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Canadian Council of Ministers of the Environment
Le Conseil canadien des ministres de l'environnement

2006-2007 Progress Report on **The Canada-Wide Acid Rain Strategy for Post-2000**

Federal/Provincial/Territorial
Ministers of Energy and Environment

ISSN 1911-1541

PN 1410

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The Canada-Wide Acid Rain Strategy for Post-2000

In October 1998, federal, provincial, and territorial Energy and Environment Ministers signed *The Canada-Wide Acid Rain Strategy for Post 2000*. The primary long-term goal of *The Strategy* is "to meet the environmental threshold of critical loads for acid deposition across Canada". As steps towards the achievement of this goal, *The Strategy* calls for a number of actions, including:

- Pursuing further emission reduction commitments from the United States;
- Establishing new sulphur dioxide (SO_2) emission reduction targets in eastern Canada;
- Preventing pollution, and keeping "clean" areas clean;
- Ensuring the adequacy of acid rain science and monitoring programs; and,
- Annually reporting on SO_2 and nitrogen oxides (NO_x) emissions and forecasts, on compliance with international commitments, and on progress in implementing *The Strategy*.

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2006/07 Progress Report on *The Canada-Wide Acid Rain Strategy for Post-2000*

1 Introduction

1.1 Background

The Canada-Wide Acid Rain Strategy for Post-2000 (hereafter called *The Strategy)*, was signed on October 19, 1998, by all 26 Canadian Energy and Environment Ministers to provide a framework for the long-term management of acid rain in Canada.

The Strategy was developed in response to the recognition by science and policy communities in the 1990s[1] that although acidifying emission control programs in both Canada and the United States were successfully meeting targets and caps, substantially greater reductions would be needed in order to halt acid rain damage in eastern Canada.

The body mandated to coordinate implementation of *The Strategy* is the Canadian Council of Ministers of the Environment (CCME) Acid Rain Task Group (ARTG)[2]. Since the inception of *The Strategy*, the ARTG has been reporting to Ministers and the Canadian public on progress made on achieving the commitments made under *The Strategy* and on sulphur dioxide (SO_2) and nitrogen oxide (NO_x) emissions and forecasts.

Commencing with this 2006/07 report, progress will be reported biennially, alternating with the biennial Canada – United States Air Quality Agreement progress report which presents similar information. Acid Rain progress reports were becoming increasingly delayed due to difficulties in the collection and development of emissions inventories, forecasts (predictions of emissions for future years) and backcasts / trends (past years' emissions). Biennial reporting will reduce the time lag between the available emissions information and the reporting period.

1.2 Highlights of the 06/07 Progress Report

In Section 2 of this progress report, an effort has been made to present an overview of the latest scientific knowledge on acid deposition to provide the reader with knowledge of "what has been done" and "what remains to be done" with respect to ensuring deposition levels do not exceed critical loads anywhere in Canada, which is the long-term goal of *The Strategy*. Also in Section 2, readers will find emissions of SO_2 and NO_x by province/territory and major provincial/territorial emitting sector, as well as a graphical representation of changes in SO_2 and NO_x emissions over the past decades nationally.

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[1] For example, the *1997 Canadian Acid Rain Assessment* (Environment Canada, 1998) indicated that large areas of eastern Canada continued to receive "twice as much sulphate as the local lakes and wetlands can tolerate without suffering long-term damage."

[2] Formerly known as the Acidifying Emissions Task Group.

As usual, this progress report also highlights recent actions taken to reduce emissions of acidifying pollutants (from the period September 2005 to August 2007) in New Brunswick, Nova Scotia, Ontario and Quebec. Section 3 of this progress report also focuses on the commitments under *The Strategy* to keep clean areas clean and prevent pollution. These commitments are becoming increasingly important in light of preliminary findings that areas of Manitoba and Saskatchewan, namely downwind of major pollution sources, could be receiving levels of acid deposition in excess of critical loads. Given the fact that emissions of acidifying pollutants are predicted to rise in western Canada due to a growing economy and population, it is clear that more needs to be done to understand the potential for acid rain damage in these "clean" regions.

Section 4 contains an overview of the federal government's action on acidifying emissions.

Section 5 highlights Canada's efforts to reduce transboundary flows of acidifying pollutants from the United States. Canada's compliance status with respect to Protocols of the UN ECE Convention on Long-Range Transboundary Air Pollution is also provided in this section.

Section 6 describes the ARTG's National Acid Rain Science Plan and the efforts underway to ensure that the important acid rain science and monitoring needs identified therein are met, and also introduces the ARTG's interest in the possibility of terrestrial eutrophication from nitrogen deposition.

1.3 Delivery of The Strategy

Many issues related to environmental protection, including acid rain, are a shared responsibility between federal and provincial/territorial governments. The interjurisdictional nature of the acid rain problem requires the cooperation of a broad range of stakeholders and coordination of efforts on a national scale. Because of this, *The Strategy* is delivered under the auspices of the Canadian Council of Ministers of the Environment (CCME). The CCME is comprised of Ministers of the Environment from the federal, provincial and territorial governments. CCME works to promote effective intergovernmental cooperation and coordinated approaches to interjurisdictional issues such as air pollution. To achieve a high level of environmental quality across the country, CCME establishes nationally-consistent environmental standards, strategies and objectives.

The Air Management Committee (AMC) reports to the Environmental Planning and Protection Committee (EPPC) of CCME. The AMC was established to manage intergovernmental approaches to air quality issues in Canada, excluding climate change. The AMC manages air-related Canada-wide standards, the work of air-related working groups and serves as the forum for federal-provincial-territorial dialogue on significant air issues. The AMC also recommends priorities for cooperative action on existing and new air quality issues, potentially including the development of national plans or strategies to address these priorities and potential mechanisms to accomplish them.

The ARTG is a working group reporting to AMC. In support of its role of coordinating *The Strategy* and reporting biennially on progress, the ARTG:

- Provides advice on the implementation of steps aimed at achieving the long-term goal of *The Strategy*
- Undertakes stakeholder consultations as outlined in its work plan
- Recommends revisions to *The Strategy* as required to better meet its objectives
- Identifies emerging issues related to acid deposition
- Tracks acid rain related science developments and provides advice on appropriate response

1.4 The ARTG's approach for coordinating the implementation of The Strategy

In order to ensure that the long-term goal of achieving critical loads is achieved, *The Strategy* commits federal, provincial and territorial Ministers of Environment and Energy to:

- Pursue further emission reduction commitments from the United States
- Establish new sulphur dioxide (SO_2) emission reduction targets in eastern Canada
- Prevent pollution, and keep "clean" areas clean
- Ensure the adequacy of acid rain science and monitoring programs
- Annually report on SO_2 and nitrogen oxides (NO_x) emissions and forecasts, on compliance with international commitments, and on progress in implementing *The Strategy*

The Strategy describes in detail the importance of these commitments in terms of meeting the overall objective of meeting critical loads, however it does not associate timeframes with each commitment or break down the commitments into the specific tasks that should be undertaken to see them achieved.

Since its inception, the ARTG has worked towards accomplishing commitments made in *The Strategy* by undertaking tasks within its purview, such as:

- Hosting a workshop to present the major conclusions of the *2004 Canadian Acid Deposition Science Assessment*, to discuss and identify the implications of the latest science to *The Strategy* and to obtain input on next steps to address acid rain
- Funding work by consultants to advance knowledge of the role of nitrogen in acidification and to develop and map critical loads and exceedances for western Canada

In 2006, the ARTG completed a five-year review of *The Strategy* and together with the *2004 Canadian Acid Deposition Science Assessment*, the review revealed that acid deposition is still exceeding critical loads across a large part of eastern Canada despite our actions to date. According to the latest acid rain science, it seems clear that more concerted and targeted efforts are needed to achieve the commitments made in *The Strategy* – consequently, the ARTG undertook to define *Strategy* commitments in terms of the specific actions or tasks required to achieve them in a Long-Term Strategic Plan.

The ARTG uses their Long-Term Strategic Plan as a tool for planning their yearly work activities and for ensuring these activities are targeted towards achieving the goals of *The Strategy*. The ARTG also considers it to be a set of recommendations to the governments that signed *The Strategy* of the specific actions that are required in order to successfully meet the long-term goal of eliminating critical load exceedances.

The Long-Term Strategic Plan is posted on CCME's website (http://www.ccme.ca/ourwork/air.html?category_id=31#387).

2 State of acid rain in Canada

2.1 Emissions of acidifying pollutants

Canada - the federal government in collaboration with its provinces and territories - has made great strides in reducing emissions of acidifying pollutants since the height of the acid rain problem in the 70s and 80s and in fine-tuning the monitoring, measurement and reporting of these emissions. Tables 1 and 2 on the following pages provide current and historical emissions of SO_2 and NO_x for sector sources, respectively. Reporting on SO_2 and NO_x emissions is a commitment under *The Strategy*.

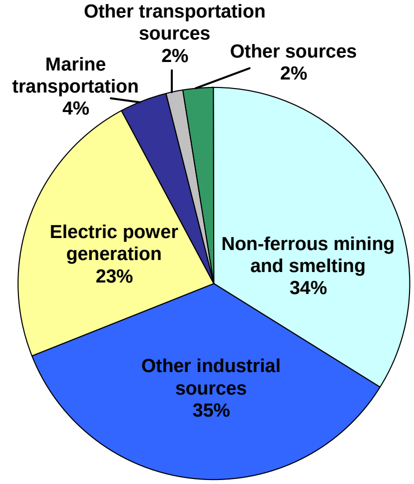

Figure 1a. Canadian emissions sources of Sulphur Dioxide in 2006 – 1.97 Mt

SO_2 emissions in 2006 totalled 1.97 million tonnes (Mt), which is 38% below the 3.2 Mt/yr national cap first defined in the 1985 First UN-ECE Sulphur Protocol (cap for 1993 and beyond) and reiterated under the Canada-U.S. Air Quality Agreement (cap for 2000 and beyond). The largest single source sector of SO_2 emissions in Canada continues to be non-ferrous smelting and refining, with 2006 emissions totalling 666 kt – all other industrial sources of SO_2 combined accounted for an additional 689 kt in SO_2 emissions in 2006. Another significant source of SO_2 emissions in 2006 was fuel combustion in electric power generating facilities (460 kt). Figure 1a illustrates these and other sector contributions to 2006 SO_2 emissions nationally.

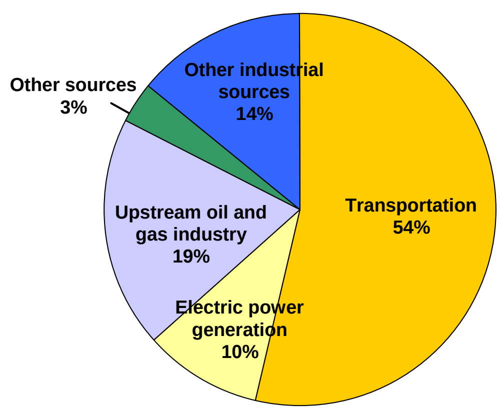

Figure 1b. Canadian emissions sources of Nitrogen Oxides in 2006 – 2.30 Mt

Source: 2006 CAC emissions for Canada, Pollution Data Division, Environment Canada (April 2008)

As shown in Table 2, national NO_x emissions in 2006 totalled 2.30 million tonnes. The most significant source of NO_x emissions in Canada continues to be the transportation sector, contributing to more than half of national emissions. Other sector contributions are shown in Figure 1b.

Figure 2 illustrates the changes in SO_2 and NO_x emissions that have occurred from 1980 to present and predicted for future years. In contrast to national SO_2 emissions, Canada's NO_x emissions have changed relatively little over time, as reductions in some sectors have been offset by increases in others.

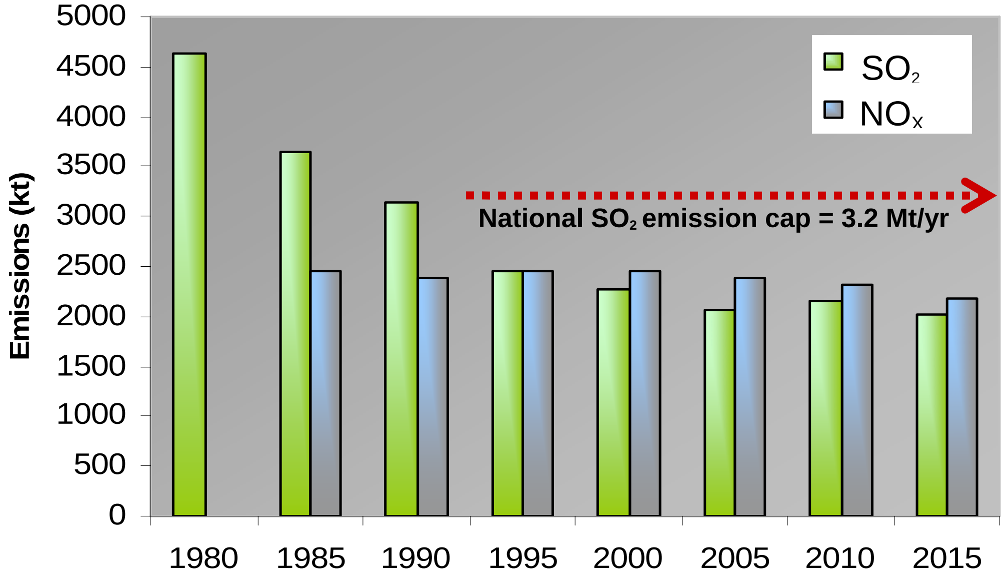

Figure 2. Canadian national emissions of SO_2 and NO_x over the time period 1980-2015
Source: Personal communication, Environment Canada's Criteria Air Contaminants Section, April 2007 (1980 NO_x emissions data is not currently available).

For example, according to Environment Canada[3], NO_x emissions from the transportation sector are projected to decrease to approximately one-half of the 1990 level by 2015 (from 1,555 kt to 783 kt) whereas emissions from the oil sands and upstream oil and gas sectors, together, are projected to increase to 2.6 times the 1990 level (from an estimated 243 kt in 1990 to 632 kt by 2015).

As a consequence of a growing population and economy in western Canada, emissions of acidifying pollutants are increasing in certain regions and this is causing concern that the western provinces (some of which have soils that are as susceptible to acid rain damage as the east) may soon show signs of acidification comparable to what has been experienced in eastern Canada. For this reason, the ARTG and other acid rain stakeholders across Canada are beginning to shift focus to western Canada, in terms of developing critical loads and other science activities.

[3] These data come from data previously published by Environment Canada on the Criteria Air Contaminants website (http://www.ec.gc.ca/pdb/cac/), which was subsequently removed to update forecast and trend data.

Table 1. Total SO_2 emissions by province and sector (kilotonnes)

	Caps [1]			Emissions (kt)					
	1994-99	2005	2010/15 [2]	1990	1995	2000	2002	2005 [3]	2006 [3]
British Columbia									
Upstream oil and gas						31	29	45	46
Non-ferrous mining and smelting						3	4	4	7
Pulp & Paper						16	16	10	14
Transportation						20	20	22	22
Other						14	13	16	16
Total	**N/A**	**N/A**	**N/A**	**90**	**111**	**85**	**82**	**97**	**105**
Alberta									
Upstream oil and gas						226	238	155	149
Oil sands						92	104	144	120
Electric power generation						125	132	130	131
Other						27	28	30	32
Total	**N/A**	**N/A**	**N/A**	**488**	**521**	**470**	**502**	**459**	**432**
Saskatchewan									
Electric power generation						95	98	98	98
Upstream oil and gas						7	8	16	16
Other						12	18	17	17
Total	**N/A**	**N/A**	**N/A**	**90**	**131**	**115**	**123**	**131**	**131**
Manitoba									
Non-ferrous mining and smelting						353	374	384	386
Other						9	7	13	6
Total	**550** [4]	**N/A**	**N/A**	**510**	**365**	**362**	**381**	**397**	**392**
Ontario									
Non-ferrous mining and smelting						255	288	241	231
Petroleum Refining						60	57	47	43
Other industrial sources						66	90	76	70
Electric power generation						166	149	115	88
Other						32	30	36	32
Total	**885**	**N/A**	**442.5**	**1152**	**613**	**579**	**614**	**515**	**464**
Quebec									
Non-ferrous mining and smelting						143	88	29 [5]	33
Aluminum industry						43	53	61	56
Petroleum Refining						15	12	13	13
Pulp and paper						22	23	25	21
Other						68	60	85	76
Total	**500**	**300**	**250**	**402**	**365**	**290**	**237**	**212**	**200**
New Brunswick									
Non-ferrous mining and smelting						12	8	9	7
Pulp and paper						12	12	13	11
Electric power generation						97	83	53	28
Other						19	13	21	17
Total	**175**	**122.5**	**87.5**	**189**	**115**	**141**	**117**	**96**	**63**
Nova Scotia									
Electric power generation						140	132	104	107
Other						27	23	36	32
Total	**189**	**142**	**142** [6]	**179**	**166**	**166**	**154**	**140**	**139**
Prince Edward Island									
Electric power generation						<0.5	<0.5	<0.5	<0.5
Other						2	2	2	2
Total	**5** [4]	**N/A**	**N/A**	**4**	**2**	**3**	**2**	**2**	**2**

	Caps			Emissions (kt)					
	1994-99	2005	2010/15 [2]	1990	1995	2000	2002	2005	2006
Newfoundland and Labrador									
Petroleum refining						25	15	14	13
Iron ore mining						8	6	8	4
Electric power generation						11	25	14	5
Other						7	10	20	19
Total	**45**	**60** [7]	**60**	**71**	**65**	**52**	**55**	**56**	**41**
Yukon									
Total	**N/A**	**N/A**	**N/A**	**N/A**	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**1**
Northwest Territories									
Mining and rock quarrying						<0.5	<0.5	<0.5	<0.5
Upstream oil and gas						0	<0.5	<0.5	<0.5
Other						<0.5	<0.5	<0.5	<0.5
Total	**N/A**	**N/A**	**N/A**	**15**	**16**	**0.5**	**0.5**	**1**	**1**
Nunavut [8]									
Total	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**<0.5**	**<0.5**	**<0.5**	**<0.5**
SOMA [9]									
Total	**1750**	**1750**	**1750**	**1872**	**1227**	**1147**	**1068**	**933**	**Not avail.**
Canada									
Total	**3200**	**3200**	**3200**	**3184**	**2469**	**2263**	**2267**	**2107**	**1971**

[1] A "cap" is a common term for an emissions limit or target. For example, the 1985 Eastern Canada Acid Rain Program established a cap for annual SO_2 emissions of 2.3 Mt / year achievable by 1994 for the seven eastern provinces, collectively. In turn, seven federal-provincial agreements were developed to outline the provincial SO_2 reduction commitments required to reach this regional cap.
[2] Caps for Quebec and New Brunswick are for 2010; the cap for Ontario is for 2015.
[3] For years 2005 and 2006 (available online at http://www.ec.gc.ca/pdb/cac/) in Table 1 above, the emission source classified as the "upstream oil and gas industry" comprises emissions from "Crude Oil and Natural Gas Production and Processing" and from "Other Upstream Petroleum Industry". Likewise, the emission source classified in Table 1 as "oil sands" comprises emissions from "Oil Sands In-Situ Extraction and Processing", "Oil Sands Mining Extraction and Processing", and "Bitumen and Heavy Oil Upgrading".
[4] Cap applied to 1994 only.
[5] As of 2005, emissions from the zinc smelter at Valleyfield will be subtracted from the line "Other" and accounted for under "non-ferrous mining and smelting".
[6] Nova Scotia has a reduction target for existing sources of 94.5 kt by 2010 (not meant to be a cap).
[7] Newfoundland and Labrador's cap of 60 kt per year is provincially regulated through the Air Pollution Control Regulations 2004 and has been in effect since January 1, 2005.
[8] Unless otherwise indicated, the emission summaries for Nunavut are included with the emissions for the Northwest Territories.
[9] The Sulphur Oxide Management Area (SOMA) was designated as part of the 1994 Second Sulphur Protocol as an area of eastern Canada within which emissions of SO_2 are capped at 1.75 million tonnes per year (beginning in 2000). The SOMA is an area of 1 million km^2 that includes all the territory of the provinces of Prince Edward Island, Nova Scotia and New Brunswick, all the territory of the province of Quebec south of a straight line between Havre-St. Pierre on the north coast of the Gulf of Saint Lawrence and the point where the Quebec-Ontario boundary intersects the James Bay coastline, and all the territory of the province of Ontario south of a straight line between the point where the Ontario-Quebec boundary intersects the James Bay coastline and Nipigon River near the north shore of Lake Superior. This designation was meant to manage those SO_2 emissions that may contribute to acidification in the United States and that also contribute to acidification in Canada.

Note: Summing provincial sector values may not equal provincial totals and summing provincial totals may not equal Canada total, due to rounding.
N/A = Not applicable
The emission summaries exclude emissions from open (e.g., landfills) and natural (e.g., forest fires) sources.

Source: National, provincial and territorial emissions inventories were developed collaboratively by Environment Canada and the different jurisdictions using information and statistics compiled through voluntary and mandatory surveys, permits, and models. Commencing in the year 2002, mandatory reported National Pollutant Release Inventory (NPRI) data by stationary point sources were used.

Table 2. Total NO_x emissions by province and sector (kilotonnes)

	Cap for 1994 and beyond	Emissions (kt)				
		1995	**2000**	**2002**	**2005**	**2006**
British Columbia						
Stationary sources			83	93	102	94
Transportation			218	209	176	171
Total	**N/A**	**331**	**301**	**302**	**278**	265
Alberta						
Stationary sources			525	532	573	575
Transportation			231	226	231	236
Total	**N/A**	**681**	**756**	**758**	**804**	811
Saskatchewan						
Stationary sources			72	73	73	68
Transportation			120	118	111	107
Total	**N/A**	**205**	**191**	**191**	**185**	175
Manitoba						
Stationary sources			9	10	12	11
Transportation			72	71	66	64
Total	**N/A**	**92**	**80**	**81**	**79**	74
Ontario [1]						
Stationary sources			208	230	177	156
Transportation			412	389	337	324
Total	**N/A**	**630**	**619**	**619**	**513**	480
Quebec						
Stationary sources			62	69	73	70
Transportation			246	247	219	210
Total	**N/A**	**332**	**307**	**316**	**292**	280
New Brunswick						
Stationary sources			37	35	33	27
Transportation			38	34	32	30
Total	**N/A**	**70**	**76**	**69**	**64**	57
Nova Scotia						
Stationary sources			38	43	43	37
Transportation			33	31	45	44
Total	**N/A**	**78**	**71**	**74**	**88**	81
Prince Edward Island						
Stationary sources			1	1	1	1
Transportation			7	6	6	5
Total	**N/A**	**10**	**8**	**7**	**7**	6
Newfoundland and Labrador						
Stationary sources			14	16	19	19
Transportation			20	20	36	34
Total	**N/A**	**46**	**34**	**36**	**54**	53
Yukon						
Stationary sources			1	1	<0.5	<0.5
Transportation			1	1	1	1
Total	**N/A**	**4**	**2**	**2**	**1**	1
Northwest Territories						
Stationary sources			4	7	7	8
Transportation			3	4	3	2
Total	**N/A**	**12**	**7**	**11**	**10**	11
Nunavut [2]						
Stationary sources			1	2	**4**	**3**
Transportation			1	1	**1**	**1**
Total	**N/A**	**N/A**	**2**	**3**	**5**	**5**
Canada Total	**2514**	**2489**	**2456**	**2469**	**2431**	**2300**

[1] Ontario's NO_X emissions reduction commitment is referenced to its 1990 baseline of 696 kilotonnes.
[2] Unless otherwise indicated the emission summaries for Nunavut are included with the emissions for the Northwest Territories

Note: Stationary sources include both point and area sources
Summing provincial sector values may not equal provincial totals and summing provincial totals may not equal Canada total, due to rounding
N/A = Not applicable
The emission summaries exclude the emissions from forest fires, prescribed burning, and landfill sites.

Source: National, provincial and territorial emissions inventories were developed collaboratively by Environment Canada and the different jurisdictions using information and statistics compiled through voluntary and mandatory surveys, permits, and models. Commencing in the year 2002, mandatory reported National Pollutant Release Inventory (NPRI) data by stationary point sources were used.

Notes on Table 1 and Table 2

Emission trend data shown is current to April 2007, with the exception of 2005 and 2006 data which is current to April 2008. Other trend data is in the process of being updated and will be available in the summer of 2008 on Environment Canada's website (http://www.ec.gc.ca/pdb/cac/cac_home_e.cfm). The update of the emissions trends is required to ensure that all emissions are estimated with the most up-to-date methodologies and that all emitting facilities are adequately captured and characterized throughout the period to 2006.

Emission projections for years beyond 2006 (not shown in the Tables but represented in Figure 2) are currently based on the year 2000 emissions inventory. Environment Canada is in the process of performing 2006-based emissions projections utilizing all the latest energy and economic information available. The Energy 2020 model is being used to develop the projections accounting for all the on-the-books reduction initiatives as well as input from sector experts, industries, and provincial authorities. These emissions projections will be published on Environment Canada's website in the summer of 2008.

Environment Canada and the different jurisdictions are continuously collaborating to improve and update the emission estimates from all sources to reflect the latest emissions estimation methods available, and to ensure the comparability of the emissions trends and projections with the latest emission estimates.

2.2 Deposition of acidifying pollutants

Acidifying emissions (namely SO_2 and NO_x) from point and area sources are deposited on the Earth's surface (namely as sulphate (SO_4^{2-}) and nitrate (NO_3^-)) in rain and snow, particles and gases and/or in cloud water and fog. Temporal and spatial information on the total deposition of these pollutants is essential to be able to determine what areas of the country are susceptible to acid rain damage, as well as what changes can be observed based on past and proposed emission control actions.

In Canada, wet deposition data are currently collected at over 70 sites across the country by the Canadian Air and Precipitation Monitoring Network (CAPMoN) and several provincial monitoring networks. Data from these networks as well as networks in the U.S. are stored in and analyzed by the Canadian National Atmospheric Chemistry (NAtChem) Database and Analysis Facility. The maps below provide a geographical comparison of wet deposition levels (kg/ha/yr) in North America between the periods 1990-1994 and 2000-2004. These two time periods occurred immediately before and after of the implementation of the Phase 1 SO_2 emission reductions legislated under Title IV of the U.S. Clean Air Act. Emission reductions under *The*

Strategy will not be fully implemented until 2010-2015. As can be observed on the maps, some monitoring sites have been shut down over the years and large areas of Canada are not being monitored. Given the paucity of the data it is not possible to draw contour lines across Canada north of 49° N latitude; therefore, dots are plotted instead.

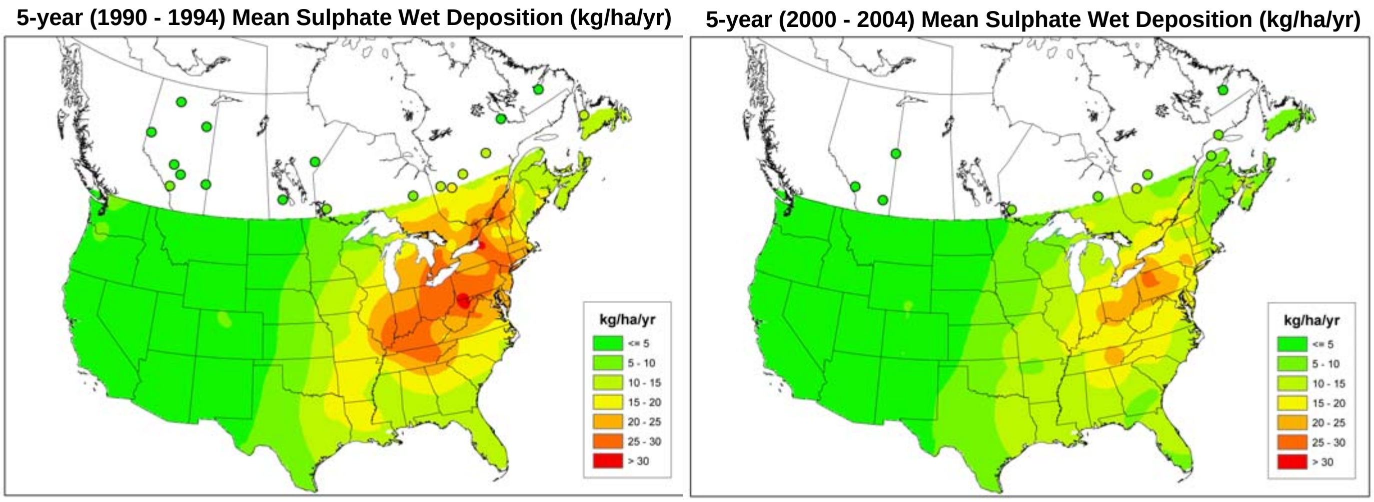

Figure 3. Changes in the spatial pattern of wet non-sea-salt sulphate deposition ($nssSO_4^{2-}$) between two 5-yr average periods: 1990-1994 and 2000-2004 (NAtChem, 2007).

The highest levels of wet non-sea-salt sulphate deposition occur in eastern North America along a southwest to northeast axis (Figure 3). Non-sea-salt sulphate refers to sulphate that is attributed only to anthropogenic sources. When comparing the two average periods a significant reduction of the area receiving over 20 kg/ha/yr (Canada's early target load)[4] can be observed. This area currently extends over the entire Ohio River Valley and a small section of southern Ontario with maximum levels (>25 kg/ha/yr) occurring immediately south of Lake Erie in eastern Ohio and western Pennsylvania. The acid-sensitive areas of the Canadian Shield in Ontario, Quebec, Nova Scotia and New Brunswick receive variable levels of wet sulphate deposition ranging from 5 to 20 kg/ha/yr.

The pattern of wet nitrate deposition in eastern North America (Figure 4) roughly matches that of wet sulphate deposition although it is more focused around the Great Lakes. Although observed changes in wet nitrate deposition are more subtle than for sulphate, wet nitrate deposition has declined significantly between the two periods with a disappearance of the area receiving over 20kg/ha/yr. Maximum levels ranging from 15-20 kg/ha/yr now encompass areas of southern Quebec, southcentral Ontario and south of Lake Erie and Lake Ontario. Deposition data for the western provinces are very sparse, but generally speaking, both wet sulphate and wet nitrate deposition levels in western Canada are currently lower than in eastern Canada.

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[4] Under the 1985 Eastern Canada Acid Rain Program, Canada committed to cap SO_2 emissions in the seven provinces from Manitoba eastwards at 2.3 million tonnes per year by 1994. The program's objective was to reduce wet sulphate deposition to a *target load* of no more than 20 kilograms per hectare per year (kg/ha/yr), which scientists defined at the time as the acceptable deposition rate to protect moderately sensitive aquatic ecosystems from acidification.

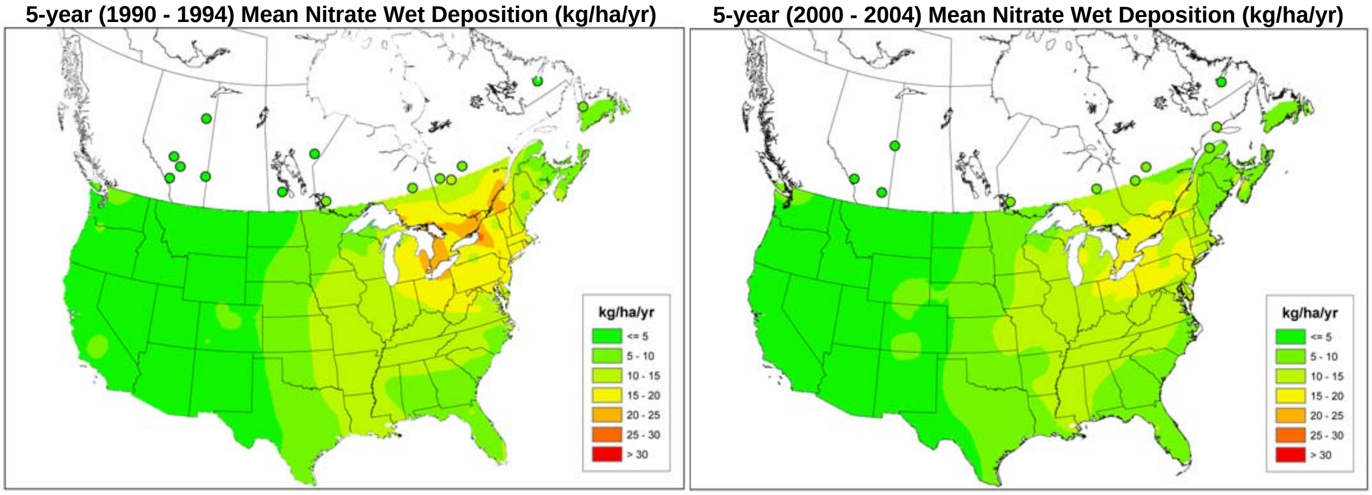

Figure 4. Changes in the spatial pattern of wet nitrate deposition between two 5-yr average periods: 1990-1994 and 2000-2004 (NAtChem, 2007).

In order to obtain a more complete picture of the ecosystem effects of acid deposition, it is necessary to know what the levels of total (wet + dry) deposition are. Measuring dry deposition is operationally complex and costly compared to wet deposition. As a result, a combined measurement/modelling technique is used to estimate dry deposition rates from measured concentrations of these pollutants in the air. Recent results (Vet et al., 2005) show that dry deposition constitutes a larger portion of total sulphur and nitrogen deposition than previously thought, ranging in eastern Canada from 24 to 46% for sulphur and 23 to 58% for nitrogen (depending on the location). Limited data from western Canada show that dry deposition constitutes a higher portion of total deposition than in eastern Canada.

A closer look at deposition at the provincial level: Trend of wet deposition of sulphate in New Brunswick

New Brunswick has operated an extensive acid rain monitoring network since the early 1980s. There are currently 13 active monitoring sites, with up to 18 sites historically. The sites are predominately located in rural locations, removed from local pollution sources. Wet deposition is a function of both sulphate concentration in precipitation and amount of precipitation received. As a result, there is both a fluctuation in wet deposition levels from year to year and variability between the concentration in precipitation and deposition measured within a single year. Figure 5 shows annual non-sea-salt sulphate concentration in precipitation and wet deposition changes over time. The lowest annual sulphate deposition level, as a network wide average, was measured in 2004, when deposition was below 9 kg/ha/yr. This is a considerable decrease from the highest measured deposition level of >20 kg/ha/yr in 1990. Long-term changes or trends can also be observed by determining the annual average sulphate concentration in precipitation for New Brunswick for all sites that are in operation.

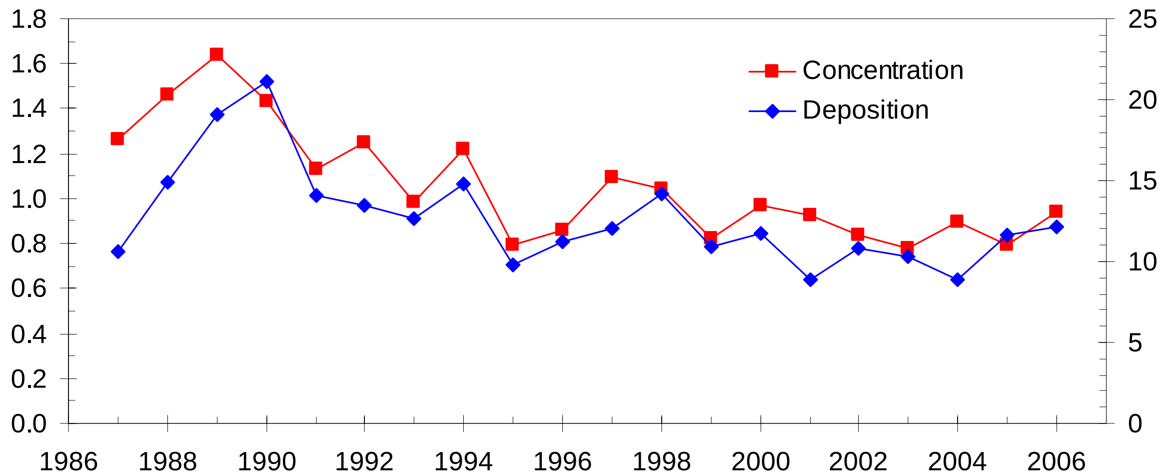

Figure 5. Trend of monitored non-sea-salt sulphate in precipitation (scale on the left = Concentration (mg/L), red line) and wet deposition (scale on the right = Deposition (kg/ha/yr), blue line) from 1987 – 2006, as measured in New Brunswick.

The long-term trends shown above indicate that sulphate deposition and the concentration of acidic pollutants in precipitation have been decreasing since the late 1980s, reflecting reductions in sulphur dioxide emissions in eastern Canada and the United States in the same time period.

In addition to precipitation chemistry monitoring, New Brunswick periodically monitors approximately 100 lakes to assess the effects of acid deposition on lake chemistry. The last survey was completed in 2006. While some lakes have shown improvements, acid deposition is still affecting certain lakes in the province.

2.3 Ecosystem critical loads and exceedances

Canada uses the critical load concept to assess the level of acidifying emission reductions required in order to protect sensitive ecosystems. A critical load is defined as the amount of acid deposition an ecosystem can withstand over the long-term before it is significantly harmed, and so is a measure of how sensitive an ecosystem is over the long-term. A critical load exceedance is a measurement of the amount of acid deposition received beyond this threshold (exceedance = acidifying deposition – critical load). In the late 1990s, when *The Strategy* was signed, critical loads were defined as the amount of wet sulphate that can be deposited onto a region and still maintain 95% of the lakes in the region at or above a pH of 6. The approach used to characterize critical loads has evolved since then, and critical load estimates, as well as estimates of exceedance, are now available for aquatic and forest ecosystems with respect to total acid deposition, i.e., wet plus dry deposition of sulphur plus nitrogen (in equivalents/ha/yr) for eastern Canada and parts of western Canada.

The critical load value for a particular region is now determined by the most sensitive ecosystem in that region, i.e., either the aquatic critical load value or the terrestrial critical load value - whichever value is lower - is used as the ecosystem's critical load value. Exceedances of critical loads have been calculated based on the average total sulphur and nitrogen deposition (both wet and dry) over the period 1994-1998 (Jeffries and Ouimet, 2005) using two different assumptions that span the possible range of effects associated with nitrogen deposition: the Nitrogen-leaching or N-leaching assumption (Figure 6) and the Steady-state assumption (Figure 7).[5]

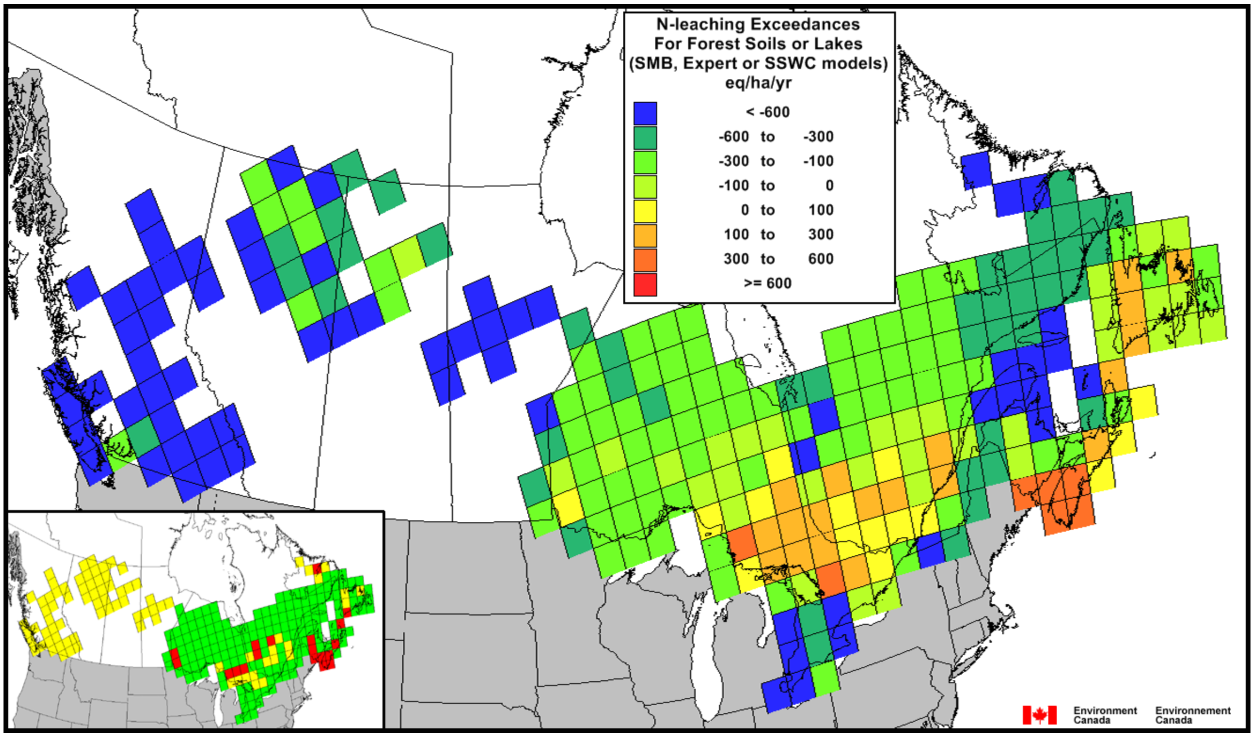

Figure 6. Short-term (N-leaching) exceedances of critical load of sulphur and nitrogen for aquatic or upland forest soils in eastern Canada based on 1994-1998 average deposition data (Jeffries and Ouimet, 2005). The index map (lower left of the Figure) indicates which model was used to calculate the critical load for that grid square: red = Expert water chemistry model (hence the critical load is an aquatic critical load); yellow = SSWC water chemistry model (aquatic critical load); and green = SMB model (upland forest soil critical load). The forest critical load data used to create this exceedance map was produced by the Forest Mapping Working Group of the New England Governors / Eastern Canadian Premiers (NEG/ECP) Secretariat in cooperation with Ontario, Environment Canada and Natural Resources Canada – Canadian Forest Service.[5]

A change in units

Due to the fact that critical loads are now expressed for sulphur and nitrogen combined and these compounds have different atomic weights, the units used are now charge equivalents or moles of charge per hectare per year (eq/ha/yr or mol_c/ha/yr), both of which are interchangeable and used in this report. Combined critical loads can no longer be reported in kg/ha/yr as was done in the past. As a point of reference, however, 400 eq/ha/yr = 19.2 kg SO_4^{2-}/ha/yr, which is close to the 1983 target of 20 kg wet SO_4^{2-}/ha/yr.

In the N-leaching assumption shown in Figure 6, acidifying deposition is considered to be all wet and dry forms of deposited sulphur and only the component of nitrogen deposition that presently

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[5] Figures 6 and 7 are reproductions of Figures 8.8a and 8.8b, respectively, from "Chapter 8 - Critical Loads: Are they being exceeded?" of the *2004 Canadian Acid Deposition Science Assessment* (Jeffries and Ouimet, 2005). This chapter of the *Assessment* also contains more details on the methodology used to develop critical loads and exceedances. Access the full version of the *Assessment* or the *Summary of Key Results* online at http://www.msc-smc.ec.gc.ca/saib/acid/acid_e.html.

leaves (or "leaches" from) a watershed, i.e., not used by plants, or transformed in other biological processes. Hence, Figure 6 illustrates the area of eastern Canada (0.5 million km^2) that is at immediate or short-term risk of being impacted by current levels of acid deposition, assuming that ecosystems have yet to reach equilibrium with respect to nitrogen deposition.

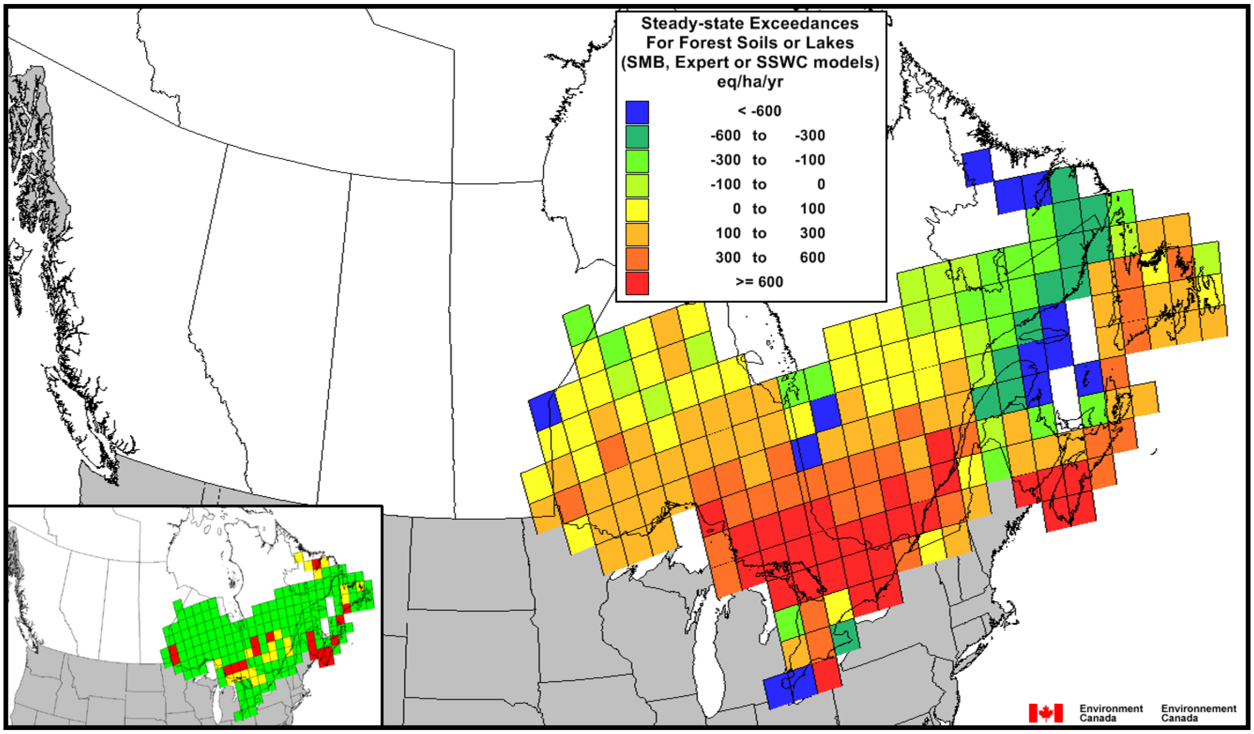

Figure 7. Long-term (Steady-state) exceedances of critical load of sulphur and nitrogen for aquatic or upland forest soils in eastern Canada based on 1994-1998 average deposition data (Jeffries and Ouimet, 2005). The index map (lower left of the Figure) indicates which model was used to calculate the critical load for that grid square: red = Expert water chemistry model (hence the critical load is an aquatic critical load); yellow = SSWC water chemistry model (aquatic critical load); and green = SMB model (upland forest soil critical load). The forest critical load data used to create this exceedance map was produced by the Forest Mapping Working Group of the New England Governors / Eastern Canadian Premiers (NEG/ECP) Secretariat in cooperation with Ontario, Environment Canada and Natural Resources Canada – Canadian Forest Service.[5]

Figure 7 shows exceedances estimated using the Steady-state assumption, considered a more accurate measure of the sustainable (long-term) impacts of current levels of acid deposition assuming that all nitrogen deposition will eventually become acidifying. In a Steady-state assumption, all deposited nitrogen on a nitrogen saturated ecosystem (one that will not be affected in terms of growth or biological activity by an increase in nitrogen deposition) is considered acidifying. The exceeded area in Figure 7 corresponds to about 1.8 million km^2.

Both immediate (Figure 6) and long-term (Figure 7) exceedances – all yellow, orange and red squares - of critical loads are located in south-central Ontario, south-western Quebec, southern Nova Scotia and New Brunswick, and Labrador.

During the last two years, significant progress has been made in assessing the sensitivity of ecosystems in western Canada to acid deposition. For example, Trent University (under contract to the ARTG) estimated and mapped critical loads and exceedances for sulphur and nitrogen for forest soils in Manitoba and Saskatchewan (Aherne and Watmough, 2006)[6]. The analyses, which employed the protocol developed by the New England Governors and Eastern Canadian Premiers[7] to develop critical loads for upland forest soils in eastern Canada and the New England states, indicated that both provinces have areas where estimated deposition of sulphur and nitrogen exceeded critical loads for forest soils. The authors suggested that the estimated critical load and exceedance values are potentially conservative and may therefore underestimate the acid deposition problem in western Canada. Furthermore, they recommend that the results be used as a broad regional indicator of a potential acid deposition problem as there are gaps in the available data used to support the critical load and exceedance estimates.

More recently, Trent University has been contracted by the ARTG to refine the above-mentioned critical loads and exceedance estimates. Firstly, the critical load values for the forest soils of Manitoba and Saskatchewan are being revised based on a number of key data updates (e.g., base cation deposition, runoff estimates) and improved estimation techniques (e.g., revised treatment of organic soils). Secondly, critical load exceedance results will be estimated for multiple *modelled* deposition fields in recognition of the fact that previous exceedance results were based on deposition fields generated using measured (not modelled) data from a limited number of acid deposition sites. This new work is expected to be available on CCME's website[8] during the summer of 2008.

Trent University is also calculating and mapping critical load and exceedance estimates for forest soils of Alberta. This work, also expected to be available on CCME's website in the summer of 2008, is being carried out following the same methodology applied to provinces east of Alberta. For the first time in Canada, the work will introduce the application of a soil point approach (i.e., soil characteristics based on *individual soil observations* made in the field) to estimate provincial critical loads, and compare these results to the critical loads calculated using the standard 'mapped-based' approach (characteristics based on general soil maps).

How will emission reductions under *The Strategy* and previous programs in Canada and the U.S. affect deposition and in turn critical load exceedance?

Assessing risk of acid rain damage to ecosystems after the full implementation of acidifying emission reduction commitments currently in place (including those made by Québec, Nova Scotia, Ontario and New Brunswick under *The Strategy* as well as programs in the U.S.) is an important step in evaluating how Canada is progressing toward eliminating critical load exceedances and protecting "clean" areas.

Acid deposition models, such as the Atmospheric Deposition and Oxidant Model (ADOM), allow scientists to predict the ambient air concentrations and deposition patterns that may result from given emissions of acidifying pollutants from various sources and prevailing

[6] Report available at http://www.ccme.ca/assets/pdf/critical_loads_mb_sk_1372_web.pdf.

[7] NEG/ECP Environment Task Group, 2001. *Critical load of sulphur and nitrogen assessment and mapping protocol for upland forests*, New England Governors and Eastern Canadian Premiers, Acid Rain Action Plan, Halifax, Canada.

[8] http://www.ccme.ca/ourwork/air.html?category_id=31#249

meteorological conditions. Most importantly, acid deposition models can be used to “fill in the gaps” of monitoring networks and also to simulate “what if?” scenarios, i.e., what acid deposition levels will result if emissions go up/go down? Conversely, acid deposition models allow scientists to estimate the magnitude of emission reductions necessary from different sources and regions to obtain certain air quality objectives or a deposition target load, such as a specific critical load.

A number of emission reduction scenarios have been analyzed with ADOM over the years. The **75FCAP** scenario was selected by the Acidifying Emissions Task Group (former name of the Acid Rain Task Group) and run by Environment Canada as part of the analysis carried out to be able to recommend adequate emission reductions for eliminating critical load exceedances under a new acid rain strategy, which we now know as *The Canada-Wide Acid Rain Strategy for Post-2000* (Environment Canada, 1997). The 75FCAP scenario assesses emission reduction outcomes based on a 75% rollback from commitments that were in place before 1996. Specifically those commitments include the targets set under the *1985 Eastern Canada Acid Rain Program* and the *US 1990 Clean Air Act Amendments.* These match the targets under the 1991 Can-US Air Quality Agreement (i.e., the Canada-US AQA reiterates the targets set under these preceding programs/amendments).

In the *2004 Acid Deposition Science Assessment*, the results of this 75FCAP scenario in ADOM were used to calculate exceedances of 1997 aquatic critical loads and showed that a 75% further SO_2 reduction in both eastern Canada and the U.S. from the above mentioned commitments would virtually eliminate critical load exceedances in all of eastern Canada with the exception of a small spot in western Québec (Moran, 2005).

Since then, Environment Canada (Moran, 2007) has redone the analysis of the 75FCAP scenario with ADOM using the most recent critical load estimates[9] and also run a scenario called **NOX3P**. NOX3P represents SO_2 and NO_x emission reductions from specific sources under *The Strategy* and previously legislated reductions in Canada and the U.S. to come into full force by 2020. Exceedances have been calculated assuming a short-term condition where acidification is caused by sulphur (S) deposition alone (N-leaching), and a long-term condition (Steady-state) where both S and nitrogen (N) are acidifying if/once watersheds become N saturated.

Figure 8 illustrates the area predicted to receive total sulphur deposition (no N deposition) in exceedance of lake or forest soil critical loads (in eq/ha/yr) for each of the two ADOM scenarios. In the first scenario (left panel of Figure 8) total S deposition in the year 2020, once commitments under *The Strategy* and previously legislated controls in Canada and the U.S. to reduce SO_2 emissions are fully implemented, will continue to exceed critical loads in areas of eastern Canada. A band of critical load exceedance ranging from about 0 to 200 eq of S/ha/yr (blue and turquoise squares) is predicted to remain across central Ontario and south-central Quebec, as well as parts of New Brunswick, Nova Scotia, and Newfoundland. One square in

[9] The most up-to-date critical loads refer to those used for the for lakes and soils in eastern and parts of western Canada published in the *2004 Canadian Acid Deposition Science Assessment* (Jeffries and Ouimet, 2005) as well as the critical loads developed for the forest soils of Manitoba and Saskatchewan (Aherne and Watmough, 2006).

central Ontario is shown to be exceeded by up to ~400 eq S/ha/yr (orange). In the second scenario (right panel of Figure 8), a further 75% SO_2 emission reduction beyond commitments in the Canada – U.S. Air Quality Agreement, but not including *The Strategy* and other more current legislation, would further reduce the area but not eliminate it.

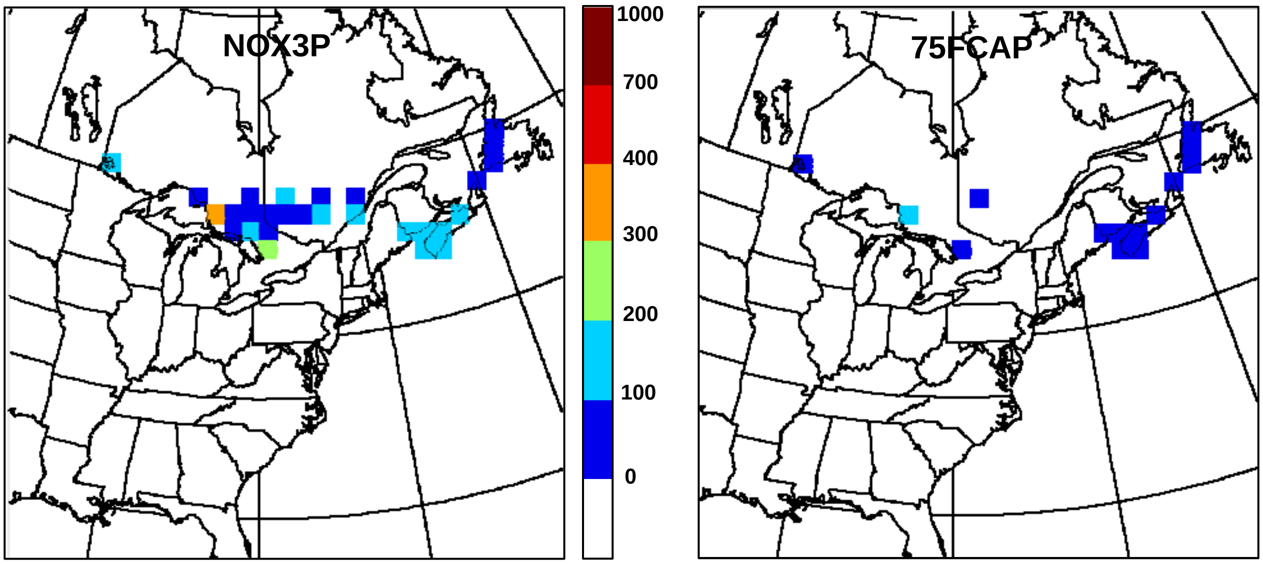

Figure 8. Sulphur deposition only critical load exceedance for ADOM scenarios NOX3P (left); and 75FCAP (right). Legend (coloured bar in the middle of the Figure) shows exceedances in eq/ha/yr.

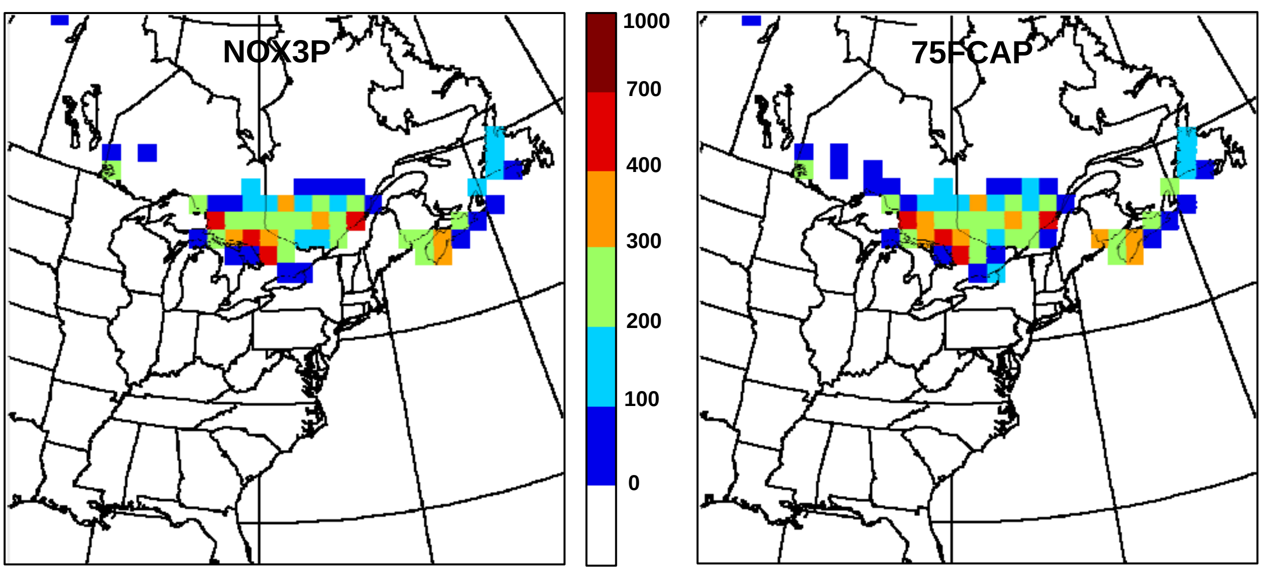

Figure 9. Total Sulphur + Nitrogen deposition critical load exceedance for NOX3P (left); and 75FCAP (right). Legend (coloured bar in the middle of the Figure) shows exceedances in eq/ha/yr.

As mentioned in a previous section, a more realistic assumption is that over the long-term, all N deposition will become acidifying in addition to S deposition. Although N saturation and leaching is currently not a problem in most eastern Canadian watersheds, the capacity for terrestrial watersheds to retain nitrogen deposition is finite (Environment Canada, 2005). Figure 9 illustrates the area predicted to receive total S + N deposition above lake and forest soil critical loads (in eq/ha/yr) for the two ADOM deposition scenarios. Critical load exceedances for S + N deposition combined cover a larger area and greater magnitude across southeastern Canada than exceedances from S deposition only. Exceedances range from 0 to 700 eq/ha/yr (blue, turquoise, green, orange and red squares) and one exceedance square can be observed in northern Saskatchewan. Combined S + N exceedances are very similar for both scenarios.

In both Figure 8 and Figure 9, emissions associated with the scenarios were as follows[10]:

- 75FCAP: Domain-total Canadian SO_2 and NO_x emissions were 579 and 1,109 kt/year respectively and domain-total U.S. SO_2 and NO_x emissions were 3,112 and 13,252 kt/yr, respectively.
- NOX3P: Domain-total Canadian SO_2 and NO_x emissions were 1,219 and 983 kt/year respectively and domain-total U.S. SO_2 and NO_x emissions were 8,252 and 7,908 kt/yr, respectively.

In conclusion, despite significant reductions in SO_2 emissions over the last few decades and a consequent decline in wet sulphate deposition levels in eastern Canada, aquatic and terrestrial critical loads will continue to be exceeded over large areas under currently in place emissions reduction measures which will be fully implemented by 2020. More importantly, in order to protect the sustainability of ecosystems over the long-term (e.g. should N acidification become more prevalent), further NO_x emission reductions are also required.

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[10] Moran, 2005, Tables 4.1 and 4.2.

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3 Provincial actions to reduce acidifying emissions

3.1 Provinces committed to reducing emissions under The Strategy

Under *The Strategy*, the four eastern provinces of New Brunswick, Quebec, Nova Scotia and Ontario put in place new targets and timelines for reducing emissions of SO2 as reported in past editions of progress reports on *The Strategy*. The following section outlines some of the various provincial measures that have been put into place or are planned to meet these goals.

New Brunswick

New Brunswick is well along in meeting its commitment to the Acid Rain Strategy for Post-2000. In fact, estimated SO_2 emissions in 2004 and 2005 are approximately 90 kilotonnes per year, representing a reduction of 50% since 1990. This has been realized largely through ongoing reductions of emissions in the electric power sector. The Coleson Cove power plant has significantly contributed to reduction of SO_2, as well as NO_x and particulate matter (PM), with the addition of flue gas desulphurization and other pollution control equipment in 2005. As a result the Grand Lake power plant has replaced Coleson Cove as the largest point source of SO_2 emissions in the province. Grand Lake is slated for decommissioning or major refurbishment with extensive pollution control equipment by 2010. Also, with the refurbishment of the Pt. Lepreau plant underway, nuclear power will continue to be an important source of energy in the province for years to come.

Since 1990, New Brunswick has also seen reduction of SO_2 emissions in its Pulp and Paper, Base Metal Smelting and Oil Refining sectors. This has been achieved through a combination of measures including the substitution of biomass fuel for fossil fuels, energy efficiency measures, and the addition of pollution control equipment.

Nova Scotia

The Nova Scotia Air Quality Regulations were amended in February 2005 to implement the SO_2 and NO_x reduction commitments announced in the provincial Energy Strategy (2001). The amended regulations include several measures to reduce SO_2 emissions. The previous provincial annual SO_2 cap was reduced by 25% to 141,750 tonnes, and included a corresponding 25% cap reduction for the province's largest SO_2 emitter, Nova Scotia Power (NSPI), by 2005. The Energy Strategy set out a target of a 50% reduction in SO_2 emissions from existing sources to 94,500 tonnes by 2010. The amendments to the Air Quality Regulations in 2005 required a further 25% reduction in NSPI's SO_2 emission cap in 2010 and the submission of SO_2 emission reduction plans by large industrial emitters by the end of 2007. The regulations also established a 2% sulphur content limit for heavy fuel oil consumed in the province.

The Energy Strategy additionally included a commitment to reduce NO_x emissions by 20% from 2000 levels by 2009. The amendments to the regulations place a corresponding cap on NO_x emissions from the largest electricity generating utility (NSPI). Additional reductions in NO_x

emissions are anticipated from the transportation sector, mainly through implementation of federal vehicle, engine and fuel measures.

Since the time of the last progress report, the 2005 SO_2 target has been met by NSPI. There has also been increased wind energy capacity introduced in Nova Scotia. In fact, it is proposed that by 2013, almost 20 per cent of Nova Scotia's electricity will be generated by renewable energy.

Ontario

Ontario’s primary focus for 2005-2007 was to achieve reductions of SO_2 from coal fired electricity generators, non-ferrous smelting operations and transboundary emission reductions. Sulphur dioxide emission reductions also have the co-benefit of reducing PM levels in ambient air.

Ontario is committed to reducing its emissions of SO_2 by 50 percent from its Countdown Acid Rain Cap, and NO_x by 45 percent from the province’s 1990 level by 2015. By 2005, Ontario had reduced its SO_2 by 42 percent and its NO_x by 25 percent from these respective base lines. In addition, coal fired electricity generator SO_2 emission rates have been reduced by 44 percent since 2003, while NO_x emissions have declined 46 percent since 2003.

Ontario is expecting to achieve the following emission reductions from 1990 baseline levels:

- Sulphur dioxide (SO_2):
    - 1990-2010 (-55% or 639 kt reduction)
    - 1990-2015 (-69% or 791 kt reduction)
- Nitrogen oxides (NO_x):
    - 1990-2010 (-34% or 239 kt reduction)
    - 1990-2015 (-43% or 300 kt reduction)

Since 2000, Ontario has implemented other key regulatory initiatives to achieve further reductions. For example, Ontario’s Emissions Trading regulation (O. Reg. 397/01) that established SO_2 and NO_x emission caps from Ontario Power Generation’s fossil plants and the electricity sector required the coal-fired Lakeview Generating Station in Mississauga to cease burning coal by April 2005 (O. Reg. 396/01). Through provincial Orders, INCO and Falconbridge are required to reduce their allowable SO_2 emissions by 34 percent, effective 2007.

In June 2004, Ontario announced a comprehensive Five-Point Plan for Cleaner Air to reduce industrial emissions of harmful air pollutants. As a result in 2005, two new regulations were promulgated that require industry to reduce their emissions of harmful air pollutants, namely O. Reg. 194/05 Industry Emissions – Nitrogen Oxides and Sulphur Dioxide and O. Reg. 419/05 Air Pollution- Local Air Quality.

Ontario’s Industry Emissions – Nitrogen Oxides and Sulphur Dioxide Regulation, O. Reg. 194/05) established new emissions caps for industrial pollution sources in Ontario starting in 2006 and becoming even stricter in 2007, 2010 and 2015. The regulation covers seven industrial sectors: iron and steel, cement, petroleum refining, pulp and paper, non-ferrous smelting, carbon black, and glass.

O. Reg. 419/05 Air Pollution- Local Air Quality sets new air quality standards, in some cases for the first time, for many harmful pollutants; introduces new atmospheric dispersion models and a faster, risk-based approach to implementing new air quality standards

The Ontario Emissions Trading Regulation (O. Reg. 397/01) is designed to reduce annual emission limits from Ontario Power Generation's (OPG's) fossil-fired generating stations (GSs) by over 50 percent (45 kt) for NO_x and 25 percent (44 kt) for SO_2 by 2007. OPG's large fossil-fired GSs are: Atikokan (coal), Lambton (coal), Lennox (oil and/or natural gas), Nanticoke (coal), and Thunder Bay (coal). On January 1, 2004, independent power producers' facilities (24 in total) fell under this same regulation.

Québec

In Québec, acid rain has been reduced by means of specific initiatives or events and regulatory measures. Notably, these include:

- closure of the Murdochville copper smelter in April 2002;
- greater use of biomass as a forest industry fuel;
- increased availability of natural gas in Québec, allowing for less use of fuel oil;
- in 1990, the Regulation respecting the quality of the atmosphere (RQA) set a maximum of 1.5% sulphur content in heavy fuel oil used in oil-burning equipment installed after June 1, 1990. Since then, a number of industrials have opted to use fuel oil with a lower sulphur content throughout their facility instead of running two systems that use fuel oils with different sulphur levels.

The RQA is currently being revamped via the Draft Air Quality Regulation (DAQR). In relation to the new draft regulation, the Horne Smelter of Xstrata Copper Canada (formerly Noranda Inc.) undertook to limit, by 2006, the SO_2 emission rate to 10% of the sulphur input rate for its copper smelter in Rouyn. Following the work already done to meet this commitment, in 2005 this plant reported emissions of 22.7 kilotonnes compared to 62.2 kilotonnes in 2002.

Since 2002, Québec's sulphur dioxide emissions have been lower than the province's annual SO_2 emissions limit of 250 kt set for 2010. Efforts are being made to maintain this situation, which include the following regulatory initiatives:

- lowering the maximum sulphur content in heavy fuel oil for all users from 2% to 1.5%, proposed in the Regulation respecting the quality of the atmosphere (RQA) as published in Gazette officielle du Québec in November 2005;
- establishing, in the Draft Air Quality Regulation, a NO_x emission limit of 2100 tonnes per year for the Tracy power station; this will also have the effect of limiting SO_2 emissions.

Other reductions will be obtained when certain interdepartmental initiatives are implemented, including the Québec Climate Change Action Plan 2006-2012, the energy efficiency measures proposed in the Québec Energy Strategy (2006), and private initiatives such as improving the energy efficiency of industrial boilers and greater use of residual biomass as fuel.

3.2 Provinces committed to keeping clean areas clean and preventing pollution

Alberta

Alberta stakeholders have expressed concerns on environmental, economic, social, and First Nations and Mètis issues associated with oil sands development. In response to these concerns, Government of Alberta initiated the oil sands development consultation process. The process was recommended by a MLA-led Consultation Advisory Group to the Ministers of Energy, Environment, and Sustainable Resource Development. An Oil Sands Multistakeholder Committee was formed and given the responsibility for directing the consultation process and making recommendations to the Government of Alberta for its consideration. Phase 1 of the two-phase process sought input from Albertans regarding their vision for oil sands development and principles to assist in guiding future policy directions. It included public meetings in seven communities throughout Alberta, which were conducted by a representative panel drawn from the members of the Multistakeholder Committee. It also included a "Vision Summit" where the views of a representative cross section of acknowledged leaders were solicited. Phase 2, which was scheduled for completion by June 2007, was intended to develop strategies and policies to implement the vision.

Alberta Environment has implemented the Alberta Clean Air Strategic Alliance's management framework for air pollutants emissions from the electric power sector in Alberta. New air emission limits for nitrogen oxides and sulphur dioxide were developed and executed through 10-year approvals. Existing limits would apply until the end of a facility's design life. Beyond this, the facility operator must either retrofit to meet the new standards or employ emissions credits. New units must meet the standards in force at time of construction. Standards will be reviewed every five years, to encourage continuous improvement. To provide industry with flexibility to meet new standards, encourage early emissions reductions and early shutdown of older units, Alberta has also developed a new emission trading regulation under the Environmental Protection and Enhancement Act and guidance documents for a trading program.

British Columbia

Emissions of SO_2 in B.C. are predominantly from the upstream oil and gas industry, followed by the pulp and paper industry, other point sources, and marine transportation. NO_x emissions are largely distributed among marine transportation, heavy-duty diesel vehicles, off-road diesel use and the upstream oil and gas industry.

Approximately 90% of the province's electricity generation is from clean or renewable resources. As part of the BC Energy Plan, released in 2007, the province has committed to maintaining this level. Clean or renewable resources include water power, solar energy, wind energy, tidal energy, geothermal energy, wood residue energy and energy from organic municipal waste. The BC Energy Plan further commits the province to eliminate all routine flaring at oil and gas producing wells and production facilities by 2016 with an interim goal to reduce flaring in half by 2011.

The province has committed $13.5 million over the next three years to achieve air quality improvements throughout the province. Planned initiatives that will reduce SO2 releases include electrified truck stops and support for other and-idling measures, retrofitting diesel buses and encouraging industry to adopt better emission technologies. This will further support airshed planning activities already underway in more than a dozen communities across the province.

Manitoba

In Manitoba, emissions from industrial developments are regulated under *The Environment Act*. Manitoba's SO_2 emissions arise mostly from the base metal smelter sector. 2005 SO_2 emissions from the base metals smelting sector were 384 kt, or 98% of total provincial SO_2 emissions. These releases can vary from year to year due to factors such as operating schedules, shutdowns, etc. Manitoba continues to work with its industry to strive to manage emissions to ensure protection of local community air quality and to natural systems downwind from the facilities.

In late 2005, the Manitoba government formally released a green strategic framework which will guide the province in its efforts to preserve and protect the environment, promote the health and well-being of Manitoba families, and stimulate and manage sustainable economic growth.[11] Among the seven priorities identified are "acting on energy and climate change", "growing a sustainable, prosperous economy", and "greening the provincial government". A key component common to these three priorities is the reduction in fossil fuel use, with an anticipated concomitant decrease in emissions of air pollutants such as acid rain causing gases. Reduced fossil fuel use will be achieved through the development and promotion of alternative energy sources (*e.g.,* wind, geothermal, hydroelectricity) and increases in energy efficiency.

New Brunswick

New Brunswick recently released its Climate Change Action Plan which outlines plans to reduce GHG emissions to 16.1 megatonnes by 2012. This goal of reducing GHG emissions by approximately 25% from current levels will be achieved through the implementation of strategic initiatives which affect all aspects of the provincial economy. These initiatives include energy efficiency, fuel switching to cleaner fuels, measures to discourage idling to promote consumer awareness of the benefits of smaller, more fuel efficient vehicles.

Key areas of activity include:

- Energy Efficiency and Renewable Energy
- Transportation
- Waste Management
- Industrial Sources and Future Energy Opportunities
- Government Leading by Example
- Adapting to the Impacts of Climate Change
- Partnerships and Communication

[11] Province of Manitoba, "Green and Growing: Building a Green and Prosperous Future for Manitoba Families", December 2005.

Since the goal of the New Brunswick Climate Change Action Plan is to reduce GHG emissions and thereby lessen our dependence upon fossil fuel combustion as a source of energy, this will cause overall emissions of other air pollutants such as SO2 and NO_x to be reduced.

Newfoundland & Labrador

The largest sources of SO_2 in Newfoundland & Labrador include electric power generation, petroleum refining, and the iron ore mining industry, together accounting for more than 80% of the province's annual SO_2 emissions in 2005.

These same sources also are main contributors to provincial NO_x emissions, in addition to a large contribution from the transportation sector (especially marine and air transportation and diesel-powered land vehicles).

Efforts to abate acidifying emissions in Newfoundland & Labrador have focussed largely on SO_2. Emissions reductions have been realized through a number of initiatives over the years and those that are ongoing. SO_2 emissions have been reduced from 94 kt in 1993 to about 42 kt in 2005.

Newfoundland & Labrador instituted a provincial SO_2 emissions cap of 60 kt/yr, in effect since January 2005 under section 7 of the Air Pollution Control Regulations 2004 (REGULATION 39/04) of the Environmental Protection Act (O.C. 2004-232). The complete regulations, including information such as ambient air quality standards, fines for exceeding emission levels for certain substances and vehicle emission standards can be found online at http://www.hoa.gov.nl.ca/hoa/regulations/rc040039.htm.

It should be noted that although this cap has not been set under the auspices of *The Canada-Wide Acid Rain Strategy* (as *The Strategy* only committed New Brunswick, Nova Scotia, Ontario and Quebec to specifically set new targets) it does contribute to a commitment under *The Strategy* to reduce emissions of SO_2 in eastern Canada. It also contributes to efforts by the provinces and states engaged in the New England Governors / Eastern Canadian Premiers (NEG / ECP) Acid Rain Program to significantly reduce emissions of SO_2.

Specific emissions reduction strategies include the application of successively more stringent SO_2 caps to emissions from the only oil refinery in the province, North Atlantic Refining Limited (Come by Chance). Planned SO_2 caps from this facility over the coming years are as follows: 13.5 kt in 2007, 13.0 kt in 2008, 12.5 kt in 2009, and 12.0 kt in 2010. SO_2 emissions from the Come by Chance refinery accounted for almost one-third of the province's SO_2 emissions in 2005 (according to the CAC emissions inventory published by Environment Canada, March 2007).

The province has also instituted limits on the sulphur content of heavy fuel oil in use by various industries. Effective March 2006, Newfoundland and Labrador Hydro must reduce the sulphur content of heavy fuel oil to 1% (from the 2% maximum previously set). Heavy fuel oil combusted by other industries must contain no more than 2% sulphur (Air Pollution Control Regulation, section 14). Smaller industries (those combusting less than 10 million litres of heavy fuel oil per annum) are have been encouraged to convert to the use of light fuel oil through various disincentives for heavy fuel oil use, such as requirements to undertake lengthy and costly exercises such as stack sampling and dispersion modelling. As of the 2007/8 provincial budget, the last of these facilities, which is the university and associated hospital (and also the largest facility under 10 million litres), were provided funding to complete the conversion. Newfoundland and Labrador paper mills have installed pollution control devices which enable them to combust more hog fuel as a fuel source thereby reducing the quantity of heavy fuel oil combusted.

There are environmental assessments underway for a proposed Crude Oil Refinery Project in Southern Head (http://news.gc.ca/web/view/en/index.jsp?articleid=320469&) and for a hydromet nickel processing facility in Long Harbour (Inco Limited). There is also a proposal for a new iron ore mine and processing facility in Labrador (LABMAG) (http://www.nmlresources.com/pdfs/brochure2007.pdf). If these projects do proceed, as new facilities they would be required to incorporate Best Available Control Technologies. Nevertheless, increased industrial activity in the province would result in some degree of increased emissions above “business as usual” projections. When offset by the province’s efforts to reduce emissions, however, these increases would be minimal.

Projected 2006 SO_2 emissions are approximately 32 kt. While several reduction achievements were realized in 2006, such as Newfoundland & Labrador Hydro converting from 2% to 1% sulphur content fuel and the closure of the Abitibi Consolidated pulp and paper mill in Stephenville, the main cause of the significant decrease between 2005 and 2006 is the fact that 2006 was the lowest electrical production year in 20 years.

Newfoundland & Labrador are currently undertaking the process of updating regulations, looking at specifics such as targets and timelines. The Government of Canada’s proposed Regulatory Framework will likely heavily impact this process, due to the fact that three industries targeted for reductions under the Regulatory Framework account for more than 80% of provincial SO_2 emissions.

Nova Scotia

Since the time of the last progress report, an airshed planner position has been established and filled, which will enable an airshed-based approach to emissions management. Nova Scotia will continue with public information and outreach activities. Nova Scotia also continues to participate in national initiatives to reduce emissions (including acidifying emissions) from several industrial sectors.

Ontario

The following four policy areas are in-place in Ontario applying to clean areas or improvement areas to help mitigate and reduce impacts of acidification, to the extent possible, thereby helping to maintain and improve environmental quality in those areas.~~:~~

1. Transportation and fuels

Ontario recognizes that increased mass transit, vehicle inspection and maintenance, and cleaner fuels are key for reduced emissions from this sector. Initiatives in these areas include:

- **Funding for public transit**: the government's five-year infrastructure investment plan, ReNew Ontario, commits the province to more than $3.1 billion over five years in direct provincial transit funding. The gas tax funding provides more than $1.4 billion to municipalities across the province to improve their public transit systems and increase ridership. In addition, the 2006 Ontario Budget allocated a one-time investment of $838 million in transit in the Greater Toronto Area, including $670 million for an expansion of the Toronto subway.
- **Emissions standards for all heavy duty diesel vehicles:** In the 2007 Budget, the Ontario government announced $150,000 for the Ontario School Bus Association to pilot a program to investigate training, education and technical means to reduce emissions from school buses.
- **Tax rebate for alternate fuel vehicles:** Ontario's 2006 budget doubles the maximum retail sales tax rebate for qualifying hybrid electric vehicles from $1,000 to $2,000 until March 31, 2012.

2. Clean energy

Ontario is shifting to cleaner and renewable sources of power that have fewer environmental impacts, including lower emissions of SO_2, NO_x, and $PM_{2.5}$. Key initiatives include:

- **Coal Replacement Initiative:** Ontario remains committed to the phase out of coal-fired generation and replacing it with cleaner sources of energy. Under Ontario Regulation 396/01 the Lakeview coal-fired power plant, representing 1,140 megawatts of generating capacity, was closed in April 2005.
- **Renewable energy projects:** The province has recently entered into agreements to purchase power from 19 new renewable energy projects, including three waterpower projects, three landfill gas and biogas projects and 13 wind farms. To date, the province has contracted for a total of over 1,300 megawatts of clean, renewable energy – enough to power over 325,000 homes.
- Through the **Standard Offer Program**, the government has announced it will pay a fixed price for electricity produced by wind, solar, biomass or small hydroelectric projects of up to 10 megawatts in size. This will make it easier and more cost-effective for businesses and entrepreneurs to sell renewable power to the grid (net metering). Over the next 10 years, this will help add up to 1,000 megawatts of renewable energy to Ontario's electricity supply – enough to power 250,000 homes. Standard Offer Program contributes approximately 3.1 kt toward SO_2 emission reductions.
- **Inefficient light bulbs:** On April 18, 2007 the Ontario government announced banning the sale of energy inefficient light bulbs by 2012, and in addition will take the lead by only purchasing cleaner energy efficient light bulbs for its own buildings.

3. Energy conservation

Ontario has put in place targets, regulations, and the Energy Conservation Bureau to build a culture of conservation that will reduce energy demand and which will, in turn, reduce emissions of smog-causing pollutants such as SO2, NO_x, and $PM_{2.5}$, from electricity generation. Key initiatives include:

- **Reduced electricity demand:** The government is committed to reducing Ontario's growth in peak electricity demand by five per cent by 2007. Ontario has also set a target of 6,300 MW of electricity demand reduction by 2025. Of this, 2,700 MW of savings are to be realized by 2010.

- **Energy Conservation Responsibility Act (Bill 21):** Introduced in 2005, this Act allows the government to require, by regulation, public agencies to prepare and publish annual (or other period) energy conservation plans. Bill 21 also facilitates the implementation of smart metering for residential and small business consumers, to help them better manage their energy use and costs.

4. Buildings and infrastructure

Released June 26, 2006 Ontario's new Building Code has the toughest energy-efficiency standards of any building code in the country. Over the next eight years alone, the Building Code's increased energy-efficiency requirements will save enough energy to power 380,000 homes.

The following policy areas in-place in Ontario work towards the prevention of significant sources of acidification from air pollution sources outside of the province which impact clean areas through transboundary air movements.

Ontario's Transboundary Air Strategy

A significant amount of Ontario's smog-causing pollutants are carried into the province by prevailing winds from neighbouring U.S. states. As a result, in June 2005, Ontario hosted the first Premier's Shared Air Summit, a conference of leading experts from the U.S. and Canada who came together to address transboundary air pollution. At this first Summit, and subsequently at the second Shared Air Summit in 2006, a Transboundary Air Strategy has been developed to support the Premier's commitment to combat transboundary air pollution. Key components of the Strategy include:

- Established two expert committees to provide strategic and scientific counsel;
- Increased partnerships with neighbouring jurisdictions and institutions;
- Participated in legal and regulatory interventions in the United States; and,
- Increased public information.

Quebec

A number of measures are currently being used to prevent air pollution and minimize its impact in regions with little pollution.

At the regulatory level, in many instances, there are stricter air emission standards for new facilities. Note that CCME-recommended standards for boiler NO_x emissions have been integrated into the Draft Air Quality Regulation.

Furthermore, the Ministry of Sustainable Development, Environment and Parks insists that new industrial projects use the best possible production and emissions treatment technologies, especially for projects that are subject to the Québec environmental assessment procedure.

Lastly, the Québec government is putting more emphasis on hydroelectric and wind power, which eliminates the NO_x and greenhouse gas emissions that come from thermal power generation.

Saskatchewan

Saskatchewan Environment has created a pilot Airshed Association in southeastern Saskatchewan, including Estevan and surrounding area, to monitor regional ambient air quality levels. Saskatchewan Environment recognized a need to collect more comprehensive ambient air quality data to meet the increasing demand of the public, universities, NGOs, industry and governments to manage air emissions. The airshed approach to air quality management is a multistakeholder consensus driven process that allows the collection of credible continuous air quality data and the open communication of data and information. Industry and other government departments will benefit through the open communication and sharing the knowledge the data reflects.

SaskPower in 2006 focused efforts related to SO_2 and NO_x reduction through its Clean Coal project feasibility study. The project team has identified technologies that should allow SaskPower's potential new unit to achieve virtually zero SO_2 emissions and NO_x emissions lower than what are obtained with current NO_x -control technologies.

SaskPower has an ongoing project to improve the performance of the LIFAC (Limestone Injection into the Furnace and Activation of Calcium Oxide) system at the Shand Power Station. Considerable work was done during the 2006 overhaul that included the installation of water lances to achieve better heat transfer through the water walls and the installation of a new sorbent delivery system to the boiler. Routine operation of the lances will result in reduced furnace exit temperatures that are more favourable for SO_2 control and this should also result in some NO_x reduction. The new sorbent injection system will permit greater and more consistent sorbent flows to achieve greater SO_2-removal. Once these and other process modifications are completed it is expected that SO_2 emissions at Shand will be reduced by about 40%. Although the main focus of this work is SO_2 reduction, an approximate 10% decrease in NO_x emissions may also occur.

4 Federal efforts to reduce acidifying emissions

On October 21, 2006 the federal government published a *Notice of intent (NOI) to develop and implement regulations and other measures to reduce air emissions*. The *NOI* states the government's intention to develop an integrated, nationally-consistent approach to reduce both air pollutant and greenhouse gas (GHG) emissions to protect the health and environment of Canadians. A key feature of the approach is addressing GHG emissions and air pollution in a coordinated manner. Most emissions of GHG and acid rain and smog-forming air pollutants originate from the combustion of fossil fuels from transportation, electricity generation and other industrial sources. Taking action on both GHGs and air pollution will maximize synergies and cost-efficiency among the options to reduce emissions and will also help prevent a situation where actions aimed at reducing air pollution could lead to increased GHG emissions and vice versa.

On April 26, 2007 the Government published a plan to reduce air pollutant and GHG emissions entitled *Turning the Corner: An Action Plan to Reduce Greenhouse Gases and Air Pollution. Turning the Corner* includes the Regulatory Framework for Air Emissions, which sets out mandatory and enforceable reductions in emissions of air pollutants and GHGs from industrial sectors and presents action plans for additional reductions from the transportation sector, consumer and commercial products and to improve indoor air quality.

Pollution prevention - Base metal smelting facilities

Base metal smelting facilities continue to be the largest source of SO_2 emissions in Canada, with 2006 emissions totalling 666,000 tonnes. There are 11 such facilities in Canada for which instruments were developed under the Canadian Environmental Protection Act, 1999. On April 29, 2006 the federal Government published a Notice in Part I of the Canada Gazette requiring base metal smelters to prepare and implement Pollution Prevention Plans, which included factors to consider such as the development and implementation of Community Air Quality Protection Programs and Smelter Emission Reduction Programs, to reduce releases of several toxic substances. The Notice and its factors to consider (including annual air release targets for pollutants) were developed through extensive consultation with provinces, industry and other stakeholders.

This initiative is expected to reduce SO_2 emissions from this sector by over 600,000 tonnes (~70%) and annual PM emissions containing metals by over 3000 tonnes (~50%) from 1998 levels by 2015 (when the plans are fully implemented). The Notice also requires facilities to publicly report on their progress in implementing the plans and their conformance with an Environmental Code of Practice every year until the plan is fully implemented. Facility reports are available online at http://www.ec.gc.ca/cepap2/.

The *Turning the Corner Action Plan* is one of the main features of the Government's comprehensive environmental agenda. More information is available at www.ecoaction.gc.ca.

4.1 Addressing emissions from industrial sources

The Regulatory Framework for Air Emissions indicates that regulations will be developed to reduce air pollutant emissions from key industrial sectors: base metal smelting, electricity generation produced by combustion; oil and gas; forest products; petroleum refining; iron and steel; some mining; and, cement, lime and chemicals. The government will require facilities in these industry sectors to reduce their emissions of NO_x, SO_2, Volatile organic compounds (VOCs), and Particulate matter (PM). The Framework proposes that these industries meet tough targets based on those applied in environmentally-leading jurisdictions adjusted, where required, to Canadian conditions.

Firms would be able to meet their caps by reducing their own emissions and using a domestic cap-and-trade emissions trading system for NO_x and SO_2 emissions. The use of credits for compliance purposes would be restricted in areas that have significantly poor air quality to help maintain a level of local or regional air quality. The Government has ongoing consultation with provinces, territories, industry and other stakeholders on its approach for reducing air pollutant emissions.

4.2 Addressing emissions from transportation sources

Transportation continues to be the largest contributing sector to NO_x emissions in Canada, with 2006 emissions from this sector accounting for more than 50% of national NO_x emissions.

The *On-Road Vehicle and Engine Emission Regulations* currently prescribe requirements for smog-forming emissions from new on-road vehicles and engines. These Regulations came into effect on January 1, 2004 (CEPA, 1999) to align Canadian standards for the control of air pollutants with those of the U.S. Environmental Protection Agency (EPA) for all classes of on-road vehicles, including emissions of hydrocarbons (HC), carbon monoxide (CO), NO_x and PM. The Regulations are phasing in more stringent standards that represent emission reductions from new vehicles of up to 95 percent relative to previous requirements.

The *Off-Road Small Spark-Ignition Engine Emission Regulations* were published in the *Canada Gazette*, *Part II,* on November 19, 2003 and came into effect on January 1, 2005. They establish smog-forming emission standards for 2005 and later model year engines found in lawn and garden machines, light-duty industrial machines, and light-duty logging machines and align with U.S. federal standards.

The *Off-Road Compression-Ignition Engine Emission Regulations* were published in the *Canada Gazette*, *Part II*, on February 23, 2005 and came into effect on January 1, 2006. They introduce smog-forming emission standards aligned with U.S. federal standards (Tier 2 and 3) for 2006 and later model year new diesel engines, such as those typically found in agricultural, construction, and forestry machines.

The Government is committed to aligning its smog-forming emission standards with the world-leading U.S. national standards. Pursuant to its Clean Air Regulatory Agenda, the Government has already:

- Published the final *Regulations Amending the On-Road Vehicle and Engine Emission Regulations* in the *Canada Gazette*, *Part II* on November 15, 2006 to introduce new requirements for 2006 and later model year on-road motorcycles to remain aligned with more stringent standards adopted by the United States Environmental Protection Agency (U.S. EPA)
- Published the proposed *Marine Spark-Ignition Engine and Off-Road Recreational Vehicle Emission Regulations* in the *Canada Gazette*, *Part I* on December 30, 2006. The proposed Regulations will introduce new emission standards for new outboard engines, personal watercraft, all-terrain vehicles (ATVS), snowmobiles, and off-road motorcycles in alignment with standards adopted by the U.S. EPA.

The current Regulations are available on Environment Canada's CEPA Registry at: http://www.ec.gc.ca/CEPARegistry/regulations/

The Government of Canada committed to support the work of the International Civil Aviation organization (ICAO) to develop international standards and recommended practices for the reduction of greenhouse gas and air pollutant emissions from aviation sources. Future regulations will likely build on these recommendations, and complement the negotiated Memoranda of Understanding (MOU) that Transport Canada (TC) signed with the Air Transport Association of Canada (ATAC) to reduce emissions of greenhouse gases from aviation sources of 24% by 2012.

The Government of Canada also committed to adopt current international standards established by the International Maritime Organization (IMO) for controlling emissions of air pollutants from ships. In addition, the Government committed to supporting the development of new, stricter international standards. Work is under way with the U.S. EPA on a study to assess the feasibility of designating North American waters as SOx Emissions Control Areas where ships must reduce sulphur emissions.

A 10-year Memorandum of Understanding (MOU) in which the railway industry voluntarily committed to an annual 115-kilotonne NOx emission limit expired in 2005. On May 15, 2007, a new MOU was signed to align Canada with the United States' air pollution objectives for locomotives and to improve the greenhouse gas emissions performance of railways. Following the expiry of the new MOU in 2010, the Minister of Transport will implement new regulations, under the *Railway Safety Act*, to ensure full alignment with U.S. Environmental Protection Agency standards, effective in 2011.

4.3 Energy efficiency

In April 2007, the federal government announced plans to strengthen energy efficiency standards for energy-using products. Amendments to the *Energy Efficiency Regulations* under the *Energy Efficiency Act* will include new and more stringent energy performance requirements for over 25 consumer and commercial products such as commercial clothes washers, commercial boilers, dishwashers and dehumidifiers. These new regulations are expected to decrease energy and electricity demand which will in turn result in reductions in air emissions, including acidifying pollutants. The government will also broaden the scope of regulations on lighting products under the *Energy Efficiency Act* to include performance standards for more general area lighting products. This means a gradual phase-out, by 2012, of inefficient products, such as incandescent bulbs for home in favour of compact fluorescents. Detailed information on the energy-efficiency regulations can be found online at Canada's Energy Efficiency Regulations website: http://oee.nrcan.gc.ca/regulations/home_page.cfm?attr=0.

5 Reducing transboundary flows of acidifying pollutants

5.1 *Canada and the United States action on acidification*

Ground level ozone and particulate matter (PM) are chief components of smog. Canada is addressing smog through its **Canada-Wide Standards (CWS) for PM and Ozone**. Under the CWS, Canada has set a target level of 65 ppb as an 8-hour average for ambient levels of ground-level ozone, to be achieved by 2010. For the period 2003-2005, regions (17) in southern and central Ontario had ozone levels above the 2010 CWS, as did 1 rural Atlantic Canada community and 1 community in British Columbia. More details are provided in the November 2006 *5-year report on The Canada-Wide Standards for Particulate Matter and Ozone* (http://www.ccme.ca/assets/pdf/pm_oz_2000_2005_rpt_e.pdf). The *5-year report* also provides links to jurisdictional progress in implementing CWS plans.

Air quality issues of interest to Canada with the United States include transboundary smog and acid rain in eastern Canada, air quality in the Georgia Basin-Puget Sound airshed of British Columbia and Washington State, marine ship pollution and opportunities for cross-border emissions trading to achieve air quality goals. Canada and the United States have a long history of cooperation on air quality, most notably through the coordinated implementation by both countries of the bilateral Air Quality Agreement (AQA), signed in 1991. This agreement initially focussed on reducing emissions of acid rain precursors (SO_2 and NO_x) and on scientific/technical cooperation. It was expanded in December 2000 with the addition of the Ozone Annex to further target ground level ozone precursor emissions of NO_x, as well as volatile organic compounds (VOCs). The Ozone Annex sets the achievement of the ozone air quality standards in the U.S. and Canada as the long-term goal. For Canada, this is the CWS for Ozone.

The Ozone Annex also added several elements to Annex 2 (scientific and technical cooperation) to place additional emphasis on ground-level ozone and its precursors, and other commitments that will result in a greater capacity to characterize, measure and model emissions of SO_2, NO_x and VOCs. Canada is working to fulfill its obligations with respect to Annex 2 of the AQA. For example, under the CCME process, Canada is undertaking an assessment of the adequacy of its air quality monitoring networks (principally the National Air Pollution Surveillance Network). The results of this assessment are expected in early 2008.

Other recent key activities include three Border Air Quality Projects completed in 2005 that fulfill a pledge made by Canada and the U.S. in 2003 to build on the continued successes of the 1991 Air Quality Agreement. Their purpose was to explore opportunities for coordinated air quality management that could result in air quality improvements and the development of innovative strategies:

- Two transboundary airshed pilot projects completed in 2005 that reported on air quality and opportunities for cooperation in the Georgia Basin – Puget Sound of B.C. and Washington State and in the Great Lakes Basin airshed of Detroit-Windsor-Port Huron-Sarnia.

- A third Canada-U.S. project reported on the feasibility of cross-border emission trading of nitrogen oxides (NO_x) and sulphur dioxide (SO2) emissions, concluding that emissions trading could allow the electricity sector to meet higher pollution standards less expensively.

Both Canada and the U.S. continue to meet commitments to reduce NO_x and SO_2 emissions under the AQA as reported on in detail in the 2006 Progress Report on the Canada-U.S. Air Quality Agreement, which was published in November 2006 (available online at http://www.ec.gc.ca/cleanair-airpur/Pollution_Issues/Transboundary_Air/Canada_-_United_States_Air_Quality_Agreement-WS83930AC3-1_En.htm).

In April 2007, Canada and the U.S. formally announced plans to begin negotiations to add an Annex to the AQA that would target particulate matter (PM), the other chief component of smog and establish further areas of scientific cooperation on air issues between Canada and the U.S. Because PM shares common precursor emissions with acid deposition it is likely that any new, more stringent targets or objectives developed under the PM Annex would contribute further to efforts to reduce transboundary flows (and impacts) of acidifying pollutants. The 4-year joint science assessment of transboundary PM[12] concluded in 2004 that further reductions in transboundary pollution would help Canada and the U.S. achieve their respective PM air quality and acid rain goals. The conclusions of this science assessment will form the scientific basis for the development of the PM Annex. It is anticipated that emission reduction commitments in the PM Annex will be based on existing and proposed programs in both countries, such as the U.S. *Clean Air Interstate Rule* (discussed in the last acid rain progress report) and the *Clean Air Visibility Rule* and the Government of Canada's *Clean Air Regulatory Agenda* (discussed in Section 4: Federal efforts to reduce acidifying emissions).

The Canadian and U.S. governments are also cooperating in evaluating the feasibility and effectiveness of establishing an International Maritime Organization (IMO) Annex VI Sulphur Oxides Emissions Control Area (SECA) along North American coastal regions. A SECA allows national governments to restrict fuel sulphur content used by marine vessels, thereby reducing the amount of sulphur dioxide emitted by this sector.

Several U.S. states and Canadian provinces continue to collaborate on acid rain (and other issues of shared concern) through the conference of New England Governors and Eastern Canadian Premiers (NEG/ECP). Related to acid rain, the NEG/ECP is defining and mapping forest critical loads for the entire NEG/ECP region. They have also launched a website (http://www.neg-ecp-environment.org/) to provide updates of their various programs.

Critical load development in the U.S.

Currently, the United States does not employ the critical loads concept on a national level as part of their federal Acid Rain Program or in air pollution standards. Recently though, a number of federal agencies have begun exploring the potential for using critical loads as a tool to protect sensitive ecosystems from SO_2 and NO_x deposition impacts. As a result, a number of State and Federal land management agencies, scientists/universities, and the EPA banded together to form the Critical Loads Ad Hoc Committee (CLAD) in July 2006, following a Multi-Agency Critical

[12] http://www.msc-smc.ec.gc.ca/saib/smog/transboundary/index_e.html

Loads Workshop in Charlottesville, Virginia in May 2006. Housed within the organizational framework of the National Atmospheric Deposition Program (NADP), CLAD is working to facilitate technical information sharing on critical loads topics within a broad multi-agency/entity audience, fill in gaps in critical loads development in the U.S., and provide consistency in development and use of critical loads in the U.S. More information on this effort is available at http://nadp.sws.uiuc.edu/clad/.

5.2 *Compliance with international commitments*

The Convention on Long-range Transboundary Air Pollution (under the United Nations Economic Commission for Europe) was the first international agreement to recognize both the environmental and health problems caused by the flow of air pollutants across borders and the pressing need for regional solutions. The Convention established a broad framework for cooperative action on air pollution and sets up a process for negotiating concrete measures to control specific pollutants through legally binding Protocols. Convention activities initially focused on reducing the effects of acid rain through control of sulphur emissions; later, the scope was widened to address NO_x, VOCs, the formation of ground-level ozone (smog) and more recently persistent organic pollutants and heavy metals. Canada ratified the Convention in 1981 and since then it has ratified six of the eight protocols under the Convention. Specifically related to acid rain, are:

- The 1985 Helsinki Protocol on the Reduction of Sulphur Emissions
- The 1988 Sofia Protocol concerning the Control of Emissions of Nitrogen Oxides
- The 1994 Oslo Protocol on Further Reduction of Sulphur Emissions

Compliance status with respect to these protocols, as well as to commitments made under the Canada-U.S. AQA are shown in Table 3 below.

Table 3. Canada's international commitments and compliance for SO_2 and NO_x in 2006.

Commitment	Compliance status in 2006
1985 UN ECE Sulphur Protocol • permanent national cap of 3.2 million tonnes of SO_2 by 1993	• national SO_2 emissions were approximately 1.97 million tonnes (38% below the cap)
1988 UN ECE NO_X Protocol • stabilise NO_X emissions at 1987 levels (2.5 million tonnes) by 1994	• national NO_X emissions were 2.3 million tonnes, or 8% below 1987 levels
1991 Canada–U.S. Air Quality Agreement • national cap on SO_2 emissions of 3.2 million tonnes by 2000 onward • reduce national NO_X emissions from stationary sources by 100 kilotonnes below the forecast level of 970 kilotonnes[a] by 2000	• national SO_2 emissions were approximately 1.97 million tonnes (38% below the cap) • national NO_X emissions from stationary sources have been reduced by over 100 kilotonnes from forecast levels
1994 UN ECE Sulphur Protocol • regional cap of 1.75 million tonnes of SO_2 by 2000 in the Sulphur Oxide Management Area (SOMA), plus the permanent national cap	• SO_2 emissions in the SOMA were 933 kilotonnes, or 47% below the SOMA cap[b]

[a] The NO_X/VOC Emission Forecast 90-B from the 1990 NO_X/VOC Management Plan forecasts national NO_X emissions to be 970,000 tonnes in 2005
[b] The emissions for the SOMA region are for 2005 as 2006 data for this region were not available at time of publication

6 Federal / provincial / territorial acid rain science and monitoring activities

6.1 Continuing Science

Continuing science, a key feature under *The Strategy*, calls for ensuring that science programs across Canada remain in a good position to monitor the health of the environment and the effectiveness of Canadian and U.S. emission control programs. The first and last comprehensive review of acid rain programs in Canada was completed in 1999. The resulting report – the *1999 Review of Acid Rain Science Programs in Canada* - recommended a series of research and monitoring activities for federal/provincial/territorial governments to undertake in order to fill in key knowledge gaps. The recommendations also emphasized the importance of maintaining existing monitoring networks. Since 1999, some but not all recommended activities were fulfilled, and monitoring networks were either shut down or reduced in capacity. A more detailed evaluation of the implementation of these recommendations can be found in the *Five Year Review of the Canada-wide Acid Rain Strategy for Post-2000.*

A National Acid Rain Science Plan

Given that acid deposition continues to be a serious problem in eastern Canada and an increasing threat in western Canada (Environment Canada, 2005), the need to maintain, and where appropriate, enhance the adequacy of acid rain science programs is evident. As a result, in 2006, the ARTG developed a **National Acid Rain Science Plan** that outlines research and monitoring activities required to be able to adequately assess environmental health and evaluate control actions. The Science Plan is based on recommendations provided by experts and stakeholders through reports and workshops released and held in 2005/2006. Research and monitoring observations provide essential information for implementing *The Strategy* and achieving its primary goal, which is 'to meet critical loads for acid deposition across Canada'. To this end, activities in the Science Plan have been prioritized on the basis of their contribution to implementing the ARTG's Long-Term Strategic Plan, another long-term plan developed by the ARTG in 2006.

Implementing the Science Plan over the next five years will be the responsibility of federal/territorial/provincial governments in collaboration with industry, academia and non-government environmental organizations. The plan focuses on addressing two main priorities: 1) improving the spatial coverage and representativeness of deposition, aquatic and terrestrial chemical and biological information across Canada, primarily in sensitive terrain in the west while at minimum maintaining current efforts in the east; and 2) continuing and enhancing research on the mechanisms and rates of ecosystem impacts and ecosystem recovery concerning acidification and related stressors. Several activities are already underway in order to address the above needs. In 2008 the ARTG will discuss strategies for promoting and implementing the activities in the Science Plan.

Critical loads and exceedances for upland forest soils in Manitoba, Saskatchewan and Alberta

Over the last two years, the ARTG has also contributed to filling in science knowledge gaps in western Canada by letting out a series of contracts to academic experts to develop critical loads and exceedances for sulphur and nitrogen deposition in order to assess the sensitivity of terrestrial ecosystems in Manitoba, Saskatchewan, and most recently Alberta. In order to maintain consistency across Canada, the protocol and guidelines developed by the New England Governors and Eastern Canadian Premiers to develop critical loads for upland forest soils in eastern Canada and the New England states are being applied. The work was conducted by academic experts from Trent University and the final reports[13] are available on CCME's website.

Results from these assessments are summarized in Section 2.3 of this document. The critical load and exceedance final reports highlight a number of important considerations to keep in mind when interpreting the information. For instance, given the scarcity of deposition data and soil geochemistry data for western Canada, the mapped critical load and exceedance information may potentially be conservative. Also, although the estimates are consistent with those of eastern Canada, there are inconsistencies among provinces due to differences in databases used and availability of data. Overall, these maps represent a broad-scale regional assessment of critical load for S and N for a particular receptor ecosystem and are not intended for site-specific assessments. Finally, these estimates should be viewed as a starting point rather than an endpoint in the process of accurately assessing ecosystem sensitivity. The final reports also recommend future science activities required to reduce the uncertainty of these estimates, all of which were incorporated in the Science Plan.

Critical loads: measured vs. modelled deposition

Due to unavailability of spatially representative deposition information for MB and SK (few deposition measurement sites), in 2007 the ARTG let out a contract to calculate exceedances of the critical load of soils in MB and SK based on deposition estimates generated by a range of air quality models. The objective of the work was to compare exceedance results from each of the models as well as from measured deposition data. The final report concludes that although there were differences among deposition patterns generated by the two models examined and those based on measurements, there was a general correspondence in exceedance. Overall, the evaluation provided a more robust estimate of and greater confidence in the potential area of exceedance for forest soils in MB and SK.

6.2 Assessing the role of nitrogen

Another key feature of *The Strategy* is to improve our understanding of the role of nitrogen in acidification, in light of existing signs that current and projected nitrogen deposition levels may undermine some of the benefits from controlling SO_2 emissions. The Science Plan mentioned

[13] Aherne, J. & Watmough, S., 2006. Calculating Critical Loads of Acid Deposition for Forest Soils in Manitoba and Saskatchewan - Final Report: Data Sources, Critical Load, Exceedance and Limitations.
Aherne, J.l., 2008. Calculating Critical Loads of Acid Deposition for Forest Soils in Alberta: Critical load, exceedance and limitations. Final Report, Environmental and Resource Studies, Trent University, Peterborough, Ontario.

above includes research and monitoring activities that will contribute to our knowledge pool in terms of how nitrogen behaves in the ecosystem.

In September 2006, members of the ARTG attended a Science Symposium on Nitrogen in Lake Louise, Alberta. The Symposium was hosted by the Clean Air Strategic Alliance (CASA), a multi-stakeholder group charged with recommending strategies to assess and improve air quality in Alberta using a consensus approach. A wide array of subjects were covered including primers on nitrogen chemistry; nitrogen eutrophication; atmospheric deposition monitoring and modelling; nitrogen acidification; the role of nitrogen in agriculture; and nitrogen oxides and health (i.e. role in PM and ozone formation). A particular focus was the behaviour, effects and management of nitrogen emissions in Alberta and the possibility of increasing nitrogen emissions causing a risk of eutrophication to western ecosystems.

Growing concern over the potential terrestrial eutrophication problem in western Canada

While Canada has been successful in reducing emission of acidifying pollutants in eastern Canada, emissions of both sulphur and nitrogen oxides in western Canada have been growing steadily and this trend is predicted to continue for some time. In Alberta emissions of sulphur and nitrogen oxides from oil sands operations are predicted to increase substantially between 2000 and 2020. Specifically, NO_x emissions from Alberta energy sectors have risen by 51% between 1990 and 2002 and are predicted to increase by 73% between 1990 and 2015. Also, emissions of NH_3 from the western provinces (British Columbia, Alberta, Saskatchewan and Manitoba) are predicted to rise by 54% between 1995 and 2015, with the bulk of emissions coming from the use/application of fertilizers and pesticides and from livestock.

The common message from experts at the CASA 2006 Science Symposium on Nitrogen (see above section) was that if nitrogenous emissions continue to rise, there is a possibility that terrestrial eutrophication damage may occur. Evidence presented at the Symposium showed that eutrophication can adversely impact ecosystems by causing the acceleration or shift from native species to non-native species, an increased growth of nuisance species, and improved conditions for the spread of invasive species. Given that eutrophication, like acidification, is a transboundary pollution issue and both of these issues are intimately linked, the ARTG is interested in investigating the issue further as well as the potential for it to be managed by CCME.