School Buses, Air Pollution & Children's Health:
Follow-up Report

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Clean Air Partnership

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Executive Summary

OPHA 2005 School Bus Report

In 2005, the Ontario Public Health Association (**OPHA**) released the report, "School Buses, Air Pollution & Children's Health: Improving Children's Health & Local Air Quality by Reducing School Bus Emissions". The report recommended that:

a. The Government of Ontario invest $10-20 million per year to reduce childhood exposure to diesel-related air pollutants and improve local air quality by:
    - Encouraging replacement of older school buses
    - Encouraging retrofits with emissions control devices for existing school buses
    - Supporting demonstration projects that promote alternative fuels and technologies and
    - Developing an educational module on proper idling and driving practices for school bus operators;
b. The Federal Government establish a Healthy School Bus Fund with $10 to 20 million per year to support programs developed by provincial governments and other organizations that are directed at the dual goals of reducing childhood exposure to diesel-related air pollutants and improving local air quality; and
c. School boards in Ontario, in collaboration with the Ontario Ministry of the Environment and Natural Resources Canada, develop formal policies respecting idling in school buses particularly in the vicinity of school properties.

This follow-up report examines the level of awareness about school bus emissions and the actions that have been taken to address them by different groups within Ontario. It also examines projects undertaken by the Federal Government, programs implemented by other provincial governments, and policies adopted by school boards in other provinces, to reduce emissions and exposures associated with school buses.

Situation in Ontario in 2010

Since 2005, the Ontario Ministry of Education (**OMofEd**) has added $16.9 million per year (or 2%) to the base funding for student transportation in Ontario to: encourage replacement of older school buses; increase the safety of buses; and increase the efficiency of the student transportation system. It has required collaboration between school boards within each area of the province to optimize and integrate the use of school buses and school bus routes. It has also supported the incorporation of average fleet age and maximum bus age criteria into the Model Contract Template that guides contract development between Student Transportation Boards/Consortia and school bus operators in Ontario. It has not, however, built into the funding formula for student transportation, costs for emission control device retrofits, alternative fuels, or alternative technologies.

The Ontario Ministry of the Environment (**OMOE**) runs the Drive Clean Program designed to encourage vehicle owners to maintain their vehicles to control emissions. The emission testing standards applied to Heavy Duty Diesel Vehicles (**HDDVs**) under the Drive Clean Program have been tightened twice since the program began. OMOE staff note that they are now the most stringent emission testing standards in North America. Diesel school buses are required to meet the most stringent HDDV standards under the Drive Clean Program. In 2007, the OMOE provided a grant of $150,000 to the Ontario School Bus Association to assist with education directed at school bus drivers.

There are 34 Student Transportation Boards/Consortia (**STB**s) in the province that are responsible for the transportation of about 810,000 students using approximately 15,400 school buses and 3,600 other vehicles. From the Clean Air Partnership (**CAP**) survey directed at these Student Transportation Boards/Consortia, it appears that: many have adopted policies to encourage replacement of older school buses; a substantial number have adopted policies to encourage driver training for fuel efficiency and idling; but very few have adopted policies related to retrofits with emission control devices, alternative fuels, or alternative technologies.

The Ontario School Bus Association (**OSBA**) represents about 80% of the school bus operators/ companies that provide most of the student transportation in Ontario. The OSBA reports that its company members try to turn over 10% of their school bus fleet each year to replace older school buses with new school buses that are "very clean and fuel efficient". The OSBA notes however, that school bus operators are not always able to meet this 10% turn-over rate because of a lack of funding from the provincial government. Since 2007, the OSBA has trained 2,600 school bus drivers in Ontario on driving and idling practices that reduce fuel use and emissions. The training was based on the FleetSmart Program for school buses that was developed by Natural Resources Canada (**NRCan**) in cooperation with the OSBA and its company members.

The results of the CAP survey directed at **school bus operators** within Ontario indicate that they are well informed about school bus emissions and exposures, but could use more information on the health impacts associated with school bus emissions and on the retrofits that can be used to reduce emissions from existing school buses. It would also appear that school bus operators would be supportive of policies related to driver training for fuel efficiency and idling, but not of policies directed at retrofits for emission control devices. The school bus operators report that they feel they are operating under tight financial circumstances that would make it difficult for them to respond to changes that are not associated with cost savings or direct funding.

The results of a survey directed at **public health advocates** within Ontario indicates that there is a high level of awareness about the health concerns presented by school bus emissions for children on buses, in school yards, and in buildings serviced by school buses among those who work on environmental

health and/or children's health issues. It also appears that members of this group have been fairly active in educating the broader community about health concerns associated with school bus emissions and idling reduction policies. However, it appears that this group of interested individuals/organizations are not as well informed about the potential for emission control devices to reduce school bus emissions or exposures.

Government of Canada School Bus Retrofits Pilot Projects

Environment Canada conducted a three phase School Bus Retrofit Pilot Project in British Columbia between 2004 and 2006 with $600,000 in funding. In the first phase, 29 school buses were retrofitted with diesel oxidation catalysts (**DOCs**) capable of reducing emissions of particulate matter (**PM**) and hydrocarbons (**HC**) by 29% and 90% respectively. In the second phase of the project, 20 school buses were retrofitted with closed crankcase ventilation devices (**CCVs**) that reduce levels of fine particulate matter (**$PM_{2.5}$**) on-board school buses. In the third phase, 308 DOCs and 200 CCVs were retrofitted on to school buses belonging to 27 public school districts and one private school in British Columbia for an average cost of $1350 per DOC and $200 to $1,000 per CCV. This project demonstrated that existing school buses can be retrofitted to substantially reduce emissions and on-board exposures without producing operational or maintenance problems.

Environment Canada has also conducted two School Bus Retrofit Pilot Projects in Ontario with $50,000 in funding. In the first project, 13 school buses from Halton and Peel Regions were retrofitted with DOCs and/or CCVs in 2009. The DOCs selected for this project are capable of reducing emissions of PM and HC by 40% and 75% respectively for a cost of $1,380 per bus installed. In the second project, 15 school buses from the London area were retrofitted with DOCs and CCVs in 2010 for a combined cost of $1,430 per bus.

School Bus Retrofit Programs - Other Provinces

Since 2005, two provincial governments have implemented school bus retrofit programs. In 2008, British Columbia directed $700,000 at its fleet of 1,500 school buses for retrofits with emission control devices with the dual goals of reducing emissions of $PM_{2.5}$ from school buses and exposure of school bus occupants to $PM_{2.5}$. This British Columbia Ministry of the Environment (**BC MOE**) managed and administered this program. Under this program, retrofits were offered to every school district in the Province that had eligible school buses. Most of the devices installed were DOCs, at a cost of $1,106 per bus installed, and CCVs at a cost of $837 per bus installed. About 40 Flow-Through Filters (**FTFs**) were also installed at a cost of $5,725 per bus installed. FTFs are capable of reducing PM emissions by more than 50%. The BC MOE reports that over 400 emission control devices were installed and that there have been no complaints and no negative feedback about operational or maintenance issues from the participating school districts.

In 2010/2011, Nova Scotia will direct $1.35 million at a School Bus Retrofit Program that aims to reduce fuel use and emissions of greenhouse gases and air pollutants. The funding for this program is directed at school bus carriers whether they are school boards or private firms. Conserve Nova Scotia (**CNS**) will administer the program but the purchase, installation and proper operation of the equipment will be the responsibility of the school bus carriers that receive funding. Five types of equipment and/or activities will be eligible for funding under this program: auxillary heaters and timers that can be used to reduce idling time; emission control devices (DOCs, CCVs, FTFs); fleet management tools such as electronic control modules; route optimization software; and accessibility upgrades with the potential to reduce fuel use and emissions.

Recommendations

It is recommended that:

1. The **Government of Canada** continue to promote retrofits for existing school buses by:
   a. Funding an ambitious School Bus Retrofit Program directed at Ontario and other provinces. This program should be directed primarily at areas of the province/country where children are exposed to elevated levels of air pollution. A secondary target audience should be school boards in northern and/or rural communities where children can experience higher exposure to school bus emissions because of longer commuting times and/or older school buses;
   b. Funding the education of school boards and school bus operators on: the health impacts of diesel-related air pollution; the emission control devices that can be retrofitted on to existing buses; and alternative fuels and technologies that can be used to reduce emissions from school buses;
   c. Funding the education of parents, teachers and children about the health benefits associated with retrofits with emission control devices for existing school buses, alternative fuels, and alternative technologies.

2. The **Ontario Government** consider:
   a. Requiring that pre-2005 school buses that change ownership cannot be registered for use on the road in Ontario by the new owners without being retrofitted with DOCs and CCV devices; and
   b. Strengthening the opacity standards that apply to school buses under the Drive Clean Program to reflect the downward trend in emissions and encourage the replacement or retrofitting of older school buses.

3. **Student Transportation Boards/Consortia in Ontario** consider adopting a number of recommended model policies pertaining to: the replacement and use of older school buses; the retrofitting of existing buses; the refuelling of school buses; and driver training.

Glossary of Terms

Organizations

BC MOE	British Columbia Ministry of the Environment
BC MofEd	British Columbia Ministry of Education
CAP	Clean Air Partnership
CARB	California Air Resources Board
CNS	Conserve Nova Scotia
EC	Environment Canada
OMOE	Ontario Ministry of the Environment
OMofEd	Ontario Ministry of Education
MSC	My Sustainable Canada
NS DofEd	Nova Scotia Department of Education
OPHA	Ontario Public Health Association
OSBA	Ontario School Bus Association
STBs	Student Transportation Boards/Consortia in Ontario
US EPA	United States Environmental Protection Agency

Technologies & Fuels

B5 or B20	5% Biodiesel Blend or 20% Biodiesel Blend
CCV	Closed Crankcase Ventilation device
CNG	Compressed Natural Gas
DOC	Diesel Oxidation Catalyst
DPF	Diesel Particulate Filter
ECM	Electronic Control Modules
FTF	Flow Through Filter
GPS	Global Positioning System
HDDV	Heavy-Duty Diesel Vehicles
HEV	Hybrid Diesel Electric Vehicles

Air Pollutants/Emissions

CO	Carbon Monoxide (air pollutant)
CO_2	Carbon Dioxide (greenhouse gas)
DPM	Diesel Particulate Matter
HC	Hydrocarbons
NO_x	Nitrogen Oxides
PM	Particulate Matter
$PM_{2.5}$	Fine Particulate Matter
CAC	Criteria Air Contaminants
GHG	Greenhouse Gases

Units of Measurement

g	Grams
kg	Kilograms
km	Kilometres
kt	Kilotonnes
VKT	Vehicle Kilometres Travelled

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I Background

A Introduction

While school buses are a very safe form of transportation for children, most are diesel-fuelled vehicles that emit diesel-related air pollutants. In 2005, the Ontario Public Health Association (**OPHA**) released the report, "School Buses, Air Pollution & Children's Health: Improving Children's Health & Local Air Quality by Reducing School Bus Emissions" (www.opha.on.ca/resources/docs/schoolbus.pdf). This report included:

- A discussion of the health impacts associated with diesel-related air pollutants including the common air pollutants and diesel particulate matter;
- A summary of the health literature related to air pollution's impact on the health of children;
- A review of several exposure studies conducted on-board school buses;
- A discussion of the different options that could be employed to reduce air pollution from, and exposure on-board, school buses including:
  - Replacement of older buses with new diesel-fuelled school buses, compressed natural gas school buses, or diesel-electric hybrid school buses;
  - Refuelling with biodiesel fuel;
  - Retrofitting existing buses with diesel particulate filters (**DPFs**), diesel oxidation catalysts (**DOCs**), or closed crankcase ventilation devices (**CCVs**);
  - Idling practices, vehicle operation, and maintenance that reduce fuel use and emissions.
- An analysis of the emissions reductions and costs associated with each of the options identified on a per-bus and fleet-wide basis on an annual and cumulative basis;
- A summary of the emission reduction programs and policies that have been directed at school buses in jurisdictions across North America; and
- Recommendations directed at the dual goals of reducing childhood exposures to diesel-related air pollutants and improving local air quality (Perrotta, 2005).

> ***"School buses are simply the safest way to transport children to school…..Despite the large number of children transported and the distances travelled, serious injuries and fatalities are very rare. In fact, less than 0.02 per cent of all Canadian road deaths involve an occupant of a school bus" (Transport Canada, 2010).***

This report, prepared by the Clean Air Partnership (**CAP**) in collaboration with the OPHA, is intended as a follow-up report to the 2005 OPHA school bus report**.** At the request of Environment Canada, it will examine:

- The impact of the 2005 OPHA school bus report on the public health community, the school boards, and the school bus operators in Ontario in terms of awareness of the health concerns associated with school bus emissions and in terms of actions to reduce emissions from school buses;
- The policies and/or contract language that the Ontario Ministry of Education (**OMofEd**) and/or Student Transportation Boards/Consortia in Ontario have adopted that influence school bus emissions and/or exposures;
- The policies and/or actions that school bus operators in Ontario have taken to reduce school bus emissions and/or exposures;
- The demographics of school buses in Ontario today with particular attention directed at full-size school buses with 72 seats; and
- The policies and/or contract language that have been established and/or used by the school boards and/or provincial governments in the two jurisdictions within Canada that have developed school bus retrofits programs -- British Columbia and Nova Scotia.

The information collected will be used to inform decisions respecting education, policy development, and program implementation in this field.

This report is based on interviews with key agencies and organizations in Ontario, British Columbia and Nova Scotia, and surveys directed at health advocates in Ontario, staff in Student Transportation Boards/Consortia in Ontario, and school bus operators/companies in Ontario.

B Summary of the 2005 OPHA School Bus Report

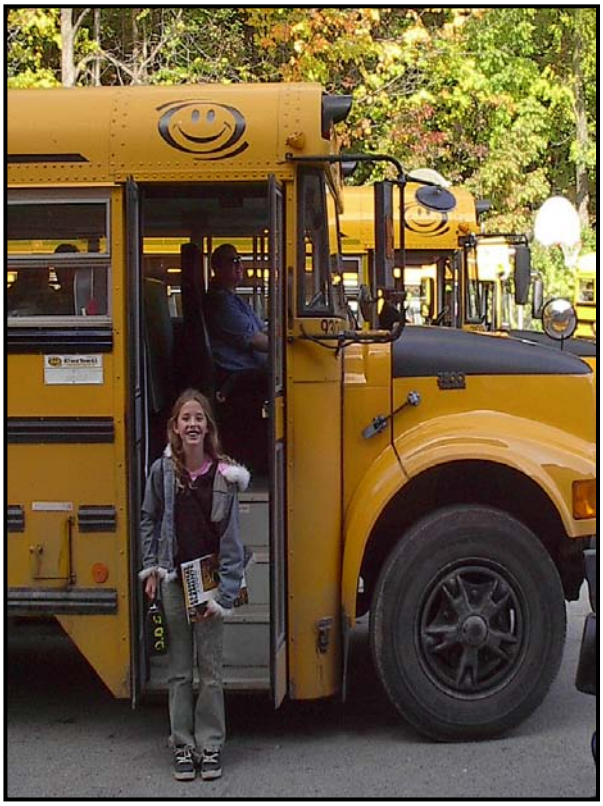
Health Concerns with Diesel Exhaust

Most school buses are heavy-duty diesel vehicles (**HDDVs**) that emit diesel-related air pollutants such as fine particulate matter (**$PM_{2.5}$**), nitrogen oxides (**NO_x**), and diesel particulate matter (**DPM**) as they travel to and from our children's schools. These diesel-related air pollutants have been clearly associated with a broad spectrum of acute and chronic health impacts. They can:

- Aggravate asthma, leading to more frequent and severe asthma attacks;
- Increase the number of respiratory infections, school and work day absences, emergency room visits, hospital admissions and premature deaths;
- Reduce lung function;
- Aggravate and induce allergies; and
- Contribute to the development of chronic heart and lung diseases including lung cancer and asthma (CEPA, 1998; US EPA, 2002 as cited by Perrotta, 2005).

Exposures On-Board School Buses

Several exposure studies have demonstrated that conventional diesel school buses can be self-polluting with emissions from tailpipes and engine compartments contributing substantially to concentrations of air pollutants on-board. They found that concentrations on-board school buses were also influenced by local air quality, traffic density on the roads travelled, wind direction, and the configuration of the windows (i.e. open or closed), idling practices, and queuing patterns (Fitz, 2003; Hill, 2003; NB Lung, 2005; Wargo & Brown, 2002 as cited by Perrotta, 2005).



While children may spend only an hour or two per day on school buses, the elevated levels of air pollutants that can be experienced on-board school buses can add considerably to their daily and annual exposures to $PM_{2.5}$ and DPM. This is a concern because children in many Ontario communities are already exposed to levels of air pollution that are harmful to their health. With their developing respiratory systems, children are very sensitive to air pollution. This is particularly true for those children with pre-existing conditions such as asthma (WHO, 2005; Wigle, 2002 as cited by Perrotta, 2005).

Childhood exposures to air pollutants can also influence the long-term health prospects of those exposed. For example, studies have demonstrated that a small shift in the average lung function of a population of children can translate into a substantial increase in the number of adults who develop respiratory diseases such as lung cancer later in life (WHO, 2005 as cited by Perrotta, 2005). With approximately 800,000 Ontario children being transported on school buses each year, these exposures represent a significant public health concern (Perrotta, 2005).

Reducing Exposures On-Board Older School Buses

Exposures studies have found that exposures on-board school buses can be significantly reduced, even under idling conditions, by outfitting school bus tailpipes with emission control devices such as Diesel Particulate Filters (**DPFs**) and school bus engines with Closed Crankcase Ventilation devices (**CCVs**). These studies also suggest that on-board exposures can be reduced by keeping doors and windows closed when buses are idling, avoiding idling when buses are waiting in front of schools, and avoiding caravanning on roadways (Hill, 2005; Fitz, 2003; NB Lung, 2005 as cited by Perrotta, 2005).

School Bus Emissions Dropping Over Time

Emissions from new school buses have declined significantly over the last 20 years as new fuel and engine emission standards have been developed and rolled out by the Government of Canada. Since 2005, when the OPHA School Bus report was released, new federal regulations respecting sulphur

levels in diesel have come into effect making ultra-low sulphur diesel the only diesel that can now be used in school buses and other on-road diesel vehicles in Canada. As can be seen by Table 1, school buses built to:

- 1994-2003 standards emit 2.5 times less PM than 1993 buses;
- 2004-2006 standards emit 10 times less hydrocarbons (**HC**) than 2003 buses;
- 2007-2009 standards emit 10 times less PM & 2 times less NO_x than 2006 buses;
- 2010 emission standards emit 6 times less NO_x than 2009 buses.

With buses built to 2007 emission standards, it is expected that levels of air pollutants on-board school buses will approach levels in ambient air. These buses, which will be outfitted with DPFs and CCVs, will not be self-polluting. This is great news for children's health and for local air quality. However, concerns about on-board exposures and local air quality remain for older school buses that remain on the road.

Table 1: Emissions For Model Year Cohorts for School Bus Analysis in Ontario, 2005

Cohort	Model Years	Emissions (Grams per brake horse power hour)		
		PM	**HC**	**NO_x**
A	Pre 1991	**0.60**	**1.3**	**6**
B	1991-1993	**0.25**	1.3	**5**
C	1994-2003	**0.10**	1.3	**4**
D	2004-2006	0.10	**0.14**	**2.25**
E	2007-2009	**0.01**	0.14	**1.2**
F	2010 and later	0.01	0.14	**0.2**

Note: The emission limits for NO_x and non-methane hydrocarbons (NMHC) are not specified separately in the 2004 standard; the 0.14 and 2.25 g/bhph values used here for NMHC and NO_x, respectively, are based on the pre-2004 limit for NMCH and our interpolation/estimate for the NO_x value (Torrie, 2005).

OPHA 2005 Findings Regarding Emissions

For the 2005 OPHA school bus report, information was collected on the number, age, Vehicle Kilometres Travelled (**VKT**), and retirement age of Ontario's school buses to estimate emissions from school buses in Ontario. It found that, in 2004:

- There were approximately 15,000 school buses in Ontario:
- Most of those were diesel-fuelled and full-size buses with 72 seats;
- They travelled, on average, 22,000 kilometres (**km**) per year;
- They were retired, on average, at 15 years of age (Torrie, 2005).

Emissions were estimated for the fleet using engine emission standards for each model year cohort, and assuming that each bus was a full-sized bus that travelled 22,000 km per year. This analysis found that, in 2004, Ontario's 15,000 school buses collectively emitted approximately: 114 tonnes of PM, 718 tonnes of HC, 2,601 tonnes of NO_x, and 285 kilotonnes of carbon dioxide (**CO_2**) (Perrotta, 2005; Torrie, 2005).

The 2005 OPHA report also estimated the cumulative emissions for the whole fleet from 2006 to 2016 assuming a retirement age of 15 years for each school bus. This analysis found that, from 2006 to 2016, under a business as usual scenario, Ontario's 15,000 school buses would emit approximately 529 tonnes of PM, 4,736 tonnes of HC, 17,790 tonnes of NO_x and 3,105 kilotonnes of CO_2 (Perrotta, 2005; Torrie, 2005).

This analysis highlighted:

- The dramatic reductions in emissions from school buses that will result from the roll-out of new fuel and engine emission standards up until 2016;
- The disproportionate contribution of the pre-1994 buses to PM emissions from the fleet as a whole;
- The dominant impact of the 1994-2003 model year cohort to emissions of PM, HC and NO_x up to 2016; and
- The significant reduction in emissions achieved with the post-2006 school buses (Perrotta, 2005; Torrie, 2005).

OPHA 2005 Conclusions Regarding Emission/Exposure Reduction Options

The 2005 OPHA school bus report also included an assessment of a number of different emission reduction options for Ontario's fleet of school buses. In 2005, this assessment concluded that:

1. Proper maintenance, idling and vehicle operation practices can be used to reduce emissions of air pollutants and greenhouse gases from all school buses by about 10%;
2. The CCVs can reduce air levels of $PM_{2.5}$ on-board school buses to levels that approach ambient air levels at a cost of approximately $400 to $600;
3. DOCs can reduce emissions of PM by 25% and HC by 85% for about $2,500. This retrofit would substantially reduce emissions along traffic corridors and in school yards. This retrofit may also reduce the toxicity of PM that enters the cabins of school buses by reducing the HC in diesel exhaust (EC, 2004);
4. DPFs, retrofitted on to school buses calibrated for low NO_x emissions, could reduce emissions of PM by 90%, HC by 90%, and NO_x by 25% from 1994-2003 model year school buses for about

$10,000 per bus. This retrofit has the potential to reduce concentrations of diesel-related air pollutants on-board school buses to levels that approach ambient air levels;

5. A 20% biodiesel blend (**B20**) can produce modest reductions in air pollutants (PM and HC by 10% and air toxics by 12 to 18%) and substantial reductions in greenhouse gases (CO_2 by about 20%). However, in 2005, B20 was associated with a cost premium as high as 20% for fuel (i.e. about $1,000 per year).
6. Replacement of a pre-1994 school bus with a new diesel bus that meets the 2007 emission standards would reduce PM emissions by 97%, HC by 90%, and NO_x by 78%. The 2007 school bus would be expected to reduce concentrations of diesel-related air pollutants on-board to levels that approach ambient air levels.
7. Replacement of a pre-1994 school bus with a new Compressed Natural Gas (**CNG**) school bus would significantly reduce emissions of PM and NOx, but could increase HC emissions by 50%. This option produces fewer air pollution benefits than the best diesel technology while costing considerably more. For these reasons, it is not recommended as a replacement option for school buses in Ontario at this time.

OPHA 2005 Recommendations

The 2005 OPHA Report recommended that:

1. The **Ontario Ministry of the Environment (OMOE)** establish a multi-year Healthy School Bus Program, with $10-20 million per year, that has the dual goals of reducing childhood exposure to diesel-related air pollutants and improving local air quality by:
   a. Ensuring the retirement of all pre-1994 model year school buses by 2007;
   b. Encouraging the replacement or retrofitting of all 1994-2003 model year school buses by 2011;
   c. Ensuring that all new school buses purchased over the next few years meet 2007 emission standards;
   d. Encouraging the installation of CCVs in all school buses in Ontario;
   e. Supporting demonstration projects that promote the development of alternative technologies and fuels; and
   f. Developing, in collaboration with Natural Resources Canada (**NRCan**), the Ontario School Bus Association (**OSBA**), and Ontario school boards, a module on proper idling, fuel management, and low emission driving practices, to be included in the provincial curriculum for school bus operators.

2. The **Government of Canada** establish a multi-year Healthy School Bus Fund, with $10 to 20 million per year, to support programs developed by provincial governments and other organizations that are directed at the dual goals of reducing childhood exposure to diesel-related air pollutants and improving local air quality.

3. **School boards in Ontario**, in collaboration with the OMOE and NRCan, develop formal policies respecting idling in school buses particularly in the vicinity of school properties (Perrotta, 2005).

II Situation in Ontario in 2010

A Introduction

The Ontario Ministry of Education (**OMofEd**) reports that 34 Student Transportation Boards and/or Consortia are responsible for organizing student transportation in the province. These 34 Student Transportation Boards/Consortia (**STB**) arrange transportation for approximately 810,500 students who will travel about 1.33 million kilometres each school day in 19,000 vehicles, 15,398 of which are school buses (OMofEd, 2010; OMofEd, 2010B)(**Appendix A**).

On average, each STB:

- Contracts the services of 28 different operators, with some hiring as few as 4 firms and some hiring as many as 81 different firms;
- Is responsible for transporting 23,838 students with numbers ranging from a low of 1,339 students in the French Consortium in Chatham to a high of 59,504 in Peel Region;
- Uses 453 buses with the number of buses ranging from a low of 37 in the French Consortium in Chatham to a high of 1,232 in Peel Region (OMofEd, 2010B)(**Appendix A**).

There are 376 students in Ontario who are being transported more than 100 km each way to school each day by 16 different STBs (OMofEd, 2008A) (see **Appendix A**).

The school buses operated by, or for, STBs across the province are, on average, 6 years old, with the average age per STB ranging from 3 years to 9 years in age. The oldest buses in each STB are, on average, 11 years old, with the oldest buses for each STB ranging from 10 years to 20 years (OMofEd, 2008A) (**Appendix A**).

B Ontario Ministry of Education

Student Transportation Boards/Consortia

There are 72 School Boards in Ontario. Since 2006, the Ontario Ministry of Education (**OMofEd**) has introduced a number of reforms to student transportation. Among these reforms was the requirement that the Public, Catholic, French and French Catholic School Boards in each area of the province collaborate and/or form consortia to coordinate and deliver transportation services to the students in each area of the province. As a result, there are now 34 Student Transportation Boards/Consortia (**STBs**) that are responsible for student transportation across the province (OMofEd, 2010).

This requirement was introduced to ensure safe, effective, and efficient transportation services across the province. The reforms have also provided the potential to reduce emissions of air pollutants and greenhouse gases from school buses by encouraging the optimization and integration of school bus routes for all school boards in each area (OMofEd, 2010).

In Ontario, 99% of school buses are operated by private firms on a contractual basis with school boards/consortia. The school boards that operate their own school buses are gradually moving away from that role; contracting services from private firms as they retire their older school buses (OMofEd, 2010).

Budgetary Changes for School Buses in Ontario

Financing for school buses in the province has changed dramatically over the last five years as well. In 2006, the OMofEd commissioned an external consultant to examine the costs associated with the

operation of school buses with safe vehicles and trained drivers across Ontario. The consultants considered replacement cycles, fuel costs, wages, insurance, maintenance, and rate of return on investment. They found that the average annual contract rate for a full size school bus in Ontario was $41,500 in 2006/2007. Based on these findings, the OMofEd allocated an additional $16.9 million to base funding for student transportation beginning in 2007/08 to ensure that STBs will have the financial capacity to fund up to the benchmark level identified by the consultant (OMofEd, 2010).

The consultant's study did include the costs associated with replacing older school buses to achieve and maintain the fleet average age at 6 years. The study did not however include costs for retrofitting pre-2007 model year school buses with emission control devices (OMofEd, 2010). (Note, the overall grant projected by the Province to STBs for student transportation in 2010/2011 is $834 million.)

Ministry Actions that Impact on School Bus Emissions/Exposures

The OMofEd is familiar with the 2005 OPHA report on school buses and understands the associated effects of emissions and exposures on older buses for children. The OMofEd has taken several steps which staff believe will reduce emissions from school buses across the province. It has:

1. Endorsed a stakeholder developed Model Contract Template for student transportation services that includes two age-related criteria for different types of buses to encourage replacement of older school buses (e.g. a maximum fleet average age of 7 years and a maximum bus age of 11 years applies to full size buses);

2. Required collaboration between School Boards within each area of the province to encourage optimization and integration of school buses and school bus routes. Transportation funding is now tied to the efficiency with which consortia utilize available technologies and routing strategies to reduce routes;

3. Established an independent "Effectiveness and Efficiency" (E&E) review process on the management practices and operations of STBs across the province. These E&E reviews examine, among other things, whether STBs require school bus operators to meet the vehicle age requirements stipulated in contractual agreements, and whether STBs are optimizing vehicle usage with transportation software and student data (OMofEd, 2010A);

4. Hosted an annual summer workshop for School Board staff to highlight various community programs that support green initiatives (e.g. Active and Safe Routes to School, Anti-idling policies, FleetSmart program); and

5. Undertook a fuel cost study to identify the best practices for the purchase of fuel and for the promotion of fuel efficiency practices among various stakeholders involved in student

transportation. The findings of this study were shared with delegates at the Canadian Pupil Transportation Conference in May, 2010 (OMofEd, 2010).

The role of the OMofEd is to fund STBs for student transportation. The OMofEd has not promoted the retrofitting of school buses because of concerns expressed by school bus operators about the potential for retrofits to increase maintenance costs and/or to create operational difficulties. Instead, the OMofEd has focused on: the reduction of school bus routes through effective software use and sharing of buses among school boards; the promotion of operational practices that result in fuel efficiencies (e.g. idling reduction); and on the replacement of older school buses (OMofEd, 2010).

C Transportation Services Model Contract Template

What is Included

As indicated earlier, the Model Contract Template was developed by student transportation stakeholders (e.g. school bus operators and STBs) in Ontario for use by STBs in the province. While use of the template is not mandated, the OMofEd recommends that all STBs review the clauses and provisions which have been identified as best practices for inclusion in their own contracts with local operators.

The Model Contract Template addresses all elements of student transportation including contract terms, safety programs, insurance, routing, and vehicles. CAP reviewed it for requirements that:

- Could be used estimate of emissions from school buses such as age and VKT;
- Could impact on emissions from individual school buses such as school bus replacement age;
- Could impact on emissions from the overall fleet of school buses such as routing efficiencies;
- Could impact on occupant exposure to school bus emissions such as idling practices and replacement age; and
- Mention of alternative fuels or retrofits with emission control devices.

The Model Contract Template contains a few sections that require the collection and provision of data by operators which could be useful for the estimation and tracking of emissions:

- Section 8.8 indicates that the Operator shall file with the Consortium's transportation office a bus route data sheet for each route stating the make, model, model number and year of manufacture of the vehicle serving the route, prior to MMM/DD of each year of the Agreement;
- Section 11.4 a. indicates that the Operator shall give full cooperation to the Consortium in any survey of transportation service or safety that the Consortium, in its sole discretion, deems necessary; and

- Section 12.2 indicates that fuel consumption is to be computed by the Operator and shown for each route by multiplying the total Route Distance by the Route Days and applying the Fuel Efficiency Factor for the Vehicle Class servicing the route (CPAC, 2008).

The Model Contract Template also contains a section dedicated to vehicle age. Section 9.3 specifies the maximum age and average for each class of school bus:

- Vehicles used in the provision of transportation services shall conform to the following maximum and average age specifications as at August 1st in each year:
  - 72 Seater vehicles - Maximum Age 12 years, average age in class 7 years
  - Wheelchair equipped vehicles - Maximum Age 10 Years, Average age 6 years
  - 20 Seater vehicles - Maximum Age 10 years, Average age in class 6 years
  - 30 Seater Vehicles - Maximum Age 10 years, Average age in class 6 years
  - Minivans and Cars - Maximum Age 8 years, Average age in class 5 years
  - Where there are fewer than X vehicles in the class, the average age shall not apply (CPAC, 2008).

What is Not Included

Routing is the responsibility of the STB, not the operator, so the policies that guide the development of routes are not covered by the Model Contract Template. There is no mention of alternative fuels such as biodiesel, retrofits with emission control devices , or idling in the Model Contract Template or its Schedules. Section 11.4.b does, however, provide language that could be used to address idling and fuel efficiency in driver training programs. It indicates that:

- The Operator's current safety program, as it relates to the safety of students using transportation services will be made available to the Consortium. Further, the Operator shall cooperate with the Consortium in the implementation and reasonable revision or redevelopment of the program " (CPAC, 2008).

This provision could be used by STBs to ensure that driver training covers operational practices such as responsible idling that reduce fuel use and/or exposure of children to air pollutants.

D Ontario Ministry of the Environment

The Ontario Ministry of the Environment (**OMOE**) runs the Province's Drive Clean Program to encourage vehicle owners to maintain their existing vehicles to reduce air pollution associated with poorly tuned vehicles. The Drive Clean emission testing standards for all Heavy Duty Diesel Vehicles (**HDDVs**) have been tightened twice since the program began and, according to the OMOE, are now among the most stringent in North America. Since the Drive Clean Program's introduction, the opacity

standard for 1991 and newer HDDVs has been tightened from 45% to 30%, while the standard for 1990 and older HDDVs was tightened from 55% to 40%. Diesel school buses are required to meet the more stringent of these standards to help protect the health of children. In 2007, the Drive Clean HDDV Program was responsible for reducing emissions of PM by approximately 254 tonnes. From 2000 through 2007, the Drive Clean Program has reduced emissions of PM emissions by more than 200 tonnes per year for a total of approximately 1,900 tonnes (OMOE, 2010).

In 2007, the OMOE provided a grant of $150,000 to the Ontario School Bus Association (**OSBA**) to assist them with actions to enhance clean air (OMOE, 2010).

E Student Transportation Boards/Consortia - Survey

Objectives

The survey for STBs in Ontario was developed to get a sense of:

- How much student transportation staff know about school bus emissions, emission control options, and the 2005 OPHA school bus report;
- The demographics of the school bus fleets in different parts of the Province in 2010; and
- The policies and/or practices that have been developed and/or implemented by STBs to address emissions associated with school buses.

The survey, attached in **Appendix B**, was developed in consultation with the Project Advisory Committee, the OMofEd, and Environment Canada. Using the Survey Monkey tool, the survey was distributed electronically by the OMofEd to staff responsible for student transportation in the 34 STBs across Ontario for three weeks in late June and early July 2010.

Survey Results

There was a 20% response rate with seven of the 34 STBs completing the survey. While the response was likely biased towards those who have taken a particular interest in the subject, it does provide some useful information about the policies and actions that have been implemented by STBs in Ontario to address school bus emissions/exposures.

Among the seven STBs that responded, two indicated that they took steps to act on the findings in the OPHA School Bus report. One took steps to institute a "no idling policy". The other developed and incorporated a "Healthy School Bus Plan" into the most recent Request for Proposals that was published in 2007 (Survey Monkey, July 2010).

When asked if they or their organizations had received questions or concerns about school bus emissions, one out of seven respondents indicated "yes". When asked to describe the question raised, the respondent indicated that it was a question from the media.
When asked if their STBs had policies or practices for the following issues:

- Six of the seven responded "yes" for the replacement of older buses;
- Four responded "yes" for the use of older school buses;
- Three responded "yes" for driver training that relates to fuel efficiency;
- Three responded "yes" for driver training that relates to idling;
- One responded "yes" for retrofitting school buses with emission control devices
- One responded "yes" for retrofitting with engine heaters;
- One responded "yes" for fuelling school buses with biodiesel (Survey Monkey, July 2010).

The following are the emission-related policies or practices that have been established by the STBs that responded to the survey:

Related to Replacement Age

- "Do not allow the use of school buses built before 1998."
- "Stipulate, in the contract with school bus operators, an average fleet age must not be more than 7 years and a maximum age of 12 years for school buses used."
- "Vehicles used in the provision of transportation services shall conform to the following maximum and average age specifications by October 20th:

  Vehicle type - Maximum Age - Average Age
  a. 54 – 72 passenger - 12 years - 7 years
  b. 30 – 48 passenger - 10 years - 6 years
  c. 15 – 24 passenger - 10 years - 6 years
  d. Wheelchair equipped buses - 10 Years - 6 years
  e. 6 – 9 passenger - 8 years - 5 years

  - Where there are less than 3 vehicles in the class, the average age shall not apply.
  - The Consortium may allow for the provision of older vehicles that otherwise comply with the requirements of this Agreement upon receipt of written notification from the Operator of vehicles and written approval from the Consortium."

Related to Idling

- "Limit idling to a maximum of 3 minutes".
- "When a vehicle is parked in a schoolyard, the following conditions must be met: the ignition turned off; and the key removed."
- "Drivers should be provided with the Ministry's Fleet Smart training or equivalent in order to reduce driving habits that are not conducive to fuel conservation." (Survey Monkey, July 2010).

Healthy School Bus Plan

One school board indicated that it has developed and implemented a "Healthy School Bus Plan" in response to the 2005 OPHA School Bus report and other health concerns expressed by parents and health professionals. The following elements of that Plan pertain to school bus emissions:

- In recognition of the new lower vehicle emissions requirements dictated by the government, the Board will require that 80% of the carrier's fleet be deployed on the basis of route length with the newer vehicles being assigned to the longest routes and the older vehicles to the shortest routes.
- Fumes from the bus and other traffic should not enter the passenger compartment when windows and doors are closed; all door and window seals must be present and intact.
- The regular maintenance of all vehicles will provide reliable, consistent and efficient service to this Board….
  - All air handling equipment on the bus needs to be maintained to the manufacturers' recommendations.
  - Engine components need to be maintained per the manufacturers' specifications and the Highway Traffic Act.
  - All fuel and oil leaks should be addressed ASAP.
  - Exhaust systems must be properly installed and maintained.
- In an effort to reduce the emissions of greenhouse gases, realize better fuel efficiency, and improve local air quality:
  - Buses should reduce their overall idling time whenever possible.
  - Buses must adhere to the municipal bylaws that limit idling.
  - Drivers must participate in the Ministry's Fleetsmart driving program or an equivalent training program to help reduce emissions through improved driving practices.
  - Buses must not be idling at school sites (even Wheelchair buses).

- Buses must not be idling while loading or unloading passengers at destination schools.
- Drivers are to be aware of the bus behind them and delay starting their vehicle until the bus behind has completed loading or unloading their passengers.
- Fleet participation in programs run by the Federal Government (i.e. Drive Smart, One Tonne Challenge, Repair the Air Fleet Challenge etc) are free of charge and can result in overall savings on fuel costs and the significant reduction of hydrocarbon emissions into our environment.

- The Board also encourages all bus carriers to investigate the following new fuel technologies with a view to converting their fleet or parts of their fleet to:
  - Use biodiesel;
  - Use alternative fuels (Compressed Natural Gas);
  - Use of Diesel-Electric Hybrid Vehicles (**HEV**).

- The Board would also encourage bus carriers to consider the following options to improve the overall reduction of emissions from their fleet:
  - Retire all pre-1994 model year buses by 2007 (per OPHA report);
  - The use of available technologies to reduce the emissions of older buses to 2007 standards;
  - The installation of closed crankcase filtration systems in all school buses;
  - The installation of a Diesel Particulate Filter for post 1994 model buses;
  - Ramp up the rate of bus replacement to newer buses with better emission standards.

- The Board will endeavour to model our practices to be consistent with the Board's commitment to the Ecoschools Initiatives.
  - The Board will encourage healthy alternatives to school bus transportation wherever feasible. These can include the "Walking School Bus".
  - Parents will be encouraged to walk their children to school.
  - Parents that must drive should be encouraged to park their vehicles in appropriate locations and turn them off instead of idling outside the school (this would help reduce overall emissions as well as the ambient air pollution inside the buses and the school).
  - Whenever possible bus loading zones should be located away from air intake equipment at the school. (New schools should plan for that in their development stage.) (Survey Monkey, July 2010).

Age Structure of School Bus Fleets in Ontario

Six STBs provided information on the age of school buses used to service their student populations (see Table 2). While these can not be considered representative of the province as a whole or of the different regions of the province, they do indicate that there may be more "older" school buses on the road than fleet averages convey. They also indicate how important this information may be when considering policies for emission and exposure reductions, and how policies may need to be applied differently to STBs across the province to reflect their different circumstances and history. For example, for the STB that has 11 pre-1994 model year school buses, retirement of these school buses should remain a high priority, while for the STBs that have many 1994-2003 model year school buses, retrofits with emission control devices may be the greater priority.

Table 2: CAP Survey Results - Student Transportation School Boards/Consortia - Demographics - Full-Size School Buses, July 2010

Region of Reporting School Board	# of Full Size Buses	# of Post-2006 Buses	# of 2004-2006 Buses	# of 1994-2003 Buses	# of Pre-1994 Buses
South Central Ontario	489	142	100	247	0
Western Ontario	300	50	85	165	0
Northern Ontario	248	28	49	171	0
South-western Ontario	280	76	81	123	0
Eastern Ontario	224	20	119	74	11
Toronto	368	99	114	155	0

F Ontario School Bus Association

Background

The Ontario School Bus Association (**OSBA**) is the association that represents school bus operators in the province. It has 140 company members who own and operate about 80% of the school buses in the province (OSBA, 2010).

The OSBA indicated that it gets its information about the number, size and age of school buses in the province from the Ontario Ministry of Transportation (OSBA, 2010). However, while that Ministry has information on the number, size and age of each school bus in the province, the MTO does not collect that data by STB (OSBA, 2010).

The OSBA has noted that there have been some important changes in the field of school bus emissions since the OPHA school bus report was released in 2005. Two sets of new federal engine emission standards were rolled out in 2007 and 2010 for school buses so new school buses are much cleaner than older school buses (OSBA, 2010).

OSBA Comments on School Bus Emission Reduction Strategies

The OSBA reports that its company members try to replace 10% of their fleet every year so they can replace older vehicles with school buses that are built to new emission standards that are "very clean and fuel efficient". The OSBA notes however, that with new school buses costing $100,000 each, company members cannot always afford to meet the 10% turn over rate because of a lack of funding from the provincial government (OSBA, 2010).

The OSBA also notes that over 99% of school buses pass the OMOE Drive Clean emissions tests. In 2009, Drive Clean reported that of the 7,026 heavy-duty diesel school buses tested for smoke opacity, only 137 (or 1.95%) failed. This is better than average for the overall HDDV population which has a fail rate of 3.5%. The OSBA believes that these statistics confirm the commitment that the student transportation industry has to fleet maintenance programs (OSBA, 2010).

The OSBA says that auxillary heaters are available for school buses at a cost of $400 to $1,500 per bus depending upon the BTU. However, it reports that the life expectancy for these devices can be short, the replacement costs can be high, and the filters and ignitions can be expensive to maintain and replace (OSBA, 2010).

The OSBA reports that staff are not aware of any school bus operators that are using Flow-Through Filter (**FTFs**) because, at a cost of approximately $5,700, school bus operators cannot afford to purchase them. It also says that school bus operators are reluctant to use a biodiesel blend greater than 5% because of gelling and clouding issues that can occur at lower temperatures (OSBA, 2010).

Since 2007, the OSBA has trained 2,600 school bus drivers in Ontario on driving and idling practices that reduce fuel use and emissions of air pollutants and greenhouse gases with $150,000 in funding provided by the OMOE. The OSBA did this using the FleetSmart Program for school buses that was developed by Natural Resources Canada (**NRCan**) in cooperation with the OSBA and its company members. The OSBA reports that a number of school bus operators and school boards have also adopted idling policies recommended by FleetSmart (OSBA, 2010).

Funding Changes for School Buses in Ontario

The OSBA acknowledges that the funding situation for school buses in Ontario has changed significantly since 2005. The OSBA also acknowledges that the OMofEd funding increase, based on the review conducted by an external consultant, has helped some School Boards to increase the funding

available for student transportation. However, the OSBA believes that the benefits have not been consistent across the province. For example, in areas of the province such as the north, where the costs associated with school bus transportation are greater, the benefits of the new funding situation have not been great (OSBA, 2010).

The OSBA cannot see its company members retrofitting or refuelling school buses unless additional funds are made available for that particular task. The OSBA believes that there are too many demands on its members' limited budgets already. Replacement of older school buses and driver training on fuel management are seen as the priorities by OSBA members because these actions provide cost efficiencies while also reducing emissions of air pollutants and greenhouse gases (OSBA, 2010).

G Ontario School Bus Operators - Survey

Objectives

The survey for Ontario school bus operators was developed to identify:

- The awareness that school bus operators (i.e. companies, not drivers) have about school bus emissions, emission control options, and the 2005 OPHA School Bus report;
- Their views about the findings and recommendations in the 2005 OPHA report;
- The demographics (i.e. age structure) of the school bus fleets in different parts of the province in 2010; and
- The emission control policies and/or practices that might be of interest to them.

The CAP survey, attached in **Appendix C**, was developed in consultation with the Project Advisory Committee, the OSBA, and Environment Canada. Using the Survey Monkey tool, the survey was distributed electronically for three weeks in late June and early July 2010 by the OSBA to its 140 member companies across Ontario.

Survey Results

There was a 9% response rate with 12 of the 140 company members completing the survey. While the response was low, it was a diverse group of school bus operators who responded; they own between 1 and 200 full-size school buses; they have contracts with between 1 and 8 STBs; and they cover a variety of geographic regions in the province (See Table 3 below).

Among the 12 respondents, only three were aware of, or had read, the 2005 OPHA School Bus report. When asked to identify the findings in the report that were useful, ineffective or impractical, the following comments were offered:

- "It is not feasible to purchase new buses to replace older buses."
- "The school bus industry has been very progressive with safety and health issues."
- "Gasoline engines may be a forgotten alternative."
- "It is not practical to retrofit every school bus in our fleet";
- "The recommendations do not apply to the real world of school bus operation in Ontario. For example, biodiesel is ineffective in cold weather; it damages/plugs up engines."
- "With government cutbacks, lower rates, competitive tendering, companies have no extra money for extra training or retrofitting school buses."
- "Most contracts stipulate that buses must be no older than 12 years, so all school buses operated today are 1998 model years or newer." (Survey Monkey, July 2010).

When asked if they, or their organizations, had been provided with sufficient training on several emissions-related questions:

a. 70% indicated "yes" for the impact that school bus idling has on air quality within schools and on-board school buses;
b. 80% indicated "yes" for differences in emissions released from older and newer buses;
c. 20% indicated "yes" for the health-related impacts associated with emissions released by school buses; and
d. 20% indicated "yes" for school bus retrofit products designed to control emissions.

When asked if it would be useful to have emission oriented policies or practices directed at the following actions:

a. 17**%** indicated "yes" for the replacement of older buses with new buses;
b. 17% indicated "yes" for limiting the use of pre-1994 school buses;
c. 92% indicated "yes" for driver training that relates to fuel efficiency;
d. 92% indicated "yes" for driver training related to idling practices;
e. 8% indicated "yes" for retrofitting school buses with emission control devices;
f. 25% indicated "yes" for retrofitting school buses with engine heaters;
g. 25% indicated "yes" for refueling school buses with biodiesel.

When asked if they have received any questions or concerns about emissions from school buses or about air quality on-board school buses, 83% indicated "no". Among those who answered "yes", the following questions and concerns were identified:

- "Complaints about mini-bus diesel vehicles idling, especially when we have a wheelchair lift, and need heat or air conditioner running. The Joint Health and Safety Committee brought the issue of mini-bus idling at the hospital door"; and
- "School bus idling in front of schools. Concerns about educational assistants meeting buses at schools with buses idling" (Survey Monkey, July 2010).

Age of School Buses by Operators

Eleven school bus operators provided information on the age structure on their fleets of school buses in Ontario (see Table 3). The results indicate that the age structure of the school bus fleets varies quite substantially from one company to another. They also suggest that there are few pre-1994 school buses remaining in the province. They also suggest that a substantial portion of Ontario's fleet of full size buses are in the 1994-2003 model year cohort; a cohort that could benefit substantially from retrofitting with emission control devices. With new school buses costing about $100,000 each, and DOCs costing about $1,100 installed, 91 existing school buses could have PM and HC emissions reduced by up to 40% and 70% respectively for the cost of replacing one school bus.

Table 3: CAP Survey Results - School Bus Operators - Demographics - Full-Size School Buses, July 2010

Region of Province	# of School Boards	# of Full-Size Buses	# of Post-2006 Buses	# of 2004-2006 Buses	# of 1994-2003 Buses	# of Pre-1994 Buses
Huron and Perth counties	1	14	6	2	6	0
Northern Ontario	4	107	44	45	41	0
Mid North		4	75	50	25	4
Huron & Bruce Counties	4	47	11	9	27	0
Southwestern Ontario	7	1	0	1	0	0
Northeastern Ontario	2	26	11	0	15	0
Southwestern Ontario	8	290	50	45	195	0
Central East	4	58	16	5	37	0
Northeastern Ontario	1	1	0	0	1	0
GTA & Southern Ontario	2	92	12	16	62	0
Manitoulin Island	2	8	1	2	5	0

Observations

There was not a strong response to this survey, which is due in part to the time of the year in which it was administered. With that said, the respondents were fairly diverse in terms of size, number of school boards serviced, and geographic distribution. From the 12 companies that did respond, a few messages are clear:

- While school bus operators feel fairly well educated about school bus emissions in terms of the age of the bus and about the potential for emissions to accumulate inside school buses and schools, they could use more information on the health impacts associated with emissions, and on retrofits that can reduce emissions;
- While school bus operators are open to policies on driver training for fuel efficiency and idling, they are more resistant to policies directed at emission control devices;
- School bus operators are operating under tight financial circumstances that make it difficult to respond to changes that are not associated with cost savings; and
- There could be a substantial number of school buses on the road that could benefit from retrofits with emission control devices.

H Ontario Public Health Advocates - Survey

Objectives

The survey for public health advocates in Ontario was developed to identify:

- How much public health advocates know about school bus emissions, emission control options, and the 2005 OPHA School Bus report;
- What questions or complaints they have received about school bus emissions; and
- What actions these individuals and/or their organizations have taken to address air quality issues associated with school bus emissions.

The survey, attached in **Appendix D**, was developed in consultation with the Project Advisory Committee, which includes three Managers of Environmental Health for three public health units in Ontario. These three Managers are also active members of the OPHA Environmental Health Working Group. The survey, developed using the Survey Monkey tool, was distributed electronically for three weeks in late June and early July 2010, through the Workgroup Chairs or Partnership Coordinators to:

- The 16 members of the OPHA Environmental Health Working Group;
- The 30 members of the Ontario Chronic Disease Prevention Alliance (**OCDPA**);
- The 24 members of the Canadian Partnership for Children's Health & Environment (**CPCHE**); and
- The 25 members of the OPHA Child and Youth Workgroup.

Survey Results

There was a 24% response rate with 23 of the 95 people who received the survey link completing the survey. Seventeen of the respondents were from eight public health units in Thunderbay, Windsor, London, Grey-Bruce, Simcoe-Muskoka, Peel Region, Peterborough, Hamilton and Toronto. Three responses were from representatives of the OPHA Environmental Health Workgroup, CPCHE, and the OCDPA. In addition, three responses were received from non-governmental organizations that are members of CPCHE and/or the OCDPA.

When asked if they knew that:

a. Concentrations of diesel-related air pollutants could accumulate inside schools from school buses idling in parking lots, 97% indicated "yes";

b. School buses could be self-polluting with concentrations of air pollutants accumulating inside the cabin of buses, 83% indicated "yes";

c. Emissions from, and exposures on-board, school buses could be greater with older school buses than newer ones, 87% indicated "yes"; and

d. Diesel-related air pollutants were associated with a variety of acute and chronic health impacts including aggravation of asthma and allergies, reduced lung function, and lung cancer, 87% indicated "yes"; and

e. There are emission control devices that can be retrofitted on to existing school buses to reduce both their emissions and the levels of air pollutants in their cabins, 48% indicated "yes" (Survey Monkey, July 2010).

When asked if they or their organizations had received questions or complaints about school bus emissions, 38% indicated that they had. In almost all cases, the questions or complaints were related to school buses idling in parking lots and/or school yards. The questions or complaints were raised by parents associated with the school in question, individuals in the general community, and by other staff within the individual's organization.

When asked if they or their organizations had conducted any outreach activities related to school buses 47% of respondents indicated that they had. When asked to describe the outreach activities:

- Several respondents indicated that their organizations had conducted anti-idling promotional campaigns that included signage and other activities on school properties;
- One respondent indicated that her organization included "no idling" policies as a recommended action in its new publication: "Advancing Environmental Health in Child Care Settings: A Checklist for Child Care Practitioners and Public Health Inspectors";

- The same respondent indicated that the higher levels of exposure that can occur inside a school are discussed in the CPCHE Primer, "Child Health and the Environment - A Primer";
- Several indicated that their public health units had promoted anti-idling policies and emission control devices to school boards in their communities;
- One respondent indicated that their public health unit provided the OPHA School Bus report to the school boards in their community;
- A few indicated that they provided educational materials and/or workshops to public health staff that included information on school bus emissions and anti-idling policies for schools and daycares; and
- One respondent indicated that his organization had produced a position paper on the issue of school bus emissions and exposures (Survey Monkey, July 16, 2010).

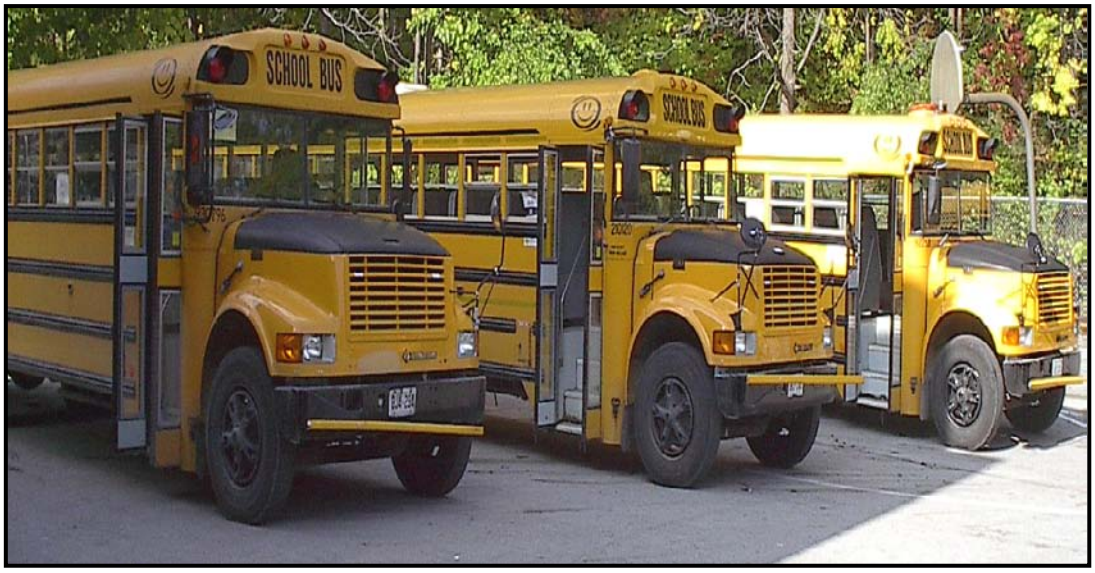
When asked if they had read the 2005 OPHA School Bus report, 61% of respondents indicated they had. Of those who answered "yes", 84% indicated that they or their organizations had taken steps to promote the OPHA school bus report or its findings:

- Several individuals sent the OPHA School Bus report to school bus operators and/or school boards in their communities;
- A few met with school boards in their communities to support the school board's participation in a school bus retrofit project;
- One met with school boards to encourage them to advocate to the federal government for funding for a retrofit project;
- One discussed the report with a local school bus operator;
- One posted the report on the partnership's website;
- One referenced the report in their organization's public educational outreach work;
- One forwarded the report along with a staff report to their Regional Board of Health;
- One indicated that the report and its findings were presented briefly at a workshop on air quality and children's health that was convened in Toronto in 2007;
- One indicated that the report was circulated electronically to alliance members; and
- One indicated that she heard a presentation on the report at the OPHA Conference in 2005, and shared the information with colleagues in her public health unit (Survey Monkey, July 2010).

Observations

The respondents to this survey clearly represent individuals and/or organizations who are informed and active on the issue of school bus emissions and exposures, and yet, it appears that there is more

work to be done in educating this group about emission control devices as a means of reducing school bus emissions, exposures inside school buses, and exposures inside buildings that can be impacted by school buses.



III Federal Initiatives

A School Bus Retrofit Pilot Project in British Columbia

Overview

Environment Canada conducted a three phase school bus retrofit project in British Columbia that began in 2004 and ended in 2006 with $600,000 in funding.

The first two phases were conducted with two School Districts situated in the Fraser Valley which experiences poor air quality on occasion. In the first phase, 29 school buses were retrofitted with Diesel Oxidation Catalysts (**DOCs**) capable of reducing PM by 29% and HC by 90% for a cost of $1350 per bus (Table 4) (MSC, 2010B).

In the second phase, 20 school buses were retrofitted with Closed Crankcase Ventilation devices (**CCVs**) that reduce levels of $PM_{2.5}$ on-board school buses.

In the third phase, the project was expanded with a Request for Expressions of Interest sent to every School District in British Columbia and the Yukon Territory. Twenty-seven additional public School Districts and one private school in British Columbia responded and 508 emission control devices were installed; 308 DOCs and 200 CCVs. It is estimated that the DOC retrofits in this phase would reduce PM emissions by approximately 500 kg in the first year. By the time that all of the 308 buses are retired, it is estimated that the retrofits will have reduced PM emissions by about 2900 kg for a cost of $145 per kg of PM reduced (Table 5) (EC, 2010).

Table 4: Environment Canada - Fraser Valley School Bus Retrofit Pilot Project, Reductions of Particulate Matter (PM) & Hydrocarbons (HC) in Phase 1, 2010 (MSC, 2010B)

	PM	HC
Pre-Retrofit Emissions/Year-29 Buses	70 kg	515 kg
% Reduction with DOCs	29%	90%
Post-Retrofit Emissions/Year-29 Buses	50 kg	51 kg
Emission Reductions/Year-29 Buses	20 kg	460 kg

Table 5: Environment Canada - British Columbia School Bus Retrofit Pilot Project, Phase 3, Reductions of Particulate Matter (PM) with Diesel Oxidation Catalyst Retrofits, 2010 (EC, 2010)

	PM
% Reduction with DOCs	40%
PM Reductions/1st Year-308 Buses	500 kg
PM Reductions/Over 11 Years - 308 Buses	2900 kg
Cost per Kg Reduced - First Year	$831/kg
Cost per Kg Reduced - Over 11 years	$145/kg

This School Bus Retrofit Pilot Project was funded and managed by Environment Canada. Environment Canada worked directly with Transportation Supervisors in School Districts across the province. The School Districts identified their interest and the vehicles they wanted retrofitted, and Environment Canada selected the vehicles that were most appropriate in terms of emission reductions, remaining years of service life, and vehicle specifications (EC, 2010).

Diesel Oxidation Catalysts (DOCs)

DOCs were selected for the retrofit project because they have a long history of successful use in the United States and other countries. A DOC uses a chemical process to change air pollutants into less harmful compounds. The DOCs selected for Phase 3 of the Environment Canada program were provided at a cost of $1350 per bus installed (EC, 2010).

DOCs are easy to fit and install. They are sized by the horsepower of the engine and they can be installed like a muffler in one to two hours. No operational problems were reported by school bus drivers with the exception of one device. That device was replaced and no further problems were encountered. The DOCs did not affect the warranties on the school buses, nor did they affect the fuel economy of the buses retrofitted (EC, 2010).

The DOC selected has been verified by the U.S. Environmental Protection Agency as capable of reducing emissions of PM, HC and carbon monoxide (**CO**) by 40%, 70% and 40% respectively (EC, 2010; EC, 2010A). Manufacturers say that DOCs will last for the life-time of the bus but their warranties cover 5 years (EC, 2010).

Closed Crankcase Ventilation Devices (CCVs)

CCVs were selected for the project because of their ability to substantially reduce air levels of $PM_{2.5}$ on-board school buses and because of their ability to further reduce emissions from the tailpipe (EC, 2010).

A CCV captures and returns oil in crankcase emissions to the oil pan, collects PM from the crankcase vapours, and directs filtered gas containing NO_x, HC and toxics to the engine for re-combustion (EC, 2010A). CCVs are attached to the exhaust vent from the engine compartment. They "filter" the combusted fuel that is being exhausted from the engine ensuring that it does not enter the cabin of the bus through the air intake or the door (EC, 2010).

CCVs come in a wider range than DOCs. They require a little more care in selection and installation. CCVs, which can cost between $200 and $1000 installed, usually require some maintenance. With most, there is a filter that needs to be changed once or twice a year. The installation can take about 3 hours (EC, 2010).

With Phase 3 of the project, operational problems were encountered with the CCV by several School Districts. The problems were attributed, in part, to improper installation and, in part, to the design of the CCVs. The supplier analysed the problem and replaced all of the devices with a newly designed CCV which is now being used on all new 2007 model year engines. No operational problems have been encountered since the new CCVs have been installed (EC, 2010; EC, 2010A). The warranties for the CCVs cover 5 years of operation (EC, 2010).

Anti-Idling Campaign

As a condition for receiving retrofit devices, the School Districts agreed to participate in an anti-idling campaign. This campaign included signage with the slogan "Young Lungs at Work" and educational materials. Environment Canada worked with Parent Advisory Committees in three School Districts to provide parents with the resource kits needed to run an anti-idling program at their schools (EC, 2010A).

B School Bus Retrofit Pilot Projects in Ontario

Halton/Peel School Bus Retrofit Pilot Project

Environment Canada initiated a school bus retrofit pilot project in southern Ontario in 2006. Environment Canada funds this project and provides technical and administrative support but the project has been managed by a non-governmental organization, My Sustainable Canada (MSC).

Working with two school bus operators (Student Transportation Canada and Attridge Transportation) and the school boards in Halton and Peel Regions, seven school buses in Halton Region and six in Peel Region were retrofitted with DOCs and/or CCVs in 2009.

The 13 buses selected were full-size school buses (i.e. 72 passenger); ten were 2004 model year school buses while three were 2003 model year buses. Under this pilot project, it was decided that buses had to have five years of service life remaining to be eligible for the retrofit. They also could not have pre-installed DOCs (MSC, 2010A).

Many of the "newer" school buses are already outfitted with DOCs. The following school buses come equipped with DOCs:

- International: Engine VT365 (2002-2004) and VT466(2004);
- Caterpillar: All post-2003 engine models;
- Cummins: Some 1993-1995 and 2001-2005 engine models (MSC, 2010A).

The DOC selected for this project cost $1080 while the CCV cost $295 with average installation costs at $300 per unit. The DOC selected has been verified by the US EPA to reduce PM by 40%, CO by 60%, and HC by 75% (MSC, 2010A). Over the life-time of these 13 buses, it is estimated that retrofits will reduce PM emissions by about 186 kg and HC emissions by about 1366 kg at a cost of $150 per kg of PM reduced or a cost of $21 per kg of HC reduced (MSC, 2010A) (see Table 6).

Table 6: Environment Canada - Halton/Peel School Bus Retrofit Pilot Project, Emissions & Emission Reductions, Particulate Matter (PM) & Hydrocarbons (HC) Over Life-Time of Buses, 2010 (MSC, 2010A)

	PM	HC
Pre-Retrofit - Emissions over Life-time -13 Buses	465 kg	1822 kg
% Reduction with DOCs	40%	75%
Post-Retrofit - Emissions over Life-time -13 Buses	276 kg	455 kg
Emission Reductions - Over Life-time - 13 Buses	186 kg	1366 kg
Cost per Kg/reduced - 1st Year	$1,520	$210
Cost per Kg/reduced - 10 years	$152	$21

All of the 13 school buses selected for this project were subjected to opacity tests that are required under the Drive Clean Program before being retrofitted. The opacity values for these 2003 and 2004 school buses ranged from 2.7 to 7.8% before retrofitting. When seven of these buses were tested after being outfitted with DOCs alone or with DOCs and CCVs combined, their opacity values dropped by 26 to 48%. In order to pass the Drive Clean test, school buses have to have opacity values that are less than 30% (MSC, 2010A).

While the Fleet Managers associated with this pilot project gave the project favourable reviews, one indicated that he felt it would have been more worthwhile to target older school buses built to higher emissions standards.

London School Bus Retrofit Pilot Project

Environment Canada conducted a second pilot project in southwestern Ontario. This area was selected for the pilot because it is an area that frequently experiences elevated levels of $PM_{2.5}$. For the school bus side of this pilot project, Elgie Bus Lines Limited, a subsidiary of Student Transportation Inc., was the school bus operator that partnered with Environment Canada. Elgie Bus Lines Limited provides student transportation to three school boards in the London area. The non-profit organization, My Sustainable Canada, was contracted to support the implementation of this project as well. Fifteen school buses were retrofitted with DOCs and CCVs in 2010 (MSC, 2010B).

The original intent of this project was to target small school buses with retrofits, but communication with vendors of emission control devices indicated that there is very little experience outfitting small school buses with emission control devices. It was decided to retrofit full-size school buses. Once again, it was decided that only school buses with five years or more of remaining service life would be eligible for retrofits. Fourteen 2003 model year school buses and one 2004 model year school bus were retrofitted with DOCs and CCVs (MSC, 2010B).

The DOC selected, along with a CCV system, has been validated by the US EPA to reduce PM by 40%, CO by 60%, and HC by 75%. The total cost for the DOC and the CCV per bus was $1,430. The vendor also charged $700 to train the operator on the installation and maintenance of the devices (MSC, 2010B).

The devices selected had to meet the following performance criteria:

For DOCs:

- Must by verified by the US EPA or the CARB;
- Must have no adverse effect on fuel efficiency;
- Must not affect the warranty of the bus, engine or other bus component;

- Product and installation must be warranted for a minimum of five years;
- Installation must be at the site of each school bus operator's fleet headquarters and the school bus operators reserve the right to perform the installation.

For CCVs:

- Must have been demonstrated as an effective emission reduction measure through a third party testing process. Verification by the US EPA or CARB preferred but not mandatory;
- Must have no adverse effect on fuel efficiency;
- Must not affect the warranty of the bus, engine or other bus component;
- Product and installation, where undertaken by the supplier or its sub-contractor, must be warranted for a minimum of five years;
- Installation must be at the site of each school bus operator's fleet headquarters and the school bus operators reserve the right to perform the installation.

Over a ten year period, it is estimated that these retrofits will reduce PM emissions by 124 kg and HC emissions by 1,290 kg at a cost of $233 per kg of PM reduced or $22.5 per kg of HC reduced (MSC, 2010B) (see Table 7).

Table 7: Environment Canada - London School Bus Retrofit Pilot Project, Emissions & Emission Reductions, Particulate Matter (PM) & Hydrocarbons (HC), Over Life-Time of Buses, 2010 (MSC, 2010B)

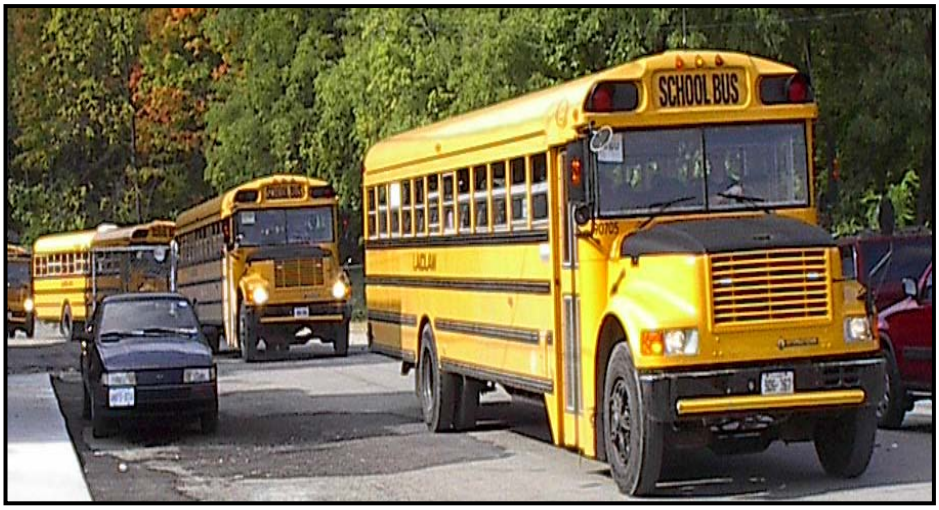
	PM	HC
Pre-Retrofit - Emissions over Life-time - 14 Buses	501 kg	1721 kg
% Reduction with DOCs	40%	75%
Post-Retrofit - Emissions over Life-time - 14 Buses	377 kg	430 kg
Emission Reductions - Over Life-time - 14 Buses	124 kg	1290 kg
Cost per Kg/reduced - 1st Year	$2,330	$225
Cost per Kg/reduced - 10 years	$233	$22.5

Biodiesel

The school bus operator for this project, Elgie Bus Lines Limited, has been using biodiesel to fuel all of its 210 diesel-fuelled vehicles for about five years now. Many of those vehicles are full-size school buses while others are small and mid-sized school buses. Elgie uses biodiesel from April to November each year. They do not use the biodiesel in the colder months because of operational problems that can occur when the temperature drops causing the biodiesel fuel to gel. Elgie has been pleased with the performance of biodiesel because the engines run very clean on this fuel. Elgie's Fleet Manager explained that, since Elgie has been using biodiesel, the opacity test results for all of its buses have dropped from 12% to 15% to about 5%. This has meant that Elgie only has to run its buses through the

Drive Clean opacity tests once every two years, instead of once per year. This has resulted in huge savings in labour costs. Elgie has compared the opacity tests on its school buses in the winter months to see what difference the biodiesel makes, and has found that the opacity test results are about 15% higher when buses are run on conventional diesel. Elgie has also found that it receives fewer complaints from the public about school bus emissions when it is using biodiesel (Elgie, 2010).

The grade of biodiesel used by Elgie varies from B5 to B20; it depends upon what is available from their supplier, Gra Ham Energy Ltd. Gra Ham Energy Ltd purchases fuel from a U.S. distributor that benefits from subsidies provided for biodiesel by the U.S. Government. Elgie began purchasing fuel from Gra Ham Energy Ltd. when the price for biodiesel was $0.01 cent per litre less than the cost of conventional diesel fuel. The cost has recently increased because U.S. subsidies have recently been removed. At present, the cost is about $0.07 per litre more than conventional diesel. For the time-being, Elgie will continue to use biodiesel because it is a green fuel that is favoured by its parent company, Student Transportation Inc. (Elgie, 2010).



IV Initiatives in Other Provinces

A Introduction

In the United States, school bus retrofit programs have become commonplace since the United States Environment Protection Agency (**US EPA**) demonstrated that retrofitting diesel-fuelled vehicles with emission control devices can be a cost effective means of reducing air pollutants relative to other EPA programs (Bronson, 2010).

The US Government runs a national program called Clean School Bus USA, under its National Clean Diesel Campaign, which includes funding for private companies and States to encourage policies and practices that support retrofitting buses with emission control devices, fuelling buses with cleaner fuels, replacing the oldest buses with less polluting buses, and reducing idling (Bronson, 2010).

Between 2007 and 2011, the US EPA did, and will, receive up to $200 million per year under the Diesel Emission Reduction Program to support reductions of emissions from diesel-fuelled equipment including school buses. Since 2000, California has spent over $100 million to replace 638 old school buses and to retrofit 4,050 existing school buses with emission control devices verified by the California Air Resources Board (**CARB**) (Bronson, 2010). Since 2003, the State of Washington has spent $25 million retrofitting 7,500 of the State's 9,000 school buses (Bronson, 2010). Since 2008, the State of Texas has retrofitted 4,882 school buses with an annual state budget of $3.7 million and an additional $2.5 million in 2008 and 2009 from the EPA program for action in poor air quality regions (Bronson, 2010).

In Canada, there are two provinces that have established School Bus Retrofit Programs, British Columbia and Nova Scotia.

B British Columbia

School Bus Retrofit Program

The Environment Canada project in British Columbia laid the ground work for a provincial school bus retrofit program that was included in the British Columbia (BC) Air Action Plan announced in 2008. The clean-up of school buses was captured under Action #7 that was directed at "making heavy-duty vehicles cleaner"(BC MOE, 2010A).

There were two elements to Action #7. The capital program directed at the replacement of older school buses was assigned to the BC Ministry of Education (**BC MofEd**), while the school bus retrofit program was assigned to the BC Ministry of the Environment (**BC MOE**). The objectives of the retrofit program are to reduce emissions from existing school buses with good service life remaining and to reduce exposure of the school bus occupants to $PM_{2.5}$ (BC MOE, 2010: BC MOE, 2010A).

In the BC MOE website, the following health arguments are offered as reasons for establishing the school bus retrofit program:

> "The exhaust from diesel-powered vehicles contains a variety of hazardous gases and particulate contaminants...Diesel exhaust is classified as a known or probable human carcinogen…Depending on the type and age of the vehicle, bus emissions may make their way into the bus cabin. The pollution comes from two sources: the tailpipe and the engine crankcase. Even though children may spend only a small portion of their day on buses, the high exposures they receive inside the bus can add considerably to their daily and annual exposures" (BC MOE, 2010A).

Program Implementation

When it came time to establish the BC School Bus Retrofit Program, the BC MOE established an advisory committee that included, among others, a technical expert from Environment Canada's Pacific Yukon Region. The BC MOE considered whether the program should be administered with grants offered to School Districts, funding offered through the BC MofEd, or run directly by the BC MOE. It was decided that the program should be run directly by the BC MOE so it could maintain control over the program and ensure its success (BC MOE, 2010).

At the outset, the plan was to retrofit up to 700 school buses in School Districts across the province. In B.C., where most school buses are owned and operated directly by School Districts, a policy decision was made to offer retrofits only for school buses owned and operated by School Districts. All School Districts that owned school buses that were suitable for retrofits were offered the opportunity to participate. Participation was voluntary (BC MOE, 2010).

The BC MOE issued a Request for Quotations (**RFQ**) for the retrofit of school buses with three different types of emission devices; DOCs, CCVs, and Flow-Through Filters (**FTFs**) that can be retrofit on to exhaust systems. It received several bids and decided to select three vendors; one for each type of emission control device. The vendors tended to be heavy-duty diesel mechanic shops; not the manufacturers of school buses, and not the manufacturers of emission control devices (BC MOE, 2010).

The RFQ was issued in the spring of 2008; the contracts were awarded in the summer of 2008; and the installations began in the fall of 2008. Under this RFQ, 400 devices have been installed at a cost of approximately $700,000. Most of the devices have been DOCs, at a cost of $1,106 per bus installed, and CCVs at a cost of $837 per bus installed. Only about 40 FTFs, at a cost of $5,725 per bus installed, have been retrofitted under this program. At this time, there is no budget for further action on this Program (BC MOE, 2010).

Flow-Through Filters (FTFs)

The BC School Bus Retrofit Program originally extended the retrofit equipment from DOCs and CCVs to include FTFs and Diesel Particulate Filters (DPFs) which provide greater emission reductions than DOCs.

However, when the RFQ process was completed, DPFs were not selected for installation on school buses under this program. Experience over the last few years has demonstrated that school bus routes do not typically provide the duty cycle required for the effective operation of DPFs. When DPFs are used in buses that stop frequently, the temperatures in the tailpipe are not high enough to "burn off" the particles, and the device becomes blocked, which creates operational problems for the bus. This has made it a "high risk" proposition for School Districts and school bus operators (EC, 2010).

Like DPFs, FTFs are capable of significantly reducing emissions from the tailpipes of school buses. They can reduce PM by more than 50%. Like DPFs, FTFs also require high temperatures to operate efficiently. However, unlike DPFs, FTFs do not create operational problems when temperatures are not sufficiently high. When temperatures are too low, FTFs allow air in the exhaust system to by-pass the filter. While this affects the device's performance in terms of emission reductions, it ensures that the operational performance of the bus is not affected. Consequently, the FTF presents fewer risks for School Districts and school bus operators. Given the cost of the FTF, however, it should only be installed on school buses that have the appropriate duty cycle and that cycle should be confirmed with a week of data logging (EC, 2010).

FTFs are easy to install; requiring only a few hours. They are designed to require very little maintenance; there is no filter to change or clean; and they should have no impact of the fuel efficiency of the school bus (EC, 2010).

Operational Issues

With the 400 emission control devices installed in BC school buses, there have been no complaints and no negative feedback about operational issues or maintenance from the participating School Districts (BC MOE, 2010). However, there were a number of concerns expressed by school districts about the impact of retrofits on the operation of vehicles before the installation. In fact, several School Districts chose not to participate in the program because of concerns about how the retrofits might affect their buses (BC MOE, 2010).

With the 400 emission control devices installed in BC school buses, there have been no complaints and no negative feedback about operational issues or maintenance from the participating School D Districts.

Biodiesel

The Province of British Columbia has announced its intention to mandate the use of a 5% average renewable content in diesel fuel by 2010. In its RFQ, the BC MOE indicates that school districts may use higher blends of biodiesel if they choose to.

Biodiesel is a fuel that is similar in its combustion profile to petroleum-based diesel but it is derived from vegetable oil or animal fat from rendering plants. It can be blended with conventional diesel to create 5%, 10% or 20% blends (B5, B10, or B20) or used as 100% biodiesel (B100) (Perrotta, 2005; Torrie, 2005). Because tailpipe emission of CO_2 from biodiesel combustion are biogenic and offset by atmospheric carbon that was fixed in the growing of the plant or animal from which the fuel is derived, tailpipe CO_2 emissions from biodiesel are not included in the quantification of greenhouse gases from human activities (Torrie, 2005; Perrotta, 2005).

Biodiesel is a relatively clean burning fuel. B100 emits 50% less PM than conventional diesel and at least 50% CO and HC. Emissions of toxic air contaminants such as formaldehyde and ketones are 60 to 90% less with biodiesel than with conventional diesel. On the down side, biodiesel can produce modest increases in emissions of NO_x; 10% more with B100 (Perrotta, 2005; Torrie, 2005).

DOCs are more effective when used with biodiesel. Biodiesel tends to create more organic PM, and less inorganic PM, than petroleum-based diesel fuel. Because DOCs capture organic PM more efficiently than inorganic PM, they tend to operate more efficiently when used on school buses fuelled with biodiesel blends (EC, 2010).

At this time, there are no school districts in BC using a biodiesel blend because biodiesel is not available in most regions of the Province. It is only available in the Vancouver area and in some parts of Victoria (BC MOE, 2010).

BC Request for Quotations (RFQ)

Emission Control Devices

When British Columbia issued its RFQ for school bus retrofits, it identified three types of retrofits that would be allowed and the number of retrofits it anticipated for each type of device:

- Level 2 & 3 Retrofit Devices - FTFs and DPFs - 75-150 devices
- Level 1 Retrofit Devices - DOCs - 200-300 Level I exhaust retrofit devices
- CCVs - 100-500 CCVs (BC MOE, 2008).

It identified the following specifications for all three types of retrofit devices:

a. Devices must have been successfully demonstrated in a school bus application.
b. The product must not affect the warranty of the bus, engine or other bus components.
c. The product and installation work (where undertaken by the Contractor or its subcontractor) must be warranted for a minimum of five years.
d. The installation site will be at each School District's fleet headquarters unless otherwise directed by the Project Manager. Each School district reserves the right to perform the installation work in-house (BC MOE, 2008).

For Level 2 & 3 Retrofit Devices, the RFQ added the following specifications:

a. Devices must be verified by the US EPA or CARB to a minimum PM removal efficiency of 50%. Proposals for verified advanced systems that result in greater emissions reductions will be

considered favourably. Proponents may choose to quote more than one Level 2/3 device for consideration.

b. Devices must not have specified requirements for duty cycle, engine exhaust temperature or other technical requirements that may be difficult to achieve universally across a wide range of school bus applications in British Columbia.

c. The product must have minimal or no adverse effect on fuel efficiency. Retrofit devices that have a neutral effect on fuel economy will be considered more favourably (BC MOE, 2008).

For Level 1 retrofit devices, it added the following specifications:

a. The Level 1 product being proposed must be a verified by the US EPA or CARB to a minimum PM removal efficiency of 20%. Proposals for verified advanced DOC systems that result in greater emissions reductions will be considered favourably.

b. The product must have no adverse effect on fuel efficiency (BC MOE, 2008)

For CCVs, it added the following specifications:

a. The CCV equipment proposed must have been demonstrated as an effective emission reduction measure in a school bus application. Verification by US EPA or CARB is preferred but is not mandatory.

b. The product must have no adverse effect on fuel efficiency.

c. The Contractor will be required to conduct a maintenance training session for School district fleet managers at a location in B.C. to be determined (BC MOE, 2008).

Contractor's Responsibilities

The statement of work in the RFQ, identified the following responsibilities to be undertaken by the contractor(s):

a. Through site inspections or alternative means, the Contractor shall ensure that the buses selected for retrofitting at each individual School District are suitable for retrofitting. The Contractor will identify any bus on the list that has a DOC or CCV already installed by the original equipment manufacturer and advise the Project Manager for confirmation. Any changes resulting from the inspection will be reflected in a change to the order.

b. The Contractor shall supply the appropriate FTF, DOC and CCV equipment, including all mounting hardware, for the buses listed in Attachment A.

c. The Contractor shall ensure that the installation of the FTF, DOC and CCV equipment will not void any existing warranty on any retrofitted vehicle. This will apply whether the installation is performed by the Contractor or by the School Districts.

d. The Contractor shall provide an option for installation services for all equipment. The Contractor may sub-contract the installation work to an approved third party. The installation location will be the fleet headquarters of each participating School district unless otherwise directed by the Project Manager. Individual School districts will have the option of having the Contractor (or its designated subcontractor) install the equipment.

e. The Contractor shall provide a list of all spare parts that may be required, along with contact information for suppliers of the parts (BC MOE, 2008).

Eligible Buses

The RFQ identifies school buses model years 1995 through to and including 2007 to be eligible for retrofits with CCVs and Level 1, 2 and 3 retrofit devices. With 2007 model year buses, the retrofits apply only to those buses equipped with 2006 model year engines because 2007 model year engines should include both DPFs and CCVs. The RFQ also notes that buses may be eligible for both CCVs and Level 1, 2 or 3 retrofit devices (BC MOE, 2008).

C Nova Scotia

Nova Scotia Ministry of Education

Replacement Cycle

In Atlantic Canada, school buses are purchased collectively with the Ministries of Education from the four Atlantic Provinces (i.e. Newfoundland,, New Brunswick, Prince Edward Island and Nova Scotia) collaborating to achieve numbers that can garner better pricing. The Nova Scotia Department of Education (**NS DofEd**) has a policy of replacing 8% of the province's school buses annually. This means that school buses in Nova Scotia are replaced on average every 12.5 years. This replacement cycle is considered optimum considering the toll that road salt takes on vehicles in Nova Scotia, even with regular preventive maintenance in force (NS DofEd, 2010).

Engine Heaters

With each annual purchase the current state-of-the-art bus technology is introduced into the fleet, that continually improves safety and operating efficiency overall. The province purchases the buses with base standard equipment that optimizes safety and efficiency. The various School Boards are able to select options that reflect the needs that are particular to their locations and terrain. Amenities can include items such as air-cushioned seats for drivers and additional hand rails for special needs students.

One option selected for all of the buses this year was an auxiliary heater with a timer that preheats the engine automatically before start-up and which minimizes the amount of engine idling time required to

heat and defrost a bus in winter. There are various manufacturers as well as a range of capacities, from a small unit that heats only the engine, to larger units that preheat the whole bus. Apart from the convenience and safety benefits of having a bus defrosted quickly, these units also save fuel and have a relatively quick payback period (NS DofEd, 2010).

Nova Scotia Diesel School Bus Retrofit Program

Conserve Nova Scotia (**CNS**), a government agency directed at energy efficiency and energy conservation, received funding provided by ecoNova Scotia for Clean Air and Climate Change, to establish a School Bus Retrofit Program in 2010. The program has two main objectives: to reduce fuel use and operating costs for student transportation; and to reduce emissions of greenhouse gases and air pollutants such as $PM_{2.5}$ from school buses to produce health and environmental benefits (CNS, 2009). Established in the fall of 2009, this is a one year program with a budget of $1.35 million to be spent in the 2010/2011 budget cycle (CNS, 2010).

Implementation of the Program

The funding for this program is directed to school bus carriers in Nova Scotia whether those carriers are School Boards that own and operate their own school buses or private firms that operate school buses on a contract basis for school boards (CNS, 2010). CNS will administer the program but the purchase, installation and proper operation of the equipment is the responsibility of the school bus carriers that receive funding (CNS, 2010). The applications for funding were released in April 2010 and reviewed in May 2010. The successful applicants have been selected but the names have not yet been publicly released**.** Most of the funding will be directed at equipment or activities that reduce fuel use, which will in turn reduce operating costs and emissions of greenhouse gases and air pollutants. Few of the applicants targeted emission control devices that have no fuel or cost savings (CNS, 2010).

Equipment/Activities Covered

CNS provided a menu of five types of equipment and/or activities that were eligible for funding. This menu includes:

1. Auxillary heaters and timers that can be used to reduce idling time;
2. Emission control devices listed below provided that they have been verified by the US EPA or the CARB:
   a. FTFs which on average reduce emissions of particulate matter by 50%. Data loggers may be required on buses prior to installing an FTF to provide assurance that bus and route are suitable for the FTFs;
   b. DOCs which, on average, reduce emissions of particulate matter from tailpipe exhaust by 25%.

c. CCVs, with PM reductions of approximately 5 to 10%, focusing on in-cabin emissions. CCV may be installed in combination with other emission control devices (CNS, 2010B).

3. Fleet management tools such as Electronic Control Modules (ECMs), ECM software, GPS units that allow real-time tracking of school buses, and staff training on this equipment, that can reduce idling time and down time of buses to produce financial and environmental benefits;
4. Route optimization software, GPS units, and staff training directed at optimizing school bus fleets, that can reduce overall VKTs to produce financial and environmental benefits;
5. Accessibility upgrades such as seat-belts or harnesses for students with special needs that can produce fuel savings and the attendant financial and environmental benefits by optimizing the use of vehicles (CNS, 2010B; CNS, 2010).

Application Process & Eligibility Criteria

In each case, applicants were required to comply with the conditions in the "Greening the School Buses Program – Application Guide" and to complete Application Forms for each type of equipment. The Application Forms required the reporting of detailed information on the school buses to be retrofitted, the VKTs, fuel use, number of students affected, the equipment and/or activity to be funded, along with cost estimates, so that emission reductions could be estimated by CNS (CNS, 2010B).

In order to be eligible for funding, school bus carriers had to agree to implement an anti-idling policy and a subsequent driver training program by November 30, 2010. They also had to agree to provide detailed information on issues such as VKT and fuel use to CNS on a quarterly basis for two years following receipt of the funding (CNS, 2010; CNS, 2010B). The eligibility criteria for the program required that school buses retrofitted under this program were CSA D250 compliant [1] and have at least 2 full years of service life remaining in Nova Scotia (CNS, 2010B).

Conserve Nova Scotia (CNS) staff have not prepared any model policies and/or contract language for school boards to encourage uptake of equipment of emission control devices. They feel that the Program's funding, along with the detailed Application Forms, provided both the incentive and the direction needed to encourage uptake by school bus operators (CNS, 2010).

School Board Policies in Nova Scotia

Staff at CNS are not aware of any school boards policies and/or contract language related to the emission performance of school buses, with the exception of those directed at idling and engine heaters (CNS, 2010). They know that several school boards have developed policies on idling because

[1] CSA D250 compliant refers to the yellow school buses that meet current school standards and excludes blue or white school buses that are used for non-school related events (CNS, 2010).

the idling policies were submitted along with every application that was submitted for the NS School Bus Retrofit Program.

Idling Policies

The Annapolis Valley Regional School Board has a Board Policy and an Administrative Procedure on Vehicle Idling. The policy identifies the health, environmental, and fuel cost concerns associated with idling, and states that "no vehicles should be idling on school property". The procedure consists of four statements:

- one indicates that operators of school buses must be trained not to idle on school property;
- one indicates that school buses should not idle unnecessarily at any time;
- one requires signage on all school properties saying "Please Turn Off Your Engine", and
- one encourages all schools to establish anti-idling campaigns for their school and communities (AVRSB, 2008)(**Appendix E**).

Auxillary Heaters & Anti-Idling Devices

The South Shore Regional School Board has developed an Administrative Procedure for Vehicle Idling as well. Revised in March 2010, it consists of 17 detailed provisions. The first five points address the four points included in the Annapolis Valley Regional School Board Administrative Procedure. The other 12 points refer to the use, operation and maintenance of engine block heaters, timers, diesel fired auxillary heaters, and manufacturers "anti-idling" devices and applicable programming. For example:

- One statement requires that from November to April, all buses use engine block heaters; and
- One requires that manufacturer's "anti-idling" devices and applicable programming be enabled at all times (SSRSB, 2010) (**Appendix E**).

V Summary, Conclusions & Recommendations

A Summary & Conclusions

1. 2005 OPHA School Bus Report Recommendations

Emissions from school buses have declined significantly over the last 20 years as new fuel and engine emission standards have been developed and rolled out by the Government of Canada. With buses built with post-2006 model year engines, it is expected that levels of air pollutants on-board school buses will approach levels in ambient air. Equipped with DPFs and CCVs, these buses are not expected to be self-polluting. This is great news for children's health and local air quality. However, for older school buses, health concerns remain both for on-board exposures and local air quality.

In 2005, the OPHA School Bus report recommended that:

1. The Ontario Government invest $10-20 million per year to reduce childhood exposure to diesel-related air pollutants and improve local air quality by encouraging: replacement of older school buses; retrofitting of existing school buses; demonstration projects that promote alternative fuels and technologies; and the development of an educational module on proper idling and driving practices for school bus operators;
2. The Government of Canada establish a Healthy School Bus Fund with $10 to 20 million per year to support programs developed by provincial governments and other organizations that are directed at the dual goals of reducing childhood exposure to diesel-related air pollutants and improving local air quality; and
3. School Boards in Ontario, in collaboration with the OMOE and NRCan, develop formal policies respecting idling in school buses particularly in the vicinity of school properties.

2. Ontario Government

Since 2005, the Ontario Government has taken a number of steps that promise to have a significant impact on school bus emissions and school bus exposures. Since 2005, the MofEd: added $16.9 million per year (or 2%) to the base funding for student transportation; included recommended average fleet age and maximum bus age guidelines in the stakeholder developed Model Contract Template to encourage the replacement of older high-emitting school buses with new low-emitting school buses; required collaboration between School Boards within each area of the province to optimize and integrate the use of school buses and school bus routes; and established an independent "Effectiveness and Efficiency " (E&E) review process on the management practices and operations of STBs across the province to encourage, among other things, efficient routing of school buses.

The increased funding for student transportation is intended to address cost updates, fuel costs, enrolment changes, and efficiency measures, but it does not address funding for retrofits to existing school buses. Nor does the Model Contract Template mention retrofits for emission control devices, auxillary engine heaters, alternative fuels such as biodiesel, or idling. The OMofEd has not been explicitly promoting school bus retrofits because it views such issues as operational issues that have to be determined by the operators when they decide how they will fulfill their contractual commitments to STBs.

The OMOE has used its Drive Clean Program to influence school bus emissions. It has tightened the Drive Clean emissions standards for all HDDVs twice since the program began. Diesel school buses are required to meet the more stringent of these HDDV standards to help protect the health of children. In 2007, the OMOE also provided a grant of $150,000 to the OSBA to assist them with education directed at school bus drivers.

3. Student Transportation Boards/Consortia

Based on the response of STBs to the CAP survey, it appears that: many STBs have adopted policies to encourage replacement of older school buses; a substantial number have adopted policies related to driver training for fuel efficiency and idling; and very few have adopted policies related to retrofits for emission control devices, alternative fuels, or alternative technologies. The policy preferences of the STBs reflect the policies in the Model Contract Template and the priorities captured by the financial formula for student transportation. While it may be helpful to educate the STBs about the benefits associated with retrofits for existing vehicles, education alone is unlikely to affect their policies. Focused funding is likely to be needed along with technical support to address operational concerns.

4. School Bus Operators

The OSBA reports that its company members try to turn over 10% of their fleet every year so they can replace older vehicles with school buses that are built to new emission standards that are "very clean and fuel efficient". The OSBA notes however, that company members cannot always afford to meet the 10% turn over rate because of a lack of funding from the provincial government (OSBA, 2010).

Since 2007, the OSBA has trained 2,600 school bus drivers in Ontario on driving and idling practices that reduce fuel use and emissions of air pollutants and greenhouse gases. The training was based on the FleetSmart Program for school buses that was developed by NRCan in cooperation with the OSBA and its company members.

The OSBA believes that its company members will not retrofit school buses with emission control devices unless additional funds are made available for that particular task. The OSBA indicated that, in

the absence of specific funding, its members will favour replacement of older school buses and driver training on fuel management because these actions provide cost efficiencies while also reducing emissions of air pollutants and greenhouse gases.

The school bus operators who responded to the CAP survey indicated that they are fairly well educated about school bus emissions and school bus exposures but they could use more information on the health impacts associated with emissions and on retrofits that can be used to reduce emissions. They also indicated that they would find model policies regarding driver training for fuel efficiency and idling useful, but not model policies directed at retrofits for emission control devices. A few expressed the view that they are operating under tight financial circumstances that make it difficult for them to respond to changes that are not associated with cost savings or direct funding.

While it appears that there is a role for education directed at school bus operators on the health impacts associated with emissions and on emission control devices, it is clear that school bus operators are unlikely to retrofit their buses without funding and technical support directed specifically at emission control devices.

5. Public Health Advocates

From the survey directed at public health advocates, it appears that there is a high level of awareness about the health concerns presented by school bus emissions for children on buses, in school yards, and in buildings serviced by school buses among those who work on environmental health and/or children's health issues. It also appears that members of this group have been fairly active in educating the broader community about these issues. However, it appears that this group of interested individuals/organizations are not as well informed about the potential for emission control devices to reduce school bus emissions or exposures. Among those individuals/groups involved in educating the public health and/or the broader community about school bus emissions, education has focused almost exclusively on idling practices and policies as the action required to address these concerns. These results suggest the need for an educational campaign directed at public health staff and at the broader community that is focused entirely on the benefits of retrofits for existing school buses.

6. Federal Programs/Projects

Since 2005, Environment Canada has conducted two school bus retrofit projects:

- Between 2004 and 2006, Environment Canada had 557 emission control devices installed on school buses belonging to 29 school boards and one private school in British Columbia for a cost of $600,000; and
- Between 2008 and 2010, Environment Canada installed emission control devices on 28 school buses being used by five school boards in Ontario for a cost of approximately $50,000.

The ambitious Environment Canada School Bus Retrofit Project directed at school buses in British Columbia has served as a model for a provincially-funded school bus program while also allaying fears about operational issues among School Districts and school bus operators in that Province. The School Bus Retrofit Projects directed at Ontario's school buses have been relatively modest to date. Given the size of Ontario's school bus fleet (15,000 school buses compared to 1,500 in British Columbia) the investment made by the Ontario Government towards school bus replacement, and the expertise gained by Environment Canada on this issue, it would appear that there is an important role for the Federal Government to play on this issue in Ontario.

7. Other Provincial Jurisdictions

Since 2005, two provincial governments have taken significant steps to address emissions from their existing school buses:

- British Columbia directed $700,000 at its fleet of 1,500 school buses for retrofits that would reduce emissions from school buses and exposures of school bus occupants to $PM_{2.5}$. In B.C., it was decided that government funding was not needed for devices that can reduce fuel use and produce cost savings. However, it was decided that funding was needed for devices that produce health benefits but no cost savings for School Districts and/or school bus operators. In BC, the retrofit program was directed at DOCs, CCVs and FTFs.

…However, it was decided that funding was needed for devices that produce health benefits but no cost savings for School Districts and/or school bus operators.

- In 2010/2011, Nova Scotia is directing $1.35 million at a School Bus Incentive Program that aims to reduce fuel use and emissions of greenhouses and air pollutants. Managed by Conserve Nova Scotia, this program allows School Boards and/or private school bus operators to apply for funding for auxillary heaters and timers, three types of emission control devices (DOCs, CCVs, and FTFs), fleet management tools such as Electronic Control Modules, route optimization software and training, or accessibility upgrades such as seat-belts or harnesses for students with special needs. Staff at Conserve Nova Scotia found that few of the applicants have targeted emission control devices that produce no fuel or cost savings.

8. Where to Retrofit & What to Retrofit?

Given the cumulative nature of school bus exposures (i.e. related to local air quality, traffic density, and school bus emissions) school bus retrofits would provide the greatest public health benefits if they were directed at the communities where children currently experience the greatest exposure to air pollution because of heavy traffic density, heavy industry, and/or transboundary air pollution. It may

also be useful to target some northern and/or rural communities where children may experience greater exposures because of longer bus trips and/or the use of older school buses.

In terms of the school buses to target, it should be noted that the public health benefits associated with retrofitting older school buses, built to weaker emission standards, may be equivalent to, or greater than, the public health benefits associated with retrofitting newer school buses built to more stringent emission standards that have a greater number of service years remaining (see Table 8). While retrofits directed at newer school buses have the potential to remove a greater amount of PM over time, the retrofits directed at older school buses have the potential to remove greater quantities of HC. The HC in diesel exhaust includes a number of toxic contaminants that add to the toxicity of the PM emissions. While the health benefits of the HC reductions are more difficult to quantify than those associated with the reductions in PM, they are potentially as significant from a health perspective.

With a DOC, which is a self-contained device similar to a muffler, it could be argued that the device could be removed from the older school bus when the bus is retired to be re-installed on another vehicle in the fleet. However, there are also concerns about what becomes of older school buses that are retired by school bus operators. While it may be unfair to expect STBs or school bus operators to retrofit old school buses before selling them, it would be good public policy for the Province to require that they be retrofitted with emission control devices by the new owners as a condition of vehicle registration.

Table 8: Emissions of Particulate Matter (PM) & Hydrocarbons (HC) for School Buses in Two Model Year Cohorts Before & After Retrofits with Diesel Oxidation Catalysts (DOC)

Model Year Cohort & Retrofit	PM (g/yr)	HC (g/yr)	Service Life Remaining	Cumulative PM Reduced (g)	Cumulative HC Reduced (g)	Cost (installed)
1994-2003 Base	4,100	53,300	2 years			
2000 & DOC	2,460	13,325		3,280	79,950	$1,100
2004-2006 Base	4,100	5,700	6 years			
2004 & DOC	2,460	1,425		9,840	25,650	$1,100
Note: Using 40% and 75% as the emissions reduction rates for PM and HC respectively for DOCs						

9. Drive Clean Program & Opacity Tests

In order for school buses to pass the vehicle maintenance test required by Ontario's Drive Clean Program, they must have an opacity reading less than 30% if they were built in 1991 or later. In 2009, Drive Clean reported that of the 7,026 heavy-duty diesel school buses tested for opacity, only 137 (1.95%) failed. When the thirteen 2003 and 2004 model year school buses from Halton and Peel Regions were subjected to opacity tests before retrofitting for the School Bus Retrofit Project, their

readings ranged from 2.7 to 7.8% opacity. These results, along with the data from the Drive Clean Program, suggest that it might be useful to tighten the opacity standards for school buses as a means of encouraging retrofits among older school buses in Ontario.

B General Recommendations

It is recommended that:

1. The **Government of Canada** continue to promote retrofits for existing school buses by:
   a. Funding an ambitious School Bus Retrofit Program directed at Ontario and other provinces. This program should be directed primarily at areas of the province/country where children are exposed to elevated levels of air pollution. A secondary target audience should be school boards in northern and/or rural communities where children can experience higher exposure to school bus emissions because of longer commuting times and/or older school buses;
   b. Funding the education of school boards and school bus operators on: the health impacts of diesel-related air pollution; the emission control devices that can be retrofitted on to existing buses; and alternative fuels and technologies that can be used to reduce emissions from school buses;
   c. Funding the education of parents, teachers and children about the health benefits associated with retrofits with emission control devices for existing school buses, alternative fuels, and alternative technologies.

2. The **Ontario Government** consider:
   a. Requiring that pre-2005 school buses that change ownership cannot be registered for use on the road in Ontario by the new owners without being retrofitted with DOCs and CCV devices; and
   b. Strengthening the opacity standards that apply to school buses under the Drive Clean Program to reflect the downward trend in emissions and encourage the replacement or retrofitting of older school buses.

C Recommendations - Student Transportation Boards/Consortia

After reviewing the policies and practices being implemented by Environment Canada, provincial agencies, and school boards in Ontario, Nova Scotia, and British Columbia, to reduce emissions from, and exposures on-board, school buses, the following policies are recommended for consideration by Student Transportation Boards/Consortia in Ontario:

1. **Encourage Replacement of Older Buses**: The Model Contract Template developed by transportation stakeholders in Ontario, and endorsed by the Ontario Ministry of Education, has recommended a maximum age limit of 12 years and an average fleet age of 7 years for full-size school buses. By adopting these age limits in policies and contract language, Boards/Consortia can ensure that the highest emitting school buses are removed from the road as quickly as possible.

2. **Limit Use of Older School Buses:** For those situations in which older school buses (i.e. >12 years) are retained for emergency purposes, contract language should limit the number of hours and/or days per year that these older buses can be used and/or require that they are retrofitted with DOCs. Given the emissions associated with **pre-1994** school buses, contracts should, however, make it mandatory to retire pre-1994 school buses altogether.

3. **Assign Routes with an Awareness for Emissions:** Buses should be assigned to routes with an awareness for emissions. Buses that do multiple routes in heavily populated areas should be assigned to school buses with **post-2006** model year engines wherever possible to reduce air levels along heavily travelled roads and exposures on-board. Newer buses should also be considered for longer routes in which children spend longer periods of time on-board.

2. **Implement Driver Training:** Drivers should be trained using Natural Resources Canada's SmartDriver Program available from FleetSmart at www.fleetsmart.gc.ca . It covers information about:
   a. The health impacts associated with diesel exhaust;
   b. The impact of unnecessary idling in school yards and residential neighbourhoods;
   c. Best operating practices (e.g. to avoid starting the bus until children are on-board and doors are closed); and
   d. Driving to reduce fuel consumption and emissions.

4. **Retrofit with Heaters:** In areas where idling is associated with heating engines and/or cabins, contracts should encourage operators to install auxillary heaters that heat engines and/or cabins.

These heaters can reduce idling and emissions, while saving fuel and money. These devices cost $400 to $1,500 to install depending on the BTU.

5. **Retrofit with Closed Crankcase Ventilation Devices (CCV):** Contracts can encourage retrofitting all **pre-2007** school buses with CCVs. These devices, which cost between $200 and $1,000 per bus installed, can substantially reduce air levels of $PM_{2.5}$ on-board school buses while also reducing tailpipe emissions. With proper installation and a filter change once or twice a year, these devices can substantially reduce childhood exposure to air pollutants.

6. **Retrofit with Diesel Oxidation Catalyst (DOCs):** Contracts can encourage operators to retrofit **pre-2005** school buses with DOCs. At a cost of about $1,100 to $1,400 per bus installed, DOCs can reduce emissions of PM and HC by as much 40% and 75% respectively. DOCs are easy to install, require no maintenance, do not affect fuel economy, and present no operational problems. These retrofits are particularly important for children in communities that experience elevated levels of air pollution.

7. **Flow-Through Filters (FTF):** Contracts can encourage operators to retrofit **pre-2005** school buses that have > **5 years** of service life with FTFs. At a cost of $5,750 per bus installed, FTFs can reduce emissions of PM by more than 50%. They do not affect fuel efficiency. They have no filters to clean or replace. The devices are sensitive to the temperature of the engine so they should only be installed on buses that have been shown to have the proper duty-cycle with data logging. Unlike DPFs however, FTFs will <u>not</u> affect the operation of the bus when temperatures are not maintained. These retrofits are particularly important for children in communities that experience elevated levels of $PM_{2.5}$.

8. **Biodiesel:** In areas that have easy access to biodiesel, contracts can encourage operators to fuel buses with 5 to 20% biodiesel blends (B5 to B20). Biodiesel can produce modest to substantial reductions in air pollutants (PM and HC by 10% and air toxics by 12 to 18%) and greenhouse gases (CO_2 by about 5 to 20%). School bus operators in southern Ontario have used biodiesel blends from April to November with no operational problems. Biodiesel is a very clean fuel that can significantly improve performance on Drive Clean tests. There is reason to believe that biodiesel produces exposure benefits for children by reducing the emissions of HC and the toxicity of PM emissions from school buses.

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Appendix A: Ministry of Education Data re: School Buses and Student Transportation in Ontario, 2010

Site	Site Name	Total # of buses	Total Transported Students on buses per day	Total # of km travelled per day by buses	Total # of students travelling 100+ km each way	Total # of operators	Oldest Age	Average Age
1	Windsor-Essex Student Transportation Services	564	35,686	49,050	0	6	15	7.8
2	Chatham Kent & Lambton Administrative School Services (C.L.A.S.S.)	316	18,644	49,968	0	10	15	8
3	Southwestern Ontario Student Transportation Services	1,184	45,963	N/A	17	13	12	N/A
4	Huron Perth Student Transportation Services	337	13,104	36,545	0	10	12	7
5	Student Transportation Service Consortium of Grey-Bruce	350	15,405	41,115	12	12	12	6
6	Student Transportation Services of Brant Haldimand Norfolk	385	20,588	36,201	0	14	N/A	7.3
7	Waterloo Region Student Transportation Service (WRSTS)	283	25,875	19,814	0	13	12	6
8	Niagara Student Transportation Services	768	32,342	52,234	0	12	N/A	N/A
9	Hamilton-Wentworth Student Transportation Services (HWSTS)	478	27,119	37,289	0	4	11	N/A
10	Service de transport de Wellington - Dufferin Student Transportation Services	416	20,568	42,562	0	18	12	7
11	Halton Student Transportation Services	437	27,791	35,031	0	9	12	8
12	Student Transportation of Peel Region	1,232	59,504	79,618	0	8	12	5.5
13	Toronto Transportation Group (TTG)	523	48,442	N/A	0	8	12	7
14	Student Transportation Services of York Region	876	47,112	113,441	0	10	12	5
15	Simcoe County Student Transportation Consortium	559	34,018	70,255	0	8	11	6
16	Durham Student Transportation Services	578	29,917	42,364	0	5	13	6
17	Trillium Lakelands District Shcool Board	395	15,393	45,533	0	12	13	6
18	Student Transportation Services of Central Ontario	551	29,770	56,315	0	33	12	8
19	Tri-board Student Transportation Services	645	34,563	100,934	5	81	11	5
20	Renfrew County Joint Transportation Consortium	231	11,027	22,791	1	21	20	9
21	Student Transportation Services of Eastern Ontario (STSEO)	636	34,891	61,548	0	49	10	6.13
22	Ottawa Student Transportation Authority	975	56,754	70,236	22	18	12	N/A
23	Nipissing Parry-Sound Student Transportation Services	337	13,391	36,846	15	27	N/A	7
24	North East Tri-Board Student Transportation	227	8,866	21,609	15	17	12	7
25	Sudbury Student Services Consortium	397	22,860	41,061	30	12	12	6.06
26	Algoma & Huron Superior Transportation Services	247	11,337	26,706	103	16	10	5
27	East of Thunder Bay Transportation Consortium	44	1,536	4,106	4	9	10	6
28	Student Transportation Services Thunder Bay	198	15,609	N/A	0	4	10	8
29	Rainy River Transportation Services	48	2,340	6,958	2	23	12	4.72
30	Northwestern Ontario Student Services Co-operative	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Site	Site Name	Total # of buses	Total Transported	Total # of km travelled per	Total # of students	Total # of operators	Oldest Age	Average Age
31	Service de transport Francobus	484	13,335	47,334	1	11	12	9
32	Consortium de transport scolaire de l'Est	271	10,999	35,422	125	13	12	6
33	Consortium de Transport Scolaire d'Ottawa	251	18,878	25,428	2	23	11	8
34	CSD catholique des Grandes Rivières	138	5,538	12,280	12	11	10	3
35	Chatham-Kent & Lambton - CSDECSO &	37	1,339	6,171	10	5	13	4
	Provincial Total	**15,398**	**810,504**	**1,326,765**	**376**	**425**		
	Provincial Average	**453**	**23,838**	**42,799**	**11**	**28**	**12**	**6**

Notes:

1	Total # of buses include full-size, mid-size and mini-size buses only
2	Total # of transported students include ridership for full-size, mid-size and mini-size buses only, excluding provincial schools students and Section 23 transportation
3	Total # of km travelled per day include full-size, mid-size and mini-size buses only
4	The Provincial total of operators is 425 because there are operators that service more than one consortia in the province.
5	Total # of students travelling 100+ km each way includes riders on all vehicles (ex. Buses, sedans, taxis..etc.)

1. Company Name:

	Response Count
	7
answered question	**7**
skipped question	**0**

2. Title/Position:

	Response Count
	6
answered question	**6**
skipped question	**1**

3. Are you aware of, or have read, the 2005 OPHA School Bus report, “Schoo Air Pollution, & Children’s Health”? www.opha.on.ca/resources/docs/schoolb

	Respons Percent
Yes	28.6
No	**71.4**
answered questio	
skipped questio	

4. If yes to #3, what steps did you or your organization take to act on the findings in that report?

	Response Count
	2
answered question	**2**
skipped question	**5**

5. If yes to #3, and no steps were taken, please explain why not.

	Response Count
	0
answered question	**0**
skipped question	**7**

6. Please indicate below the topics about which you and/or your organization have sufficient knowledge:

	Response Percent	Response Count
The impact that school bus idling has on air quality within schools and on-board school buses.	50.0%	1
Differences in emissions released from older and newer buses.	**100.0%**	**2**
The health-related impacts associated with emissions released by school buses.	**100.0%**	**2**
School bus retrofit products specifically designed to control emissions.	50.0%	1
	answered question	**2**
	skipped question	**5**

7. Have you received any questions or concerns about emissions from school buses or about air quality on-board school buses?

	Response Percent	Response Count
Yes	14.3%	1
No	**85.7%**	**6**
	answered question	**7**
	skipped question	**0**

8. If yes to #7, what questions and/or concerns have you received?

	Response Count
	1
answered question	**1**
skipped question	**6**

9. How many full size school buses (i.e. 72 seats) are used by your school board and/or consortium?

	Response Count
	7
answered question	**7**
skipped question	**0**

10. How many of the full size buses used by your school board and/or consortium are post-2006 model year buses?

	Response Count
	7
answered question	**7**
skipped question	**0**

11. How many of the full size buses used by your school board and/or consortium are 2004-2006 model year buses?

	Response Count
	7
answered question	**7**
skipped question	**0**

12. How many of the full size buses used by your school board and/or consortium are 1994 to 2003 model year buses?

	Response Count
	7
answered question	**7**
skipped question	**0**

13. How many of the full size buses used for your school board and/or consortium are pre-1994 model year buses?

	Response Count
	7
answered question	**7**
skipped question	**0**

14. Which of the following issues does your school board/consortium have policies or practices for?

	Response Percent	Response Count
Repacement of older buses with new buses	**85.7%**	**6**
Limiting the use of pre-1994 school buses	57.1%	4
Driver training that relates to fuel efficiency	42.9%	3
Driver training that relates to idling practices	42.9%	3
Retrofitting school buses with emission control devices	14.3%	1
Retrofitting school buses with engine heaters	14.3%	1
Fuelling school buses with biodiesel	14.3%	1
	answered question	**7**
	skipped question	**0**

15. For any of the policies or practices identified in #14, please provide the language used in the policy and/or contract, or describe the practice.

	Response Count
	6
answered question	**6**
skipped question	**1**

1. Company Name:

	Response Count
	13
answered question	**13**
skipped question	**0**

2. Title/Position:

	Response Count
	13
answered question	**13**
skipped question	**0**

3. Are you aware of, or have you read, the 2005 OPHA School Bus report, “Sc Buses, Air Pollution, & Children’s Health”? www.opha.on.ca/docs/resources/schoolbus.pdf

	Respons Percent
Yes	23.1
No	**76.9**
answered questio	
skipped questio	

4. If yes to #3, what findings in the report did you or your organization find useful?

	Response Count
	3
answered question	**3**
skipped question	**10**

5. If yes to #3, what findings in the report did you or your organization find ineffective and/or impractical?

	Response Count
	3
answered question	**3**
skipped question	**10**

6. Indicate the topics below for which you have had sufficient training.

	Response Percent	Response Count
The impact that school bus idling has on air quality within schools and on-board school buses.	72.7%	8
Differences in emissions released from older and newer buses.	**81.8%**	**9**
The health-related impacts associated with emissions released by school buses.	27.3%	3
School bus retrofit products specifically designed to control emissions.	18.2%	2
answered question		**11**
skipped question		**2**

7. Have you received any questions or concerns about emissions from school buses or about air quality on-board school buses?

	Response Percent	Response Count
Yes	23.1%	3
No	**76.9%**	**10**
answered question		**13**
skipped question		**0**

8. If yes to #7, please share the questions and/or concerns in the space below.

	Response Count
	3
answered question	**3**
skipped question	**10**

9. How many full size school buses (i.e. 72 seats) does your company own in Ontario?

	Response Count
	13
answered question	**13**
skipped question	**0**

10. How many full size school buses does your company operate in Ontario?

	Response Count
	13
answered question	**13**
skipped question	**0**

11. How many school boards did you provide services to during the 2009-10 school year?

	Response Count
	13
answered question	**13**
skipped question	**0**

12. What geographic area of the Province does your company cover?

	Response Count
	13
answered question	**13**
skipped question	**0**

13. How many of your company's full size buses are post-2006 model year buses?

	Response Count
	13
answered question	**13**
skipped question	**0**

14. How many of your company’s full size buses are 2004-2006 model year buses?

	Response Count
	12
answered question	**12**
skipped question	**1**

15. How many of your company’s full size buses are 1994-2003 model year buses?

	Response Count
	13
answered question	**13**
skipped question	**0**

16. How many of your company’s full size buses are pre-1994 model year buses?

	Response Count
	12
answered question	**12**
skipped question	**1**

17. Which issues below, would you or your company find it useful to have model policies or practices for?

	Response Percent	Response Count
Replacement of older buses with new buses	15.4%	2
Limiting the use of pre-1994 school buses	15.4%	2
Driver training that relates to fuel efficiency	**92.3%**	**12**
Driver training that relates to idling practices	**92.3%**	**12**
Retrofitting school buses with emission control devices	7.7%	1
Retrofitting school buses with engine heaters	23.1%	3
Fuelling school buses with biodiesel	23.1%	3
	answered question	**13**
	skipped question	**0**

1. Organization Name:

	Response Count
	23
answered question	**23**
skipped question	**0**

2. Title/Position:

	Response Count
	23
answered question	**23**
skipped question	**0**

3. Did you know that school buses can be self-polluting with diesel-related air pollutants from each bus accumulating inside the cabin of each bus?

	Response Percent	Response Count
yes	**82.6%**	**19**
no	17.4%	4
answered question		**23**
skipped question		**0**

4. Did you know that diesel-related air pollutants can accumulate inside schools when school buses idle on school properties?

	Response Percent	Response Count
yes	**95.7%**	**22**
no	4.3%	1
answered question		**23**
skipped question		**0**

5. Did you know that emissions from, and exposures on-board, older school buses can be greater than those from newer school buses?

	Response Percent	Response Count
Yes	**87.0%**	**20**
No	13.0%	3
answered question		**23**
skipped question		**0**

6. Did you know that diesel-related air pollutants are associated with a variety of acute and chronic health impacts including the aggravation of asthma and allergies, reduced lung function, and lung cancer?

	Response Percent	Response Count
Yes	**87.0%**	**20**
No	13.0%	3
answered question		**23**
skipped question		**0**

7. Did you know that there are emission control devices that can be retrofitted on to existing school buses to reduce both, their emissions, and the levels of air pullutants in their cabins?

	Response Percent	Response Count
Yes	47.8%	11
No	**52.2%**	**12**
answered question		**23**
skipped question		**0**

8. Have you or your organization received any complaints/questions about school bus emissions?

	Response Percent	Response Count
Yes	38.1%	8
No	**61.9%**	**13**
answered question		**21**
skipped question		**2**

9. If yes to #8, what was the question or complaint?

	Response Count
	10
answered question	**10**
skipped question	**13**

10. Have you or your organization conducted any outreach activities with regards to school buses?

	Response Percent	Response Count
Yes	47.6%	10
No	**52.4%**	**11**
answered question		**21**
skipped question		**2**

11. If yes to #10, what activities have you engaged in?

	Response Count
	11
answered question	**11**
skipped question	**12**

12. Have you or your organization done any research work on school bus emissions?

	Response Percent	Response Count
Yes	23.8%	5
No	**76.2%**	**16**
answered question		**21**
skipped question		**2**

13. If yes to #12, what issue did you examine?

	Response Count
	6
answered question	**6**
skipped question	**17**

14. Have you ever seen or read the 2005 OPHA School Bus report, “School B Air Pollution,& Children’s Health”? www.opha.on.ca/resources/docs/schoolb

	Respons Percent
Yes	**60.9**
No	39.1
answered questio	
skipped questio	

15. If yes to #14, did you or your organization take any steps to promote the OPHA school bus report, its findings, or its recommendations?

	Response Percent	Response Count
Yes	**84.6%**	**11**
No	15.4%	2
answered question		**13**
skipped question		**10**

16. If yes to #15, what steps did you take?

	Response Count
	11
answered question	**11**
skipped question	**12**

Appendix E: Idling Policies & Procedues

SOUTH SHORE REGIONAL SCHOOL BOARD ADMINISTRATIVE PROCEDURES

ADMINISTRATIVE PROCEDURE #

TITLE	*PAGE*
Vehicle Idling	**Page 1 of**

DEPARTMENT	*SECTION*

BOARD APPROVED:
REVISED: March 2, 2010
REF: BP #
MONITORING DATE: Annually
RELATED POLICIES & DOCUMENTS:

1. **Drivers operating school board vehicles are instructed that their vehicles will not be left idling on school property.**
2. **Any contracted service vehicles will follow the same policy and procedure.**
3. **Drivers operating school board vehicles are instructed to reduce unnecessary idling at any time.**
4. **Schools would be well advised to have signs posted requesting drivers to "PLEASE TURN OFF YOUR ENGINE"**
5. **Schools are encouraged to establish an active anti-idling awareness campaign for their school and community and to provide regular reminders in their school publications.**
6. **The South Shore Regional School Board insists that from November to April all buses must use engine block heaters. Timers may be used for this purpose and should be set for three to four hours before the AM route.**
7. **Extension cords for the block heaters will be supplied by the South Shore Regional School Board.**
8. **Buses should be parked within a reasonable distance to a suitable outlet preferable within 30 meters.**
9. **Outlets for the purpose of supplying power to the block heater should be of ample size and in a good state of repair.**
10. **Drivers operating buses equipped with diesel fired auxiliary heaters will be instructed on the proper use of this equipment and encouraged to use them whenever required.**
11. **Engine pre-heaters will be maintained following regularly scheduled PM's**
12. **Drivers are instructed to report any problems relating to winter starting/warm-up to dispatch or maintenance**

13. **Engine warm-up should be kept to a reasonable extent at all times.**
14. **During colder weather engines will be warmed as per manufacturer's recommendations, however, extended periods of unnecessary idling cannot be tolerated.**
15. **Manufacturers "anti-idling" devices and applicable programming will be enabled at all times.**
16. **Exceptions to parts of this policy may be granted to special needs requirements. These cases will be reviewed and only approved by authorized transportation staff.**
17. **In the event of a mechanical problem which may prevent a bus from restarting once shut down, direction will be provided by authorized transportation staff.**

Annapolis Valley Regional School Board

Board Policy – BP 201.5

Vehicle Idling

Department: **Finance and Operations**
Section: **Operations**

The Annapolis Valley Regional School Board is committed to the provision of healthy learning and working environments for students and staff. The School Board recognizes that vehicle exhaust fumes contribute pollution to the environment. Unnecessary vehicle idling increases pollution which contributes to adverse effects on the environment and the health of individuals. In addition, it is a proven fact that turning off a vehicle engine rather than idling saves fuel and is not detrimental to the vehicle's operation. The School Board believes that no vehicles should be idling on school property.

The administrative procedures to this policy provide guidelines to reduce the incidence of vehicle idling on school property in the Annapolis Valley Regional School Board.

Specifically

- The Director of Finance & Operations shall be responsibility for the implementation and monitoring of this policy.
- This policy will be monitored annually.

Board Approved: February 6, 2008
Ref: AP 201.5
Monitoring Date: Annually
Revised: Date

Annapolis Valley Regional School Board

Administrative Procedure – AP 201.5

Vehicle Idling

Department: Finance and Operations
Section: Operations

1. All operators of School Board vehicles or vehicles providing contracted services will be instructed that their vehicles will not be left idling on school property.

2. All operators of School Board vehicles will be further instructed that their vehicles will not be left idling unnecessarily at any time.

3. All school sites will be posted with signage requesting drivers to **"Please Turn Off Your Engine"**.

4. Schools are encouraged to establish an active anti-idling awareness campaign for their school and community and to provide regular reminders in their school publications.

Implementation & Monitoring

- The Director of Finance and Operations will be responsible for the implementation and monitoring of these administrative procedures.

- These administrative procedures will be monitored annually.

Superintendent Approved: January 14/09
Ref: BP 201.5
Monitoring Date: Annually
Revised: