Fine Particles and Ozone in Québec
Relative to the Canada-wide Standards

2009 Report

Développement durable, Environnement et Parcs

Québec

May 2010

Production Team

Authors

Daniel Busque, Biologist, M.Sc., Direction du suivi de l'état de l'environnement
Julie Paradis, Chemist, M.Sc., Direction des politiques de la qualité de l'atmosphère
Martine Proulx, Engineer, M.Sc., Direction des politiques de la qualité de l'atmosphère

Revision

Michel Bisson, Air Quality Analyst, Direction du suivi de l'état de l'environnement
Michel Guay, Engineer, M.Sc., Direction des politiques de la qualité de l'atmosphère

Photos taken from the 31st floor of the Marie-Guyart building in Québec: looking east
Left: A day of summer smog in Québec, September 10, 2002 – 3:32 p.m.
Right: A clear day in Québec, September 24, 2002 – 3:45 p.m.
Source: Roger Lemire, MDDEP

Reference

BUSQUE, Daniel, Julie PARADIS and Martine PROULX, 2010. Fine Particles and Ozone in Québec Relative to the Canada-wide Standards (2009 Report), Québec, Ministère du Développement durable, de l'Environnement et des Parcs, Direction des politiques de la qualité de l'atmosphère, ISBN 978-2-550-58951-8 (PDF), 27 p.

Legal deposit – Bibliothèque et Archives nationales du Québec, 2010

ISBN 978-2-550-58951-8 (PDF)

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1 Introduction

In June 2000, the federal, provincial and territorial governments, with the exception of Québec, adopted the **Canada-wide Standards for Particulate Matter and Ozone**. The standard for particles concerns the fine fraction of total particles (PM), namely fine particles with a diameter of less than 2.5 microns, also called $PM_{2.5}$. To comply with these standards, the governments committed to take steps to reduce concentrations of these pollutants in the ambient air by year 2010. Though not a signatory to the Canada-wide Environmental Standards Sub-Agreement, the Government of Québec acts in harmony with the other jurisdictions with regard to these air quality standards.

Ozone (O_3) and fine particles are two of the main pollutants responsible for smog. Extensive scientific studies reveal that they have significant effects not only on health, causing chronic bronchitis, asthma and premature death, but also on the environment. Ozone also causes damage to crops and increases vulnerability to disease among certain species of trees. In addition, fine particles reduce visibility in the air.

Ozone is formed through chemical reactions among nitrogen oxides (NO_x) and volatile organic compounds (VOCs), especially in summer when the weather is warm and sunny. Fine particles measured in the atmosphere are distinguished by their origin: primary fine particles are emitted directly into the atmosphere, while secondary fine particles are formed through chemical reactions involving sulphur dioxide (SO_2), NO_x, VOCs and ammonia (NH_3).

Recognition of the Canada-wide Standards is a step toward reducing the risks of these pollutants to human health and the environment. As management objectives, the standards represent a balance between, on the one hand, seeking the best possible protection for health and the environment, and on the other, the feasibility and costs of reducing pollutant emissions into the atmosphere.

The Canada-wide Standards

The Canada-wide Standards for Particulate Matter and Ozone are defined as follows[1]:

- fine particles: 30 $\mu g/m^3$ (average over a period of 24 hours) by 2010. Achievement of this target will be determined based on the 98th percentile annual ambient measurement, averaged over three consecutive years;
- ozone: 65 ppb (average over a period of 8 hours) by 2010. Achievement of this target will be determined based on the 4th-highest annual ambient measurement, averaged over three consecutive years.

1. Source: Canadian Council of Ministers of the Environment (CCME) (http://www.ccme.ca/assets/pdf/pmozone_standard_e.pdf).

2 Description of Territory

For the implementation of the Canada-wide Standards, more specifically the verification of compliance with those standards, the governments must report on the compliance of urban agglomerations of over 100 000 inhabitants. In Québec, six census metropolitan areas (CMAs) are concerned: Montréal, Québec, Gatineau, Saguenay, Sherbrooke and Trois-Rivières. According to the 2006 census, those six urban agglomerations represent two-thirds of the population of Québec.

CMAs of over 500 000 inhabitants are subdivided into reporting sub-areas (RSAs). Montréal has nine of these sub-areas, Québec city has five, and Gatineau two (Ottawa-Gatineau has over 500 000 inhabitants). As well, the CMA of Trois-Rivières has been subdivided into two RSAs for the south shore and north shore respectively. The areas and sub-areas are presented in the maps in Appendix 1. The monitoring stations associated with each area and sub-area, together with the pollutants measured there in 2008, are presented in Appendix 2.

The determination of the areas and sub-areas, and the methodology used in the calculation of indicators and the establishment of statistics, follow the directives in the *Guidance Document on Achievement Determination of the Canada-wide Standards* (http://www.ccme.ca/assets/pdf/1391_gdad_e.pdf).

3 Overview of Results Relative to the Canada-wide Standards (CWS)

For Québec, the present report constitutes the second assessment of the method proposed for evaluating compliance with the Canada-wide Standards. An overview of the results is presented in Maps 1 and 2 in Appendix 3.

These results are the combined effect of local emissions and a variable contribution from the transboundary transport of these pollutants and their precursors. It should be noted that the portion of the contribution from local emissions tends to increase with the duration of smog episodes.

Ozone

The 2008 results (the average of data from 2006, 2007 and 2008) show that ozone indicators for the CMA of Gatineau and three of the eight RSAs of Montréal are over the standard of 65 ppb, the target set for 2010. The CMAs of Québec, Saguenay, Sherbrooke and Trois-Rivières do meet the standard, with values ranging from 58 ppb to 65 ppb. Detailed data are presented in Appendix 4.

Figure 1 illustrates the value of this indicator from west to east. As can be seen, there is a progressive decrease with greater distance from the Ontario border. As well, between 2005[2] and 2008 the value of the indicator declined in most of the CMAs. The RSAs of Québec and the northeast crown of Montréal, together with the CMA of Saguenay, are the only areas where the indicator stagnated or deteriorated slightly.

Transboundary flow from the United States and Ontario contributes significantly to the rise in concentrations of ozone from May to September for areas in southwestern parts of Québec near the borders. Generally speaking, from 25% to 30% of the ozone observed in these regions comes from the United States, while 30% to 60% comes from Ontario. Also, the contribution from local emissions of ozone precursors varies by region, from 15% in the Outaouais area to 65% in the Québec area (http://www.mddep.gouv.qc.ca/air/info-smog/fiche-formation_en.pdf).

2. Average of data from 2003, 2004 and 2005.

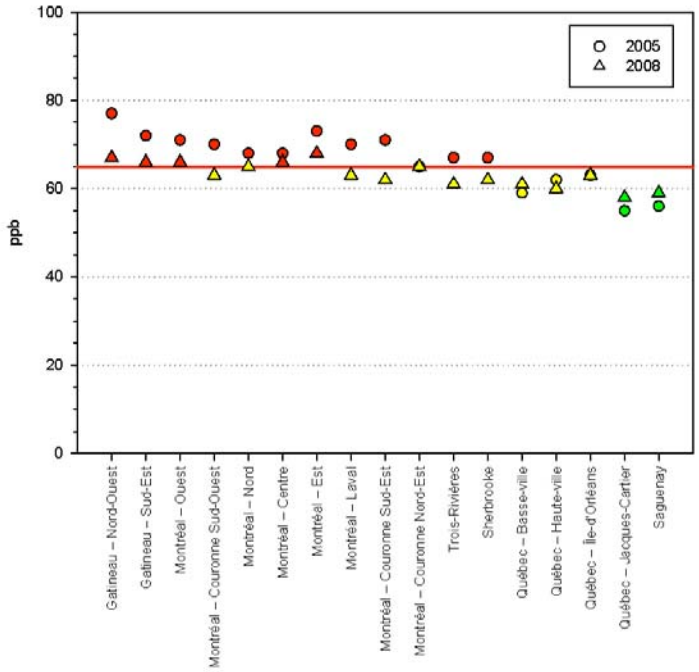


Figure 1: Value of the CWS indicator for ozone in 2005 and 2008

Note: The CWS indicator for ozone represents the 4th-highest value in the daily maximums of running 8-hour average concentrations (ppb) averaged over three consecutive years (e.g. 2006, 2007 and 2008).

Fine particles

The results for 2008 (the average of data from 2006, 2007 and 2008) show that the indicators for fine particles are all below the standard of 30 µg/m³ set for 2010. Only two RSAs in Montréal are within 10% of the standard (from 27 to 30 µg/m³). In the other areas, indicator values range from 17 to 25 µg/m³. Detailed data are presented in Appendix 5.

In all of the CMAs, the value of the fine particle indicator improved from 2005 to 2008 (Figure 2).

Transboundary transport of fine particles and their precursors can also have an impact on the concentrations measured, both in summer and winter.

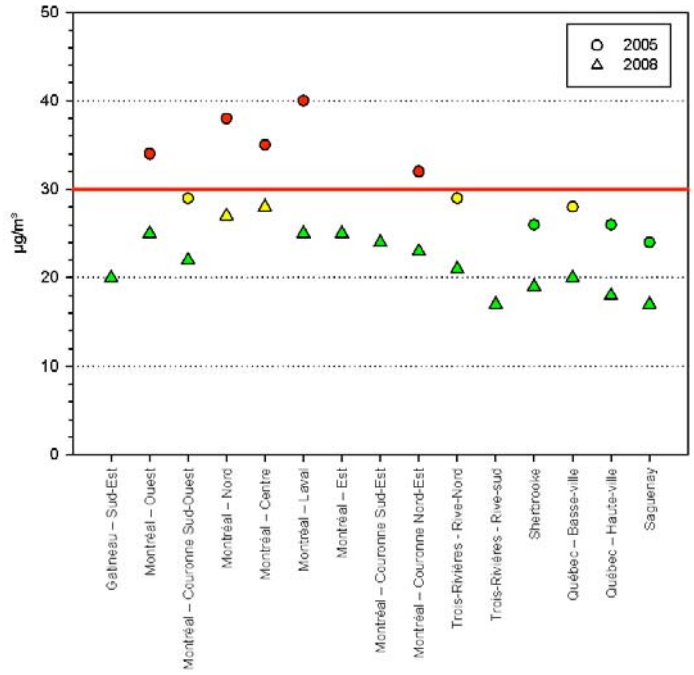


Figure 2: Value of the CWS indicator for fine particles in 2005 and 2008

Note: The CWS indicator for fine particles represents the 98th percentile of daily data on 24-hour average concentrations (µg/m^3) averaged over three consecutive years (e.g. 2006, 2007 and 2008).

4 Overview of Atmospheric Emissions

Note: It should be mentioned that each year's emission values are revised regularly to take into account improved methods of evaluating emissions, previously unlisted sources, and so on. Such revision explains why previously published values for certain data[3] are different from those in the present report.

Table 1 presents Québec emissions for the years 2003 to 2007 of $PM_{2.5}$ (primary fine particles), ozone precursors (NO_x and VOCs) and secondary fine particle precursors (NO_x, SO_2 and VOCs). Detailed data for 2007 are presented in Appendix 6.

3. André Grondin, Michel Bisson and René Bougie, 2007. *The Canada-wide Standards for particulate matter and ozone: Québec five-year progress report (2001-2005)*, Québec, Ministère du Développement durable, de l'Environnement et des Parcs, Direction des politiques de l'air, ISBN 978-2-550-50051-3 (PDF), 19 pp.

Table 1: Atmospheric Emissions of $PM_{2.5}$ and of Ozone and Secondary Fine Particle Precursors for the Years 2003 to 2007 (in tonnes)
Note: Totals may not sum due to independent rounding.

Pollutants	Industry	Transportation	Wood Heating	Other Sources	TOTAL
2003					
$PM_{2.5}$	32 526	12 047	33 463	1 376	**79 412**
SO_2	203 115	23 636	483	31 656	**258 890**
NO_x	42 363	235 617	3 379	24 321	**305 679**
VOCs	91 157	141 635	48 892	80 915	**362 599**
2004					
$PM_{2.5}$	30 635	11 895	32 678	1 161	**76 368**
SO_2	200 115	22 623	471	20 307	**243 516**
NO_x	42 010	227 889	3 300	22 125	**295 324**
VOCs	93 414	134 438	47 746	81 923	**357 521**
2005					
$PM_{2.5}$	29 625	11 658	30 578	833	**72 694**
SO_2	169 305	22 513	441	16 569	**208 828**
NO_x	46 490	218 998	3 088	20 103	**288 679**
VOCs	92 050	127 511	44 679	82 567	**346 807**
2006					
$PM_{2.5}$	30 918	11 274	27 904	704	**70 800**
SO_2	170 612	21 331	403	12 078	**204 425**
NO_x	42 798	210 011	2 818	18 057	**273 684**
VOCs	87 122	123 085	40 775	81 553	**332 535**
2007					
$PM_{2.5}$	28 140	10 933	31 476	808	**71 356**
SO_2	147 148	20 467	454	13 744	**181 814**
NO_x	45 836	202 205	3 179	22 294	**273 514**
VOCs	86 697	118 363	45 991	71 124	**322 175**

Source: Ministère du Développement durable, de l'Environnement et des Parcs, Inventaire québécois des émissions atmosphériques (IQÉA), Direction des politiques de la qualité de l'atmosphère, October 2009.

Figures 3 to 6 show the distribution of 2007 emissions among the principal emitters, with the trends from 1990 to 2007.

Fine particles

Residential wood heating (44%) and the industrial sector (40%) are the principal contributors of $PM_{2.5}$ emissions in Québec.

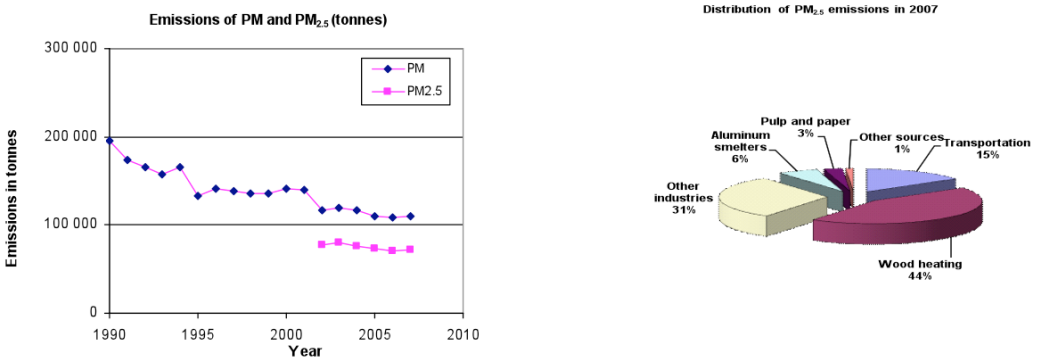


Figure 3: 1990-2007 trends and the 2007 distribution of $PM_{2.5}$ emissions

$PM_{2.5}$ emissions have been inventoried in Québec since 2002. Emissions of total particles (PM) are therefore used to express the trend since 1990. Assuming that the trend for fine particles is similar to that for total particles, it can be seen that emissions have gradually declined. While emissions from non-industrial combustion (including wood heating) vary from year to year, with no trend either upwards or downwards, those from industry show a gradual decrease, though one less pronounced than in previous years.

Sulphur dioxide

81% of SO_2 emissions are from the industrial sector, primarily aluminum smelters (30%) and non-ferrous metal extraction (11%).

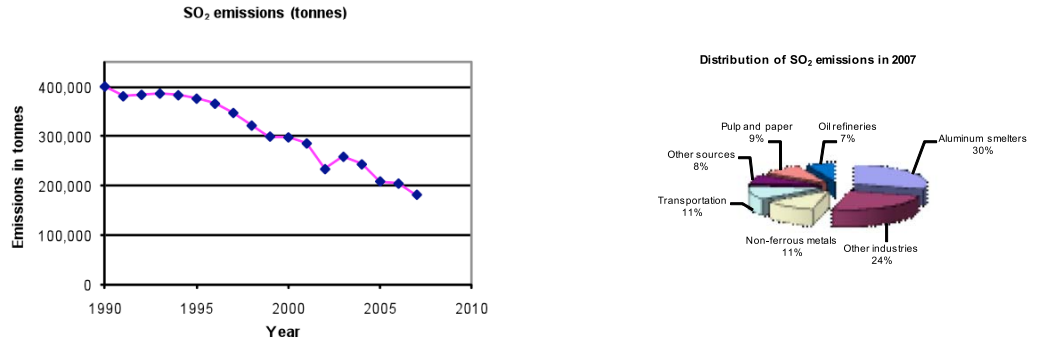


Figure 4: 1990-2007 trend and the 2007 distribution of SO_2 emissions

Continuous reductions have occurred over the past 18 years, primarily in the sector of non-ferrous metal extraction (copper). A gradual decrease is also noted in the transportation sector. This is excellent performance, especially considering the increase in emissions from aluminum smelters (34% between 2000 and 2007) due to the expansion of this industry in Québec over the last two decades.

Emissions of SO_2 from copper extraction were chopped by 88% between 2000 and 2007. Just between 2004 and 2005, SO_2 emissions fell by 59%, thanks to better selection of inputs and emissions capture initiatives at the one remaining plant in the sector. The

closing in 2002 of the copper extraction plant in Murdochville helped lower total Québec emissions of SO_2 (about 40 000 tonnes) by 14% compared to the level in 2001 (a reduction of 35% for the sector).

Contributing to the decline in SO_2 emissions are the enormous changes undergone by the wood processing and paper sector in recent years. According to a study on job losses by the Ministère des Ressources naturelles et de la Faune (MRNF), since 2005 there have been numerous temporary and permanent closings in the wood transformation industry, the pulp and paper industry, and the furniture industry.

Nitrogen oxides

With regard to NO_x, the transportation sector is by far the greatest emitter (74%).

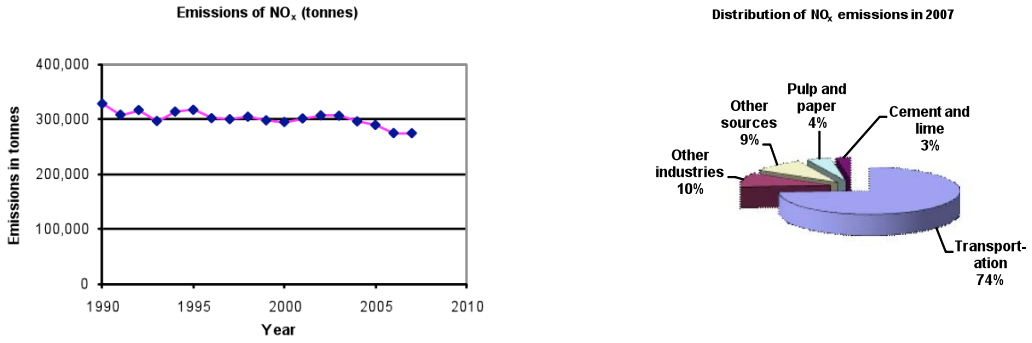


Figure 5: 1990-2007 trend and the 2007 distribution of NO_x emissions

The trend shows a slight but steady reduction, due essentially to the transportation sector. For the other sectors, slight reductions in one domain are cancelled out by increases in others. However, future reductions can be expected through the gradual replacement of cars and trucks by models that are much less polluting.

Volatile organic compounds

Aside from transportation, which contributed 37% of VOC emissions in 2007, the major contributor to emissions is the use of solvents, primarily in the sectors referred to as “Other sources” and “Other industries”.

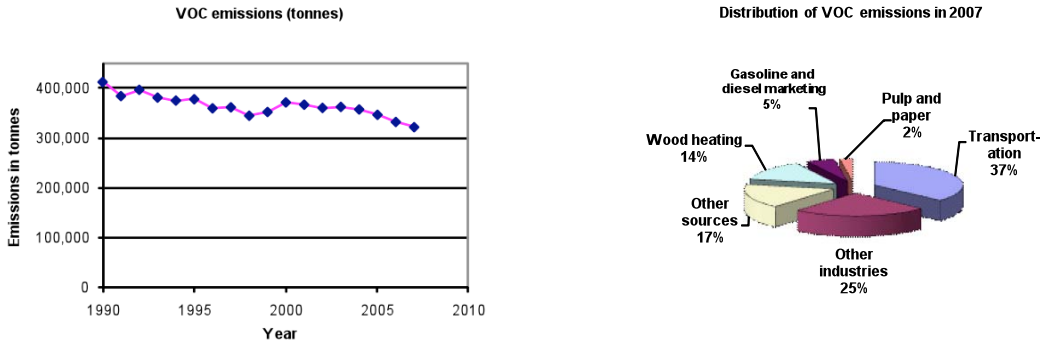


Figure 6: 1990-2007 trend and 2007 distribution of VOC emissions

The trend shows a slight but steady decline in VOC emissions that should continue in future. The decrease is primarily due to the reduction of emissions from gasoline-powered road vehicles.

5 Elements of Intervention

Ambient air monitoring network

In December 2008, 26 ozone analyzers and 20 fine particle analyzers were in operation, in the territory defined in section 2, to monitor the Canada-wide Standards strategy. In the coming years it will be important to maintain and strengthen this monitoring network as much as possible, to complete its territorial coverage and increase knowledge about the impact of atmospheric transport on smog, be it transboundary or not.

It is worth mentioning that since 2008, under the Air Quality Monitoring Program, a new generation of fine particle measuring devices is being used. This is one of the factors explaining the higher 98th percentile values observed in 2008 in the Montréal region (Appendix 5). Moreover, after improvements to the data quality control process this information could be revised and updated.

Air quality indexing and forecasting programs (AQI and Info-Smog)

Since February 2004, Québec's Ministère du Développement durable, de l'Environnement et des Parcs (MDDEP), in collaboration with Environment Canada, the city of Montréal and the Ministère de la Santé et des Services sociaux du Québec, has published an air quality index (AQI) for the whole of Québec except the island of Montréal. The city of Montréal publishes the same index based on monitoring stations it operates on its territory. The AQI provides the public with information about the quality of the air, updated hourly.

For Québec: (http://www.mddep.gouv.qc.ca/air/iqa/index_en.htm).

For Montréal: (http://www.rsqa.qc.ca/framville.asp?url=framrsqf.asp).

In collaboration with the same partners, the Ministère participates in the air quality forecasting program (Info-Smog). Environment Canada publishes air quality forecasts and advance warnings when poor quality air is expected. Like the AQI, this program both informs the public and raises awareness about the problem of smog and related issues. As of summer 2006, Info-Smog covers the same territory as the AQI, all year round. This territory extends over a large part of southern Québec and represents 95% of Québec's population.

Current and future reduction of atmospheric emissions of fine particles and the precursors of ozone and fine particles

Industry

The interventions of the Québec government are primarily aimed at reducing industrial emissions. Examples include the overhaul of the *Regulation respecting the quality of the atmosphere* (RQA) in the form of the *Draft air quality regulation* (DAQR), and the depollution attestations (operating permits) applicable to large industry under the *Industrial waste reduction program* (IWRP). These interventions are also intended to increase knowledge about emissions of fine particles, their precursors, and the precursors of ozone.

Reduction of fine particle emissions: The tightening of standards for many industrial sources will bring about a reduction of fine particle emissions, since currently available reduction technologies are highly effective at removing fine particles. The gradual decrease already observed should become more pronounced when the DAQR is in place, since the latter tightens standards for certain sources of particle emissions in the industrial sector, making it mandatory to install monitoring equipment and perform compliance sampling at the largest sources. For example, fine particle reductions are expected on the order of 400 tonnes per year in atmospheric emissions from biomass boilers, relative to levels in 2006.

According to the 2007 environmental compliance assessment of the pulp and paper sector, the main reasons for the reduction of fine particle emissions are the installation of more effective scrubber systems on incinerators and the conversion of some boilers to natural gas.

Reduction of SO_2 emissions (secondary fine particle precursor): The maximum sulphur content in heavy oil will be lowered in two stages: from 2% to 1.5%, throughout Québec, a year after adoption of the DAQR. One year later the standard will be further lowered to 1% in areas where natural gas is available. Increased recovery of sulphur from copper extraction processes will also be required when the DAQR is adopted. In this case however, the one company concerned has already taken the appropriate measures, so no significant further reduction is expected in the coming years.

According to the 2007 environmental compliance assessment of the pulp and paper sector, the conversion of boilers from heavy oil to natural gas has also contributed to the reduction of SO_2 emissions. Other changes having the same result are the phasing out of the sulphite process at some pulp plants, and an increased use of incinerated waste for the production of steam.

Reduction of NO_x emissions (ozone and secondary fine particle precursor): The DAQR sets an annual emission limit of 2100 tonnes for the Tracy thermal power plant. Note that of late the plant has had limited use, and in future Hydro-Québec will restrict its use to the winter peak. When fossil fuel burners are replaced, units with low NO_x emissions will be required.

In the pulp and paper sector, the conversion of boilers from heavy oil to natural gas has also contributed to the reduction of NO_x emissions according to the 2007 environmental compliance assessment.

Reduction of VOC emissions (ozone and secondary fine particle precursor): With adoption of the DAQR, new emission limits will be set for solvent use, printing activities, dry cleaning and paint shops. Application of an ambient air standard for certain VOCs, such as formaldehyde from wood panelboard mills and styrene from the manufacture of composite materials (fibreglass and resins), will also be pursued.

Meanwhile, depollution attestations have been issued under the IWRP in the pulp and paper sector and the aluminum industry. The issuing process for these attestations is currently underway for the mining and metallurgy sectors other than aluminum. Exhaustive measurement campaigns carried out by the pulp and paper industry for $PM_{2.5}$, NO_x and VOC emissions were used to inventory emissions from that sector. For the aluminum sector, studies on $PM_{2.5}$ and VOC emissions are currently underway.

In July 2009, under the *Canadian Environmental Protection Act*, the federal government adopted the *VOC Concentration Limits for Automotive Refinishing Products Regulations*, and in September 2009 the *VOC Concentration Limits for Architectural Coatings Regulations*. These requirements are taken into account in the DAQR. They will help to ensure that the steady decline in VOC emissions continues. The federal government is also preparing draft regulations in other sectors to reduce emissions of volatile organic compounds.

Due to the progress achieved by the industrial sector since 1990 and the importance of emissions from industrial processes, which are harder to reduce, the potential for further reduction in that sector is relatively limited. Preliminary analysis however indicates that additional gains could be made through the following means:

- increased replacement of fuel oil by natural gas, biogas, electricity or biofuels;
- improved combustion efficiencies;
- improved manufacturing processes.

Residential wood heating

With regard to wood heating appliances (stoves and fireplaces), Québec participates in public information and awareness programs on the impact of wood heating on air quality and health, as well as recommended practices. For example, during the winter season the Info-Smog forecasting program notifies citizens in most of southern Québec when conditions are unfavourable for the use of these appliances.

The *Regulation respecting wood-burning appliances* (Q-2, r.1. 0001) restricts the manufacture, distribution and sale of wood heating appliances to those with EPA or CSA B.415.1 certification, and has been in force since September 1, 2009. In the long term,

this measure by the Government of Québec should contribute to a gradual decrease in fine particle emissions.

The city of Montréal has also adopted its own regulation on solid fuel burning appliances. This regulation came into force on April 28, 2009 and covers the entire territory of Montréal. It forbids the installation of such appliances both in new and existing constructions, with the exception of pellet burning stoves with EPA or CSA B.415.1 certification.

Under Québec's *Municipal Powers Act*, municipalities can take complementary action to the *Regulation respecting wood-burning appliances*, by adopting their own regulations on the installation of wood-burning stoves. A few municipalities have already done so.

Transportation

The implementation of measures set forth in the Québec 2006-2012 *Climate Change Action Plan* (CCAP) has had, or will have, a significant effect on air quality. Complete information on the CCAP can be found through the following link:

http://www.mddep.gouv.qc.ca/changements/plan_action/index-mesures-en.htm.

Published in June 2009, the third annual report on the results of the CCAP mentions that since 2007, virtually all of the measures set forth in the Plan have been implemented.

In a similar vein, the *Québec Public Transit Policy* provides for investments on the order of $4.5 billion between 2006 and 2012. The Policy targets an 8% increase in public transit use by 2012. In addition, five programs under the CCAP specifically target infrastructure improvements for both public transit and active transportation (bicycle paths, pedestrian networks, etc.) throughout Québec.

The Government of Québec is also working to improve energy efficiency in the transportation of merchandise. The financial assistance program to improve energy efficiency in the freight sector includes the implementation of multi-modal projects and the use of new technologies to improve energy efficiency in truck fleets and marine/rail transportation. The *Heavy-duty Vehicle Maintenance and Inspection Program* was put in place in June 2006. According to the 2009 CCAP report, since the program came into force 1447 inspections have been done on the road and 646 statements of offence have been issued. Indeed, in August 2008 the Ministère published a visual characterization of the heavy-duty vehicle fleet, revealing that by 2007, as a consequence of the program, the non-compliance rate had fallen by 52%. It is estimated that this program will bring about a reduction of 450 tonnes of emissions per year, essentially in fine particles. The *Regulation respecting environmental standards for heavy vehicles* can be consulted through the following link:

http://www.canlii.org/en/qc/laws/regu/rq-c-q-2-r15.3/latest/rq-c-q-2-r15.3.html.

The visual characterization report (in French) can be consulted at:

http://www.mddep.gouv.qc.ca/air/pieval/Rapport-PIEVAL2007.pdf.

As for light vehicles, it is worth mentioning the adoption in December 2009 of the *Regulation respecting greenhouse gas emissions from motor vehicles*. Québec thereby became the first province in Canada to put into force the strictest standards in North America. Moreover, a refundable provincial tax credit encourages consumers to choose fuel efficient or electric cars.

Other interventions

When authorizing new facilities, the MDDEP will continue to ensure that the best production and emission treatment technologies are used, so as to minimize emission increases and avoid any significant deterioration of ambient air quality.

Additional reductions will be obtained through the implementation of certain interdepartmental initiatives, including the CCAP, that are aimed at action in other domains. These range from agriculture (MAPAQ's *Prime-Vert* program) to waste management (the MDDEP's *Biogaz* program as well as a biomethanation program) to energy efficiency measures proposed in Québec's *Energy Efficiency Strategy* (2006).

Lastly, the Government of Québec is committed to hydroelectricity and wind power, which avoid the emissions of NO_x and greenhouse gases that come with thermal power plants.

6 Conclusion and Next Steps

This second assessment of the Canada-wide Standards shows that in 2008 the indicators for ozone and fine particles had improved relative to 2005. For fine particles, the indicators in all CMAs are below the target set for 2010. For ozone, only a few RSAs in southern Québec have indicators over the Canada-wide Standard. In sum, the emission reduction measures implemented by the MDDEP and other departments and levels of government should bring genuine improvement in the indicators for ozone and fine particles. There is every reason to expect that as these efforts continue, Québec will succeed in achieving the objectives of the Canada-wide Standards. The next steps to be taken include the following:

Ambient milieu

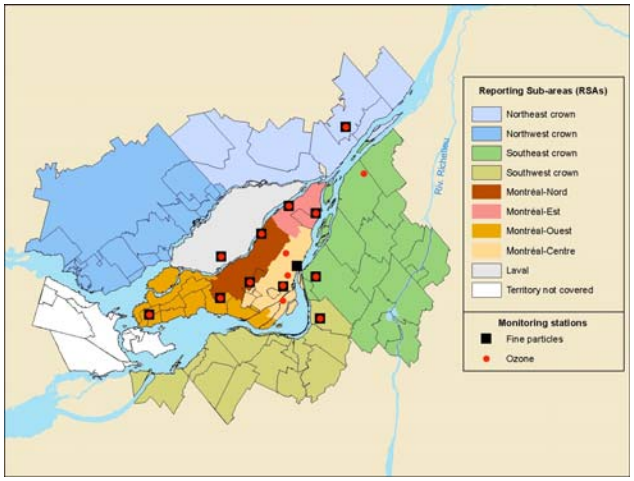
- Maintain and continue upgrading the monitoring network for ozone and fine particles.
- Improve public awareness of the air quality index and produce reports on air quality in Québec.
- Increase knowledge about the impact of atmospheric transport of pollutants on smog, whether transboundary or not.
- Improve assessments of the influence of transboundary flow of pollutants and precursors, the influence of background levels, and the impact of natural events, so as to consider them in future annual and five-year appraisals of the degree of achievement of the Canada-wide Standards.

Reduction of emissions

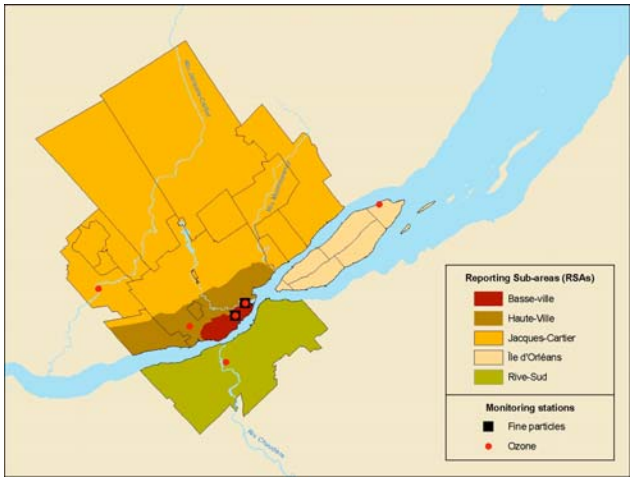
- Extend the characterization of fine particles and precursors to other industrial sectors and examine opportunities for reduction of these pollutants.
- Complete the overhaul of the *Regulation respecting the quality of the atmosphere*.
- Continue raising public awareness of the *Regulation respecting wood-burning appliances*.
- Continue work toward setting up an inspection and maintenance program for light vehicles.
- Continue the implementation of measures provided for by the CCAP, particularly in the transportation and energy sectors, by encouraging the development and uptake of public transit and alternative modes of transportation, and by improving energy efficiency in the transportation of merchandise.

Thus, the Québec approach is characterized by concerted action among government departments, agencies and partners, all working together to protect the environment and public health in a context of sustainable development. Combined with the measures already in place, future actions should contribute to continuing the improvement of air quality in Québec.

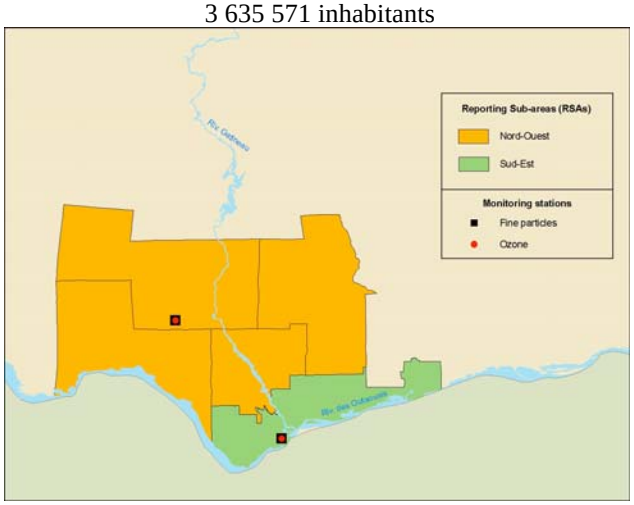
Appendix 1: Maps of the Six Census Metropolitan Areas (CMAs) and Reporting Sub-areas (RSAs) with their Populations[4]



Montréal and its reporting sub-areas,
3 635 571 inhabitants

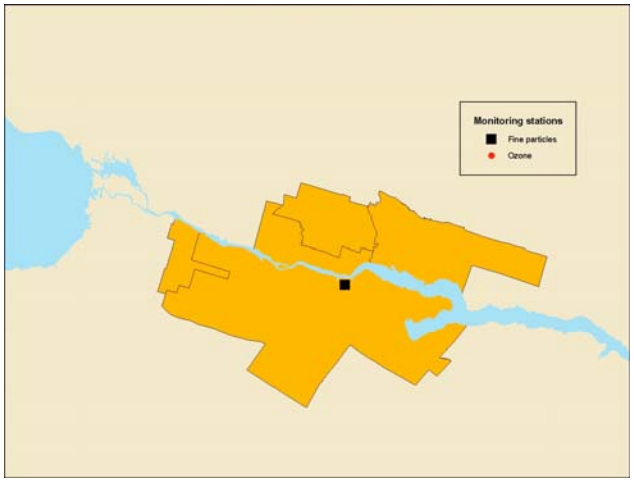


Québec and its reporting sub-areas,
715 515 inhabitants

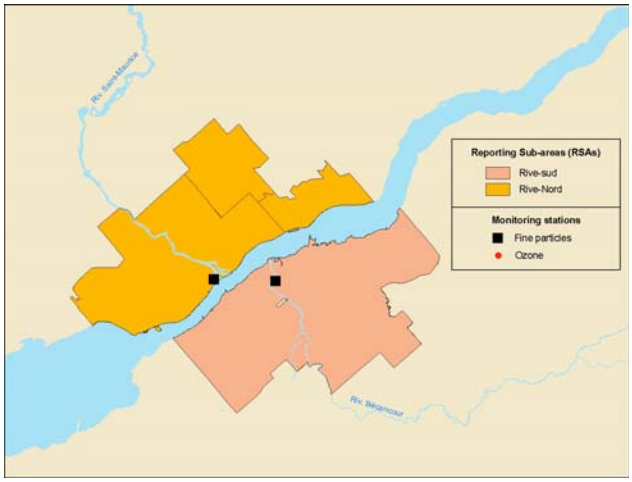


Gatineau and its reporting sub-areas,
283 959 inhabitants

Sherbrooke, 186 952 inhabitants



Saguenay, 151 643 inhabitants



Trois-Rivières and its reporting sub-areas,
141 529 inhabitants

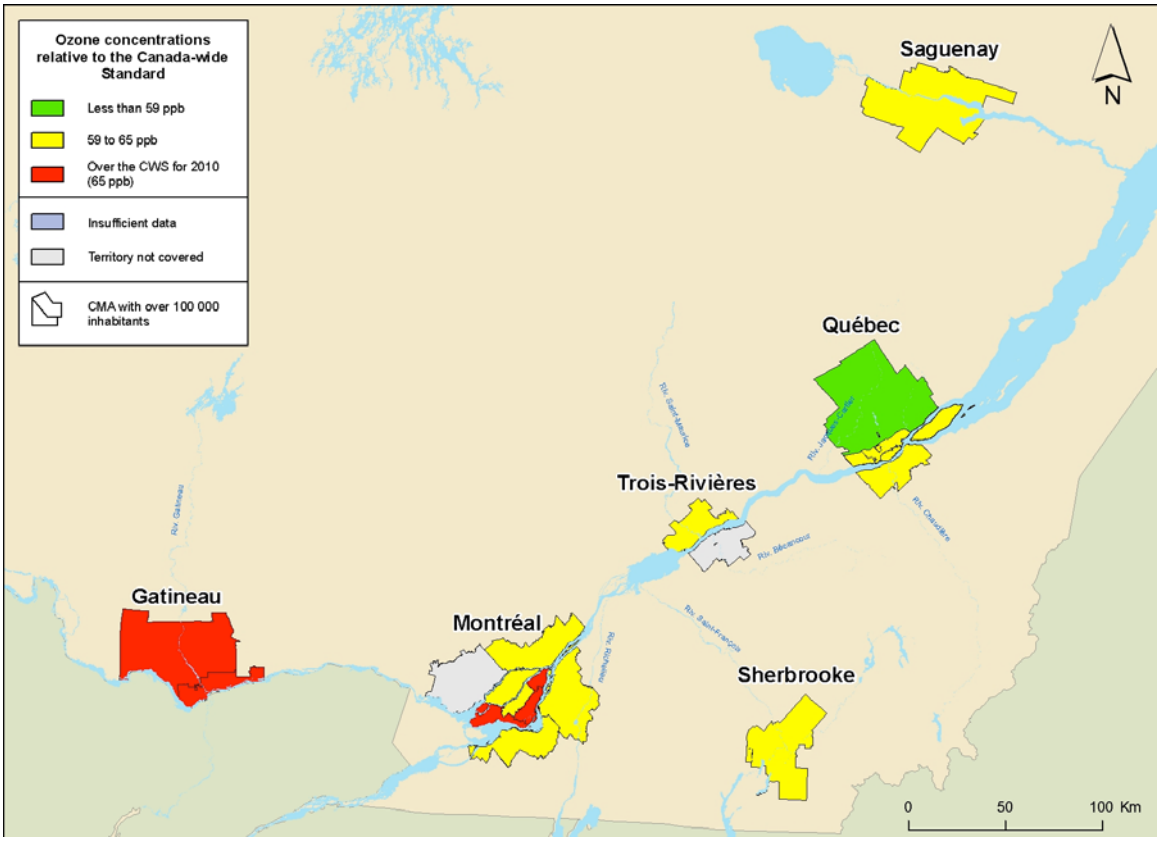
4. According to the 2006 Census, Statistics Canada.

Appendix 2: Census Metropolitan Areas and Sub-areas Subject to the Canada-wide Standards for Ozone and Fine Particles[1]

Spatial Reference Units		Reference Stations		Pollutants Measured	
Census metropolitan area (CMA)	Reporting sub-area (RSA)	Name	Station no.	Ozone	Fine particles
Montréal	Montréal-Centre	Jardin botanique	06001	x	
		Ontario	06012	x	
		Drummond	06013		x
		Hochelaga-Maisonneuve	06054		x
		Maisonneuve	06061	x	
		Verdun	06068	x	
	Montréal-Ouest	Aéroport de Montréal	06066	x	x
		Saint-Anne-de-Bellevue	06099	x	x
	Montréal-Nord	Décarie	06028	x	x
		Parc-Pilon	06029	x	x
	Montréal-Est	Saint-Jean-Baptiste	06003	x	x
		Rivière-des-Prairies	06055	x	x
	Laval	Chomedey	06205	x	x
	Northeast crown	L'Assomption	06500	x	x
	Southeast crown	Bourassa	06600	x	x
		Varennes 1	06613	x	
	Southwest crown	Parc Océanie	06760	x	x
Québec	Basse-ville	Des Sables	03006	x	x
		Parc Les Primevères	03021	x	---
	Haute-ville	Saint-Charles-Garnier	03028	x	x
	Jacques-Cartier	Sainte-Catherine	03712	x	
	Île d'Orléans	Saint-François	03712	x	
	Rive-Sud	Charny	03061	x	
Trois-Rivières	Rive-Nord	Ursulines	04019	x	x
	Rive-Sud	Bécancour	04504		x
Sherbrooke		Parc Cambron	05018	x	x
Saguenay		Université de Chicoutimi	02022	x	x
Gatineau	Sud-Est	Hull	07002	x	x
	Nord-Ouest	La Pêche	07400	x	x

1. The selection of territory covered by the Canada-wide Standards was carried out in accordance with directives in the *Guidance Document on Achievement Determination of the Canada-wide Standards*.

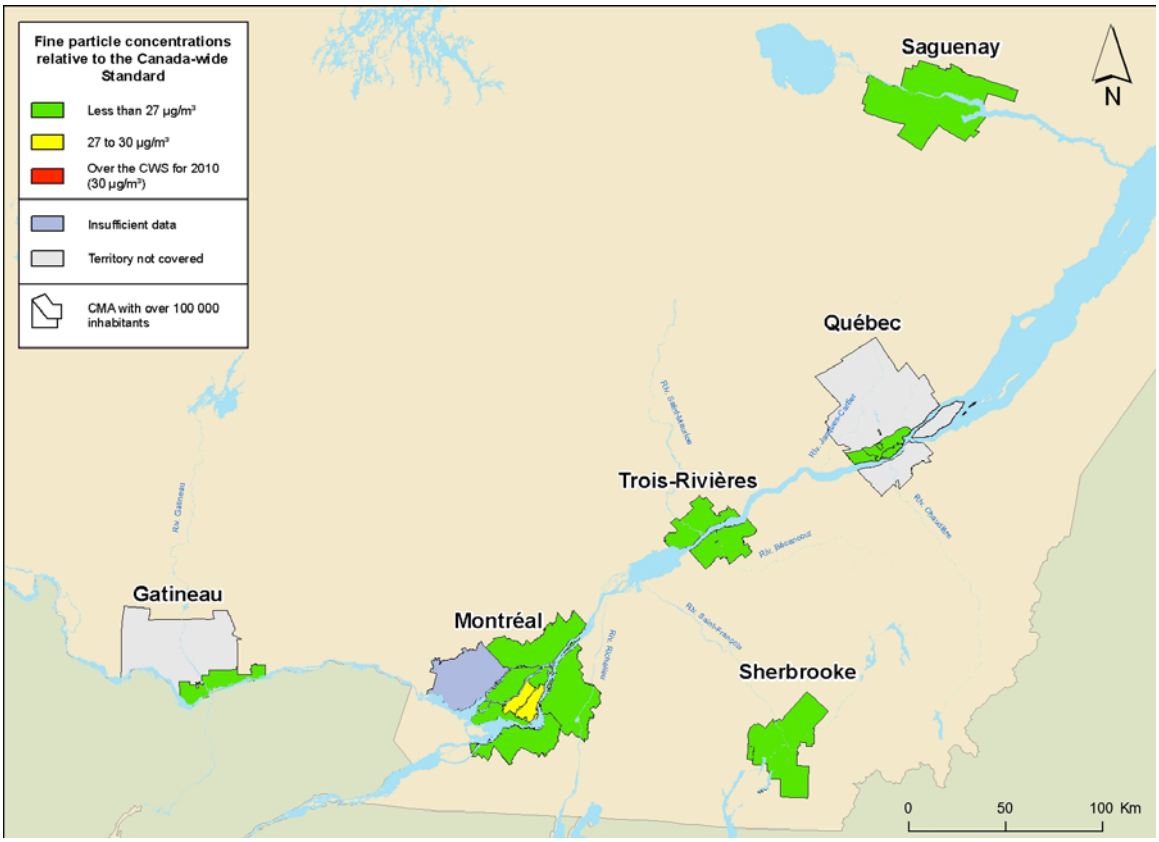
Appendix 3: Cartographic Representation of the Canada-wide Standards



Map 1: Value of the CWS indicator for ozone in 2008

Note: The CWS indicator for ozone in 2008 represents the 4th-highest value in the daily maximums of running 8-hour average concentrations (ppb) averaged over the years 2006, 2007 and 2008.

Appendix 3: Cartographic Representation of the Canada-wide Standards (continued)



Map 2: Value of the CWS indicator for fine particles in 2008

Note: The CWS indicator for fine particles in 2008 represents the 98th percentile of daily data on 24-hour average concentrations ($\mu g/m^3$) averaged over the years 2006, 2007 and 2008.

Appendix 4: Canada-wide Standards – Ozone

Spatial Reference Units		4th-highest value of daily maximums of 8-hour running averages (ppb)[1]			3-year Average
Census metropolitan areas (CMAs)	Reporting sub-areas (RSA)	2006	2007	2008	CWS indicator in 2008
Montréal	Montréal-Centre (4 stations)	63.6	70.8	62.6	66
	Montréal-Ouest (2 stations)	63.1	71.6	63	66
	Montréal-Nord (2 stations)	64.6	71.5	60	65
	Montréal-Est (2 stations)	65.6	75	63.1	68
	Laval (1 station)	62.1	68.8	58.9	63
	Northeast crown (1 station)	60.9	72.6	61.3	65
	Southwest crown (1 station)	61.9	67.6	60.8	63
	Southeast crown (2 stations)	61.1	66.3	57.5	62
Québec	Basse-ville (2 stations)	59.6	68	54.4	61
	Haute-ville (1 station)	60.1	66.1	54.5	60
	Jacques-Cartier (1 station)	56.4	64.9	54.1	58
	Île d'Orléans (1 station)	62.3	66.9	58.9	63
	Rive-Sud (1 station)	58.9	68.3	53.3	60
Trois-Rivières	Rive-Nord (1 station)	59.3	69.5	53.9	61
Sherbrooke	(1 station)	58.5	65.1	61.3	62
Saguenay	(1 station)	61.5	59.8	54.4	59
Gatineau	Sud-Est (1 station)	66.8	—[2]	65	66
	Nord-Ouest (1 station)	63.9	70.6	67.9	67

1. The 4th-highest value is reported if there is at least 75% data completeness for the period from April 1 to September 30.

2. The value for this year cannot be used in calculating the three-year average because it does not meet completeness criteria, i.e. the amount of data is insufficient to produce the indicator.

Note: The calculation of indicators was carried out in accordance with directives in the *Guidance Document on Achievement Determination of the Canada-wide Standards*.

Appendix 5: Canada-wide Standards – Fine Particles

Spatial Reference Units		98th percentile of daily data over 24 hours (µg/m³)[1]			3-year Average
Census metropolitan areas (CMAs)	Reporting sub-areas (RSAs)	2006	2007	2008	CWS indicator in 2008
Montréal	Montréal-Centre (2 stations)	26	24.6	31.9	28
	Montréal-Ouest (2 stations)	24.3	23.4	22.8	25
	Montréal-Nord (2 stations)	23.6	25	31.3	27
	Montréal-Est (2 stations)	21.6	22.9	29.6	25
	Laval (1 station)	23.8	22.5	29.1	25
	Northeast crown (1 station)	19	24.3	26.5	23
	Southwest crown (1 station)	20.3	22	22.6	22
	Southeast crown (1 station)	23.8	25	23.1	24
Québec	Basse-ville (2 stations)	19.7	21	19.6	20
	Haute-ville (1 station)	18.8	18.5	16.4	18
Trois-Rivières	Rive-Nord (1 station)	21	21.5	19	21
	Rive-Sud (1 station)	17.8	19.3	15.3	17
Sherbrooke	(1 station)	21	19.9	15.8	19
Saguenay	(1 station)	19	16.7	14.1	17
Gatineau	Sud-Est (1 station)	—[2]	19.9	19.9	20

1. The value of the 98th percentile is reported if there is at least 75% data completeness over four quarters.

2. The value for this year cannot be used in calculating the three-year average because it does not meet data completeness criteria, i.e. the amount of data available is insufficient to produce the indicator.

Note: The calculation of indicators was carried out in accordance with directives in the *Guidance Document on Achievement Determination of the Canada-wide Standards*.

Appendix 6: Detailed Atmospheric Emissions for 2007 in Québec[5]

Sector	Pollutants (tonnes) in 2007				
	SO_2	VOCs	NO_x	PM	$PM_{2.5}$
Pulp and Paper	**16 981**	**7 476**	**11 894**	**3 356**	**1 961**
Wood Transformation	**404**	**6 685**	**2 345**	**4 539**	**2 082**
Sawmills	275	3 920	1 228	2 643	1 259
Panelboard mills	129	2 765	1 116	1 896	823
Iron & Steel Industries	**21 900**	**773**	**10 721**	**4 257**	**2 644**
Metallurgy	9 813	339	2 179	2 337	1 353
Iron and steel foundries	26	26	75	139	105
Iron ore pelletizing	10 954	13	8 285	1 471	1 006
Ferro-alloys	1 107	396	181	309	180
Aluminum Smelters	**53 538**	**1 529**	**651**	**8 249**	**4 262**
Chemical Industries	**6 464**	**1 462**	**2 617**	**694**	**265**
Organic chemicals	15	342	80	47	23
Inorganic chemicals	5 886	416	1 323	586	206
Petrochemicals	564	704	1 214	62	36
Oil Refineries	**11 891**	**2 452**	**4 848**	**918**	**643**
Cement and Lime Plants	**10 984**	**60**	**7 417**	**1 316**	**549**
Cement	8 978	57	6 576	1 106	539
Lime	2 006	3	841	209	10
Zinc Extraction	**5 218**	**1**	**39**	**162**	**76**
Copper Extraction	**15 620**	**3**	**251**	**513**	**102**
Other Industries	**4 149**	**66 298**	**5 146**	**36 877**	**15 556**
Plastic products	1	6 200	57	6	5
Rubber products	14	2 981	50	31	14
Unclassified industries with area emissions	477	21 286	1 180	3 010	1 378
Refractory products	0	1	26	33	9
Carbon electrodes	308	0	9	78	18
Food and beverages	353	2 980	392	306	86
Unclassified industries	1 784	673	2 720	685	385
Asbestos mining and milling	222	0	77	40	9
Magnesium extraction	1	0	1	6	5
Cement concrete plants	2	13	5	780	117
Bituminous concrete plants	5	66	14	2 434	175
Ore extraction	761	1	144	25 415	12 670
Rock quarries	1	1	32	990	255
Bakeries	0	2 153	19	0	0
Grain handling and flour mills	7	1	12	2 725	238
Other wood products	179	838	167	266	158

5. Note: Totals may not sum due to independent rounding.

Sector	Pollutants (tonnes) in 2007				
	SO_2	VOCs	NO_x	PM	$PM_{2.5}$
Printing	1	5 829	45	1	1
Adhesives	0	4 421	4	0	0
Industrial surface coatings	36	18 067	98	34	16
Paints and coatings manufacturing	0	746	5	36	18
Various	0	42	93	0	0
Non-industrial combustion	**13 752**	**46 635**	**23 921**	**34 879**	**32 221**
Thermal plants in public services	1 219	82	8 526	216	159
Biomass cogeneration plants	436	164	1 686	329	190
Public administration	339	7	250	27	10
Agriculture	55	9	342	14	11
Wood heating	454	45 991	3 179	33 288	31 476
Business and institutions	8 087	235	6 408	700	251
Residential	3 163	148	3 530	305	125
Transportation	**20 467**	**118 363**	**202 205**	**12 451**	**10 933**
Aircraft	730	1 814	10 667	173	169
Automobiles, diesel	5	158	514	50	46
Other diesel	1 576	5 184	51 708	4 617	4 479
Other transportation	0	0	0	0	0
Boats	17 435	791	23 304	2 238	1 977
Heavy trucks, diesel	196	2 118	52 489	1 464	1 348
Heavy trucks, gasoline	10	741	2 805	38	32
Light trucks, diesel	10	328	742	70	64
Light trucks, gasoline	120	18 877	18 625	96	81
Railways	190	246	9 138	337	310
Off-road, gasoline	24	59 983	8 050	2 058	1 896
Motorcycles	1	806	430	8	5
Pipelines	0	2	37	1	1
Tire wear	0	0	0	1 166	403
Automobiles, gasoline	170	27 315	23 696	135	122
Various sources	**446**	**70 438**	**1 458**	**1 122**	**62**
Incinerators	333	244	1 126	37	24
Dry cleaning	0	178	0	0	0
Landfill sites	2	516	308	1 077	34
Gasoline and diesel marketing	111	16 587	24	8	4
Non-industrial solvent use	0	52 913	0	0	0
TOTAL	**181 814**	**322 175**	**273 514**	**109 331**	**71 356**