



United Nations

FCCC/ARR/2021/CAN



Framework Convention on  
Climate Change

Distr.: General  
11 May 2022

English only

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## **Report on the individual review of the inventory submission of Canada submitted in 2021\***

### **Note by the expert review team**

#### *Summary*

Each Party included in Annex I to the Convention must submit an annual inventory of emissions and removals of greenhouse gases for all years from the base year (or period) to two years before the inventory due date (decision 24/CP.19). This report presents the results of the individual review of the 2021 inventory submission of Canada, conducted by an expert review team in accordance 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 greenhouse gas inventories”. The review took place from 18 to 23 October 2021 remotely.

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\* In the symbol for this document, 2021 refers to the year in which the inventory was submitted, not to the year of publication.



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## Abbreviations and acronyms

2006 IPCC Guidelines	<i>2006 IPCC Guidelines for National Greenhouse Gas Inventories</i>
2019 Refinement to the 2006 IPCC Guidelines	<i>2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories</i>
AD	activity data
Annex I Party	Party included in Annex I to the Convention
Article 8 review guidelines	“Guidelines for review under Article 8 of the Kyoto Protocol”
C	carbon
c-C <sub>4</sub> F <sub>8</sub>	perfluorocyclobutane
C <sub>2</sub> F <sub>6</sub>	perfluoroethane
CAC	Cement Association of Canada
CBM-CFS-3	carbon budget model of the Canadian forest sector
CCS	carbon dioxide capture and storage
CF <sub>4</sub>	tetrafluoromethane
CF <sub>ckd</sub>	emissions correction factor for cement kiln dust
CH <sub>4</sub>	methane
CLI	Canadian Lime Institute
CO <sub>2</sub>	carbon dioxide
CO <sub>2</sub> eq	carbon dioxide equivalent
Convention reporting adherence	adherence to the “Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual greenhouse gas inventories”
CRF	common reporting format
CSC	carbon stock change
DOC	degradable organic carbon
DOC <sub>f</sub>	fraction of degradable organic carbon that decomposes
EEA	European Environment Agency
EF	emission factor
EF <sub>cl</sub>	emission factor for clinker uncorrected for cement kiln dust
EF <sub>dol</sub>	emission factor for dolomite or dolomitic limestone calcination
EF <sub>h-c</sub>	emission factor for high-calcium limestone calcination
EF <sub>toc</sub>	emission factor for total organic carbon in raw feed
EMEP	Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe
EOR	enhanced oil recovery
ERT	expert review team
F <sub>NPR</sub>	fraction of nitrogen in protein
Frac <sub>GASM</sub>	fraction of applied organic nitrogen fertilizer materials and of urine and dung nitrogen deposited by grazing animals that volatilizes as ammonia and nitrogen oxides
Frac <sub>LeachMS</sub>	fraction of managed manure nitrogen losses due to leaching and run-off
GCV	gross calorific value
GHG	greenhouse gas
HFC	hydrofluorocarbon
HWP	harvested wood products
IE	included elsewhere
IEF	implied emission factor
IPCC	Intergovernmental Panel on Climate Change
IPPU	industrial processes and product use

KP-LULUCF	activities under Article 3, paragraphs 3–4, of the Kyoto Protocol
LULUCF	land use, land-use change and forestry
MCF	methane conversion factor
MSW	municipal solid waste
N	nitrogen
N <sub>2</sub> O	nitrous oxide
NA	not applicable
NE	not estimated
NEU	non-energy use
Nex	nitrogen excretion
NF <sub>3</sub>	nitrogen trifluoride
NH <sub>3</sub>	ammonia
NIR	national inventory report
NO	not occurring
NO <sub>x</sub>	nitrogen oxides
ODS	ozone-depleting substance(s)
OX	oxidation factor
PFC	perfluorocarbon
QA/QC	quality assurance/quality control
SF <sub>6</sub>	sulfur hexafluoride
SWDS	solid waste disposal site(s)
UNFCCC Annex I inventory reporting guidelines	“Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual greenhouse gas inventories”
UNFCCC review guidelines	“Guidelines for the technical review of information reported under the Convention related to greenhouse gas inventories, biennial reports and national communications by Parties included in Annex I to the Convention”
VS	volatile solid(s)
Wetlands Supplement	<i>2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands</i>

## I. Introduction

1. This report covers the review of the 2021 inventory submission of Canada, organized by the secretariat in accordance with the UNFCCC review guidelines, particularly in part III thereof, namely the “UNFCCC guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention” (annex to decision 13/CP.20). The review took place from 18 to 23 October 2021 remotely<sup>1</sup> and was coordinated by Javier Hanna Figueroa and Sevdalina Todorova (secretariat). Table 1 provides information on the composition of the ERT that conducted the review for Canada.

Table 1

**Composition of the expert review team that conducted the review for Canada**

<i>Area of expertise</i>	<i>Name</i>	<i>Party</i>
Generalist	Mikhail Gitarskiy	Russian Federation
	Olia Glade	New Zealand
Energy	Elena Gavrilova	North Macedonia
	Rana Humbatova	Azerbaijan
	Haakon Marold	Australia
IPPU	Wolfram Jörß	European Union
	Kakhaberi Mdivani	Georgia
	Samir Tantawi	Egypt
Agriculture	Marci Baranski	United States
	Kent Buchanan	South Africa
	Christopher John Dore	United Kingdom
LULUCF and KP-LULUCF	Mattias Lundblad	Sweden
	Walter Oyhantcabal	Uruguay
	Marina Shvangiradze	Georgia
Waste	Maryna Berezhnytska	Ukraine
	Medeia Inashvili	Georgia
	Sergii Shmarin	Ukraine
Lead reviewers	Mikhail Gitarskiy	
	Kakhaberi Mdivani	

2. The basis of the findings in this report is the assessment by the ERT of the Party’s 2021 inventory submission in accordance with the UNFCCC review guidelines.

3. The ERT has made recommendations that Canada resolve the findings related to issues.<sup>2</sup> Other findings, and, if applicable, the encouragements of the ERT to Canada to resolve them, are also included.

4. 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.

5. Annex I presents the annual GHG emissions of Canada, including totals excluding and including LULUCF, indirect CO<sub>2</sub> emissions, and emissions by gas and by sector.

<sup>1</sup> Owing to the circumstances related to the coronavirus disease 2019, the review had to be conducted remotely.

<sup>2</sup> Issues are defined in decision 13/CP.20, annex, para. 81.

## II. Summary and general assessment of the Party's 2021 inventory submission

6. Table 2 provides the assessment by the ERT of the Party's 2021 inventory submission with respect to the tasks undertaken during the review. Further information on the issues identified, as well as additional findings, may be found in tables 3 and 5.

Table 2

### Summary of review results and general assessment of the 2021 inventory submission of Canada

Assessment		Issue ID#(s) in table 3 or 5 <sup>a</sup>	
Date of submission	Original submission: NIR, 12 April 2021; CRF tables (version 1), 12 April 2021		
Review format	Centralized review conducted remotely		
Application of the requirements of the UNFCCC	Have any issues been identified in the following areas:		
Annex I inventory reporting guidelines and the Wetlands Supplement (if applicable)	(a) Identification of key categories?	No	
	(b) Selection and use of methodologies and assumptions?	Yes	E.5, A.16, A.18, L.14
	(c) Development and selection of EFs?	Yes	E.2, I.24, A.8, A.10, A.13, A.24, W.3, W.4
	(d) Collection and selection of AD?	Yes	E.1, I.21, I.25, I.26, I.29, L.6, L.8, L.12, W.10, W.13
	(e) Reporting of recalculations?	No	
	(f) Reporting of a consistent time series?	No	
	(g) Reporting of uncertainties, including methodologies?	Yes	G.3
	(h) QA/QC?	No	
	(i) Missing categories, or completeness? <sup>b</sup>	Yes	I.2, I.16, I.18, A.19, A.20, L.1, L.2, L.13, L.18, W.11
	(j) Application of corrections to the inventory?	No	
Significance threshold	For categories reported as insignificant, has the Party provided sufficient information showing that the likely level of emissions meets the criteria in paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines?	No	E.10, E.11, I.2, I.18, A.9
Description of trends	Did the ERT conclude that the description in the NIR of the trends for the different gases and sectors is reasonable?	Yes	
National inventory arrangements	Have any issues been identified with the effectiveness and reliability of the institutional, procedural and legal arrangements for estimating GHG emissions?	No	
Response from the Party during the review	Has the Party provided the ERT with responses to the questions raised, including the data and information necessary for assessing conformity with the UNFCCC Annex I inventory reporting guidelines and any further guidance adopted by the Conference of the Parties?	Yes	
Recommendation for an exceptional in-country review	On the basis of the issues identified, does the ERT recommend that the next review be conducted as an in-country review?	No	

<sup>a</sup> Further information on the issues identified, as well as additional findings, may be found in tables 3 and 5.

<sup>b</sup> Missing categories for which methods are provided in the 2006 IPCC Guidelines may affect completeness and are listed in annex III.

### III. Status of implementation of recommendations included in the previous review report

7. Table 3 compiles the recommendations from previous review reports that were included in the most recent previous review report, published on 11 May 2020,<sup>3</sup> and had not been resolved by the time of publication of the report on the review of the Party’s 2019 inventory submission. The ERT has specified whether it believes the Party had resolved, was addressing or had not resolved each issue by the time of publication of this review report and has provided the rationale for its determination, which takes into consideration the publication date of the most recent previous review report and national circumstances.

Table 3  
**Status of implementation of recommendations included in the previous review report for Canada**

<i>ID#</i>	<i>Issue classification<sup>a, b</sup></i>	<i>Recommendation made in previous review report</i>	<i>ERT assessment and rationale</i>
<b>General</b>			
G.1	Key category analysis (G.6, 2019) Transparency	Include in future submissions an explanation of how individual categories have been aggregated in each sector for the purpose of the key category analysis.	Resolved. The explanation of individual category aggregation for the key category analysis is provided in the NIR (part 2, annex 1, table A1-1, pp.2–3). During the review, Canada clarified that table A1-1 was included in part 2 of the NIR in response to the previous review recommendation. The Party further clarified that new information was included in table A1-1 to facilitate understanding of the key category aggregation in the 2021 inventory submission. The ERT considers that the recommendation has been addressed and the issue is resolved.
G.2	QA/QC and verification (G.5, 2019) Convention reporting adherence	Implement additional QA/QC procedures to ensure correct use of notation keys in the CRF tables and consistency of reporting across the CRF tables and the NIR. Justify the use of notation keys, particularly “NE” and “IE”, in CRF table 9.	Resolved. Canada corrected its application of notation keys “NE” and “IE” in the CRF tables and explained their use in CRF table 9. In addition, the Party made efforts to ensure consistency between CRF table 9 and NIR tables A5-1 and A5-2 (part 2, annex 5, pp.199–210), in which inventory completeness is assessed and categories reported as “NE” and “IE” are summarized, demonstrating that it implemented additional QA/QC procedures. The ERT considers that the recommendation has been addressed and the issue is resolved.
G.3	Uncertainty analysis (G.4, 2019) Convention reporting adherence	Include a quantitative uncertainty assessment for the base year for all source and sink categories in the next submission.	Not resolved. The ERT noted that Canada has not yet reported the uncertainty assessment for the base year (1990). During the review, the Party indicated that the uncertainty assessment for the base year is included in the inventory improvement plan and will be performed and reported in the 2022 inventory submission.
<b>Energy</b>			
E.1	1. General (energy sector) – gaseous fuels – CO <sub>2</sub> , CH <sub>4</sub> and N <sub>2</sub> O	Take steps to ensure that the conversion of volumes of natural gas to energy units is completed appropriately for both marketable	Addressing. The Party reported in its NIR (chap. 3, section 3.2.4.6, p.65) the progress made, in collaboration with Statistics Canada and other agencies, on improving the quality of the national energy balance and disaggregating fuel-use data. During the

<sup>3</sup> FCCC/ARR/2019/CAN. The ERT notes that the report on the individual inventory review of Canada’s 2020 inventory submission has not been published yet. As a result, the latest previously published inventory review report reflects the findings of the review of the Party’s 2019 inventory submission.

<i>ID#</i>	<i>Issue classification<sup>a, b</sup></i>	<i>Recommendation made in previous review report</i>	<i>ERT assessment and rationale</i>
	(E.1, 2019) (E.1, 2017) (E.2, 2016) (E.4, 2015) (19, 2014) Accuracy	and non-marketable natural gas. Document the progress of efforts in the improvement plan and in the NIR.	review, the Party clarified that efforts to address the issue are ongoing and noted that following the completion of data collection and quality assessment in 2021 it will develop representative EFs and calorific values which it plans to use in future GHG inventories. The ERT considers that the recommendation has not yet been fully addressed.
E.2	1. General (energy sector) – all fuels – CO <sub>2</sub> , CH <sub>4</sub> and N <sub>2</sub> O (E.4, 2019) (E.4, 2017) (E.25, 2016) Accuracy	Update CO <sub>2</sub> EFs where appropriate (following the plan referred to in ID# E.3 in the 2016 inventory review report) and provide references for these in the NIR.	Addressing. Canada provided information in annex 6 to the NIR (tables A6.1-2, A6.1-9 and A6.1.14, pp.211–217) on updates to CO <sub>2</sub> EFs for diesel, gasoline and coal and further disaggregated EFs for non-marketable gas for the Province of Alberta. During the review, Canada noted that CO <sub>2</sub> EFs for natural gas will be updated in the 2022 inventory submission. The ERT considers that the recommendation has not yet been fully addressed.
E.3	1. General (energy sector) – all fuels – CO <sub>2</sub> , CH <sub>4</sub> and N <sub>2</sub> O (E.5, 2019) (E.5, 2017) (E.25, 2016) Transparency	Document all instances where the calorific values and/or the CO <sub>2</sub> EFs deviate from the ranges set out in the 2006 IPCC Guidelines, and provide concise explanations of the reasons for these deviations, where the reasons are understood; where the reasons are not understood, investigate them.	Not resolved. The ERT noted that some calorific values and EFs used by Canada remain outside of the ranges set out in the 2006 IPCC Guidelines and are not justified by the Party in its NIR. For example, the anthracite EF reported for 2019 in CRF table 1.A(d) is 23.47 t C/TJ on a GCV basis, equating to about 23.90 t C/TJ on a net calorific value basis, which is below the lower end (25.8 t C/TJ) of the range of default values provided in the 2006 IPCC Guidelines (vol. 2, chap. 1, table 1.3, p.1.21). During the review, Canada noted that it is an oil- and gas-producing country with unique resources and country-specific EFs and GCVs for major fuels, including non-marketable gas. It also noted that the recommendation has not been implemented because it was deemed to be an unnecessary step in improving the national inventory owing to the lack of supporting information to justify the relevance of IPCC default values where EFs are based on country-specific studies. For each country-specific fuel study, supporting documentation is available to ensure the transparency and quality of the information on country-specific EFs. The ERT noted that the development and implementation of country-specific EFs is common practice for many Parties where they are demonstrably more accurate than the IPCC default values and are developed in a manner consistent with the 2006 IPCC Guidelines. Justification for any country-specific EFs is required in accordance with paragraph 12 of the UNFCCC Annex I inventory reporting guidelines, which states that Annex I Parties shall transparently explain in their annual GHG inventory submissions what data and/or parameters have been used. The ERT – acknowledging the default net calorific values provided in the 2006 IPCC Guidelines (vol. 2, chap. 1, table 1.3, p.1.21) and the default range of EFs for fossil fuels, which might not include all possible country-specific fuels – noted that where significant discrepancies are observed between the Party’s EF values and the default values from the 2006 IPCC Guidelines, it is important to note these in the NIR and to discuss the reasons why the country-specific EFs are unique.
E.4	Feedstocks, reductants and other NEU of fuels – liquid fuels – CO <sub>2</sub> (E.7, 2019) (E.23, 2017) Comparability	Report NEU of liquefied petroleum gas (propane and butane) using the correct notation key “IE” in CRF table 1.A(d).	Resolved. The Party reported NEU of liquefied petroleum gas (propane and butane) using the notation key “IE” in CRF table 1.A(d).



<i>ID#</i>	<i>Issue classification<sup>a, b</sup></i>	<i>Recommendation made in previous review report</i>	<i>ERT assessment and rationale</i>
E.5	1.A.3 Transport – liquid fuels – CO <sub>2</sub> (E.12, 2019) (E.26, 2017) Accuracy	Estimate CO <sub>2</sub> emissions from lubricants combusted in two-stroke engines separately using appropriate OXs and report them in the energy sector.	Not resolved. The ERT noted that Canada has not yet provided separate estimates for CO <sub>2</sub> emissions from lubricants combusted in two-stroke engines. The Party reported in its NIR (table 8.5, p.194) that work is under way to improve the already modified version of the Nonroad Engines, Equipment and Vehicles model of the United States Environmental Protection Agency (known as NONROAD), which will cover emissions from the consumption and combustion of lubrication oils used in two-stroke gasoline engines. During the review, the Party clarified that the issue is being addressed as part of the extensive update to the off-road emissions model, but that the improved model may not be delivered in time for the 2022 inventory submission.
E.6	1.A.3 Transport – liquid fuels – CO <sub>2</sub> , CH <sub>4</sub> and N <sub>2</sub> O (E.13, 2019) (E.27, 2017) Transparency	Finalize the update of the methodological documentation on the Motor Vehicle Emissions Simulator and Nonroad Engines, Equipment and Vehicles models and include a summary of the documentation in the NIR.	Not resolved. The Party reported in its NIR (table 8.5, p.194) that work is under way to improve the already modified Nonroad Engines, Equipment and Vehicles model of the United States Environmental Protection Agency (known as NONROAD) used in the estimates, including updated reference tables to ensure the inclusion of new off-road equipment types in the model. During the review, the Party clarified that efforts will be made to finalize the methodological documentation on the model and summarize it in the NIR for the 2022 inventory submission.
E.7	1.A.3.a Domestic aviation – CO <sub>2</sub> and CH <sub>4</sub> (E.26, 2019) Comparability	Correct the application of the GCV to CH <sub>4</sub> and CO <sub>2</sub> emissions from jet kerosene under category 1.A.3.a for the entire time series and report the correct values in CRF table 1.A(a) (sheet 3), providing an explanation of the recalculations in the NIR.	Resolved. The Party reported in its NIR (part 1, chap. 3, section 3.2.6.5, p.71) only on recalculations performed on the application of an updated methodology to better define aircraft movements and did not mention the correction of the application of the GCV to CH <sub>4</sub> and CO <sub>2</sub> emissions from jet kerosene. During the review, the Party clarified that recalculations following the correction of the application of the GCV to CH <sub>4</sub> and CO <sub>2</sub> emissions from jet kerosene were not explained in the NIR as the EFs in the NIR were determined on a volumetric basis (g/l), and that correcting the application of the GCV for the time series did not affect the GHG emissions or volume of fuel consumed. The ERT noted that the IEF values reported in CRF table 1.A(a) (sheet 3) (0.52 kg/TJ for CH <sub>4</sub> and 68.44 t/TJ for CO <sub>2</sub> for 2019) for jet kerosene under subcategory 1.A.3.a domestic aviation are broadly consistent with the default values given in the 2006 IPCC Guidelines (vol. 2, chap. 3, tables 3.6.4 and 3.6.5, p.3.64).
E.8	1.B.1.a Coal mining and handling – solid fuels – CH <sub>4</sub> (E.27, 2019) Comparability	Report the production data for subcategory 1.B.1.a.i.1 in the correct unit of measurement in CRF table 1.B.1.	Not resolved. The CH <sub>4</sub> IEF values (0.01 kg/t for 2019) reported for subcategory 1.B.1.a.i.1 mining activities (underground mines) remain lower by a factor of 1,000 than the average default value of 10.05 kg/t (2006 IPCC Guidelines, vol. 2, chap. 4, section 4.1.3.2, p.4.11) throughout the time series. Therefore, the ERT concluded that production data for subcategory 1.B.1.a.i.1 were not reported using the correct unit of measurement. During the review, Canada explained that the production values reported for subcategory 1.B.1.a.i.1 are in kt, and not in Mt, which is the correct reporting unit for CRF table 1.B.1, but that the reported CH <sub>4</sub> emissions are correct. The Party noted that coal production values will be reported in Mt in CRF table 1.B.1 in its 2022 inventory submission.
E.9	1.B.1.a Coal mining and handling – solid fuels – CO <sub>2</sub>	Report the CO <sub>2</sub> emissions from underground mines as “NA” and indicate in the NIR that no CO <sub>2</sub> emissions associated with flaring and	Addressing. The ERT noted that Canada reported “NA” for CO <sub>2</sub> emissions from underground mines in CRF table 1.B.1, but the NIR text did not indicate that CO <sub>2</sub> emissions from underground mines are not occurring. During the review, the Party

<i>ID#</i>	<i>Issue classification<sup>a, b</sup></i>	<i>Recommendation made in previous review report</i>	<i>ERT assessment and rationale</i>
	(E.19, 2019) (E.17, 2017) (E.20, 2016) (E.29, 2015) Transparency	drainage systems of underground mines occur in the country.	clarified that efforts to address the issue are ongoing and an update to the NIR will be completed for the 2022 inventory submission. The ERT also notes that, should it be confirmed that there are no CO <sub>2</sub> emissions associated with flaring and drainage systems of underground mines, the reporting of “NO” would be correct in accordance with paragraph 37(a) of the UNFCCC Annex I inventory reporting guidelines.
E.10	1.B.1.b Solid fuel transformation – solid fuels – CO <sub>2</sub> and CH <sub>4</sub> (E.22, 2019) (E.20, 2017) (E.33, 2016) Transparency	Report CO <sub>2</sub> and CH <sub>4</sub> emissions from briquette manufacturing under solid fuel transformation. If this cannot be done, use the correct notation key for solid fuel transformation (“IE” instead of “NE”) and update the description in the NIR accordingly.	Addressing. The Party reported CO <sub>2</sub> and CH <sub>4</sub> emissions from briquette manufacturing as “NE” under solid fuel transformation in CRF table 1.B.1. During the review, the Party clarified that production at the only char plant in the country has been estimated as peaking at 100 kt in 2009. Using the default EF values of 1,570 g CO <sub>2</sub> /kg, 40.3 g CH <sub>4</sub> /kg and 0.08 g N <sub>2</sub> O/kg from the 2019 Refinement to the 2006 IPCC Guidelines (vol. 2, chap. 4, table 4.3.3, p.4.103) the activity would produce emissions of approximately 260 kt CO <sub>2</sub> eq, which is below the threshold of significance of 0.05 per cent of Canada’s national total emissions (365.12 kt CO <sub>2</sub> eq) and below 500 kt CO <sub>2</sub> eq. As such, reporting emissions for this subcategory as “NE” is appropriate in accordance with paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines. The Party indicated that for transparency purposes it will include additional text on this issue in section 3.1.1 of the NIR of its 2022 inventory submission.
E.11	1.B.1.b Solid fuel transformation – solid fuels – CO <sub>2</sub> and CH <sub>4</sub> (E.23, 2019) (E.21, 2017) (E.33, 2016) Transparency	Document the methodology and data sources used to estimate emissions from briquette manufacturing in the NIR.	Not resolved. The Party reported CO <sub>2</sub> and CH <sub>4</sub> emissions from briquette manufacturing as “NE” under solid fuel transformation in CRF table 1.B.1. During the review, the Party clarified that it considers these emissions insignificant and a related explanation will be included in the NIR of its next inventory submission (see ID# E.10 above).
E.12	1.C CO <sub>2</sub> transport and storage – all fuels – CO <sub>2</sub> (E.25, 2019) (E.30, 2017) Transparency	Provide transparent information on the subcategories under which the fugitive CO <sub>2</sub> emissions from the two CO <sub>2</sub> EOR projects are reported and how the Party ensures comprehensive coverage of fugitive CO <sub>2</sub> emissions from these projects in the NIR.	Not resolved. The ERT noted that Canada’s reporting in CRF table 1.C of CO <sub>2</sub> captured and injected from EOR projects is in accordance with the 2006 IPCC Guidelines (vol. 2, chap. 5, sections 5.5–5.6, pp.5.10–5.12). However, the NIR did not contain transparent information on the subcategories under which the fugitive CO <sub>2</sub> emissions from these projects are reported and how the Party ensures the comprehensive coverage of such emissions. During the review, the Party clarified how each source of emissions under category 1.C is reported, including fugitive emissions from projects that use CO <sub>2</sub> injection to enhance oil production reported in subcategories 1.B.2.a.2 oil – production, 1.B.2.c.1.i venting – oil and 1.B.2.c.2.i flaring – oil. Canada noted that it will include further descriptions on this issue in section 3.4 of the NIR of its 2022 inventory submission.
IPPU			
I.1	2. General (IPPU) – CO <sub>2</sub> (I.4, 2019) (I.20, 2017) Completeness	Provide information to enable an evaluation of whether all CO <sub>2</sub> emissions from significant uses of urea are included in the inventory, including by providing an overview table in	Resolved. The Party added to its reporting in CRF table 2(I).A-H (sheet 1) CO <sub>2</sub> emission estimates for “other uses of urea” under category 2.B.10 other. The Party explained in its NIR (part 1, chap. 4, section 4.9.1, p.98) that “other uses of urea” take into account potential emissions from urea used as an ingredient in the manufacture of resins, plastics

<i>ID#</i>	<i>Issue classification<sup>a, b</sup></i>	<i>Recommendation made in previous review report</i>	<i>ERT assessment and rationale</i>
		the NIR listing the use(s) of the CO <sub>2</sub> emissions recovered from NH <sub>3</sub> production, by the category in which they are reported in the GHG inventory.	and coating products. To determine the amount of “other uses of urea”, the total quantity of urea produced at NH <sub>3</sub> plants is balanced with the urea that is imported to and exported from Canada, the quantity used for agriculture, and the estimated quantity of urea-based additives required in catalytic converters for vehicles. In its NIR (part 1, chap. 4, section 4.9.2, pp.100–101), the Party listed the uses of CO <sub>2</sub> emissions recovered from NH <sub>3</sub> production by the category in which they are reported, allowing the ERT to conclude that all CO <sub>2</sub> emissions from significant uses of urea are included in the inventory. Nevertheless, the ERT identified a related accuracy issue (see ID# 1.24 in table 5).
I.2	2.A.4 Other process uses of carbonates – CO <sub>2</sub> (I.2, 2019) (I.2, 2017) (I.2, 2016) (I.10, 2015) Completeness	Include CO <sub>2</sub> emissions from ceramics production in the inventory or demonstrate that the emissions are insignificant, as defined in paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.	Addressing. The NIR (part 1, chap. 4, section 4.4.1, p.89) was updated and includes information explaining how CO <sub>2</sub> emissions from ceramics production were estimated for 2005–2007 and 2011–2018. The Party reported AD and CO <sub>2</sub> emissions for subcategory 2.A.4.a ceramics using the notation key “NE” in CRF table 2(I).A-H (sheet 1) for the complete time series, indicating that it considers these emissions insignificant. However, the NIR does not explicitly include the results of these estimates in order to demonstrate that the threshold of significance (likely level of emissions below 0.05 per cent of Canada’s national total emissions and not exceeding 500 kt CO <sub>2</sub> eq) was not exceeded. During the review, the Party provided the ERT with the results from its assessment, which demonstrates that the CO <sub>2</sub> emissions for this subcategory were insignificant, and stated that it will include the results of this assessment in the NIR of the 2022 inventory submission. The ERT considers that the recommendation has not yet been fully addressed.
I.3	2.B.2 Nitric acid production – N <sub>2</sub> O (I.7, 2019) (I.21, 2017) Transparency	Provide more transparent information on the EFs used for nitric acid production in the NIR, including how EFs provided in the NIR are used for the estimation of emissions, and the years and number of plants for which they are used.	Resolved. In its NIR (part 1, chap. 4, section 4.6, pp.93–94), Canada provided information on how EFs for nitric acid production provided in the NIR are used for the estimation of emissions, and the years and number of plants for which they are used.
I.4	2.B.3 Adipic acid production – CO <sub>2</sub> (I.26, 2019) Convention reporting adherence	For category 2.B.3 (adipic acid production), report CO <sub>2</sub> emissions for 2010 onward as “NO” in both the NIR and in CRF table 2(I).A-H (sheet 1) in the next inventory submission.	Resolved. Adipic acid has not been produced in Canada since 2009, as described in the NIR (part 1, chap. 4, section 4.7.1, p.95). In CRF table 2(I).A-H (sheet 1), the notation key “NO” was used for 2010 onward.
I.5	2.B.8 Petrochemical and carbon black production – CO <sub>2</sub> and CH <sub>4</sub> (I.9, 2019) (I.5, 2017) (I.3, 2016) (I.11, 2015) Completeness	Include CO <sub>2</sub> and CH <sub>4</sub> emissions from ethylene oxide production in the inventory or demonstrate that the emissions are insignificant, as defined in paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.	Resolved. CO <sub>2</sub> and CH <sub>4</sub> emissions from ethylene oxide production were estimated for the entire time series and reported in the NIR and CRF table 2(I).A-H (sheet 1).

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I.6	2.C.1 Iron and steel production – CO <sub>2</sub> (I.11, 2019) (I.7, 2017) (I.4, 2016) (I.5, 2015) (37, 2014) Transparency	Include the allocation of NEU of other reductants identified in this category in the improvement plan and implement steps to further disaggregate the energy statistics and other (industrial processes) category.	Addressing. Canada reported in the NIR (part 1, chap. 4, section 4.10.6, p.104) its plan to report process emissions associated with natural gas and coal as reductants under category 2.C.1 iron and steel production as soon as supporting information is available to disaggregate energy statistics data. For coal, a fraction of coal (aggregated with non-energy fuels in energy statistics) used in iron and steel production is currently reported under category 2.D.3 other – other and undifferentiated. During the review, the Party stated that natural gas has been identified as a reductant used in both blast furnace and direct reduced iron production in Canada and that efforts are ongoing to identify its use throughout the time series, along with methods to further disaggregate natural gas use in the energy sector (reported under category 1.A.2 manufacturing industries and construction). The ERT considers that the recommendation has not yet been fully addressed.
I.7	2.C.3 Aluminium production – CO <sub>2</sub> , PFCs and SF <sub>6</sub> (I.13, 2019) (I.22, 2017) Transparency	Include information on the shares of process-related emissions from aluminium production estimated using different methodological tiers across the time series in the NIR.	Addressing. Canada did not include in the NIR the shares of process-related emissions from aluminium production estimated using different methodological tiers prior to 2015. However, the Party reported in the NIR (part 1, chap. 4, section 4.11.2, p.105) that all process-related emissions for this sector have been estimated using a tier 3 approach since 2015. During the review, Canada explained that information regarding the use of different methodological tiers across the time series has recently been received by Canada's GHG inventory team from the Aluminium Association of Canada and stated that explanations will be included in the NIR of the 2022 inventory submission. The ERT considers that the recommendation has not yet been fully addressed.
I.8	2.C.4 Magnesium production – SF <sub>6</sub> (I.28, 2019) Accuracy	Carry out the planned improvement to recalculate SF <sub>6</sub> emissions using data from companies for 2010 onward to increase the accuracy of estimated SF <sub>6</sub> emissions from magnesium casting and explain the recalculation in the NIR.	Resolved. In the NIR (part 1, chap. 4, section 4.12.2, pp.106–107), the Party reported on the data-collection activities for SF <sub>6</sub> use from magnesium casting companies for 2010 onward and on the methods applied to cover data gaps. Recalculations for 2010–2018 are explained in the NIR (part 1, chap. 4, section 4.12.5, p.107). The recalculations resulted in changes to the SF <sub>6</sub> emission estimates ranging from –0.12 to 9.55 per cent.
I.9	2.C.4 Magnesium production – CO <sub>2</sub> (I.29, 2019) Comparability	Correct the notation key reported in CRF table 2(I).A-H for category 2.C.4 for CO <sub>2</sub> emissions from “NA” to “NO” for years during which primary magnesium production did not occur.	Not resolved. Canada continued to report CO <sub>2</sub> emissions from magnesium production for category 2.C.4 magnesium production as “NA” in CRF table 2(I).A-H (sheet 2) for the years where primary magnesium production did not occur (after 2008). During the review, the Party clarified that the change of the notation key used in CRF table 2(I).A-H (sheet 2) for CO <sub>2</sub> emissions for category 2.C.4 from “NA” to “NO” for years where there was no primary magnesium production is a planned improvement for the 2022 inventory submission.
I.10	2.C.5 Lead production – CO <sub>2</sub> (I.30, 2019) Transparency	Improve the transparency of the reporting on this category by including a description of lead production in Canada and clarifying where the process emissions from lead production are reported in the NIR.	Resolved. The Party included a description of category 2.C.5 lead production in the NIR (part 1, chap. 4, section 4.13, p.108) and explained that CO <sub>2</sub> emissions from the use of reductants in this category are included in the estimates for category 2.D.3 other – other and undifferentiated, owing to the current lack of data for disaggregating emissions. It

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I.11	2.C.6 Zinc production – CO <sub>2</sub> (I.31, 2019) Transparency	Improve the transparency of the reporting on this category by including a description of zinc production in Canada and clarifying where the process emissions from zinc production are reported in the NIR.	also indicated that it plans to identify the type of production processes and disaggregate the emissions, if possible, based on the type of reductant.  Resolved. The Party included a description of category 2.C.6 zinc production in the NIR (part 1, chap. 4, section 4.13, p.108) and explained that CO <sub>2</sub> emissions from the use of reductants in this category are included in the estimates for category 2.D.3 other – other and undifferentiated, owing to the current lack of data for disaggregating emissions. It also indicated that it plans to identify the type of production processes and disaggregate the emissions, if possible, based on the type of reductant.
I.12	2.D Non-energy products from fuels and solvents use – CO <sub>2</sub> and CH <sub>4</sub> (I.17, 2019) (I.12, 2017) (I.8, 2016) (I.6, 2015) (37 and 41, 2014) (47, 2013) (78, 2012) (77, 2011) Transparency	Implement the scheduled improvements for this category, reporting on progress in future inventory submissions, and continue the improvements necessary to document the methods and sources of AD and EFs in the NIR.	Not resolved. The ERT noted that planned improvements for this category have not been implemented. In the NIR (part 1, chap. 8, section 8.3, p.194), Canada reported that it plans to evaluate whether the EFs for various NEUs of petroleum products and natural gas, developed on the basis of studies conducted in 1992 and 2005, are still valid and to update them if necessary. The ERT also noted that, in the NIR (part 1, chap. 4, section 4.14, pp.108–110), no progress since the 2019 inventory submission was reported for the documentation of methods and sources of AD and EFs.
I.13	2.D Non-energy products from fuels and solvents use – CO <sub>2</sub> (I.18, 2019) (I.24, 2017) Accuracy	Investigate whether the subcategory other products corresponds to paraffin wax use as defined in the 2006 IPCC Guidelines and, if that is the case, reallocate the emissions for category 2.D.3 to category 2.D.2 (paraffin wax use) and estimate emissions using the default oxidized-during-use factor from the 2006 IPCC Guidelines rather than the default carbon storage factor from the <i>Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories</i> . If the subcategory other products does not correspond to paraffin wax use, then explore whether the data on paraffin wax use (as defined in the 2006 IPCC Guidelines) can be identified within the AD for subcategory 2.D.3 to allow separate reporting of the associated emissions.	Resolved. Canada reported in the NIR (part 1, chap. 4, section 4.14.2, p.109) that “other products” accounted in category 2.D.3 other – other and undifferentiated include paraffin waxes and unfinished products (items that cannot be identified in end-product terms), that the disaggregation of paraffin wax use from national energy statistics data is not possible and that therefore the use of the default oxidized-during-use factor from the 2006 IPCC Guidelines (vol. 3, chap. 5, section 5.3.2.2, p.5.12) is not possible. The ERT considers that the recommendation has been addressed.
I.14	2.D.3 Other (non-energy products from fuels and solvent use) – CO <sub>2</sub> (I.22, 2019) (I.15, 2017)	Improve the consistency of the information provided in CRF table 1.A(d) and in the IPPU sector, in particular regarding categories 2.D.3 (non-energy products from fuels and solvent	Resolved. The ERT noted that the consistency of CO <sub>2</sub> emissions reported in the IPPU sector with the CO <sub>2</sub> emissions from the NEU of fuels reported in CRF table 1.A(d) has been significantly improved. For example, the sum of NEU CO <sub>2</sub> emissions reported for 2017 in CRF table 1.A(d) for categories 2.B chemical industry and 2.D non-energy products from fuels and solvent use is 17,227.85 kt CO <sub>2</sub> while the sum of CO <sub>2</sub> emissions

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	(I.23, 2016) Accuracy	use – other) and 2.B.8 (petrochemical and carbon black production).	reported for those categories in CRF table 2(I) is 17,252.31 kt CO <sub>2</sub> , resulting in a difference of 0.1 per cent of NEU CO <sub>2</sub> emissions. In the 2019 inventory submission, the respective difference amounted to 20.9 per cent. For NEU CO <sub>2</sub> emissions for 2017, assigned in CRF table 1.A(d) to category 2.C metal industry, the respective difference to CO <sub>2</sub> emissions reported in CRF table 2(I) decreased from 9.9 per cent in the 2019 inventory submission to 2.2 per cent in the 2021 inventory submission. During the review, the Party explained that the consistency of information provided in CRF table 1.A(d) was improved through the automation of data transfer to the energy sector from IPPU categories.
I.15	2.D.3 Other (non-energy products from fuels and solvent use) – CH <sub>4</sub> and N <sub>2</sub> O (I.32, 2019) Transparency	Include in the NIR an explanation of which CH <sub>4</sub> and N <sub>2</sub> O emissions are estimated, where they are allocated and, if they are not estimated, indicate this in CRF table 2(I).A-H (sheet 2).	Resolved. Canada reported in the NIR (part 1, chap. 4, section 4.14.2, p.109) that emissions of CH <sub>4</sub> and N <sub>2</sub> O for category 2.D.3 non-energy products from fuels and solvent use are included under category 2.B.8 petrochemical and carbon black production. The Party indicated this in CRF table 2(I).A-H (sheet 2) and also provided an explanation in CRF table 9.
I.16	2.F Product uses as substitutes for ODS – PFCs (I.23, 2019) (I.25, 2017) Completeness	Estimate all PFC emissions in category 2.F using the 2006 IPCC Guidelines, making appropriate revisions to the NIR to reflect the use of the updated methodologies.	Addressing. In the NIR (part 1, chap. 4, section 4.17.2, pp.115–116) the Party reported that PFC emissions in the relevant categories – namely 2.F.1 refrigeration and air conditioning, 2.F.2 foam blowing agents and 2.F.5 solvents – were estimated using the methodologies from the 2006 IPCC Guidelines. However, for PFC emissions for category 2.F.4 aerosols, Canada reported in the NIR (part 1, chap. 4, section 4.17.2, p.116) that emissions are expected to be negligible since major gas distributors did not report any PFC use in aerosols in voluntary data submissions made in 2009 and 2019. The ERT noted that Canada did not report information on PFC emission estimates for category 2.F.3 fire protection in its NIR (part 1, chap. 4, section 4.17, pp.115–116) despite methods for such estimates being provided in the 2006 IPCC Guidelines (vol. 3, chap. 7, section 7.6, pp.7.61–7.65). During the review, the Party explained that the use of PFCs for category 2.F.3 fire protection has never been reported to the inventory team by distributors via voluntary surveys, including those conducted in 2009 and 2019, and that PFC emissions for this category are therefore assumed to be negligible in Canada (similar to category 2.F.4 aerosols). Canada stated that an explanation will be provided in the NIR of the 2022 inventory submission. The ERT considers that the recommendation has not yet been fully addressed as no emission estimates have been reported for category 2.F.3 fire protection. Furthermore, the ERT identified a related accuracy issue in category 2.F product uses as substitutes for ODS (see ID# I.29 in table 5).
I.17	2.F Product uses as substitutes for ODS – PFCs (I.33, 2019) Accuracy	Increase the accuracy of emission estimates reported under this category by collecting and using data on PFC use for the entire time series, including 2010–2013.	Resolved. The Party reported in the NIR (part 1, chap. 4, section 4.17.2, pp.115–116) on a series of surveys covering AD for 1995–2000, 2003–2007, 2008–2009 and 2014–2019 and explained that it used interpolations to obtain AD for the missing years 2001–2002 and 2010–2013. Nevertheless, the ERT identified a related accuracy issue in category 2.F product uses as substitutes for ODS (see ID# I.29 in table 5).

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I.18	2.G.2 SF <sub>6</sub> and PFCs from other product use – PFCs and SF <sub>6</sub> (1.34, 2019) Completeness	Investigate whether the SF <sub>6</sub> and PFC uses mentioned in the 2006 IPCC Guidelines (vol. 3, chap. 8, section 8.3) occur in the country. If emissions from such uses do not occur, report them as “NO”. If such emissions do occur, estimate and report them, or, if they are considered insignificant, report them as “NE”, provide in the NIR a justification for the insignificance, in accordance with paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines, and explain in CRF table 9 why these emissions are reported as “NE”.	Not resolved. Canada reported “NE” for PFC and SF <sub>6</sub> emissions for category 2.G.2 SF <sub>6</sub> and PFCs from other product use in CRF table 2(II). The ERT noted that the NIR (part 1, chap. 4, section 4.18, pp.117–119) does not contain a justification for the insignificance of these emissions, in accordance with paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines, and that CRF table 9 does not contain an explanation for the use of the notation key “NE”. During the review, the Party clarified that since preliminary research of applications within category 2.G.2 yielded no results, it assumed that emissions for this category were insignificant. During the collection exercise of PFC and SF <sub>6</sub> sales data from major gas distributors for 2014–2020, Canada identified some end users that may use these gases for the applications mentioned in the 2006 IPCC Guidelines (vol. 3, chap. 8, section 8.3, pp.8.23–8.34). Canada further clarified that follow-ups with these end users are ongoing and that a tier 1 estimate will be made for the years for which data were collected once the follow-ups are complete. If the estimate is significant, Canada explained that it will develop a time series of PFC and SF <sub>6</sub> estimates for this category and report them in the NIR and CRF tables. If emissions are demonstrated to be insignificant, as defined in paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines, Canada explained that it will continue reporting “NE” for this category in the CRF tables. The ERT considers that the recommendation has not yet been addressed because no PFC and SF <sub>6</sub> emissions for category 2.G.2 SF <sub>6</sub> and PFCs from other product use have been reported or a justification for the insignificance of these emissions provided in the NIR, in accordance with paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.
I.19	2.G.4 Other (other product manufacture and use) – PFCs (1.35, 2019) Comparability	Report on PFCs used in electronic insulators and for heat transfer in the electronics industry under category 2.E.1 instead of category 2.G.4 in the next submission.	Addressing. The Party reported in its NIR (part 1, chap. 4, section 4.15.1, p.110) that emissions for category 2.E.1 integrated circuit or semiconductor do not include PFCs used as electrical insulation, dielectric coolants or as a heat transfer medium, which are included under category 2.G.4 other (other product manufacture and use). Furthermore, the Party reported in its NIR (part 1, chap. 4, section 4.18.1, p.117) that emissions for category 2.G.4 other (other product manufacture and use) do include PFCs used as dielectric coolants or as a heat transfer medium, which are not ODS substitutes or electronics industry-related. The ERT noted that PFC emissions from heat transfer fluids should be reported in category 2.E.4 heat transfer fluid and that the 2006 IPCC Guidelines (vol. 3, chap. 6, pp.6.1–6.32) do not mention the use of PFCs as electric or electronic insulators in the electronics industry. The ERT also noted that the Party used the notation key “NA” rather than “IE” for reporting PFCs under category 2.E.4 heat transfer fluid. It further noted that Canada reported emissions of CF <sub>4</sub> , C <sub>2</sub> F <sub>6</sub> and c-C <sub>4</sub> F <sub>8</sub> under category 2.E.1 integrated circuit or semiconductor in CRF tables 2(II) and 2(II).B-H (sheet 1) and explained in the NIR (part 1, chap. 4, section 4.15.2, p.110) that these emissions stem from semiconductor manufacturing. During the review, the Party clarified that it has been confirmed that AD reported for the use of PFCs as a “heat transfer medium” for 2014–2018 under category 2.G.4 (voluntarily collected from a gas distributor in 2019) were actually intended for reporting the use of PFCs as

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Agriculture			refrigerants and that these AD will be reallocated to category 2.F.1 refrigeration and air conditioning for the 2022 inventory submission, and the emissions will be recalculated accordingly. The Party also clarified that other AD reported under category 2.G.4 are still under review and that legacy data sources are being investigated in order to ensure that emission estimates are attributed to the correct categories. The ERT considers that the recommendation has not yet been fully addressed.
A.1	3. General (agriculture) (A.1, 2019) (A.11, 2017) Transparency	Provide the correct references to the sources of Nex rates for dairy and other cattle and of the EFs for CH <sub>4</sub> emissions from manure management for mules and asses in the NIR.	Resolved. Canada included clear references in the NIR (part 2, annex 3, section A3.4.4.1, p.96) to the methodology used and relevant input data. It also provided additional explanatory information and references to the relevant sections of the 2006 IPCC Guidelines, where appropriate, including correct references to the sources of Nex rates for dairy and other cattle and of the CH <sub>4</sub> EFs for manure management for mules and asses. The ERT considers that the recommendation has been addressed.
A.2	3. General (agriculture) – CH <sub>4</sub> (A.12, 2019) Transparency	Provide in the NIR sufficient information and data on the categorization of animal used (subcategory list and a description of the subcategories used in the estimations), AD (number of animals per province and subcategory of animal), parameters (i.e. MCF, VS, biodegradability of manure, animal waste management systems, Nex rate, weight, daily weight gain, mature weight, mean winter temperature, milk production, milk fat content, percentage of females that give birth in a year, number of offspring, feed digestibility and any other parameter used in the estimations), equations and EFs used for the estimates of enteric fermentation and manure management of dairy cattle, non-dairy cattle and swine at the level of disaggregation used in the estimations and explicitly explaining changes along the time series (e.g. if weight changes between subcategories and provinces, the information is requested to be reported at subcategory and region level).	Not resolved. The ERT noted that while the NIR does contain equations and EFs, it also contains insufficient information and data on the categorization of animals, AD, parameters, equations and EFs at the level of disaggregation used in the calculation and their changes along the time series for CH <sub>4</sub> emission estimates for categories 3.A enteric fermentation and 3.B manure management for cattle and swine. During the review, the Party explained that it is “establishing a workplan to improve documentation related to agricultural livestock in response to this recommendation”. It also explained that it plans to include additional AD in the NIR of its 2022 inventory submission, but noted the challenges of including such an extensive amount of additional information in a report (or accompanying appendices) which needs to be in a printable format. It further indicated that “prioritization will be given to livestock data and parameters that can be accommodated in a printed publication, followed by separate release of remaining livestock data in an electronic format”. The ERT considers that the recommendation has not yet been addressed.
A.3	3. General (agriculture) – CH <sub>4</sub> (A.12, 2019) Transparency	Provide clear references for the sources of the data, parameters and EFs, as well as documentation on any assumption used in the calculations following the protocol for expert	Addressing. Canada provided references for the sources of data, parameters and EFs presented in relevant chapters of the NIR. However, where assumptions are used in calculations, Canada did not provide comprehensive documentation in accordance with the protocol for expert elicitation included in annex 2A.1 to the 2006 IPCC Guidelines (vol. 1, chap. 2). One example is the data describing each beef and dairy production



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		elicitation included in annex 2A.1, chapter 2, volume 1, of the 2006 IPCC Guidelines.	stage obtained by surveying beef and dairy cattle specialists used in the calculation of annual tier 2 EFs for enteric fermentation and a second example is the calculation of VS based on ash content and digestible energy, which were derived from expert consultations for the calculation of emissions from manure management. During the review, the Party explained that it is “establishing a workplan to improve documentation related to agricultural livestock in response to this recommendation”, and that it plans to include additional information on this matter in the NIR of its 2022 inventory submission. The ERT considers that the recommendation has not been fully addressed because there are assumptions used in calculations that are still not supported by accompanying documentation such as that outlined in the protocol for expert elicitation included in annex 2A.1 to the 2006 IPCC Guidelines.
A.4	3. General (agriculture) – CH <sub>4</sub> (A.12, 2019) Transparency	Provide a clear explanation of the rationale for selecting the various parameters and assumptions. The information provided must be detailed enough to clearly follow any estimation included in the Excel estimation files.	Not resolved. The ERT noted that Canada did not provide in the NIR a clear explanation of the rationale for selecting the various parameters and assumptions used, including detailed information to enable the ERT to replicate the calculations of emissions reported in the CRF tables or easily follow any estimations included in Canada’s Excel estimation spreadsheets, which include detailed information on the parameters used. During the review, the Party explained that it is “establishing a workplan to improve documentation related to agricultural livestock in response to this recommendation”. The ERT considers that the recommendation has not yet been addressed because the Party has not provided sufficiently detailed information supporting the rationale for selecting the various parameters and assumptions for the calculation of CH <sub>4</sub> emissions from the agriculture sector.
A.5	3. General (agriculture) – CH <sub>4</sub> (A.12, 2019) Transparency	Where a model is used to obtain any parameter or EF used in the estimates (e.g. swine growth model), provide the following information, as suggested in the IPCC document <i>Use of Models and Facility-Level Data in Greenhouse Gas Inventories</i> , to assess the model: basis and type of model (statistical, deterministic, process-based, empirical, top-down, bottom-up, etc.); application and adaptation of the model; main equations and processes; key assumptions; domain of application; how the model parameters were estimated; description of key inputs and outputs; details of calibration and evaluation with calibration data and independent data; description of the approach to the uncertainty and sensitivity analyses, and the results of these analyses; QA/QC procedures adopted; and references to peer-	Not resolved. The ERT noted that there is still insufficient information in the NIR (including any reference to publicly available methodological reports) describing the models used to estimate CH <sub>4</sub> emissions for categories 3.A enteric fermentation and 3.B manure management, when compared with the information whose provision is suggested in the IPCC document <i>Use of Models and Facility-Level Data in Greenhouse Gas Inventories</i> and required in paragraph 50(a) of the UNFCCC Annex I inventory reporting guidelines. During the review, the Party explained that it is “establishing a workplan to improve documentation related to agricultural livestock in response to this recommendation”. It noted the challenges of including such an extensive amount of additional information in a report which needs to be in a printable format; however, the ERT pointed out that Canada could choose to publish the information requested in a public methodological report and reference that document in the NIR. The ERT considers that the recommendation has not yet been addressed because the Party has not yet made the relevant improvements to the content of the NIR in line with the recommendation.

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A.6	3.A.1 Cattle – CH <sub>4</sub> (A.13, 2019) Transparency	reviewed literature. If the information is too extensive to be included in the NIR, even as an annex, publish all of the information requested in a public methodological report and reference that document in the NIR as a source of information.  Provide a clear description of the production subcategories of dairy cattle in the NIR to facilitate understanding of their main characteristics. Provide in the NIR a clear description of the AD, parameters and methodologies used to explain the weight values of dairy cattle and describe how these values can be replicated. Provide in the NIR a transparent justification of the daily weight gain of mature dairy cows. Explain in the NIR why there is no change in the average daily weight gain linked to feed quality.	Not resolved. The ERT noted that Canada did not provide in the NIR a clear description of the production subcategories of dairy cattle, or a clear description of the AD, parameters and methodologies used to explain the weight values of dairy cattle, or a transparent justification of the daily weight gain of mature dairy cows, or an explanation as to why there is no change in the average daily weight gain linked to feed quality. During the review, the Party clarified that it is “establishing a workplan to improve documentation related to agricultural livestock in response to this recommendation”. It noted that it expects to complete its workplan within one year. The ERT considers that the recommendation has not yet been addressed because the Party has not yet made the relevant improvements to the content of the NIR in line with the recommendation.
A.7	3.A.1 Cattle – CH <sub>4</sub> (A.14, 2019) Transparency	Provide a clear description of the production subcategories of cattle in the NIR to facilitate understanding of their main characteristics. Provide quantitative and qualitative information on the values used for all parameters involved in the tier 2 estimation of enteric fermentation at the regional level, including detailed references to the sources of the information and assumptions used. Ensure consistency when determining the parameters by region and animal type by developing a transparent protocol by which to assign the values and revise the estimates, when appropriate.	Not resolved. The ERT noted that Canada did not provide in the NIR a clear description of the production subcategories of cattle, or quantitative and qualitative information on the values used for all parameters involved in the tier 2 estimation of enteric fermentation at the regional level. Regarding the consistency of the parameters by region and animal type, the Party did not provide in the NIR information on how it ensured consistency when determining these parameters, including by developing a transparent protocol by which to assign the values used for all parameters. During the review, the Party clarified that it is “establishing a workplan to improve documentation related to agricultural livestock in response to this recommendation”. It noted that it expects to complete its workplan within one year. The ERT considers that the recommendation has not yet been addressed because the Party has not yet made the relevant improvements to the content of the NIR in line with the recommendation.
A.8	3.A.4 Other livestock – CH <sub>4</sub> (A.15, 2019) Accuracy	Estimate the enteric fermentation EF for llamas and alpacas on the basis of the proportion of llamas to alpacas (using statistics or expert judgment), using the EF for alpacas from table 10.10 of the 2006 IPCC Guidelines and estimating an approximate EF for llamas on the basis of the EF for alpacas and the weight of llamas.	Not resolved. The Party continued to estimate emissions from llamas and alpacas combined, rather than making emission estimates for llamas and alpacas separately. During the review, the Party explained that it obtained data on the llama and alpaca total population, which were not disaggregated by animal type. The Party noted that the impact of including assumptions to allow emission estimates to be made separately for llamas and alpacas would not be significant, given the small magnitude of the CH <sub>4</sub> emissions for this subcategory (177 kt CO <sub>2</sub> eq or 0.02 per cent of national total GHG emissions for 2019, which is below the threshold of significance of 365.12 kt CO <sub>2</sub> eq

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			(0.05 per cent of national total emissions for 2019) and below 500 kt CO <sub>2</sub> eq). The Party also noted the inherent uncertainties in the emission estimate for this category. The ERT agrees with the Party's assessment that the impact would be below the threshold of significance; however, it notes that transparency of the reporting on this issue would be improved if the Party explained in the NIR why it is not considered necessary to make separate emission calculations for llamas and alpacas and improve the accuracy of the estimates.
A.9	3.B Manure management – CH <sub>4</sub> and N <sub>2</sub> O (A.2, 2019) (A.3, 2017) (A.12, 2016) Accuracy	Provide in the NIR the reasons why emissions from anaerobic lagoon and daily spread have not been estimated, in accordance with paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.	Addressing. In the NIR (part 2, annex 3, section A3.4.3.3, p.88) the Party noted that since “the existence of these types of systems was not identified in the expert consultation carried out by Marinier et al. (2004) or across farm environmental management surveys...therefore, the amount of manure treated by these systems is assumed to be negligible”. The ERT considers that, if the non-occurrence of these types of systems is confirmed, the above information included by the Party in the NIR could be sufficient justification for using the notation key “NO” in reporting data and emissions for anaerobic lagoon and daily spread management systems in the country and related emissions, rather than “NE”, which is currently used. However, during the review, Canada explained that it reported “NE” because “it is possible that a small number of systems occur but have not been captured by the coverage of existing survey products”. The ERT considers that the recommendation has not been fully addressed because this possible gap in survey data has not been explained in the NIR, and the use of the notation key “NE” has not been justified in accordance with paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.
A.10	3.B Manure management – CH <sub>4</sub> (A.16, 2019) Accuracy	Construct a time series of average temperatures for each region for 1990–2017 and use MCFs for all animals on the basis of those average annual temperatures and in line with the 2006 IPCC Guidelines (i.e. using the 10 °C value if the average annual temperature is below 10 °C).	Not resolved. Canada did not construct a time series of average temperatures for each region for 1990–2017 and later years in the time series (2018 and 2019) and use MCFs for all animals on the basis of those average annual temperatures. The Party reported in the NIR (part 1, chap. 8, section 8.3, p.195) that it has included an item to address this issue in its inventory improvement plan. The Party plans to implement the approach from the 2019 Refinement to the 2006 IPCC Guidelines, which uses monthly temperatures and retention time as predictors of CH <sub>4</sub> loss, rather than an average annual temperature. The ERT considers that the recommendation has not yet been addressed because the Party has not used MCFs for all animals on the basis of regional average annual temperatures in line with the 2006 IPCC Guidelines (vol. 4, chap. 10, section 10.4.2, pp.10.43–10.47).
A.11	3.B.2 Sheep – CH <sub>4</sub> (A.17, 2019) Convention reporting adherence	Report the correct average VS daily excretion for sheep and lambs in the NIR.	Resolved. The Party reported the correct VS daily excretion for sheep and lambs in the NIR (part 2, annex 3, table A3.4-10, p.87). The ERT considers that the recommendation has been fully addressed.
A.12	3.B.3 Swine – CH <sub>4</sub> (A.19, 2019) Transparency	Provide in the NIR a detailed description of the methodologies used in estimating the VS of swine, as well as the values of the	Not resolved. Canada did not provide in the NIR a detailed description of the methodologies used in estimating the VS of swine, or the values of the parameters by subcategory and region, or explicit references to the sources of data used. During the

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		parameters by subcategory and region (i.e. weight, weight gain, VS and any other parameter used) and explicit references to the sources of data (i.e. document, page, table, row and column). Where assumptions for the selection of the parameters are used, provide detailed information on the assumptions in line with the protocol for expert elicitation included in annex 2A.1, chapter 2, volume 1, of the 2006 IPCC Guidelines.	review, the Party clarified that it is “establishing a workplan to improve documentation related to agricultural livestock in response to this recommendation”. It noted that it expects to complete its workplan within one year. The ERT considers that the recommendation has not yet been addressed because the Party has not yet made the relevant improvements to the content of the NIR.
A.13	3.B.3 Swine – N <sub>2</sub> O (A.18, 2019) Accuracy	Correct the estimates of the Nex rate of market swine by using the appropriate value for market swine given in table 10.19 of the 2006 IPCC Guidelines, or provide documented and supported information for the assumptions regarding the erroneous values proposed in table 10.19 of the 2006 IPCC Guidelines.	Not resolved. The Party explained in the NIR (part 2, footnote to table A3.4-21, p.97) its current approach for Nex rate estimates. However, the ERT noted that the Party did not use the appropriate Nex rate for swine (0.42 kg N/1,000 kg animal mass/day) from table 10.19 of the 2006 IPCC Guidelines (vol. 4, chap. 10, section 10.5.2, p.10.59). During the review, the Party noted that an updated version of volume 4, chapter 10, of the 2006 IPCC Guidelines has been published with corrected default Nex rate values and explained that it plans to use in its 2022 inventory submission the corrected Nex rate for swine. The ERT considers that the recommendation has not yet been addressed because the Party has not yet corrected the Nex rate for market swine in line with the most up-to-date version of the 2006 IPCC Guidelines.
A.14	3.B.4 Other livestock – CH <sub>4</sub> (A.3, 2019) (A.12, 2017) Transparency	Provide a more detailed explanation of and/or background documentation on the assumption regarding proxies for minor livestock categories as well as on the derivation of the EFs for CH <sub>4</sub> emissions from manure management in the NIR.	Resolved. The NIR (part 2, annex 3, section A3.4.3, p.84) contains additional information clearly presenting the use of proxies for category 3.B.4 other livestock as well as additional methodological descriptions for manure management (part 2, annex 3, section A3.4.4.1, p.96) and EFs (part 2, annex 3, section A3.4.3.7, p.91). The ERT considers that the recommendation has been addressed because the Party has included in the NIR sufficient additional explanatory information as requested in the recommendation.
A.15	3.B.4 Other livestock – N <sub>2</sub> O (A.5, 2019) (A.14, 2017) Transparency	Explain in the NIR that the calculated Nex rate for camels in CRF table 3.B(b) is different from the default value for camels in the 2006 IPCC Guidelines because it reflects the Nex rate from llamas and alpacas (which is assumed to have the same default Nex rate as sheep).	Resolved. The Party clearly stated in its NIR (part 2, annex 3, section A3.4.4.1, p.96) that the Nex rate for sheep, and not the default value for camels from the 2006 IPCC Guidelines (vol. 4, chap.10, table 10.19, p.10.59), is used for llamas and alpacas. A similar explanation was provided in the documentation box of CRF table 3.B(b). The ERT considers that the recommendation has been addressed because the Party provided explanatory information addressing the recommendation in both the NIR and CRF table 3.B(b).
A.16	3.B.5 Indirect N <sub>2</sub> O emissions – N <sub>2</sub> O (A.6, 2019) (A.15, 2017) Accuracy	Estimate indirect N <sub>2</sub> O emissions from manure management systems due to leaching and run-off by using a tier 2 approach and by developing the value of Frac <sub>LeachMS</sub> on the basis of country-specific data on N run-off	Addressing. Canada estimated indirect N <sub>2</sub> O emissions from manure management by applying N loss factors to the quantity of manure N contained in each animal waste management system and default N <sub>2</sub> O EFs, except for dairy cattle and swine, for which N loss factors were estimated using an emission model. The Party reported progress on this issue in the NIR (part 2, annex 3, section A3.4.4.2, p.98), stating that “leaching is estimated only for the dairy and swine sectors, where country-specific information on

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		and leaching from manure management systems.	the fraction of N loss due to leaching and runoff was available” and that three to five years are required to obtain the necessary data and integrate them into a new model structure with the aim of comprehensively addressing this issue. During the review, when asked why several years are needed to make this improvement, the Party clarified that this is considered to be a low-priority improvement, and resources have primarily been allocated to higher-priority improvements that are anticipated to have a significant impact on emissions. It explained that using estimates based on proxy data (using country-specific information for other livestock types) as a more immediate solution may not result in representative estimates. The ERT considers that the recommendation has not been fully addressed because the Party has not yet implemented a tier 2 approach for estimating indirect N <sub>2</sub> O emissions from leaching and run-off for livestock categories other than dairy cattle and swine.
A.17	3.B.5 Indirect N <sub>2</sub> O emissions – N <sub>2</sub> O (A.7, 2019) (A.16, 2017) Convention reporting adherence	Use the correct table numbers in the descriptions of various parameters in equation A3-27 (part 2, p.112, of the 2017 NIR) in the NIR and improve the QA/QC procedures to prevent the occurrence of such errors.	Resolved. The Party added correct information to the NIR ensuring that the notes for equation A3.4-11 (NIR part 2, p.99 – equivalent to equation A3-27 of the 2017 NIR) refer to the appropriate data tables in the NIR. The ERT considers that the recommendation has been addressed because the Party has ensured that the NIR includes correct internal referencing.
A.18	3.B.5 Indirect N <sub>2</sub> O emissions – N <sub>2</sub> O (A.20, 2019) Accuracy	Estimate the percentage of managed manure N for the livestock category that volatilizes as NH <sub>3</sub> and NO <sub>x</sub> taking into account the volatilization of both NH <sub>3</sub> and NO <sub>x</sub> in line with the 2006 IPCC Guidelines.	Not resolved. The ERT noted that Canada did not estimate the percentage of managed manure N for the livestock category that volatilizes as NH <sub>3</sub> and NO <sub>x</sub> taking into account the volatilization of both NH <sub>3</sub> and NO <sub>x</sub> in line with the 2006 IPCC Guidelines (vol. 4, chap. 10, section 10.5.1, pp.10.54–10.57). During the review, the Party explained that it plans to address this recommendation in a future inventory submission, and that some initial analysis suggests that the fraction of NO <sub>x</sub> losses for dairy and swine is expected to be minimal. Regarding the timing when it is expected that NO <sub>x</sub> will be incorporated into the calculations, the Party indicated that it is considering implementing the related methodology from the <i>EMEP/EEA air pollutant emission inventory guidebook 2019</i> , but that some evaluation work is needed beforehand. The Party did not provide any indication of when this improvement might be implemented. The ERT considers that the recommendation has not yet been addressed.
A.19	3.D Direct and indirect N <sub>2</sub> O emissions from agricultural soils – N <sub>2</sub> O (A.8, 2019) (A.6, 2017) (A.9, 2016) (A.16, 2015) Completeness	Report direct N <sub>2</sub> O emissions from sewage sludge and other organic fertilizers applied to soils.	Addressing. The Party included direct N <sub>2</sub> O emissions from sewage sludge application in its emission estimates and reported information on the methodology used (NIR part 2, annex 3, section A3.4.5, pp.103–104). It also provided in the NIR (part 1, table 8-5, p.196) information on the collection, analysis and integration of data into the existing organic N fertilizer methodology for estimating N <sub>2</sub> O emissions from the application of compost to soils in its improvement programme, and has taken steps towards collecting these AD. During the review, the Party indicated that N <sub>2</sub> O emissions from compost are expected to be reported “in the short term”, once the related AD have been compiled. The ERT considers that the recommendation has not yet been fully addressed because although the Party has reported direct N <sub>2</sub> O emissions from sewage sludge applied to soils, it has not yet reported direct N <sub>2</sub> O emissions from compost applied to soils.

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A.20	3.D.b Indirect N <sub>2</sub> O emissions from managed soils – N <sub>2</sub> O (A.9, 2019) (A.7, 2017) (A.15, 2016) Completeness	When estimating direct N <sub>2</sub> O emissions from application of sewage sludge and other organic fertilizers to soils, also estimate the related indirect N <sub>2</sub> O emissions.	Addressing. The Party estimated and reported indirect N <sub>2</sub> O emissions from sewage sludge applied to agricultural soils and described the methodology used in the NIR (part 2, annex 3, section A3.4.5.2, p.112). During the review, Canada indicated that it plans to estimate and report indirect N <sub>2</sub> O emissions from compost applied to soils once it has estimated and reported direct N <sub>2</sub> O emissions from compost application (see ID# A.19 above). The ERT considers that the recommendation has not yet been fully addressed.
A.21	3.D.b.1 Atmospheric deposition – N <sub>2</sub> O (A.10, 2019) (A.8, 2017) (A.16, 2016) Comparability	Correct the reporting of Frac <sub>GASM</sub> in the additional information table of CRF table 3.D to correspond to the Frac <sub>GASM</sub> value (0.2 kg NH <sub>3</sub> -N+NO <sub>x</sub> -N/kg N) provided in the 2006 IPCC Guidelines, which was used in the inventory.	Resolved. The Party reported a Frac <sub>GASM</sub> value of 0.18 for 2019 in the additional information table of CRF table 3.D and provided explanations for this value in a comment to the corresponding cell of this table. During the review, Canada explained that its Frac <sub>GASM</sub> calculation is more detailed than that provided in the 2006 IPCC Guidelines. The losses of NH <sub>3</sub> -N and NO <sub>x</sub> -N are determined for each manure management type of each livestock type. This gives a weighted average value for Frac <sub>GASM</sub> , which varies from year to year depending on livestock numbers. This approach is clearly presented in the NIR (part 2, annex 3, section A3.4.4.2, p.99). The ERT considers that the recommendation has been addressed, and that the approach used by the Party is fully acceptable.
A.22	3.G Liming – CO <sub>2</sub> (A.21, 2019) Comparability	Develop the underlying AD time series for limestone and dolomite, for example, by using the ratio of limestone to dolomite used to calculate the weighted EF, and use the corresponding IPCC default EFs separately for limestone and dolomite, as specified in the 2006 IPCC Guidelines (vol. 4, chap. 11, section 11.3.2). Report separately the emissions from limestone and dolomite assumed to be applied to soils in CRF table 3.G-I in the next submission.	Not resolved. Canada did not develop the underlying AD time series separately for limestone and dolomite for its estimates in this category. Moreover, it did not include this issue in its planned inventory improvements, as reported in the NIR (part 1, chap. 8, section 8.3, pp.189–198). However, during the review, the Party explained that that it plans to report separately in its 2022 inventory submission the emissions from limestone and dolomite on the basis of the ratio of limestone to dolomite used and the default EFs from the 2006 IPCC Guidelines (vol. 4, chap. 11, section 11.3.2, p.11.29).
A.23	3.H Urea application – CO <sub>2</sub> (A.11, 2019) (A.17, 2017) Transparency	Provide transparent information to substantiate the significant inter-annual variability in the CO <sub>2</sub> emissions from urea application for 1993–1994, 2006–2007, 2011–2012, 2012–2013 and 2013–2014 in the NIR.	Resolved. The ERT noted that Canada explained in the NIR (part 1, chap. 5, section 5.7.3, p.141) that urea-based fertilizer shipments in Canada vary “due to price fluctuations, climate factors influencing crop production, and other factors”. During the review, the Party explained that it has not been able to definitively identify specific factors that give rise to the inter-annual variability in the consumption of urea in the country. The ERT considers that the recommendation has been addressed because the Party has made reasonable efforts to determine the reasons for the inter-annual variability of urea usage and has included a corresponding explanation in the NIR.
LULUCF			
L.1	4. General (LULUCF) (L.1, 2019) (L.1, 2017) (L.2, 2016) (L.4, 2015)	Improve the completeness of reporting of the pools in all mandatory categories currently	Addressing. CSCs in several pools for some mandatory categories continued to be reported as “NE” (e.g. net CSCs in mineral and organic soils in grassland). The Party reported in its NIR (part 1, table 8-5, pp.196–197; part 2, table A5-1, pp.199–202) and

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	(59, 2014) (9 and 63, 2013) Completeness	reported as “NE” and include a description on how the notation keys have been used.	in CRF table 9 that this notation key was used owing to a lack of AD. The ERT notes that, according to the inventory improvement plan (NIR table 8-5, p.196), efforts to resolve the issue of data collection are under way. The ERT considers that the recommendation has not yet been fully addressed.
L.2	4. General (LULUCF) (L.2, 2019) (L.2, 2017) (L.3, 2016) (L.13, 2015) Completeness	Improve the completeness of representing land areas in the LULUCF sector by amending the reporting (both the land-use change matrix and the estimates for category-specific emissions and removals in the CRF tables) by including all land areas and making it clear which categories and subcategories occur in Canada and whether the emissions/removals are calculated or not. This includes both managed land areas where no emissions or removals are expected (e.g. grassland remaining grassland) and unmanaged areas.	Addressing. The Party reported in its NIR (part 1, pp.146–148; part 2, pp.120–164) and in CRF table 4.1 information on land representation considering the IPCC land categories and harmonizing them with the national definitions for different categories. The ERT noted that a very large area of lands in Canada is considered unmanaged and that the Party explained in the NIR the criteria used to differentiate managed from unmanaged lands. CRF table 4.1 shows that most land uses and land-use changes are tracked, but some are reported as “IE”, reflecting that the land representation system is not completely implemented. Lastly, the Party estimated most, but not all, emissions and removals (see ID# L.1 above). The ERT considers that this recommendation has not yet been fully addressed.
L.3	4. General (LULUCF) (L.3, 2019) (L.3, 2017) (L.14, 2016) Convention reporting adherence	Provide more details in the NIR on how the CRF categories are disaggregated in the Canadian key category analysis, in accordance with paragraph 50(d)(ii) of the UNFCCC Annex I inventory reporting guidelines, particularly in relation to where emissions from biomass burning are included.	Resolved. The Party included in the NIR (part 2, table A1.1, pp.2–3) an exhaustive list of the aggregated categories as well as explanations regarding the rationale for category aggregation for the key category analysis, in accordance with paragraph 50(d)(ii) of the UNFCCC Annex I inventory reporting guidelines. The Party also indicated in table A1-1 in which categories biomass burning is included (forest land remaining forest land, land converted to cropland, grassland remaining grassland, land converted to wetlands and land converted to settlements). The ERT noted that the aggregation is consistent with the information reported in CRF table 4(V) and that, since Canada does not yet have the AD to report separately biomass burning in organic soils, emissions from biomass burning in organic soils are reported together with emissions from biomass burning in mineral soils. The ERT acknowledges the improvements made by Canada and considers that this recommendation has been fully addressed.
L.4	Land representation (L.4, 2019) (L.4, 2017) (L.16, 2016) Transparency	Specify in the NIR that the total land area is included in the inventory and report the land area in CRF table 4.1 separately for unmanaged forest, unmanaged grassland and unmanaged wetlands.	Addressing. The Party did not report in its NIR the total area of Canada nor specify that the total land area of the country is included in the GHG inventory. The ERT noted that, in CRF table 4.1, Canada reported a total area (managed lands + unmanaged lands) of 996,357.06 kha. According to Statistics Canada, the area of Canada is 9,984,670 km <sup>2</sup> , equivalent to 998,467 kha ( <a href="http://www150.statcan.gc.ca/n1/pub/11-402-x/2011000/chap/geo/geo-eng.htm">www150.statcan.gc.ca/n1/pub/11-402-x/2011000/chap/geo/geo-eng.htm</a> ). The difference in area between the two sources, 2,109.94 kha, suggests that the land matrix may not be exhaustive. During the review, Canada explained that there could be fractional differences in total estimates, depending on the geomatic layers that were used in the compilation. Such differences are explained by analytical errors, such as resolution and scale or projections. Canada further explained that, “...given the extensive areas and diverse landscape and environmental

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L.5	Land representation (L.5, 2019) (L.5, 2017) (L.17, 2016) Transparency	Include in the NIR the correction of the reporting in CRF table 4.1 (to include information on annual changes) as part of the planned improvement, along with any update on the status of implementation of other parts of the ongoing project to revise and improve the consistency and completeness of the land-transition matrix.	<p>conditions of our country it is a significant challenge to have an accurate single value to represent the total national area”. The ERT acknowledges that Canada reported separately in CRF table 4.1 the land area for unmanaged forest, unmanaged grassland and unmanaged wetlands, and indicated that clarifications regarding land area will be included in the NIR of its next inventory submission.</p> <p>Addressing. The Party reported in CRF table 4.1 information on annual changes in area in different land-use categories, including the recommended correction in the reporting. Although the planned improvements (NIR part 1, table 8-4, p.192) include improving the completeness and consistency of land representation, no timeline or status is provided for the implementation of the work to improve the consistency and completeness of the land-transition matrix (see ID# L.2 above). During the review, Canada indicated that efforts are ongoing, including the consideration of alternative methods, to gradually integrate into the reporting missing land use and land-use change categories. Therefore, the ERT considers that the recommendation has not yet been fully addressed.</p>
L.6	Land representation – CO <sub>2</sub> , CH <sub>4</sub> and N <sub>2</sub> O (L.18, 2019) Accuracy	Ensure that, for all years and all land-use categories in its land-use matrix, the values reported for year X–1 in the “final area” row in CRF table 4.1 equal the values reported in year X in the “initial area” column to improve the consistency of the land use and land-use change reported and ensure consistency with the area changes reported in the sectoral background tables. Recalculate the associated emissions and removals, where appropriate. Explain in the NIR the reason for recalculating the associated GHG emissions and removals as a result of the land-transition matrices being revised.	<p>Addressing. The Party reported in CRF table 4.1 initial areas for different land-use categories that are very similar, but not the same, as the final areas for these land-use categories reported for the previous year (e.g. for 2019 and 2018, respectively). It explained in the NIR (part 1, p.146) that these discrepancies resulted from the reporting method, under which only the area of agricultural grassland was reported under grassland, and only the areas where emission-generating activities occur were reported under wetlands and settlements. Nevertheless, the ERT noted that the area changes reported in CRF table 4.1 are consistent with those reported in CRF tables 4.A–4.F. Lastly, the NIR indicates that significant recalculations were performed in the category 4.A.1 forest land remaining forest land owing to improved consideration of insect disturbances and enhanced AD on residential use of firewood (part 1, p.153), and small recalculations in cropland owing to an update to an internal land-use source file that impacted annual cropland area estimates by less than 10 ha (part 1, p.161); however, no information has been provided on recalculations of emissions and removals as a result of the land-transition matrices being revised. During the review, the Party indicated that there is no accurate authoritative reconciled land-use classification resource in Canada, as data on land-use areas come from multiple sources, such as the census of agriculture and provincial estimates of managed forest land. It explained that the differences in cropland areas are due to the interpolation and extrapolation processes that take place between the agricultural census, carried out every five years. Further, only managed land for grassland, wetlands and settlements is reported, and not the total areas for these categories owing to uncertainty in the total areas for these land-use types that cannot be resolved using the information obtained from different data sources. The Party stated that efforts are ongoing and a variety of methods are being explored with the aim to integrate missing land use and land-use change areas into the land-transition matrices. The ERT considers that the recommendation has not yet been fully addressed.</p>



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L.7	4.A Forest land – CO <sub>2</sub> (L.7, 2019) (L.16, 2017) Completeness	Estimate the CO <sub>2</sub> emissions from drained organic forest soils by developing the peatland module for the carbon budget model of the Canadian forest sector or any other country-specific methods. Pending the development of such methods, estimate and report the CO <sub>2</sub> emissions using the tier 1 methodology and the default EFs in the 2006 IPCC Guidelines together with AD derived from the new statistics.	Resolved. The Party reported in its NIR (part 1, p.151) and CRF table 4(II) the CO <sub>2</sub> emissions that occur in drained organic forest soils, for the subcategories where this process occurs. It is explained in the NIR (part 2, p.124) that Canada used for the estimates AD derived from provincial statistics, consultations and historical documents, and the tier 1 method and EFs from the Wetlands Supplement. The ERT noted that the Party did not specify what kind of consultations were held for supporting the emission estimates. During the review, Canada explained that it will include in the NIR of its next inventory submission information about the expert consultations. The ERT considers that the recommendation has been addressed.
L.8	4.A Forest land – CO <sub>2</sub> , CH <sub>4</sub> and N <sub>2</sub> O (L.8, 2019) (L.7, 2017) (L.19, 2016) Accuracy	Disaggregate the CSC in mineral and organic soils to increase transparency and comparability and ensure that the emissions are neither under- nor overestimated.	Resolved. The Party did not report in CRF table 4.A disaggregated CSC in mineral and organic soils under forest land. During the review, Canada reported on the progress regarding this specific recommendation, indicating that statistics were obtained for drained forest areas and CSC in organic soils were reported, that a peatland module for the CBM-CFS-3 model continues to be under development with the aim of estimating emissions and removals from organic soils in forest land, and that a study commissioned by Environment and Climate Change Canada determined that drainage in forest land was only conducted operationally in Quebec and a tier 1 estimate of forest drainage was being completed. In addition, Canada explained that emissions of CO <sub>2</sub> , CH <sub>4</sub> and N <sub>2</sub> O in Quebec are currently reported in CRF table 4(II) and the related CSCs are reported as “IE” in CRF table 4.A to avoid double counting of CO <sub>2</sub> emissions (see ID# L.7 above). Canada further noted that for the rest of the country’s forest areas, there is no evidence that management of organic soils occurs and that it will continue to use the notation key “IE” with the explanation that all soil CSCs are reported under mineral soils because the AD currently available do not allow their disaggregation into organic and mineral soils, which is in line with the provisions of footnote 5 to CRF table 4.A. The ERT commends Canada for its efforts to address this issue and considers that the recommendation has been addressed.
L.9	4.A.1 Forest land remaining forest land – CO <sub>2</sub> (L.19, 2019) Transparency	Include and document the justification for the assumption that all emissions and subsequent removals due to stand-replacing fires in managed forest land are not anthropogenic. Include information on how these non-anthropogenic circumstances, which are the source of significant emissions, are beyond the control of, and not materially influenced by, the country, and tend to average out across time, as described in the managed land proxy definition.	Not resolved. The Party did not include in the NIR enough information justifying the assumption that all emissions and subsequent removals due to stand-replacing fires in managed forest are not anthropogenic; or provide sufficient information on how such non-anthropogenic circumstances, which are the source of significant emissions, are beyond the control of, and not materially influenced by, the country, and tend to average out across time, as described in the managed land proxy definition. During the review, Canada indicated that it will include additional information in the NIR of the 2022 inventory submission. The ERT considers that the recommendation has not yet been addressed.

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L.10	4.A.1 Forest land remaining forest land – CO <sub>2</sub> (L.20, 2019) Transparency	Improve the transparency of the reporting by further disaggregating the AD on each forest land subdivision in CRF table 4.A with a row for forest land not affected by natural disturbance and a row for forest land affected by natural disturbance, and include in the NIR a land-use matrix that shows the annual changes of areas of forest land that qualify as being subject to natural disturbances, together with a table containing their emissions and removals.	Addressing. The Party reported in CRF table 4.A disaggregated AD on each forest land subdivision, with a row for forest land not affected by natural disturbance and a row for forest land affected by natural disturbances. The ERT notes that reporting separately forest land affected by natural disturbances exceeds the requirements of the UNFCCC Annex I inventory reporting guidelines and commends the Party for doing so. However, the Party did not include in the NIR a land-use matrix that shows the annual changes of areas of forest land that qualify as being subject to natural disturbances, together with a table containing their emissions and removals. During the review, the Party clarified that it plans to include this land-use matrix together with the related table in the NIR of the 2022 inventory submission. The ERT considers that the recommendation has not yet been fully addressed.
L.11	4.A.1 Forest land remaining forest land – CO <sub>2</sub> (L.21, 2019) Convention reporting adherence	Update the text in the NIR chapter on the energy sector which states that carbon emitted as CO <sub>2</sub> during forest fires is considered in the forest carbon balance in order to prevent misunderstanding and improve the consistency of the reporting.	Resolved. The ERT noted that Canada provided in the NIR (part 2, p.241) a detailed explanation for forest fires and “uncontrollable natural disturbances” and how CO <sub>2</sub> emitted is considered in the forest carbon balance. The ERT considers that the updated text is correct and prevents any misunderstanding and improves the consistency of the reporting.
L.12	4.A.2 Land converted to forest land – CO <sub>2</sub> (L.9, 2019) (L.8, 2017) (L.7, 2016) (L.19, 2015) Accuracy	Provide additional information on why using zero for annual area conversions to forest land for 2009–2013 is considered reasonable compared with other alternative ways to construct the time series. Continue with efforts to acquire the missing AD for land converted to forest land.	Addressing. The Party did not provide additional information on why using zero for annual land area conversions to forest land for 2009–2013 can be considered reasonable. Nevertheless, Canada indicated in the NIR (part 1, table 8-4, pp.154 and 192; part 2, p.132) that new AD on land converted to forest land were included for the Province of Ontario for 2007–2016 and were considered in the estimates for this category, demonstrating the Party’s efforts to acquire missing AD. During the review, Canada clarified that there is currently limited access to information on afforestation activities. It explained that – until suitable data can be obtained to demonstrate that afforestation has occurred since 2008 – the assumption of no afforestation activities for the post-2008 period is preferred to alternative ways to construct the time series (e.g. extrapolation of existing afforestation data) because federal subsidies to promote the afforestation activities stopped after 2008, so it is not considered reasonable to assume that current afforestation activities are similar to those that occurred in previous years as indicated in the existing AD. Canada also provided additional information for cases where natural vegetation is allowed to be established on cropland or abandoned cropland, explaining that these events are captured in the perennial woody biomass estimates. It clarified that once a land becomes forest land, the activity would be considered as a cropland conversion to forest land event, provided this land meets the forest definition and falls into the managed forest land category. The ERT noted that although the improvement plan includes an item to gather information on land converted to forest land (NIR part 1, p.155), it does not provide a timeline for the completion of this task. During the review, Canada further indicated that continued efforts are under way to obtain more AD from provincial and territorial resource management agencies and confirmed that there is no specific time frame for establishing a national system to track the conversion of land to

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			managed forest land. The ERT considers that the recommendation has not yet been fully addressed.
L.13	4.A.2.1 Cropland converted to forest land – CO <sub>2</sub> (L.10, 2019) (L.17, 2017) Completeness	Include the loss of the biomass in cropland in the CSC in living biomass due to conversion of cropland to forest land for all types of cropland, including abandoned cropland. If these biomass losses are already accounted for under cropland in the Century model, then the Party should transparently document how these are already accounted for in the NIR.	Addressing. The Party reported in CRF table 4.A CSC from the loss of carbon in living biomass due to the conversion of cropland to forest land for different reporting zones of the country. The NIR (including methodological annex 3.5) did not document how these losses are accounted for in the Century model used for the calculations. In response to a question posed by the ERT during the review, Canada clarified that efforts are ongoing to determine how much abandoned cropland exists, and for how long that land has been abandoned, so there are as yet no authoritative estimates of abandoned cropland areas that have been developed. For this reason, it is assumed that there is no woody biomass on-site at the time of conversion. Canada also clarified that estimates of woody biomass loss on cropland are carried out separately on the basis of a sampling methodology. It added that complete reconciliation of the methodologies for monitoring forest land converted to cropland, cropland converted to forest land and woody biomass loss on cropland will take time, but it is currently assumed that issues such as accounting specifically for biomass loss on cropland undergoing afforestation fall within the error bounds of each of the methodologies, and that specifically reporting on biomass loss in cropland converted to forest land would entail a high risk of double counting. The ERT acknowledges the progress made by Canada but considers that the recommendation has not yet been fully addressed.
L.14	4.A.2.1 Cropland converted to forest land – CO <sub>2</sub> (L.22, 2019) Accuracy	Report carbon losses due to the conversion of cropland to forest land applying at least a tier 2 methodology using default values provided in the 2006 IPCC Guidelines for biomass in annual cropland for years when cropland is converted to forest land and if the analysis demonstrates that the likely level of emissions meets the criteria in paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines use the notation key “NE”, and, for years when conversion did not occur, if emissions or removals did not occur in those pools, report them as “NA”.	Addressing. The Party reported in CRF table 4.A carbon losses due to the conversion of cropland to forest land, in the subcategories where these land-use changes occurred. However, the ERT noted that the NIR (part 1, p.154 and part 2, p.233) contains only general information on such losses and does not provide any details on the specific tier method and EFs used to estimate them. The ERT also noted that the Party’s use of notation keys is in line with the UNFCCC Annex I inventory reporting guidelines. During the review, Canada indicated that cropland conversion to forest land is not a key category and as such does not require implementation of a tier 2 methodology. The ERT considers that the recommendation has not yet been fully addressed.
L.15	4.D.2.2 Land converted to flooded land – CO <sub>2</sub> (L.11, 2019) (L.18, 2017) Accuracy	Estimate the emissions from land converted to flooded land using either the level 2 approach (country-specific EFs) or the level 3 approach (country-specific methodology) given in appendix 2 to the 2006 IPCC Guidelines, applying a set of assumptions (e.g. regarding	Resolved. The Party reported in its NIR (chap. 6, section 6.7.2, p.168; annex 3, section A3.5.6.2, pp.158–159) that it used a combination of the tier 3 method implemented in the CBM-CFS-3 model and the tier 2 method from the 2006 IPCC Guidelines (vol. 4, appendix 2) for estimating emissions from land converted to flooded land. It also reported in CRF table 4.D the resulting emission estimates for land converted to flooded land (e.g. from an area of 38.62 kha it reported emissions of 174.37 kt CO <sub>2</sub> for 2019). The ERT considers that the recommendation has been fully addressed.

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		the steady-state transition period) that are appropriate to the approach selected.	
L.16	4.D.2.2 Land converted to flooded land – CO <sub>2</sub> (L.12, 2019) (L.18, 2017) Accuracy	Classify flooded land as land converted to flooded land or flooded land remaining flooded land using a transition period consistent with the assumptions regarding the steady-state transition period used in the methodological approach selected.	Resolved. The Party classified flooded land as land converted to flooded land or flooded land remaining flooded land using a period of 10 years after flooding to report emissions (NIR part 1, p.146). The election of this period is based on country-specific measurements and reflects the steady state for emissions from flooded land. Canada also clarified that for all other transitions the IPCC default period of 20 years was used. The ERT considers that the recommendation has been fully addressed.
L.17	4.D.2.2 Land converted to flooded land – CO <sub>2</sub> (L.23, 2019) Convention reporting adherence	Correct the error in the reporting of emissions from organic soils (i.e. reporting CSC in organic soils for some subdivisions of other land converted to flooded land as “IE”, when area of organic soils is reported as “NO”, instead of reporting it as “NO”).	Resolved. The Party corrected the error previously identified in the reporting of emissions from organic soils in CRF table 4.D. The ERT considers that the recommendation has been fully addressed.
L.18	4(III) Direct N <sub>2</sub> O emissions from N mineralization/ immobilization and 4(IV) indirect N <sub>2</sub> O emissions from managed soils – N <sub>2</sub> O (L.13, 2019) (L.10, 2017) (L.10, 2016) (L.24, 2015) Completeness	Estimate all the direct N <sub>2</sub> O emissions as well as the associated indirect N <sub>2</sub> O emissions from N mineralization or immobilization associated with loss or gain of soil organic matter. Until the estimation is implemented, provide information on the planned improvement and assessment of the quantitative impact of this missing category in accordance with the provisions in paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.	Addressing. The Party reported in CRF table 4(III) direct N <sub>2</sub> O emissions from N mineralization or immobilization associated with loss or gain of soil organic matter for cropland and grassland remaining grassland, but reported these emissions as “NE” for forest land, wetlands and settlements. It is stated in the NIR (part I, p.151) that, on the basis of calculated direct and indirect N <sub>2</sub> O emissions from net soil organic carbon losses in stands under anthropogenic influence aggregated at the reporting unit level, potential emissions from this source can be deemed insignificant in accordance with paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines. In addition, the documentation box of CRF table 4(III) indicates that direct emissions of N <sub>2</sub> O in grassland remaining grassland and in urban trees are not estimated owing to a lack of data. The ERT noted that while indirect N <sub>2</sub> O emissions from N mineralization or immobilization are reported as “IE” in CRF table 4(IV), the documentation box of that table contains an explanation that these emissions are reported in the agriculture sector (with the exception of emissions in forest land remaining forest land, which are not reported because they are considered insignificant). During the review, the Party indicated that it evaluated the applicability of the default methodology for estimating N <sub>2</sub> O emissions from mineralization to Canadian forests based on domestic science and available data and it found that soil N <sub>2</sub> O emissions from net soil organic carbon losses in forest land remaining forest land can be deemed insignificant in accordance with the provisions of paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines and that it will document this in the 2022 inventory submission. The ERT considers that the recommendation has not yet been fully addressed, as the quantitative impact of the missing estimates has not been provided in accordance with paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.
L.19	4.G HWP – CO <sub>2</sub> (L.16, 2019) (L.13,	Include data for 1900–1940 for estimating emissions for the category HWP, as part of	Addressing. The Party included data for 1900–1940 for estimating emissions from HWP. It reported in its NIR (part 2, p.135) that the carbon inputs for 1900–1940 were

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	2017) (L.13, 2016) (L.22, 2015) Transparency	the improvement work in relation to the category and consider how the uncertainty may be affected.	backcast on the basis of historical production data by extrapolating information for 1941–1989, while the consumed and exported magnitudes were calculated using average proportions from statistics for 1961–1965 (five-year period). At the same time, Canada included an uncertainty analysis in the NIR (part 2, p.138) but did not include a discussion on how the uncertainty is affected by the assumptions made and the techniques used for gap-filling of data for 1900–1940. During the review, Canada indicated that a more comprehensive analysis of uncertainty associated with historic HWP was carried out in the 2021 inventory submission than the analysis in the previous inventory submissions. The ERT considers that the recommendation has not yet been fully addressed.
L.20	4.G HWP – CO <sub>2</sub> (L.17, 2019) (L.19, 2017) Transparency	Provide in the NIR the information provided during the review on the data (disaggregated by product category) and calculations for the HWP pool together with the information on carbon inputs, carbon losses and CO <sub>2</sub> emissions for CRF table 4.G (sheet 1) so as to enable the ERT to assess the comparability of Canada’s reporting on the HWP pool with that of other Parties.	Resolved. The Party reported in its NIR (part 1, pp.150 and 155–158; part 2, pp.134–138) and CRF table 4.G information on the data and calculations for the HWP pool, using the simple decay approach. Canada used a national tier 3 model for this pool (National Forest Carbon Monitoring, Accounting and Reporting System for HWP). The model tracks HWP subpools and carbon flows between the subpools through the different life cycles of wood products. NIR table 6-7 (part 1, p.156) provides information on the carbon stocks of the different subpools and related CO <sub>2</sub> emissions. In CRF table 4.G (sheet 1), the Party reported using approach B (production approach). The ERT noted the information provided in the NIR (part 1, pp.150–151; part 2, pp.134–138, 149, 162, 201 and 233–239) on data disaggregated by product category and calculations for the HWP pool, together with information on carbon inputs, carbon losses and CO <sub>2</sub> emissions for CRF table 4.G (sheet 1). It noted that the net balance of the HWP pool (in Mt CO <sub>2</sub> eq), including both carbon inputs and carbon losses, presented in NIR figure 6-5 (part 1, p.157) provides relevant information on the comparability of Canada’s reporting with that of other Parties. The above-mentioned information also enhanced the transparency of the submission and enabled the ERT to conclude that Canada’s reporting on the HWP pool is comparable with that of other Parties. The ERT considers that the recommendation has been addressed.
L.21	4.G HWP – CO <sub>2</sub> (L.24, 2019) Transparency	Include in the NIR a clear explanation of the assumptions and methods applied for estimating emissions from HWP for 1900–1940.	Addressing. The Party provided in its NIR (part 2, pp.134–136) an overview of the model used for calculating HWP estimates, including some information on the assumptions and methods applied for estimating emissions of HWP for 1900–1940. During the review, Canada noted that currently available data do not allow it to differentiate between the amount of chips and pellets exported and indicated that it included additional information on historical data for HWP for 1900–1989. The ERT considers that the recommendation has not yet been fully addressed because the information provided in the NIR is not entirely transparent, in particular on assumptions used for determining the carbon inputs for historical harvest for 1900–1940.
L.22	4.G HWP – CO <sub>2</sub> (L.25, 2019) Transparency	Improve the transparency of the reporting by including in the NIR the explanation and clarifications on the treatment of firewood in	Addressing. The Party reported in its NIR (part 2, p.136) that all wood transferred from the forest to the HWP pool is included in the HWP model used in the estimates, but that some of the products associated with portions of wood, such as wood chips and pellets,

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		the HWP model provided during the review, and include information on the amount of wood chips and pellets exported and revise the emission estimates, if needed, when new information on sources and volumes of firewood produced become available.	are not explicitly identified in the data. Unlike for other HWP, estimates for wood chips and pellets are based on firewood consumption surveys. Wood used for bioenergy, such as pellets and chips, is assumed to be sourced from the “milling residue” output category in the HWP model. This carbon is quantified and allocated to bioenergy but is undifferentiated from other residual waste, all of which is assumed to be oxidized on disposal. The export of wood chips and pellets is currently missing and not considered in the model. Regarding the revision of the estimates for firewood, the NIR (part 1, p.158) indicates that recalculations were performed on the basis of available improved residential use data, revised spatial allocation of firewood harvest and corrected values for the moisture content of industrial fuelwood. During the review, Canada indicated that the AD requested in the recommendation are currently not available and that the information in the NIR clearly indicates which data are available. The ERT notes that the transparency of the reporting has improved and the estimates have been revised, but considers that the recommendation has not yet been fully addressed because the Party has not provided all necessary information on the amount of wood chips and pellets exported.
L.23	4.G HWP – CO <sub>2</sub> (L.26, 2019) Transparency	Improve the transparency of the reporting by including in the NIR and the documentation box to the CRF tables a detailed explanation of the origin of the data for each column in table 4.G (sheet 1) and the assumptions used.	Resolved. Canada documented in the NIR (part 2, annex 3, section A3.5.3, pp.134–138) and CRF table 4.G (sheet 1) all data sources and assumptions used in the estimates of HWP.
L.24	4.G HWP – CO <sub>2</sub> (L.27, 2019) Comparability	Include the correct half-life parameters for firewood in the NIR and the CRF tables.	Resolved. The Party reported in its NIR (part 2, annex 6, footnote to table A.6.5-3, p.238) that firewood and mill residue are assumed to be burned and disposed of, respectively, in the year of harvest. Accordingly, Canada reported “NA” for the half-life of firewood in CRF table 4.G (sheet 1). In addition, the ERT notes that in the previous review report, Canada clarified that carbon transfers from forests to HWP include all carbon in wood removed from forest sites, regardless of the intended use or ultimate location of that wood. The ERT considers that the recommendation has been fully addressed.
Waste			
W.1	5.A Solid waste disposal – CH <sub>4</sub> (W.12, 2019) Accuracy	Implement the plan to collect data on landfilled sewage sludge, include it in the model for estimating emissions from landfills and report the resulting emissions in future submissions.	Resolved. The Party reported in its NIR (part 1, p.175; part 2, p.168) that sewage sludge from wastewater is landfilled in SWDS and accounted in the fractions of landfilled waste. The ERT noted that NIR table A3.6-3 (p.170) provides values of the fractions of solid waste disposed of, including sewage sludge, and that NIR figure 7-1 (part 1, chap. 7, p.176) shows sewage sludge among the materials landfilled. During the review, the Party confirmed that the plan to collect data on landfilled sewage sludge has been implemented and the quantities of sewage sludge landfilled are now estimated on the basis of accounting for the sewage sludge production, and that the resulting emissions are included taking into account sewage sludge incineration, composting and export (which are also reported). The ERT considers that the recommendation has been fully addressed.

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W.2	5.A.1 Managed waste disposal sites – CH <sub>4</sub> (W.13, 2019) Convention reporting adherence	Report the same values consistently as a percentage within the same CRF table.	Resolved. The Party reported in CRF table 5.A, under subcategory 5.A.1.a anaerobic (managed waste disposal sites), a value of 48.38 per cent for DOC <sub>f</sub> for 2019 instead of the previous incorrect value of 0.5 (as a fraction). The ERT considers that the recommendation has been addressed.
W.3	5.A.1 Managed waste disposal sites – CH <sub>4</sub> (W.14, 2019) Accuracy	Either provide in the NIR additional information that supports the assumption that biogenic carbon from rubber and leather would degrade in disposal sites, or include the estimated DOC of rubber and leather in the first-order decay model used for calculating CH <sub>4</sub> emissions from landfills.	Addressing. The Party reported in its NIR (part 2, annex 3, table A3.6-1, p.167) DOC and DOC <sub>f</sub> values used for calculations of all fractions of municipal solid waste, including rubber and leather. Specifically, the 2006 IPCC Guidelines (vol. 5, chap. 2, section 2.3.1, footnote 5 to table 2.4, p.2.14) are referred to as the source of information for DOC <sub>f</sub> =0 for rubber. However, NIR table A3.6-1 does not provide information on the source for the DOC <sub>f</sub> value of 0.1 for leather. During the review, the Party clarified that the DOC <sub>f</sub> value of 0.1 for leather is based on the value for less decomposable wastes provided in footnote 1 to table 3.0 of the 2019 Refinement to the 2006 IPCC Guidelines (vol. 5, chap. 3, section 3.2.3, p.3.12). The ERT considers that the recommendation has been addressed with respect to rubber, but not yet with respect to leather, owing to the lack of information in the NIR on the source for the DOC <sub>f</sub> value of 0.1.
W.4	5.A.2 Unmanaged waste disposal sites – CH <sub>4</sub> (W.15, 2019) Accuracy	Either justify in the NIR applying the default OX for well-managed SWDS together with the default CH <sub>4</sub> correction factor for unmanaged SWDS, or use the default value of OX (0) for unmanaged waste disposal sites.	Not resolved. The Party reported under planned improvements (NIR part 1, chap. 7, section 7.3.5, p.177) that it is reviewing its use, for unmanaged industrial wood waste, of the OX value of 0.1 recommended in the 2006 IPCC Guidelines (vol. 3, chap. 5, table 3.2, p.3.15) for managed landfills, and that it is examining the parameters used for the pulp and paper industry (now considered separately from industrial wood waste) to determine an appropriate OX value for this industry. The OX value of 0.1 is still used in calculations, as stated in the NIR (part 2, annex 3, section A3.6.1.3.2, p.174). During the review, the Party clarified that it is exploring this issue and has included it among its planned improvements for the next inventory submission. The ERT considers that the recommendation has not yet been addressed because the Party did not provide a justification for using an OX value of 0.1 for unmanaged landfills.
W.5	5.C.1 Waste incineration – CO <sub>2</sub> (W.16, 2019) Completeness	Report CO <sub>2</sub> emissions from sewage sludge incineration in CRF table 5.C under “biogenic” as a memo item in the next submission by reporting emission values (rather than reporting them as “NE”), and ensure that AD are reported in a consistent manner (either in line with the column header of CRF table 5.C (kt wet weight) or in a comment specifying that the AD refer to the dry weight).	Resolved. The Party reported CO <sub>2</sub> emissions from sewage sludge incineration in CRF table 5.C, under subcategory 5.C.1.a biogenic – other. The ERT noted that the Party did not provide an indication in the documentation box of CRF table 5.C as to whether the AD for this subcategory are reported in terms of kt wet weight or kt dry weight. During the review, the Party confirmed that CO <sub>2</sub> emissions from sewage sludge incineration are reported for information purposes and the AD for this subcategory in CRF table 5.C are reported in kt wet weight.
W.6	5.D Wastewater treatment and discharge – CH <sub>4</sub>	Include the total organic product in CRF table 5.D for both municipal and industrial wastewater in the next submission.	Addressing. The Party reported in CRF table 5.D the total organic product for domestic wastewater, but not for industrial wastewater – although the NIR (part 1, p.182) states that AD are available for industrial wastewater. During the review, the Party clarified that the reporting system for industrial wastewater covers only emissions. However, the

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	(W.17, 2019) Transparency		ERT noted that during the previous review, the Party confirmed that AD for domestic wastewater were obtained on the basis of per capita organic load to wastewater and population served by plants by treatment type, and that AD for industrial wastewater were obtained on the basis of survey results from facilities, and provided estimates of biochemical oxygen demand and chemical oxygen demand for both municipal and industrial wastewater for 2017. The ERT considers that the recommendation has not yet been fully addressed because the Party has not reported a value for total organic product for industrial wastewater and is still using the notation key “NA” in CRF table 5.D.
W.7	5.D Wastewater treatment and discharge – N <sub>2</sub> O (W.18, 2019) Comparability	Report in CRF table 5.D the value used for the fraction of N in protein in the next submission.	Not resolved. The Party did not report the fraction of N in protein (known as F <sub>NPR</sub> ) in the additional information box in CRF table 5.D and used instead the notation key “NO”. During the review, the Party confirmed that it used the default value 0.16 for the fraction of N in protein in its calculations for 1990–2016 and that it will provide this information for the latest reported year in its next inventory submission. The ERT considers that the recommendation has not yet been addressed because the Party did not report the value for the fraction of N in protein.
W.8	5.D Wastewater treatment and discharge – N <sub>2</sub> O (W.19, 2019) Transparency	If the planned improvement to report emissions from sewage sludge applied to soils under the agriculture sector (see ID# A.8 of the 2019 inventory review report) is delayed, remove the reference to the agriculture sector from the wastewater chapter of the NIR.	Resolved. The Party reported in CRF table 3.D the AD and corresponding emissions for sewage sludge applied to soils. The reference to the agriculture sector was retained in the wastewater chapter of the NIR. During the review, the Party confirmed that the recommendation has been implemented. The ERT considers that the recommendation has been fully addressed.
W.9	5.D.1 Domestic wastewater – CH <sub>4</sub> (W.20, 2019) Accuracy	Either include the default industrial correction factor in the total organic product (biochemical oxygen demand, five-day test) calculation for collected wastewater, or use country-specific values on the basis of the analysis of new data from wastewater treatment plants in future submissions.	Resolved. The Party reported in its NIR (part 2, equation A3.6-16, p.183) the correction factor for domestic wastewater with industrial load (Ind <sub>Cor</sub> =1.25). During the review, the Party confirmed that this coefficient was actually used in calculations. The ERT considers that the recommendation has been addressed.
W.10	5.D.2 Industrial wastewater – CH <sub>4</sub> (W.22, 2019) Convention reporting adherence	Include the amount of CH <sub>4</sub> flared in CRF table 5.D, replacing “NO” where relevant, in the next submission.	Not resolved. The Party continued to report “NO” for CH <sub>4</sub> flared in CRF table 5.D. During the review, the Party stated that flaring of CH <sub>4</sub> from industrial wastewater does occur and the notation key “NO” was used in error. It clarified that the system for the reporting of data on industrial wastewater from plants (Canada’s GHG facility reporting programme) covers only information on emissions, and that it is exploring ways to improve this system. However, the ERT noted that Canada confirmed during the previous review that data on the amount of CH <sub>4</sub> flared under category 5.D.2 are available from facilities with on-site anaerobic wastewater treatment. Moreover, in its 2019 NIR, the Party stated that industrial wastewater facilities provided volumes of biogas vented, flared and used for heat or energy purposes. The ERT considers that the recommendation has not yet been addressed.



<i>ID#</i>	<i>Issue classification<sup>a, b</sup></i>	<i>Recommendation made in previous review report</i>	<i>ERT assessment and rationale</i>
W.11	5.D.2 Industrial wastewater – CH <sub>4</sub> (W.23, 2019) Completeness	Report updated information on sewage sludge gas used for energy recovery and the resulting CH <sub>4</sub> emissions as soon as they become available, and ensure that all biogas reported for energy recovery in the waste sector is included under the energy sector.	Not resolved. The Party has reported 0.55 kt for CH <sub>4</sub> emissions and 18.60 kt for the amount of CH <sub>4</sub> from sewage sludge gas used for energy recovery since 2015. No updated information on these values was provided, although a related improvement was planned, as indicated in the previous review report. During the review, the Party clarified that the system for the reporting of data on industrial wastewater from plants (Canada's GHG facility reporting programme) covers only information on emissions, and that it is exploring ways to improve this system. The ERT considers that the recommendation has not yet been addressed because the Party has not yet provided updated values for CH <sub>4</sub> emissions from use of biogas from sewage sludge for energy recovery, nor evidence that all biogas reported for energy recovery in the waste sector is included under the energy sector.

<sup>a</sup> References in parentheses are to the paragraph(s) and the year(s) of the previous review report(s) in which the issue was raised. Issues are identified in accordance with paras. 80–83 of the UNFCCC review guidelines and classified as per para. 81 of the same guidelines.

<sup>b</sup> The reports on the reviews of the 2018 and 2020 inventory submissions of Canada were not available at the time of this review. Therefore, the recommendations reflected in this table are taken from the 2019 inventory review report. For the same reason, 2020 and 2018 are excluded from the list of review years in which issues could have been identified.

#### IV. Issues identified in three or more successive reviews and not addressed by the Party

8. In accordance with paragraph 83 of the UNFCCC review guidelines, the ERT noted that the issues included in table 4 have been identified in three or more successive reviews, including the review of the 2021 inventory submission of Canada, and had not been addressed by the Party at the time of publication of this review report.

Table 4

##### Issues identified in three or more successive reviews and not addressed by Canada

<i>ID#</i>	<i>Previous recommendation for issue</i>	<i>Number of successive reviews issue not addressed<sup>1</sup></i>
General	No issues identified.	
Energy		
E.1	Take steps to ensure that the conversion of volumes of natural gas to energy units is completed appropriately for both marketable and non-marketable natural gas. Document the progress of efforts in the improvement plan and in the NIR.	6 (2014–2021)
E.2	Update CO <sub>2</sub> EFs where appropriate (following the plan referred to in ID# E.3 in the 2016 inventory review report) and provide references for these in the NIR.	4 (2016–2021)
E.3	Document all instances where the calorific values and/or the CO <sub>2</sub> EFs deviate from the ranges set out in the 2006 IPCC Guidelines, and provide concise explanations of the reasons for these deviations, where the reasons are understood; where the reasons are not understood, investigate them.	4 (2016–2021)

<i>ID#</i>	<i>Previous recommendation for issue</i>	<i>Number of successive reviews issue not addressed<sup>d</sup></i>
E.5	Estimate CO <sub>2</sub> emissions from lubricants combusted in two-stroke engines separately using appropriate OXs and report them in the energy sector.	3 (2017–2021)
E.6	Finalize the update of the methodological documentation on the Motor Vehicle Emissions Simulator and Nonroad Engines, Equipment and Vehicles models and include a summary of the documentation in the NIR.	3 (2017–2021)
E.9	Report the CO <sub>2</sub> emissions from underground mines as “NA” and indicate in the NIR that no CO <sub>2</sub> emissions associated with flaring and drainage systems of underground mines occur in the country.	5 (2015–2021)
E.10	Report CO <sub>2</sub> and CH <sub>4</sub> emissions from briquette manufacturing under solid fuel transformation. If this cannot be done, use the correct notation key for solid fuel transformation (“IE” instead of “NE”) and update the description in the NIR accordingly.	4 (2016–2021)
E.11	Document the methodology and data sources used to estimate emissions from briquette manufacturing in the NIR.	4 (2016–2021)
E.12	Provide transparent information on the subcategories under which the fugitive CO <sub>2</sub> emissions from the two CO <sub>2</sub> enhanced oil recovery projects are reported and how the Party ensures comprehensive coverage of fugitive CO <sub>2</sub> emissions from these projects in the NIR.	3 (2017–2021)
IPPU		
I.2	Include CO <sub>2</sub> emissions from ceramics production in the inventory or demonstrate that the emissions are insignificant, as defined in paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.	5 (2015–2021)
I.6	Include the allocation of NEU of other reductants identified in this category in the improvement plan and implement steps to further disaggregate the energy statistics and other (industrial processes) category.	6 (2014–2021)
I.7	Include information on the shares of process-related emissions from aluminium production estimated using different methodological tiers across the time series in the NIR.	3 (2017–2021)
I.12	Implement the scheduled improvements for this category, reporting on progress in future inventory submissions, and continue the improvements necessary to document the methods and sources of AD and EFs in the NIR.	9 (2011–2021)
I.16	Estimate all PFC emissions in category 2.F using the 2006 IPCC Guidelines, making appropriate revisions to the NIR to reflect the use of the updated methodologies.	3 (2017–2021)
Agriculture		
A.9	Provide in the NIR the reasons why emissions from anaerobic lagoon and daily spread have not been estimated, in accordance with paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.	4 (2016–2021)
A.16	Estimate indirect N <sub>2</sub> O emissions from manure management systems due to leaching and run-off by using a tier 2 approach and by developing the value of $Frac_{LeachMS}$ on the basis of country-specific data on N run-off and leaching from manure management systems.	3 (2017–2021)
A.19	Report direct N <sub>2</sub> O emissions from sewage sludge and other organic fertilizers applied to soils.	5 (2015–2021)

<i>ID#</i>	<i>Previous recommendation for issue</i>	<i>Number of successive reviews issue not addressed<sup>a</sup></i>
A.20	When estimating direct N <sub>2</sub> O emissions from application of sewage sludge and other organic fertilizers to soils, also estimate the related indirect N <sub>2</sub> O emissions.	4 (2016–2021)
LULUCF		
L.1	Improve the completeness of reporting of the pools in all mandatory categories currently reported as “NE” and include a description on how the notation keys have been used.	7 (2013–2021)
L.2	Improve the completeness of representing land areas in the LULUCF sector by amending the reporting (both the land-use change matrix and the estimates for category-specific emissions and removals in the CRF tables) by including all land areas and making it clear which categories and subcategories occur in Canada and whether the emissions/removals are calculated or not. This includes both managed land areas where no emissions or removals are expected (e.g. grassland remaining grassland) and unmanaged areas.	5 (2015–2021)
L.4	Specify in the NIR that the total land area is included in the inventory and report the land area in CRF table 4.1 separately for unmanaged forest, unmanaged grassland and unmanaged wetlands.	4 (2016–2021)
L.5	Include in the NIR the correction of the reporting in CRF table 4.1 (to include information on annual changes) as part of the planned improvement, along with any update on the status of implementation of other parts of the ongoing project to revise and improve the consistency and completeness of the land-transition matrix.	4 (2016–2021)
L.12	Provide additional information on why using zero for annual area conversions to forest land for 2009–2013 is considered reasonable compared with other alternative ways to construct the time series. Continue with efforts to acquire the missing AD for land converted to forest land.	5 (2015–2021)
L.13	Include the loss of the biomass in cropland in the CSC in living biomass due to conversion of cropland to forest land for all types of cropland, including abandoned cropland. If these biomass losses are already accounted for under cropland in the Century model, then the Party should transparently document how these are already accounted for in the NIR.	3 (2017–2021)
L.18	Estimate all the direct N <sub>2</sub> O emissions as well as the associated indirect N <sub>2</sub> O emissions from N mineralization or immobilization associated with loss or gain of soil organic matter. Until the estimation is implemented, provide information on the planned improvement and assessment of the quantitative impact of this missing category in accordance with the provisions in paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.	5 (2015–2021)
L.19	Include data for 1900–1940 for estimating emissions for the category HWP, as part of the improvement work in relation to the category and consider how the uncertainty may be affected.	5 (2015–2021)
Waste	No issues identified.	

<sup>a</sup> Reports on the reviews of the 2018 and 2020 inventory submissions of Canada have not yet been published. Therefore, 2018 and 2020 were not included when counting the number of successive years for this table.

## V. Additional findings made during the individual review of the Party's 2021 inventory submission

9. Table 5 presents findings made by the ERT during the individual review of the 2021 inventory submission of Canada that are additional to those identified in table 3.

Table 5

### Additional findings made during the individual review of the 2021 inventory submission of Canada

<i>ID#</i>	<i>Finding classification</i>	<i>Description of finding with recommendation or encouragement</i>	<i>Is finding an issue?<sup>a</sup></i>
General			
G.4	CRF tables	<p>The ERT noted that numerical values for emissions of precursor gases were not reported in the appropriate CRF tables under the relevant sectors in accordance with paragraph 29 of the UNFCCC Annex I inventory reporting guidelines. During the review, the Party clarified that the details of how and where to access estimates of ozone and aerosol precursors (i.e. carbon monoxide, NO<sub>x</sub>, non-methane volatile organic compounds, sulfur oxides) are included in annex 7 to the NIR. The Party also clarified that the notation key "IE" was used in the CRF tables for these pollutants as they are included in Canada's air pollutant emissions inventory (available at <a href="http://www.canada.ca/APEI">www.canada.ca/APEI</a>) and reported separately to the United Nations Economic Commission for Europe under the Convention on Long-range Transboundary Air Pollution via the Centre on Emission Inventories and Projections (<a href="http://www.ceip.at">www.ceip.at</a>). Noting that, according to paragraph 37(d) of the UNFCCC Annex I inventory reporting guidelines, the notation key "IE" is to be used for emissions by sources and removals by sinks of GHGs that have been estimated but not reported under the expected category but rather included elsewhere in the inventory, the ERT concluded that the Party's use of "IE" for precursor gases is not in accordance with the UNFCCC Annex I inventory reporting guidelines.</p> <p>The ERT reiterates the encouragement from the previous review report for Canada to report numerical values for emissions of precursor gases (as reported to the United Nations Economic Commission for Europe under the Convention on Long-range Transboundary Air Pollution) in the appropriate CRF tables under the relevant sectors and to ensure that it uses the notation keys in accordance with the UNFCCC Annex I inventory reporting guidelines.</p>	Not an issue
G.5	Inventory submission	<p>The ERT noted that the structure of the NIR in the 2021 inventory submission is not consistent with the outline and general structure of the NIR referred to in paragraph 51 of the UNFCCC Annex I inventory reporting guidelines. For instance, the descriptions, references and sources of information for specific methodologies, including higher-tier methods and models, assumptions, EFs and AD, as well as the rationale for their selection as required by paragraph 50(a) of the UNFCCC Annex I inventory reporting guidelines, are not included under the individual inventory sectors described in part I of the NIR. The ERT also noted that some information on AD, methods and parameters could be found in the annexes to the NIR (part 2). During the review, the Party clarified that in its view the NIR follows the outline and general structure contained in the appendix to annex I to decision 24/CP.19.</p> <p>The ERT encourages Canada to include in the sectoral chapters of part I of the NIR descriptions, references and sources of information for specific methodologies, higher-tier methods and models, assumptions, EFs and AD, as well as the rationale for their selection as required by paragraph 50(a) of the UNFCCC Annex I inventory reporting</p>	Not an issue

ID#	Finding classification	Description of finding with recommendation or encouragement	Is finding an issue? <sup>a</sup>
G.6	Inventory submission	<p>guidelines, following the outline and general structure of the NIR referred to in paragraph 51 of the UNFCCC Annex I inventory reporting guidelines.</p> <p>In the NIR, the ERT was unable to identify numerical values for the AD used to estimate GHG emissions for the following categories: 1.A fuel combustion; 1.B fugitive emissions from oil and gas (except for the AD for abandoned oil and gas wells); 2.B chemical industry; 2.C metal industry; 2.D non-energy products from fuels and solvent use; 2.E electronics industry; 2.F product uses as substitutes for ODS; and 2.G other product manufacture and use. The ERT noted that in accordance with paragraph 48 of the UNFCCC Annex I inventory reporting guidelines Annex I Parties shall submit an NIR containing detailed and complete information on their inventories. It also noted that in accordance with paragraph 50(a) of the UNFCCC Annex I inventory reporting guidelines the NIR shall include EFs and AD, as well as the rationale for their selection. The ERT further noted that the lack of AD in the NIR reduces transparency and hampers the comparability of reporting with that of other Annex I Parties' national GHG inventories, and makes it difficult to understand how inventory estimates have been made. During the review, Canada clarified that a compendium of EFs is included in annex 6 to the NIR (part 2), which is also published as a separate document on the Internet (<a href="http://www.open.canada.ca">www.open.canada.ca</a>). In addition, it stated that AD were well referenced throughout the NIR and generally available to the general public. In particular, annex 3 to the NIR (part 2) includes tables with clear references to the source of AD, including weblinks where available.</p> <p>The ERT recommends that Canada include in its NIR numerical values for the AD used to estimate GHG emissions for the following categories: 1.A fuel combustion; 1.B fugitive emissions from oil and gas; 2.B chemical industry; 2.C metal industry; 2.D non-energy products from fuels and solvent use; 2.E electronics industry; 2.F product uses as substitutes for ODS; and 2.G other product manufacture and use. Where the AD have been included in the NIR or otherwise made publicly available, the ERT recommends that the Party include clear references to annex 3 to the NIR, where the relevant AD could be found.</p>	Yes. Transparency
Energy			
E.13	1.C.2 Injection and storage – CO <sub>2</sub>	<p>The Party reported in CRF table 1.C the amount of CO<sub>2</sub> injected for EOR operations under subcategory 1.C.2.a injection and the amount of CO<sub>2</sub> injected during the reporting year into long-term storage under subcategory 1.C.2.b storage. The ERT notes that CRF table 1.C does not differentiate between CCS and EOR for the purpose of reporting, and that the amount of CO<sub>2</sub> reported under 1.C.2.a injection corresponds to the total amount injected for all EOR and CCS operations. In addition, the amount of CO<sub>2</sub> reported under 1.C.2.b storage is the cumulative closing stock for the reporting year of both EOR and CCS in the geological formations since any EOR and CCS operations began. The ERT acknowledges that since the 2006 IPCC Guidelines do not contain any specific guidance on this matter (vol. 2, chap. 5), the issue on data reporting under 1.C.2.b storage might prove difficult to interpret. However, the ERT notes that the IPCC Inventory Software for implementing the 2006 IPCC Guidelines (<a href="http://www.ipcc-nggip.iges.or.jp/software/index.html">www.ipcc-nggip.iges.or.jp/software/index.html</a>) provides explicit guidance on the cumulative reporting of injected and/or stored CO<sub>2</sub>. During the review, the Party clarified that the volumes of industry-captured CO<sub>2</sub> used for EOR were not considered as injected into long-term storage. The ERT noted that the Party's approach attempts to differentiate between EOR and CCS in CRF table 1.C and hence leads to the incorrect reporting of injection AD for subcategory 1.C.2.b storage. Canada also clarified during the review that it does not consider industry-captured and injected CO<sub>2</sub> used as a solvent in EOR to be in long-term storage until the oilfield goes out of production and is sealed against leaks, as a portion of the CO<sub>2</sub> is continuously recycled. The ERT notes that this is not consistent with the <i>IPCC Special Report on Carbon Dioxide Capture and Storage</i> (pp.206–215) or the 2006 IPCC Guidelines (vol. 2, chap. 5,</p>	Yes. Comparability

ID#	Finding classification	Description of finding with recommendation or encouragement	Is finding an issue? <sup>a</sup>
E.14	1.C.2.b Storage – CO <sub>2</sub>	<p>section 5.3, p.5.8), in which residual trapping mechanisms are discussed. The ERT also notes that CO<sub>2</sub> that is injected for EOR is not completely recycled, with a residual amount continuously being trapped in the formation. The presence of this injected CO<sub>2</sub> must be estimated for each year and reported as it is a potential source of emissions for subcategory 1.C.2.b storage. Exclusion of EOR from 1.C.2.a injection and 1.C.2.b storage will lead to completeness issues and could result in an underestimate of CO<sub>2</sub> emissions for category 1.C CO<sub>2</sub> transport and storage. The ERT considers that disaggregation of EOR and CCS activities could be presented in the NIR, if required.</p> <p>The ERT recommends that the Party estimate and report under subcategory 1.C.2.b storage the cumulative closing stock amount of CO<sub>2</sub> for each year of the time series since the commencement of CO<sub>2</sub> injection in both long-term storage and operational EOR formations, taking into account the volumes injected and lost as fugitive emissions during production for each year of the time series and reported in CRF table 1.B.2 in accordance with footnotes 1 and 3 to CRF table 1.C. The ERT also recommends that the Party report all CO<sub>2</sub> injected for both EOR and CCS activities in subcategory 1.C.2.a injection.</p> <p>The Party reported CO<sub>2</sub> emissions for subcategory 1.C.2.b storage as “NO” in CRF table 1.C, and explained in the NIR (chap. 3, section 3.4, p.81) that there are no estimates for emissions from storage since the EOR process recovers all CO<sub>2</sub> for reuse. The ERT noted that this is not in accordance with the 2006 IPCC Guidelines (vol. 2, chap. 5, section 5.3, p.5.8), which note that only a proportion of the amount injected is commonly produced along with oil, hydrocarbon gas and water at production wells. During the review, the Party clarified that to date no CO<sub>2</sub> migration outside of the well bore has occurred, and that until recently there has been little or no injection into long-term geological storage. The Party noted that the EOR formation is not being treated as permanent geological storage until abandonment, which the ERT considers inconsistent with the intent of CRF table 1.C. The Party also noted that according to the modelling and simulation results from the first phase (2000–2004) of a research programme led by the International Energy Agency’s Greenhouse Gas Research and Development Programme, after EOR operations are completed, over 98 per cent of CO<sub>2</sub> will remain trapped in the Weyburn reservoir. The ERT notes that the 2006 IPCC Guidelines (vol. 2, chap. 5, section 5.7.2, p.5.17) for the Weyburn project indicate that there is no evidence to date for the escape of injected CO<sub>2</sub>. However, further monitoring of soil gases is necessary to verify that this remains the case in the future and more detailed work is necessary to understand the causes of variation in soil gas contents, and to investigate further possible conduits for gas escape. The Party further noted that it will report emissions for subcategory 1.C.2.b storage as “NA” in CRF table 1.C. The ERT does not consider this appropriate as it disregards an activity that is occurring in Canada and might be generating emissions.</p> <p>Noting that both EOR and CCS operations should be included in the reporting, the ERT recommends that the Party document in the NIR the basis for concluding that emissions from the geological formations are not occurring, including evidence of applicable monitoring and/or modelling throughout the time series from the commencement of CO<sub>2</sub> injection. If the Party cannot demonstrate that fugitive emissions from the geological formations subject to CCS and/or EOR operations are estimated for each year of operation, the ERT recommends that the Party report emissions for subcategory 1.C.2.b storage using the notation key “NE”.</p>	Yes. Transparency
IPPU	I.20 2. General (IPPU) – CO <sub>2</sub> , CH <sub>4</sub> , N <sub>2</sub> O,	<p>The Party reported in NIR sections on category-specific QA/QC and verification (chap. 4, sections. 4.3.4, 4.4.4, 4.5.4, 4.8.4, 4.9.4, 4.12.4, 4.14.4 and 4.17.4) that informal QC checks were carried out for several IPPU categories. However, it did not describe what these checks involved. During the review, Canada explained that such informal</p>	Not an issue

ID#	Finding classification	Description of finding with recommendation or encouragement	Is finding an issue? <sup>a</sup>
	HFCs, PFCs and SF <sub>6</sub>	<p>QC checks are more thorough than the general tier 1 QC checklist used by the Party, as referenced in the NIR (chap. 1, section 1.3.2.1, p.21), and include, for example: checking for AD and EF transcription errors between source files and emission estimate compilation files; checking that provincial/territorial-level estimates (presented in NIR annexes 11 and 12) add up to the national total estimates; checking for new changes (facility openings or capacity expansions) in categories previously assessed as insignificant or not occurring and reported as “NE” or “NO” in the CRF tables, to ensure that these notation keys are accurate for all years of the time series; and checking facility-reported EFs against those reported for similar facilities and circumstances in other national inventories and the IPCC emission factor database (<a href="http://www.ipcc-nggip.iges.or.jp/EFDB/main.php">www.ipcc-nggip.iges.or.jp/EFDB/main.php</a>).</p> <p>The ERT reiterates the encouragement to the Party to improve the transparency of the documentation of its QA/QC procedures when preparing its inventory by explaining in the respective NIR sections on category-specific QA/QC and verification the specific QC checks carried out for each category.</p>	
I.21	2.A.1 Cement production – CO <sub>2</sub>	<p>The inter-annual changes in CO<sub>2</sub> IEF values reported for category 2.A.1 cement production between 2016 and 2019 (8.4 per cent for 2016–2017, 7.5 per cent for 2017–2018 and –14.8 per cent for 2018–2019) were significant. The ERT noted that for 2018, the reported CO<sub>2</sub> IEF value (0.63 t/t) is the highest of all reporting Parties (0.45–0.63 t/t); for 2017, the reported CO<sub>2</sub> IEF value (0.59 t/t) is among the highest of all reporting Parties (0.47–0.59 t/t); and for 2018–2019 the inter-annual change in AD is uncommonly high (20.7 per cent). During the review, the Party clarified that it received detailed reporting data directly from facilities beginning in 2017, and that the clinker production AD reported by facilities was found to be incomplete for 2017 and 2018. One facility did not report its clinker production for 2017 and two facilities did not report their clinker production for 2018. The Party has made efforts to contact these facilities and have them report their clinker production for these years. Updates of 2017 and 2018 AD are therefore expected. The Party explained that the 2017–2018 CO<sub>2</sub> emission estimates were not affected by the incomplete clinker production data set because they were obtained through continuous emission monitoring systems.</p> <p>The ERT recommends that the Party collect complete AD for clinker production for 2017 and 2018 and report updated AD in the CRF tables, ensuring that reported CO<sub>2</sub> IEFs are accurate in its next inventory submission.</p>	Yes. Comparability
I.22	2.A.1 Cement production – CO <sub>2</sub>	<p>The ERT noted that for calculations of CO<sub>2</sub> emissions for category 2.A.1 cement production a tier 2 method was applied by Canada for 1990–2016, and a tier 3 method for 2017–2019. The NIR (chap. 4, section 4.2.3, p.86) does not address the CO<sub>2</sub> EFs time-series consistency. During the review, the Party clarified that the splicing techniques provided in the 2006 IPCC Guidelines (vol. 1, chap. 5, section 5.3.3, pp.5.8–5.14) were assessed and that a modified average splicing technique was chosen as being the most suitable. With this approach, EF<sub>cl</sub> (annual calcination EF based on clinker production), EF<sub>toc</sub> (annual EF for CO<sub>2</sub> emissions from total organic carbon in raw feed) and CF<sub>ckd</sub> (correction factor for the loss of cement kiln dust and by-pass dust) for 2015–2016 are averages calculated on the basis of the 2014 values provided by CAC and the 2017 values calculated from available detailed facility-reported data. This modified average splicing technique was chosen because the country-specific EF<sub>cl</sub>, EF<sub>toc</sub> and CF<sub>ckd</sub> were last updated for 2014 by CAC. The EF<sub>cl</sub>, EF<sub>toc</sub> and CF<sub>ckd</sub> calculated on the basis of the 2017 detailed facility-reported data are comparable with the EF<sub>cl</sub>, EF<sub>toc</sub> and CF<sub>ckd</sub> updated in 2014. A similar approach was applied for 1990–2014 to ensure the time-series consistency of calculated CO<sub>2</sub> emissions and CO<sub>2</sub> EFs. In addition, CAC provided national cement production data for the calculation of EF<sub>cl</sub>, EF<sub>toc</sub> and CF<sub>ckd</sub> for 1990, 2000 and 2002–2014. The EF<sub>cl</sub>, EF<sub>toc</sub> and CF<sub>ckd</sub> for 1991–1999 were taken to be an average of the 1990 and 2000 EF<sub>cl</sub>, EF<sub>toc</sub> and CF<sub>ckd</sub>, while the EF<sub>cl</sub>, EF<sub>toc</sub> and CF<sub>ckd</sub> for 2002 were taken to be an average of the 2000 and 2002 EF<sub>cl</sub>, EF<sub>toc</sub> and CF<sub>ckd</sub>. The Party stated during the review that it intends to include the respective information in the NIR of the 2022 inventory submission.</p>	Yes. Transparency

ID#	Finding classification	Description of finding with recommendation or encouragement	Is finding an issue? <sup>a</sup>
I.23	2.A.2 Lime production – CO <sub>2</sub>	<p>The ERT recommends that the Party explain in the NIR the measures taken to ensure time-series consistency of CO<sub>2</sub> EFs and corresponding CO<sub>2</sub> emission estimates for category 2.A.1 cement production, including information on the splicing technique used and assumptions made for this purpose.</p> <p>The ERT noted that for calculations of CO<sub>2</sub> emissions for category 2.A.2 lime production a tier 2 method was applied by Canada for 1990–2016, and a tier 3 method for 2017–2019. The NIR (chap. 4, section 4.3.3, p.88) does not address the time-series consistency of CO<sub>2</sub> EFs. During the review, the Party clarified that the splicing techniques provided in the 2006 IPCC Guidelines (vol. 1, chap. 5, pp.5.1–5.2) were assessed and that a modified average splicing technique was chosen as being the most suitable. With this approach, the EF<sub>dol</sub> (annual EF for dolomitic lime production) and EF<sub>h-c</sub> (annual EF for high-calcium lime production) for 2009–2016 are averages calculated on the basis of the 2008 values provided by CLI and the 2017–2019 values calculated from available detailed facility-reported data. This modified average splicing technique was chosen because the country-specific EF<sub>dol</sub> and EF<sub>h-c</sub> were last provided in 2008 by CLI. The EF<sub>dol</sub> and EF<sub>h-c</sub> calculated from the 2017–2019 detailed facility-reported data are comparable with the EF<sub>dol</sub> and EF<sub>h-c</sub> provided in 2008. The 1990–2007 EF<sub>dol</sub> and EF<sub>h-c</sub> were assumed to be the same as the 2008 EF<sub>dol</sub> and EF<sub>h-c</sub> provided from CLI because no other national EFs were available and were considered the most representative EFs for that time period. The Party stated during the review that it intends to include the respective information in the NIR of the 2022 inventory submission.</p> <p>The ERT recommends that the Party explain in the NIR the measures taken to ensure the time-series consistency of CO<sub>2</sub> EFs and corresponding CO<sub>2</sub> emission estimates for category 2.A.2 lime production, including information on the splicing technique used and assumptions made for this purpose.</p>	Yes. Transparency
I.24	2.B.1 Ammonia production – N <sub>2</sub> O	<p>The ERT noted that according to the NIR (chap. 4, section 4.5.2, equation 4-3, p.93), Canada assumed emissions of 5 kg CO<sub>2</sub>/t urea consistent with the range of 2–7 kg CO<sub>2</sub>/t urea given in the 2006 IPCC Guidelines (vol. 3, chap. 3, section 3.2.2.3, box 3.3, p. 3.16), and subtracted these from the CO<sub>2</sub> recovery accounted for urea production in category 2.B.1 ammonia production. The resulting CO<sub>2</sub> recovery factor used by Canada is thus 0.728 kg CO<sub>2</sub>/kg urea, equal to 0.733 kg CO<sub>2</sub> recovery/kg urea produced, which is the stoichiometric ratio from the 2006 IPCC Guidelines (vol. 3, chap. 3, section 3.2.2.3, box 3.3, p.3.16) minus 0.005 kg CO<sub>2</sub> emission/kg urea produced (indicated above). The ERT notes that CO<sub>2</sub> emissions reported in category 2.B.1 ammonia production are calculated by subtracting CO<sub>2</sub> recovery from generated CO<sub>2</sub> stemming from fuel use for NH<sub>3</sub> production. On the other hand, the ERT notes that in response to a previous recommendation (see ID# I.1 in table 3), Canada reported under category 2.B.10 other, CO<sub>2</sub> emissions from other uses of urea (NIR part 1, chap. 4, section 4.9.2, pp.100–101) using a urea balance, which accounts for urea production (considered for estimates in category 2.B.1 ammonia production), urea imports and exports, urea use considered in CO<sub>2</sub> emission estimates for the agriculture sector in category 3.H urea application and CO<sub>2</sub> emission estimates in category 2.D.3 other – use of urea in selective catalytic reduction vehicles. For the calculation of CO<sub>2</sub> emissions from the urea balance in category 2.B.10 other, the stoichiometric EF of 0.733 kg CO<sub>2</sub>/kg urea is used. During the review, Canada stated that, as it understood, 5 kg of CO<sub>2</sub> is emitted per tonne of urea in addition to the 0.733 t CO<sub>2</sub> contained within each tonne of urea that is assumed to be emitted during its use. The ERT agrees with this interpretation of the 2006 IPCC Guidelines; however, it considers that in a mass balance perspective the carbon content of the fuel used for NH<sub>3</sub> production is the single carbon source of all related CO<sub>2</sub> emissions for NH<sub>3</sub> production and from applications of urea, including CO<sub>2</sub> emissions that may be attributed to urea production according to the 2006 IPCC Guidelines. Therefore, the ERT considers that a subtraction of CO<sub>2</sub> emissions during urea production from CO<sub>2</sub> recovery in produced urea as carried out by Canada in the estimation of CO<sub>2</sub> emissions from NH<sub>3</sub> production in category 2.B.1 ammonia production leads to double counting. The share of</p>	Yes. Accuracy



<i>ID#</i>	<i>Finding classification</i>	<i>Description of finding with recommendation or encouragement</i>	<i>Is finding an issue?<sup>a</sup></i>
		<p>carbon feed accounted as emitted during urea production and accounted by Canada as emitted in category 2.B.1 ammonia production by subtracting these emissions from CO<sub>2</sub> recovery would also be accounted by Canada as intermediately stored in urea, as 0.733 kg CO<sub>2</sub>/kg urea is accounted for carbon storage in urea, and as subsequently emitted from the application of urea by means of the urea balance used for CO<sub>2</sub> emissions in category 2.B.10 other.</p> <p>The ERT recommends that the Party improve the accuracy of its emission estimates by fully applying the stoichiometric recovery factor of 0.733 kg CO<sub>2</sub>/kg urea for CO<sub>2</sub> emission estimates in category 2.B.1 ammonia production. In the event that Canada wishes to explicitly account for CO<sub>2</sub> emissions during urea production in its reporting, the ERT recommends that the Party report such emissions in category 2.B.10 other and simultaneously subtract these CO<sub>2</sub> emissions from the CO<sub>2</sub> emissions reported in category 2.B.1 ammonia production in order to avoid double counting.</p>	
I.25	2.C.1 Iron and steel production – CO <sub>2</sub>	<p>The ERT noted a significant drop (–32.21 per cent) in the CO<sub>2</sub> IEF reported for subcategory 2.C.1.b pig iron from 2016 to 2017. During the review, Canada explained that emissions from both direct reduced iron and pig iron production are summarized in subcategory 2.C.1.b pig iron and that AD received from the Canadian Steel Producers Association and used in the estimates did not contain AD for direct iron reduction for 2013–2016. Canada also explained that CO<sub>2</sub> emission estimates for 2.C.1.b pig iron are not affected by missing AD for direct iron reduction, as the CO<sub>2</sub> emissions are based on the carbon content of metallurgical coke (NIR equation 4-9, p.103).</p> <p>The ERT recommends that the Party collect AD for direct iron reduction for 2013–2016 and report updated AD in the CRF tables of its next inventory submission, ensuring that reported CO<sub>2</sub> IEFs are accurate or, if this is not possible, provide a clear explanation of the issue in the NIR.</p>	Yes. Comparability
I.26	2.C.3 Aluminium production – CO <sub>2</sub>	<p>The ERT noted that AD in category 2.C.3 aluminium production decreased by 15.6 per cent from 2018 to 2019 and that the CO<sub>2</sub> IEF increased by 14.5 per cent between these two years. The CO<sub>2</sub> IEF of 1.92 t/t reported for 2019 is above the default value range (1.6–1.7 t/t) provided in the 2006 IPCC Guidelines (vol. 3, chap. 4, section 4.4.2.2, p.4.47). During the review, the Party clarified that the inter-annual change in the CO<sub>2</sub> IEF from 2018 to 2019 is due to missing production data from one facility for 2019, but that this did not impact the emissions reported by the facility. Canada stated that efforts have been made to obtain the missing AD for 2019 and that, once obtained, these data will be included in the 2022 inventory submission.</p> <p>The ERT recommends that the Party collect complete AD for aluminium production for 2019 and report updated AD in the CRF tables, ensuring that reported CO<sub>2</sub> IEFs are accurate in its next inventory submission.</p>	Yes. Comparability
I.27	2.C.3 Aluminium production – PFCs	<p>The ERT noted that the values given for AD in CRF table 2(II).B-H (sheet 1) for CF<sub>4</sub> and C<sub>2</sub>F<sub>6</sub> by-product emissions for category 2.C.3 aluminium production are in kt, instead of t as required for this CRF table. Consequently, the IEFs for CF<sub>4</sub> and C<sub>2</sub>F<sub>6</sub> reported by Canada in CRF table 2(II).B-H (sheet 1) are in units of kg/kt instead of kg/t. During the review, the Party stated that it intends to correct the AD units in CRF table 2(II).B-H (sheet 1) in the next inventory submission.</p> <p>The ERT recommends that the Party report aluminium production AD for CF<sub>4</sub> and C<sub>2</sub>F<sub>6</sub> by-product emissions in CRF table 2(II).B-H (sheet 1) in t rather than kt, and ensure that the respective IEFs are accurate and expressed in kg/t.</p>	Yes. Comparability
I.28	2.C.3 Aluminium production – SF <sub>6</sub>	<p>The ERT noted that the AD values for aluminium casted reported in in CRF table 2(II).B-H (sheet 1) for SF<sub>6</sub> emissions under category 2.C.3 aluminium production for the whole time series are the same as the AD values for</p>	Yes. Comparability

ID#	Finding classification	Description of finding with recommendation or encouragement	Is finding an issue? <sup>a</sup>
I.29	2.F Product uses as substitutes for ODS – HFCs and PFCs	<p>primary aluminium production reported for CF<sub>4</sub> and C<sub>2</sub>F<sub>6</sub> by-product emissions (see ID# I.27 above). In the NIR (part 1, chap. 4, section 4.11.2, p.105), the Party explained that SF<sub>6</sub> emissions were assumed to be equal to SF<sub>6</sub> consumption in the aluminium industry. During the review, the Party stated that it intends to change the AD from aluminium casted to SF<sub>6</sub> consumed in order to replicate the approach used for the reporting of SF<sub>6</sub> emissions in category 2.C.4 magnesium production. The ERT noted that the current reporting does not impact the emission estimates but it affects the comparability of the reported IEFs.</p> <p>The ERT recommends that the Party improve the comparability and transparency of its reporting by selecting appropriate AD following the approach used for reporting SF<sub>6</sub> emission estimates in CRF table 2(II).B-H (sheet 1) for category 2.C.3 aluminium production and accurately report AD and related IEFs using the appropriate units.</p> <p>The Party reported in its NIR (part 1, chap. 4, section 4.16.2, pp.113–114, and part 1, chap. 4, section 4.17.2, pp.115–116) on the surveys conducted to collect the AD used in the emission estimates for HFCs and PFCs for this category. During the review, Canada clarified that since publishing the NIR, it has realized that some AD on mixtures of HFCs and PFCs for 2008–2020 collected in those surveys have not been properly disaggregated, and that the PFC shares of these mixtures have not been included in the reported PFC estimates for applications under categories 2.F.1 refrigeration and air conditioning and 2.F.5 solvents. Canada stated that these missing data will be included in the calculations for categories 2.F.1 refrigeration and air conditioning and 2.F.5 solvents for the 2022 GHG inventory submission.</p> <p>The ERT recommends that the Party reassess available AD on HFC and PFC mixtures in category 2.F product uses as substitutes for ODS for the complete time series, in particular for 2008–2020, and consider them in a revision of the PFC emission estimates and, if applicable, HFC emission estimates, for all categories and subcategories under category 2.F product uses as substitutes for ODS to be reported in the next inventory submission.</p>	Yes. Accuracy
Agriculture			
A.24	3.B Manure management – N <sub>2</sub> O	<p>The Party reported in CRF table 3.B(b) a deer population size and Nex rate of 30,570 and 13.578 kg N/head/year, respectively, for 2019. The ERT noted that this results in a total Nex of 415,079.46 kg N/year, but the total Nex for deer reported in CRF table 3.B(b) is 413,255.54 kg N/year. Similarly, for mules and asses, the 2019 population size and Nex rate are reported as 8,832 and 26.8275 kg N/head/year, respectively, resulting in a total Nex of 236,940.48 kg N/year, but the total Nex for mules and asses reported in CRF table 3.B(b) is 233,667.53 kg N/year. A similar but much smaller discrepancy is noted in the Nex reported for buffalo. During the review, the Party confirmed that there is an error in the reported Nex for deer, mules and asses, and buffalo, and noted that the impact of this error on the national total emissions is small (0.000005 per cent).</p> <p>The ERT recommends that the Party correct the error in calculations and report correct Nex data for deer, mules and asses, and buffalo in its next inventory submission for all relevant years of the time series.</p>	Yes. Accuracy
LULUCF			
No findings for the LULUCF sector additional to those included in table 3 were made by the ERT during the review.			

<i>ID#</i>	<i>Finding classification</i>	<i>Description of finding with recommendation or encouragement</i>	<i>Is finding an issue?<sup>a</sup></i>
Waste			
W.12	5.C.1 Waste incineration – CO <sub>2</sub> , CH <sub>4</sub> and N <sub>2</sub> O	<p>The Party reported in its NIR (part 2, table A6.3-10, p.178) the amounts of waste by type (municipal, clinical, hazardous, sewage sludge) incinerated in non-energy-from-waste facilities that are reported under the waste sector in CRF table 5.C. However, the quantity of MSW incinerated in non-energy-from-waste facilities reported in NIR table A3.6-10 for 2019 (891,112 kt) (part 2, annex 3, p.178) is not consistent with the MSW amounts reported in CRF table 5.C (13.50 kt wet weight for biogenic and 9.63 kt wet weight for non-biogenic MSW). During the review, the Party clarified that the values provided in the NIR are incorrect, while those presented in CRF table 5.C are correct.</p> <p>The ERT recommends that the Party explore the cause of the inconsistencies among the amounts of incinerated MSW reported in the NIR and CRF table 5.C, confirm that the correct and accurate data are used for calculations and report these amounts consistently in the NIR and CRF table 5.C, and, if necessary, revise the corresponding emission estimates.</p>	Yes. Convention reporting adherence
W.13	5.D.1 Domestic wastewater – CH <sub>4</sub>	<p>The Party reported “NE” for the amount of CH<sub>4</sub> for energy recovery in CRF table 5.D and noted in its NIR (part 2, annex 3, p.189) that, while CH<sub>4</sub> recovery from anaerobic digestion of sludge is universally practised in Canada, there are currently no data available for assessing to what extent the recovered CH<sub>4</sub> is used for energy purposes, and that it is still planning as an improvement to determine to what extent CH<sub>4</sub> recovered from wastewater treatment and anaerobic digestion of sludge at wastewater treatment plants is used for energy purposes. During the review, the Party stated that it does not know whether CH<sub>4</sub> recovered from anaerobic digestion of sludge is used for energy or simply flared. It also stated that it made the assumption that all CH<sub>4</sub> recovered is flared.</p> <p>The ERT recommends that the Party complete the planned improvement to determine the extent to which CH<sub>4</sub> recovered from wastewater treatment and anaerobic digestion of sludge at wastewater treatment plants is used for energy purposes and, if it can be ascertained that the recovery of CH<sub>4</sub> for energy use from these sources occurs in the country, report the amounts of CH<sub>4</sub> recovered for energy from domestic wastewater for the applicable years, ensuring consistency with the reporting in the energy sector, and include in the NIR detailed information on this issue.</p>	Yes. Comparability

<sup>a</sup> Recommendations made by the ERT during the review are related to issues as defined in para. 81 of the UNFCCC review guidelines.

## Annex I

### Overview of greenhouse gas emissions and removals as submitted by Canada in its 2021 inventory submission

1. Tables I.1–I.3 provide an overview of the total GHG emissions and removals as submitted by Canada. Table I.1 shows total GHG emissions, including and excluding LULUCF and, for Parties that have decided to report indirect CO<sub>2</sub> emissions, with and without indirect CO<sub>2</sub>. Tables I.2 and I.3 show GHG emissions reported under the Convention by Canada by gas and by sector, respectively.

Table I.1

#### Total greenhouse gas emissions and removals for Canada, base year–2019

(kt CO<sub>2</sub> eq)

	<i>Total GHG emissions excluding indirect CO<sub>2</sub> emissions</i>		<i>Total GHG emissions and removals including indirect CO<sub>2</sub> emissions<sup>a</sup></i>	
	<i>Total including LULUCF</i>	<i>Total excluding LULUCF</i>	<i>Total including LULUCF</i>	<i>Total excluding LULUCF</i>
1990	544 707.24	601 523.69	545 528.86	NA
1995	626 574.18	656 298.72	627 692.40	NA
2000	711 770.28	733 511.34	712 683.46	NA
2010	695 497.91	702 802.75	696 166.59	NA
2011	707 543.12	714 078.51	708 234.50	NA
2012	707 736.88	717 172.39	708 437.81	NA
2013	721 177.63	725 371.84	721 911.54	NA
2014	719 063.47	722 557.67	719 761.69	NA
2015	727 110.17	723 096.02	727 884.97	NA
2016	707 029.32	706 933.91	707 718.48	NA
2017	716 788.41	716 092.01	717 413.41	NA
2018	736 886.99	728 475.89	737 495.87	NA
2019	740 122.96	730 244.94	740 682.47	NA

*Note:* Emissions and removals reported in the sector other (sector 6) are not included in the total GHG emissions.

<sup>a</sup> The Party reported indirect CO<sub>2</sub> emissions in CRF table 6.

Table I.2

**Greenhouse gas emissions and removals by gas for Canada, excluding land use, land-use change and forestry, 1990–2019**(kt CO<sub>2</sub> eq)

	<i>CO<sub>2</sub><sup>a</sup></i>	<i>CH<sub>4</sub></i>	<i>N<sub>2</sub>O</i>	<i>HFCs</i>	<i>PFCs</i>	<i>Unspecified mix of HFCs and PFCs</i>	<i>SF<sub>6</sub></i>	<i>NF<sub>3</sub></i>
1990	458 007.41	93 257.21	38 504.39	970.54	7 557.90	NO, NA	3 225.92	0.32
1995	490 951.38	115 117.64	41 146.81	460.51	6 346.94	NO, NA	2 275.16	0.28
2000	566 552.29	120 789.22	35 527.26	2 754.84	4 984.53	NO, NA	2 902.96	0.24
2010	558 804.01	101 405.95	32 554.98	7 729.05	1 860.02	NO, NA	448.58	0.15
2011	569 870.20	100 779.78	32 736.69	8 592.52	1 689.58	NO, NA	409.60	0.15
2012	569 262.73	102 573.74	33 987.45	9 084.73	1 802.69	NO, NA	460.89	0.15
2013	573 698.74	103 533.69	35 975.92	10 075.12	1 622.30	NO, NA	465.93	0.15
2014	570 563.42	104 944.37	34 605.21	10 949.36	1 092.46	NO, NA	402.66	0.19
2015	573 061.38	102 246.02	35 306.39	11 037.15	973.34	NO, NA	471.67	0.06
2016	559 566.96	98 769.62	36 164.24	11 296.67	769.98	NO, NA	366.19	0.25
2017	569 360.44	98 584.81	35 569.03	11 511.08	750.79	NO, NA	315.44	0.43
2018	579 470.37	98 663.87	36 852.83	12 519.77	627.01	NO, NA	341.54	0.49
2019	582 389.61	97 761.48	36 602.29	12 413.71	596.78	NO, NA	480.46	0.62
<b>Percentage change 1990–2019</b>	<b>27.2</b>	<b>4.8</b>	<b>–4.9</b>	<b>1 179.1</b>	<b>–92.1</b>	<b>NA</b>	<b>–85.1</b>	<b>90.8</b>

Note: Emissions and removals reported in the sector other (sector 6) are not included in this table.

<sup>a</sup> Excluding indirect CO<sub>2</sub> emissions for LULUCF as reported in CRF table 6.

Table I.3

**Greenhouse gas emissions and removals by sector for Canada, 1990–2019**(kt CO<sub>2</sub> eq)

	<i>Energy</i>	<i>IPPU</i>	<i>Agriculture</i>	<i>LULUCF</i>	<i>Waste</i>	<i>Other</i>
1990	471 559.58	57 020.36	46 939.85	–55 994.83	26 003.90	NA
1995	512 895.07	58 445.20	53 948.73	–28 606.32	31 009.72	NA
2000	591 707.57	54 113.83	57 021.26	–20 827.88	30 668.68	NA
2010	569 362.37	50 690.49	55 057.70	–6 636.16	27 692.19	NA
2011	577 444.91	54 325.37	54 896.87	–5 844.01	27 411.36	NA
2012	574 886.77	58 511.37	56 871.36	–8 734.58	26 902.88	NA
2013	582 877.13	56 213.78	59 323.96	–3 460.30	26 956.97	NA
2014	584 315.74	53 934.37	57 671.71	–2 795.98	26 635.85	NA
2015	584 644.35	53 493.22	58 256.62	4 788.95	26 701.82	NA

	<i>Energy</i>	<i>IPPU</i>	<i>Agriculture</i>	<i>LULUCF</i>	<i>Waste</i>	<i>Other</i>
2016	566 415.39	54 475.07	59 366.02	784.57	26 677.43	NA
2017	577 805.77	53 042.66	58 340.58	1 321.40	26 902.99	NA
2018	587 515.62	54 345.48	59 426.82	9 019.98	27 187.97	NA
2019	589 287.62	54 318.00	59 058.08	10 437.53	27 581.25	NA
<b>Percentage change 1990–2019</b>	<b>25.0</b>	<b>–4.7</b>	<b>25.8</b>	<b>–118.6</b>	<b>6.1</b>	<b>NA</b>

*Note:* Totals include indirect CO<sub>2</sub> emissions reported in CRF table 6.

## Annex II

### Additional information to support findings in table 2

#### Missing categories that may affect completeness

The categories for which estimation methods are included in the 2006 IPCC Guidelines that were reported as “NE” or for which the ERT otherwise determined that there may be an issue with the completeness of the reporting in the Party’s inventory are the following:

- (a) 2.A.4 other process uses of carbonates (CO<sub>2</sub>) (see ID# I.2 in table 3);
- (b) 2.F product uses as substitutes for ODS (PFCs) (see ID# I.16 in table 3);
- (c) 2.G.2 SF<sub>6</sub> and PFCs from other product use (PFCs and SF<sub>6</sub>) (see ID# I.18 in table 3);
- (d) 3.D direct and indirect N<sub>2</sub>O emissions from agricultural soils (N<sub>2</sub>O) (see ID# A.19 in table 3);
- (e) 3.D.b indirect N<sub>2</sub>O emissions from managed soils (N<sub>2</sub>O) (see ID# A.20 in table 3);
- (f) 4.A.2.1 cropland converted to forest land – biomass pool (CO<sub>2</sub>) (see ID# L.13 in table 3);
- (g) 4.B wetlands and settlements converted to cropland – all carbon pools (CO<sub>2</sub>) (see ID# L.2 in table 3);
- (h) 4.C grassland remaining grassland – organic and mineral soils pools (CO<sub>2</sub>) (see ID# L.1 in table 3);
- (i) 4.E grassland converted to settlements – dead organic matter and organic and mineral soils pools (CO<sub>2</sub>) (see ID# L.1 in table 3);
- (j) 4.E cropland and wetlands converted to settlements – all pools (CO<sub>2</sub>) (see ID# L.1 in table 3);
- (k) 4(III) direct N<sub>2</sub>O emissions from N mineralization/immobilization (N<sub>2</sub>O) (see ID# L.18 in table 3);
- (l) 4(IV) indirect N<sub>2</sub>O emissions from managed soils (N<sub>2</sub>O) (see ID# L.18 in table 3);
- (m) 5.D.2 industrial wastewater (CH<sub>4</sub>) (see ID# W.11 in table 3).

## Annex III

### Reference documents

#### A. Reports of the Intergovernmental Panel on Climate Change

IPCC. 1997. *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*. J.L. Houghton, L.G. Meira Filho, B. Lim, et al. (eds.). Paris: IPCC/Organisation for Economic Co-operation and Development/International Energy Agency. Available at <http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html>.

IPCC. 2005. *IPCC Special Report on Carbon Dioxide Capture and Storage. Prepared by Working Group III of the Intergovernmental Panel on Climate Change*. B. Metz, O. Davidson, H. de Coninck, et al. (eds.). Cambridge and New York: Cambridge University Press. Available at <https://www.ipcc.ch/report/carbon-dioxide-capture-and-storage/>.

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IPCC. 2019. *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*. E. Calvo Buendia, K. Tanabe, A. Kranjc, et al. (eds.). Geneva: IPCC. Available at <https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html>.

#### B. UNFCCC documents

##### Annual review reports

Reports on the individual reviews of the 2011, 2012, 2013, 2014, 2015, 2016, 2017 and 2019 inventory submissions of Canada, contained in documents FCCC/ARR/2011/CAN, FCCC/ARR/2012/CAN, FCCC/ARR/2013/CAN, FCCC/ARR/2014/CAN, FCCC/ARR/2015/CAN, FCCC/ARR/2016/CAN, FCCC/ARR/2017/CAN and FCCC/ARR/2019/CAN, respectively.

##### Other

Aggregate information on greenhouse gas emissions by sources and removals by sinks for Parties included in Annex I to the Convention. Note by the secretariat. Available at [https://unfccc.int/sites/default/files/resource/AGI\\_2021\\_Final%20Version.pdf](https://unfccc.int/sites/default/files/resource/AGI_2021_Final%20Version.pdf).

Annual status report for Canada for 2021. Available at [https://unfccc.int/sites/default/files/resource/asr2021\\_CAN.pdf](https://unfccc.int/sites/default/files/resource/asr2021_CAN.pdf).

#### C. Other documents used during the review

Responses to questions during the review were received from Raphaëlle Pelland St-Pierre (Environment and Climate Change Canada), including additional material on the methodology and assumptions used.