from biomass burned, though no indication was given in the NIR for the time period over which the EFs would be applicable. The ERT takes note of these investigations and welcomes the planned improvement in the estimations of

wildfire emissions using these newly developed EFs and encourages Canada to implement these in its next annual submission.

F. Waste

1. Sector overview

91. In 2008, emissions from the waste sector amounted to 21,664.48 Gg CO₂ eq, or 2.9 per cent of total GHG emissions. Since 1990, emissions have increased by 14.9 per cent. The key driver for the rise in emissions is the population growth and the increased waste generation per capita which offsets the mitigation efforts of Canada, including landfill gas recovery, provincial/municipal waste diversion projects and international export of MSW. Within the sector, 94.5 per cent of the emissions were from solid waste disposal on land, followed by 4.4 per cent from wastewater handling and 1.2 per cent from waste incineration.

92. Canada reported emissions from unmanaged waste disposal sites as “NE” with the assumption that there are few unmanaged sites, that they are all shallow and small in size, and that there is not a significant volume of emissions from those sites. In addition, in CRF table 6.A, Canada reports that historical data and current data are unavailable or unreliable and that annual MSW disposed in unmanaged landfills is unknown. However, by assuming all waste disposals are in managed landfills, Canada considers that emissions from waste disposed in reality in unmanaged landfills are conservatively accounted for under the subcategory of managed waste disposal. In the NIR, Canada explained that it is considering implementing a study to isolate the data of waste treated in unmanaged landfills, and could be used for the next submission if new data will be accurate enough. The ERT acknowledges that this is a conservative approach, however it recommends that Canada collect accurate AD, either directly or through appropriate proxy collection efforts, so that emissions from the unmanaged landfills can be estimated. In addition, the ERT recommends that emissions from unmanaged landfills be reported as “IE” in the Party’s next annual submission, if separate emissions from the unmanaged landfills are not estimated. Canada also reported CH₄ emissions from industrial wastewater as “NE”. In response to the list of potential problems and further questions raised by the ERT during the centralized review, Canada provided CH₄ emission estimates for this category for the whole time series in its revised 2010 submission (see paras. 98–99 below). The ERT welcomes this effort to improve the completeness of the inventory.

93. Canada estimates CH₄ emissions from solid waste disposal on land, wastewater handling and waste incineration using country-specific methods with country-specific data that are based on provincial-level data. The ERT commends Canada for its efforts to develop methodologies in line with the IPCC good practice guidance, and notes that AD at the provincial level as presented in the NIR are helpful in considering the profile of the waste in landfill sites and wastewater treated. The ERT considers that further improvements of the presentation of AD and the models used for the estimates would facilitate review by ERTs, in a way to show links between these provincial level estimation results with the national totals presented in the NIR.

2. Key categories

Solid waste disposal on land – CH₄

94. Canada applied the IPCC tier 2 methodology with country-specific CH₄ generation potential (L₀) and CH₄ generation constant (k). The CH₄ generation potentials of respective provinces are estimated for three different time periods (1941–1975, 1976–1989 and 1990–2008) with province-level degradable organic carbon (DOC) values of those periods that

were derived based on waste composition data for 2002. In response to a question from the ERT, Canada explained that the waste composition data obtained in 2002 are the latest, and the application of DOC values obtained from these data to the 1990–2000 data series may cause a slight underestimation for those years due to there being more waste diversion programmes implemented around 2002 than in 1990. Considering the time required for decay, together with the increasing trends of rapidly or moderately decay waste (food, garden and park waste) that can be observed in table 3A-45 of the NIR in the 2010 submission, the ERT strongly recommends that Canada update its waste composition data and improve its estimates in future annual submission.

95. In addition, Canada reports the existence of landfill sites designated solely for construction and demolition waste with the assumption that no significant amount of biodegradable waste is present in those sites. However, it is also observed by Canada that more construction and demolition waste is brought to the landfills in general and those changes in management practice may also change the profile of waste in the landfill sites. During the centralized review, Canada informed the ERT that it is currently examining a programme to enable the federal inventory agency to obtain more frequent periodic updates of waste composition data, and that it would also include composition of waste as per IPCC waste categories in its next annual submission. The ERT encourages Canada to continue to consider ways to update its waste composition data to incorporate construction and demolition waste and improve its estimates in future annual submissions.

3. Non-key categories

Wastewater handling – CH₄

96. In estimating CH₄ emissions from domestic and commercial wastewater handling, Canada applied a country-specific EF (4.015 kg CH₄/person/day), which is a product of the CH₄ generation rate (0.22 kg CH₄/kg BOD₅) and the per capita biochemical oxygen demand (BOD₅) loading rate of 0.05 kg. The rate of CH₄ generation from the anaerobic decomposition of organic matter in wastewater (0.22 kg CH₄/kg BOD₅) is much lower than the IPCC default value (0.6 kg CH₄/kg BOD₅). During the centralized review, Canada informed the ERT that the value for the CH₄ generation rate will be replaced with 0.37 kg CH₄/kg BOD₅ in its next annual submission using its country-specific conversion factor from COD to BOD, instead of the IPCC factor. In addition, Canada noted that the MCF equal to 1 used in its inventory is an error and resulted in overestimation of emissions. Canada further noted that this MCF will be corrected with the value of 0.2 determined by expert judgement in its next annual submission. However, in the NIR, the application of the MCF = 1 and the application of the BOD₅ rate (0.05 kg BOD₅/person per day) were not well documented, in that those parameters were not actually used in the method applied by Canada, as was clarified by Canada to the ERT after the centralized review. The ERT strongly recommends that Canada document its method and the EFs and parameters used in a more transparent and detailed manner in its next annual submission.

97. Sewage sludge treated at landfill sites or incinerated is reported under the management of solid waste and incineration of waste. Responding to comments from previous review reports, Canada explained that the AD of municipal sludge handling from wastewater treatment are unavailable and reported as “NE”. In response to the draft review report, Canada stated that sewage sludge quantities being landfilled are included in the aggregate values of MSW disposed of provided by Statistics Canada, and emissions of CH₄ from domestic and commercial wastewater handling of sludge are collected from the anaerobic digesters and utilized for energy purposes with negligible fugitive CH₄ emissions. In the NIR, Canada explained that recovery of CH₄ has not been confirmed and is not expected to occur. The ERT therefore recommends that the Party change the notation of the recovery under this category from “NE” to “NO”.

98. CH₄ emissions and recovery from industrial wastewater were reported by Canada as “NE” in its 2010 submission, due to the absence of information about treatment systems used in different industries. In response to the list of potential problems and further questions raised by the ERT during the centralized review, Canada provided CH₄ emission estimates from pulp and paper, and food industries in its revised 2010 submission. Overall, the impact of the new estimates is an increase by 7.40 Gg CO₂ eq or 0.03 per cent for the waste sector. For 1990, the new estimates represent an overall increase of 1.54 Gg CO₂ eq or 0.01 per cent for the waste sector.

99. The ERT welcomes the efforts of Canada to provide the missing estimates and improve the completeness of its inventory. The ERT recommends that, in its next annual submission, Canada improve the explanation and documentation of the methods and data used for each province and facility, in particular, by providing the data that are actually used for the emission estimates before aggregating them to the national level.

Waste incineration – CO₂, CH₄ and N₂O

100. In its 2010 submission, Canada estimated CO₂ emissions from the incineration of MSW using country-specific EFs, specific to its provinces. For estimating N₂O, IPCC default EFs for MSW are used. To estimate emissions from sewage sludge, EFs for CH₄ are obtained from the U.S. Environmental Protection Agency and IPCC default for N₂O are used. Canada reported in the NIR that it is considering a refinement to its existing AD, including waste composition, and intends to develop country-specific or technology-based EFs to use for the emission estimates of this category. The ERT encourages Canada to implement this plan and to use the results for the emission estimates of this category in its next annual submission.

G. Supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

1. Information on activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol

Overview

101. Canada submitted estimates for afforestation, reforestation and deforestation activities under Article 3, paragraph 3, of the Kyoto Protocol and for cropland management, as Canada elected this activity under Article 3, paragraph 4, of the Kyoto Protocol. Canada chose to account for activities under Article 3, paragraphs 3 and 4, at the end of the commitment period. The ERT noted that Canada reported as “IE” direct N₂O emissions from N fertilization as they are reported in the agriculture sector (see para. 82 above) and for limestone application because emissions are reported under cropland management. For the base year, 1990, estimates for cropland management were provided in tables 5(KP-I)B.2 and 5(KP-II)3, 4 and 5. Canada provided in the NIR all supplementary information required under Article 3, paragraphs 3 and 4, of the Kyoto Protocol. In addition, a QA/QC analysis was provided for all KP-LULUCF activities. Canada reported that no factoring out of effects caused by increased CO₂ concentration or N deposition was applied to the estimates, which is not mandatory, but information is required.

102. Canada uses the same definitions, approaches and methodologies for the KP-LULUCF reporting as under the Convention. The land information system MARS is based on sampling techniques within established geo-referenced boundaries encompassing units of land subject to afforestation, reforestation, deforestation or cropland management. This is in line with method 1 of the IPCC good practice guidance for LULUCF. The time series of land converted from or to forest are elaborated by interpretation of Landsat images. Linear interpolations between the years of Landsat images were applied. Canada stated in

the NIR that it will extend the mapping with images of the time period 2000–2008. The ERT expects that the update will also affect AD of afforestation, reforestation and deforestation. The ERT welcomes the Party's efforts, which will improve the quality of estimates that now are based on extrapolation and encourages Canada to implement these new data in its next annual submission.

Activities under Article 3, paragraph 3, of the Kyoto Protocol

Afforestation and reforestation – CO₂

103. Canada limits its reporting of afforestation and reforestation activities to forest plantations mainly carried out on abandoned farmland; post-harvest tree planting and natural vegetation that is allowed to establish on abandoned farmland is excluded. The data set used for the estimates is the same as that used for the reporting under the Convention. In the NIR, Canada reported that, in addition to the area update by applying new remote sensing data, area estimates from a carbon sequestration initiative are reviewed. The ERT recommends that Canada report updates and the effect of the completed time series (see para. 102 above) on these activities and on further progress made in its next annual submission.

Deforestation – CO₂, CH₄ and N₂O

104. The data set used for the estimates for deforestation is the same as that used for the reporting under the Convention. Deforestation events identified by remote sensing technology are manually delineated and assigned to the proper time period using ancillary data. In addition, temporary losses of forests are excluded by visual interpretation and by using ancillary data. The ERT noted that the conversion of unmanaged forests is included under deforestation. Uncertainty of forest conversion data is estimated, using the error propagation method, to be 38 per cent. The ERT welcomes the Party's ongoing efforts and recommends that Canada implement the new findings and the updated time series mentioned in paragraph 85 above in the estimations and provide transparent descriptions of the improvements in its next annual submission.

Activities under Article 3, paragraph 4, of the Kyoto Protocol

Cropland management – CO₂, CH₄ and, N₂O

105. The ERT noted that Canada's estimates of cropland management under the Kyoto Protocol are generally consistent with those provided under the Convention. The difference is due to the fact that emissions and removals from forest land converted to cropland since 1990 are reported under deforestation activities, which is in line with the IPCC good practice guidance for LULUCF. During the centralized review, Canada provided to the ERT a time series of AD on cropland remaining cropland, forest land converted to cropland and grassland converted to cropland. For the base year (1990) estimates, forest conversion rates to cropland were included starting in 1971. Residual changes in the soil carbon stock of those forest conversions are still included in the estimates. The ERT noted that Canada reports the controlled burning of biomass in the base year and in 2008 as "NE". In the NIR of its 2010 submission, Canada stated that it will provide a full time series of controlled burning of crop residues in its next annual submission under the agriculture sector. After the centralized review, in response to the list of potential problems and further questions raised by the ERT, Canada provided estimates of CH₄ and N₂O emissions for the field burning of agricultural residues category, which were deemed appropriate by the ERT (see paras. 80 and 81 above).

106. In chapter A11.1.2 of the NIR, it is reported that the land converted to cropland originates from grassland only. According to the NIR (table 7-3 and chapter A5.5), the conversion from wetlands and settlements to cropland, as well as conversions from cropland to wetlands and settlements are not estimated. Losses of cropland to other land-use are not estimated. The ERT recommends that Canada provide transparent information on such conversions and their effects on sinks and sources in its next annual submission.

2. Information on Kyoto Protocol units

Standard electronic format and reports from the national registry

107. Canada has not reported information on its accounting of Kyoto Protocol units in the SEF tables, in accordance with decisions 15/CMP.1 and 14/CMP.1. Canada was not required to submit a SEF report as its national registry did not transfer or acquire any Kyoto Protocol units in the reported period. The ERT took note of the findings included in the SIAR. The SIAR was forwarded to the ERT prior to the review, pursuant to decision 16/CP.10.

National registry

108. The ERT took note of the SIAR and its finding that the reported information on the national registry is complete and has been submitted in accordance with the annex to decision 15/CMP.1. The ERT further noted from the SIAR and its finding that the national registry continues to meet the requirements 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 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. The ERT took note of the information on the national registry provided by Canada in its NIR.

Calculation of the commitment period reserve

109. Canada has reported its commitment period reserve in its 2010 annual submission. The Party confirmed that its commitment period reserve has not changed since the initial report review (2,512,613,494 t CO₂ eq), as it is based on the assigned amount and not on the most recently reviewed inventory. The ERT agrees with this figure.

3. Changes to the national system

110. Canada reported that there were no changes in its national system since the previous annual submission. The ERT concluded that Canada's national system continues to be in accordance with the requirements of national systems outlined in decision 19/CMP.1.

4. Changes to the national registry

111. Canada provided information on changes to its national registry in annex 11 to the NIR of its 2010 annual submission. The Party reported changes in the name and contact information of the registry administrator and changes to the data integrity measures of the registry, including a secondary disaster recovery site that was successfully tested in November 2009, in response to the recommendation of the 2008 review report.

112. The ERT concluded that, taking into account the confirmed changes in the national registry, Canada's national registry continues to meet the requirements 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

decisions of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP).

5. Minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol

113. In its 2010 annual submission, Canada has reported information on the minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol, as requested in chapter I.H of the annex to decision 15/CMP.1.

114. The reported information is considered complete and transparent. The process to establish and implement climate change response measures in Canada includes comprehensive consultation among involved stakeholders at international and national levels as well as an extensive public consultation with provinces on planned activities.

115. Canada has undertaken a number of fiscal and tax measures in order to phase out market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all GHG-emitting sectors. Canada reported that detailed information on its assistance to developing countries, as well as activities for the transfer technology and finance transfer, is provided in Canada's Fifth National Communication on Climate Change.

III. Conclusions and recommendations

116. Canada made its 2010 annual submission on 15 April 2010. The annual submission contains the GHG inventory (comprising CRF tables and an NIR) and supplementary information under Article 7, paragraph 1, of the Kyoto Protocol (information on: activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, Kyoto Protocol units, changes to the national system and the national registry and minimization of adverse impacts in accordance with Article 3, paragraph 14, of the Kyoto Protocol). This is in line with decision 15/CMP.1. Canada submitted revised emission estimates on 18 October 2010 in response to the list of potential problems and further questions raised by the ERT during the course of the centralized review.

117. 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 complete in terms of geographical coverage, years, sectors and gases as well as generally complete in terms of categories. Canada has submitted a complete set of CRF tables for the years 1990–2008 and an NIR. However, the ERT identified several categories reported as "NE" in the energy, industrial processes, agriculture, waste and LULUCF sectors. In response to the list of potential problems and further questions raised by the ERT during the centralized review, Canada provided CH₄ and N₂O emission estimates for field burning of agricultural residues (see para. 81 above) and CH₄ emission estimates for industrial wastewater (see para. 98 above). In addition, Canada provided revised CH₄ emission estimates for natural gas distribution (see para. 46 above). The overall impact on the total GHG emissions of these new and revised estimates is an increase of 146.62 Gg CO₂ eq or 0.02 per cent in 2008 and an increase of 79.31 Gg CO₂ eq or 0.01 per cent in 1990. The ERT agreed with these emission estimates. The ERT recommends that Canada provide estimates for all remaining missing categories that are known to occur in the country and that are identified in this report in its next annual submission, in order to improve the completeness of reporting in accordance with the requirements of the UNFCCC reporting guidelines, Article 5, paragraph 2, of the Kyoto Protocol and decision 15/CMP.1.

118. The submission of information required under Article 7, paragraph 1, of the Kyoto Protocol has been prepared and reported in accordance with decision 15/CMP.1.

119. Canada'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. However, the ERT identified some instances where Canada's inventory is not fully in line with these guidelines, in particular regarding completeness of estimates, but also regarding transparency and time-series consistency.

120. Canada provided all supplementary information required under Article 3, paragraphs 3 and 4, of the Kyoto Protocol. Canada uses the same definitions, approaches and methodologies for the KP-LULUCF reporting as under the Convention, and its approach is in line with the IPCC good practice guidance for LULUCF. However, the ERT noted that information on conversions from and to cropland is not fully consistent between the reporting under the Convention and under the Kyoto Protocol.

121. Canada has reported in its NIR, and in its response to the SIAR, that because 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.

122. The national system continues to perform its required functions as set out in the annex to decision 19/CMP.1.

123. The national registry continues to meet the requirements 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.

124. Canada has reported the information requested in chapter I.H of the annex to decision 15/CMP.1, "Minimization of adverse impacts in accordance with Article 3, paragraph 14" as part of its 2010 annual submission. The reported information is considered complete and transparent.

125. In the course of the review, the ERT formulated a number of recommendations relating to the completeness, transparency and time-series consistency of the information presented in Canada's annual submission. The key recommendations are that Canada:

(a) Provide estimates of all emissions that are known to occur in the country and that are identified in this report, in particular in the industrial processes sector;

(b) Provide descriptions of the methodologies used for the energy sector and the rationale behind the selection of country-specific parameters, as well as updating the country-specific EFs currently use for fuel combustion categories;

(c) Provide descriptions of the methodologies used for the LULUCF sector and the rationale behind the selection of country-specific parameters, as well as better documentation of the CO₂ emissions/removals from forest land and from forest land converted to cropland categories;

(d) Continue with the update and improvement of uncertainty analyses using the most recent inventory data available and further development of uncertainty estimates for the LULUCF sector;

(e) Increase the transparent use of references in CRF tables to sections of the agriculture chapter and annex 3 to the NIR and also to the equations used in emission estimates;

(f) Correct inconsistencies between the NIR and CRF tables with respect to animal weights, Nex values and other livestock production information and strengthening QA/QC procedures for the reporting of methodologies and parameters in order to avoid inconsistencies and transparency issues;

(g) Increase the transparency of the NIR by adding relevant information on data sources and EFs used in all categories of the industrial processes sector as well as improving the time-series consistency and comparability by using a single method for all years and for all industrial plants under a category, wherever possible;

(h) Provide transparent information on conversions from and to cropland, that is not fully consistent between the reporting under the Convention and under the Kyoto Protocol, and their effects on sinks and sources in its next annual submission

(i) Improve the consistency in the classification of managed and unmanaged lands in the land matrix used for the LULUCF sector estimates.

IV. Questions of implementation

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

Annex I

Documents and information used during the review

A. Reference documents

Intergovernmental Panel on Climate Change. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Available at <http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html>.

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 2010. Available at <http://unfccc.int/resource/docs/2008/asr/can.pdf>.

Synthesis and assessment report on the greenhouse gas inventories submitted in 2010. Available at <http://unfccc.int/resource/webdocs/sai/2010.pdf>.

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

UNFCCC. *Standard Independent Assessment Report, Parts I and II*. Available at http://unfccc.int/kyoto_protocol/registry_systems/independent_assessment_reports/items/4061.php.

B. Additional information provided by the Party

Responses to questions during the review were received from Mr. Duane Smith and Ms. Jackie Mercer (Greenhouse Gas Division of Environment Canada), including additional material on the methodology and assumptions used. The following documents¹ were also provided by Canada:

Aluminium Association of Canada, 2002. *Framework Agreement on Voluntary Greenhouse Gas Reductions in Quebec Entered into between the Government of Quebec and the Aluminium Association of Canada.*

Coote, D.R., B.C. Liang and E.C. Huffman. 2008. *Crop residue burning in Canada.* Quebec: Greenhouse Gas Division of Environment Canada.

A.J. Chandler & Associates, Inc, 2003. *Municipal Solid Waste Incineration in Canada: An Update On Operations 1999-2001.*

Environment Canada. 2009. *An Inventory Of Landfill Gas Recovery and Utilization in Canada.* The Greenhouse Gas Division of Environment Canada.

¹ Reproduced as received from Canada.

Annex II

Acronyms and abbreviations

AD	activity data
AWMS	animal waste management systems
BOD	biochemical oxygen demand
CH ₄	methane
CKD	cement kiln dust
CO ₂	carbon dioxide
CO ₂ eq	carbon dioxide equivalent
CMP	Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
CRF	common reporting format
DOC	degradable organic carbon
EF	emission factor
ERT	expert review team
GHG	greenhouse gas; unless indicated otherwise, GHG emissions are the sum of CO ₂ , CH ₄ , N ₂ O, HFCs, PFCs and SF ₆ without GHG emissions and removals from LULUCF
HFCs	hydrofluorocarbons
IE	included elsewhere
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram (1 kg = 1,000 grams)
KP-LULUCF	and use, land-use change and forestry emissions and removals from activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol
LULUCF	land use, land-use change and forestry
MCF	methane conversion factor
MSW	municipal solid waste
N	nitrogen
NA	not applicable
NE	not estimated
Nex	nitrogen excretion
NH ₃	ammonia
NO	not occurring
N ₂ O	nitrous oxide
NIR	national inventory report
PFCs	perfluorocarbons
QA/QC	quality assurance/quality control
SEF	standard electronic format
SF ₆	sulphur hexafluoride
SIAR	standard independent assessment report
VS	volatile solids
UNFCCC	United Nations Framework Convention on Climate Change