SUMMARY REPORT

Multi-pollutant Emission Reduction Analysis Foundation (MERAF) for the Canadian Ready-Mixed Concrete Sector

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Environment Canada
and
The Canadian Council of Ministers of Environment (CCME)

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While members of the Technical Advisory Network (TAN) participated in draft report reviews, the text of this report does not necessarily incorporate all comments suggested by the TAN members and therefore does not necessarily reflect the views of all TAN members.

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Abstract

This report provides background technical information on the Canadian ready-mixed concrete sector. The contents include a profile of the industry, sector emissions (current and projected), domestic and international emission standards, best available pollution prevention and control techniques, possible emission reduction options and identification of areas for further analysis.

Summary

S.1 Introduction

Air pollution affects the health of all Canadians, especially children and the elderly. A major air pollution concern is 'smog'.

'Smog' refers to a noxious mixture of air pollutants that can often be seen as a haze in the air. The two main ingredients in smog that are known to affect human health are ground-level ozone and fine airborne particles. Other smog pollutants of concern are nitrogen oxides, sulphur dioxide and carbon monoxide.

Studies from the Toronto Public Health Department, Government of Canada and Ontario Medical Association all demonstrate the potential impacts of air pollution on health. Research studies worldwide, including from Health Canada, have demonstrated that air pollution can lead to premature death, increased hospital admissions, more emergency room visits and higher rates of absenteeism. Exposure to smog can lead to irritation of the eyes, nose and throat, it can worsen existing heart and lung problems, and in extreme cases it can result in an early death.

Environment Canada and the Canadian Council of Ministers of the Environment (CCME) are committed to addressing particulate matter and ground-level ozone. In June 2000, CCME Ministers, with the exception of Quebec, endorsed Canada-wide Standards (CWS) for Particulate Matter (PM) and Ground-level Ozone. These standards set ambient limits for PM less than 2.5 microns ($PM_{2.5}$) and ozone to be obtained by the year 2010. The standards are as follows:

- $PM_{2.5}$: 30 micrograms/m^3, 24 hour averaging time, by year 2010 (Achievement to be based on the 98th percentile ambient measurement annually, averaged over 3 consecutive years.)

- Ozone: 65 parts per billion, 8 hour averaging time, by year 2010 (Achievement to be based on the 4th highest measurement annually, averaged over 3 consecutive years.)

When these CWS were endorsed, CCME Ministers also agreed to a list of Joint Initial Actions aimed at reducing pollutant emissions contributing to PM and ozone. The Joint Initial Actions include the development of comprehensive Multi-pollutant Emission Reduction Strategies (MERS) for key industrial sectors. The MERS approach is an effort to pursue integrated solutions to problems of smog, acid rain, toxic releases, and climate change.

A MERS is considered to be a national picture of sector emission reduction plans, to be built from jurisdictional PM and ozone plans and national multi-pollutant emissions reduction analysis. Jurisdictional implementation plans on PM and ozone, which will be prepared by individual jurisdictions, will outline emission reduction initiatives to achieve these CWS.

The MERS are developed in partnership with provinces, territories and stakeholders and will focus on three general activities:

- *National Multi-pollutant Emission Reduction Analysis Foundation (MERAF)*: Technical feasibility studies of emission reduction options and costs, and economic profiles, as input into development of sector actions in jurisdictional plans. Work contributing to the MERAF may be conducted by industry, other stakeholders, and the federal government.

- *Forum for Information Sharing & Coordination:* Jurisdictions and stakeholders to share information on how a particular sector is being dealt with in different parts of the country.

- *National Sector Roll-up*: The national picture of the sector is to be assembled by 2003 based on actions in jurisdictional plans and national multi-pollutant analysis.

This MERAF report for the Canadian Ready-Mixed Concrete Sector represents the first phase in the MERS process. It is intended as a source of information on technically feasible emission reduction options for consideration in the development of jurisdictional implementation plans under the CWS. The report draws upon readily available information. It is not intended as a policy document.

More specifically, the report provides:
- A profile of the ready-mixed concrete industry in Canada;
- A multi-pollutant inventory of emissions from the industry;
- A review of emission standards, programs and policies in Canada and abroad;
- A set of available techniques (control technologies and management practices) to reduce emissions from the industry;
- An evaluation of the potential emission reductions and costs associated with the available techniques;
- An analysis of data constraints; and
- An assessment of areas for possible further analysis.

S.2 Industry Profile

Concrete is an essential product used in a variety of construction, infrastructure, and industrial applications. It is made by mixing cement and supplementary cementitious materials (SCM), water, and coarse (stone) and fine (sand) aggregates. The cement reacts with water and hardens into a rock-like mass. Cement typically accounts for nine to 13 percent by weight of the finished concrete.

In 1998, Canada's ready-mixed concrete sector had shipments valued at over $1.9 billion and employed over 9,000 workers. Statistics Canada reports nearly 700 establishments in the sector, though industry representatives suggest that this estimate is too low. All but a few facilities employ less than 50 workers each. Ownership is widely dispersed. The large cement manufacturers and a second-tier of medium-sized companies have multiple ready-mixed concrete facilities. However, the majority of owners operate only one plant.

Since ready-mixed concrete cannot be transported long distances, the sector's geographic distribution follows closely the levels of economic activity in the regional markets across the country.

Production of ready-mixed concrete is generally concentrated in areas with the most manufacturing and construction. Ontario accounts for 32 percent of Canada's production of ready-mixed concrete, with Alberta, Quebec and British Columbia accounting for about 17 to 19 percent each. The remaining 14 percent of production is spread throughout other provinces and territories.

Ready-mixed concrete suppliers serve local markets since this commodity can not be transported long distances. For this reason, the commodity in this form is not exported.

S.3 Emission Sources and Data

The air pollutants examined in this report included:

Criteria air contaminants (CAC):

- Particulate matter (Total, $<10\mu m$, and $<2.5\mu m$)
- Nitrogen oxides (NOx)
- Sulphur oxides (SOx)
- Carbon monoxide (CO)
- Volatile Organic Compounds (VOC)

Greenhouse gases:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxides (N_2O)

Emissions were estimated for the year 2000 from base information and assumptions, and projections were made to year 2020. The emissions for year 2000 were generated by applying the U.S. Environmental Protection Agency's AP-42 emission factors for uncontrolled and controlled sources to specific levels of activity and fuel consumption in the Canadian sector.

Some uncertainties exist in the emissions inventories. First, the current uptake of emission controls in Canadian facilities is not known. In the absence of data on currently installed controls, assumptions were made about existing levels of control in this industry. Discussions with industry representatives provided additional qualitative information.

Second, there is uncertainty associated with the AP-42 emission factors. Although the US EPA AP-42 is the main internationally accepted source of emission factors for ready-mixed concrete processes, the emission factors for this sector are based on very limited test data that is now a decade old.

Given these uncertainties, the emissions presented in the tables below are considered the best estimate possible. Emissions by process are presented in the main body of this report.

A clear conclusion is that particulate matter is the main pollutant of concern emitted from this sector. The sector accounts for about 1.6%, 1.0% and 0.5% respectively of the total filterable PM, PM_{10} and $PM_{2.5}$ emissions from all industrial sources in Canada. Comparatively small quantities of criteria air contaminants and greenhouse gases are emitted, associated mainly with the combustion of natural gas and distillate oil for water heating.

Table T.1: Criteria Air Contaminant Emissions from Ready-mixed Concrete Facilities, 2000

Province	Emissions (metric tonnes)						
	Total PM	PM_{10}	$PM_{2.5}$	CO	SO_2	NO_x	VOC
Atlantic	861	265	88	7	10	9	0
Quebec	2,100	642	219	18	28	23	1
Ontario	4,040	1,240	422	36	54	45	2
Manitoba	199	62	20	1	2	2	0
Saskatchewan	255	79	25	2	3	2	0
Alberta	1,640	597	171	15	22	18	1
British Columbia	1,190	363	124	10	16	13	1
Yukon and NWT	NA	NA	NA	NA	NA	NA	NA
Total Sector Emissions	**10,300**	**3,240**	**1,070**	**89**	**134**	**112**	**6**
% of Total Industrial Emissions*	**1.6%**	**1.0%**	**0.5%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**

Source: 2000 data = ICF estimates.
(*) Total industrial emissions were based on Environment Canada's *1995 Criteria Air Contaminant Emissions for Canada (Residual Discharge Information System 1999)*. These are "process" emissions and exclude fuel combustion emissions.
Ready-mixed Concrete Sector emissions for 2000 include process and fuel combustion emissions.
Figures may not add exactly due to rounding.

Table T.2: GHG Emissions from Ready-mixed Concrete Facilities, 2000

Province	Emissions (metric tonnes)		
	CO_2	CH_4	N_2O
Atlantic	10,700	0.2	0.1
Quebec	28,700	0.6	0.3
Ontario	55,600	1.2	0.5
Manitoba	2,130	0.0	0.0
Saskatchewan	2,770	0.1	0.0
Alberta	22,800	0.5	0.2
British Columbia	16,000	0.4	0.2
Yukon and NWT	N/A	N/A	N/A
Total Sector Emissions	**139,000**	**3.1**	**1.3**
% of National Emissions*	**0.03%**	**0.00%**	**0.00%**

Source: 2000 data = ICF estimates.
(*) Total industrial emissions were based on Environment Canada's 1997 Greenhouse Gas Inventory and include both process and fuel combustion emissions.

Growth projections obtained from both industry and Natural Resources Canada suggest that concrete production may grow by about 1-3 percent each year through to 2020. Assuming no improvements are made in emission control technologies and practices, emissions can be expected to grow at similar rates.

S.4 Current Emissions Management

In reviewing the regulatory and non-regulatory instruments of Canadian and international jurisdictions, it is apparent that a wide range of emission control practices prevails. In Canada, provincial and territorial governments regulate emissions from ready-mixed concrete plants, mostly under general air quality and facility permitting regulations. Most of the regulations in Canada do not have specific provisions for the ready-mixed concrete sector, except in Alberta and the Greater Vancouver Regional District. Quebec confers approvals for ready-mixed concrete facilities under a general air quality regulation, but in granting those approvals it relies on conditions specified in a regulation for hot-mix asphalt plants. New Brunswick issues Approvals to Operate under their Air Quality Regulation and their Water Quality regulation for all industrial activities in province, including ready-mixed concrete facilities. These approvals are issued on a facility basis and contain certain conditions that that the facility must meet.

Drawing from numerous regulations and codes of practice in Canada and abroad, a range of emission control options has been identified for the ready-mixed concrete sector. The principle of Best Available Techniques (BATs) was used to develop the recommended list and that was a practice or technology prescribed in an existing regulation of a jurisdiction.

All seven regional associations are at various stages in the development of best environmental practices guides. Some of these guides are broad in scope and cover practices for wastewater and solid waste management in addition to emissions.

The identified BATs may be helpful to jurisdictions when considering provincial, territorial or regional air management planning priorities. Small plants operating in small markets in remote areas, sometimes for limited durations, may not require the stringency of control that might be needed for plants in urban areas where air quality levels periodically exceed the ambient air quality objectives of the Canada-wide Standards. In other cases, stringent controls may be appropriate non-urban areas where plants may impact parks and wilderness and pristine air quality is to be protected. Also, some jurisdictions may choose to require a better emission performance for new plants than for existing plants. The applicability and usefulness of the BATs depends highly on these and other factors.

The possible environmental and human health benefits by further reducing source emissions and the consequent improvement in ambient air quality in the vicinity of plants have not been considered. This type of analysis was beyond the scope of this study.

Recognizing the need for flexibility, the following table summarizes the available techniques for prevention and control for each stage in the ready-mixed concrete production process without designating any particular one technique as preferred. The comments in the table highlight some of the contextual parameters that may influence or limit the applicability of any particular technique.

In addition to the specific control techniques, best practice can be identified in emissions performance. For example, the GVRD Bylaw 937 Schedule D requires fugitive dust emissions from ready-mixed concrete facilities not to exceed a 20% opacity limit over a six-minute period. The same opacity limit exists in Quebec for hot mix asphalt plants. Oregon's Air Contaminant Discharge Permit Requirements for ready-mixed concrete facilities prescribe an opacity of no more than 20% for more than three minutes in any one hour. Based on these existing standards, an overall 20% opacity limit for fugitive dust emissions from any process at a ready-mixed concrete facility forms the basis for the best practices.

A 5% opacity reflects the performance achievable by fabric filter systems. This technology is identified as best practice based on GVRD Bylaw 937 Schedule D requirements.

Table T.3: Best Available Techniques for the Ready-mixed Concrete Sector

Technique / Practice	BAT	Comments
1. Traffic Areas		
A. Pave high traffic areas.	Y	Typically concrete paving, not asphalt, is needed because of its higher durability. As paving areas increase stormwater runoff, care must be taken to manage runoff appropriately.
B. Keep paved areas clean (sweep/vacuum/wash).		If paved areas are washed, care must be taken to manage runoff appropriately.
C. Treat fugitive dust emissions from unpaved areas with: • Water sprays **OR** • Using non-chloride dust suppressants.		If water sprays are used, care must be taken to manage runoff appropriately.
2. Aggregate Unloading		
A. Ensure aggregates are received damp and remain so during unloading.	Y	Since aggregates for ready-mixed concrete are usually washed before delivery, aggregates are usually received damp.
B. Use the following methods for dust suppression: • Water misting sprays for existing and new facilities; • Enclose unloading points for new facilities for truck deliveries.		If aggregates are not received damp, and fugitive dust emissions occur, these alternative techniques may be considered. Aggregates may be received from barge or truck. Enclosures are only suitable for truck deliveries.
3. Aggregate Storage		
A. Shelter stockpiles from wind. Install enclosures on at least three sides or use trees or buildings as wind shelters.	Y	Enclosures are usually suitable for smaller stockpiles, while trees and buildings are more feasible for larger stockpiles. Trees are effective wind barriers but the time required for a seedling to mature must be taken into consideration. New facilities have the option of orienting the plant so that stockpiles are sheltered from prevailing winds.
B. Minimize surface area of stockpiles.	Y	
C. Store aggregates in storage bins.	Y	Bins may be suitable for facilities that receive small quantities of aggregates (e.g. just-in-time deliveries). It is generally not feasible for facilities that receive large quantities of aggregate to store the aggregates in bins.
D. Cover stockpiles if needed to control excess fugitive emissions.		Covering may help where high winds increase the potential of fugitive dust generation.
E. Treat stockpiles where winds may cause fugitive dust emissions with: • Water **OR** • An approved dust suppressant		Care must be taken to manage runoff appropriately.

Table T.3: Best Available Techniques for the Ready-mixed Concrete Sector (continued)

Technique / Practice	BAT	Comments
4. Cement and SCM Storage Silos		
A. Install dust collection system to achieve the following PM concentrations: • 50mg/m3 for existing facilities • 30mg/m3 for new facilities	Y	The South Coast Air Quality Management District in California has adopted a 50mg/m3 emission limit. This limit has also been adopted by Australia, and as a guideline in the UK. Discussions with manufacturers indicate that lower PM emissions (e.g. 30mg/m3) may be possible with cartridge filters rather than fabric filters. The recommended 30mg/m3 PM concentration should be substantiated through equipment testing.
B. Install high level indicator and interlocking audio and/or visual alarms.	Y	The gauges must be kept dry to ensure the longevity of the indicator.
4. Conveyor Belts and Transfer Points		
A. Install covers on conveyor belts.		Particularly useful when conveyors are exposed to wind.
B. Install and maintain spill trays under conveyor system.		
C. Install belt-scraping devices on the head pulleys of the conveyor belts.	Y	Scraping devices should be replaced every 6 months.
D. Minimize the drop height between conveyors.	Y	Plant design feature.
E. Minimize the number drop points.	Y	Plant design feature.
6. Aggregate Weigh Hopper		
F. Minimize drop heights.	Y	Plant design feature.
7. Cement and SCM Weigh Hopper		
G. Install dust collection system that: • Collects dust, treats and exhausts to atmosphere or vents back to the silo **OR** • Collects dust and vents back to the silo.	Y	Dust collection systems are usually used at this point, not solely related to regulatory requirements but to an inherent economic benefit of minimizing losses of valuable cement product.
H. Install dust tight seals between discharge chute and hopper.		
I. Fully enclose the delivery system.	Y	
8. Boilers		
J. Ensure NOx emissions from new boilers do not exceed 17g/Gj.	Y	Total filterable PM emissions and NOx emissions are lower for boilers that use natural gas instead of fuel oil.

S.5 Emission Reduction Opportunities

The controlled emission factors from AP-42 were used to estimate the maximum emission reductions that would result from moving from the assumed current uptake rates for the BATs to a scenario involving 100% uptake across the sector by 2010. In a scenario that assumes an uptake of 100%, reductions up to 3,826 tonnes of total PM filterable, or up to 37% relative to year 2000, would appear possible.

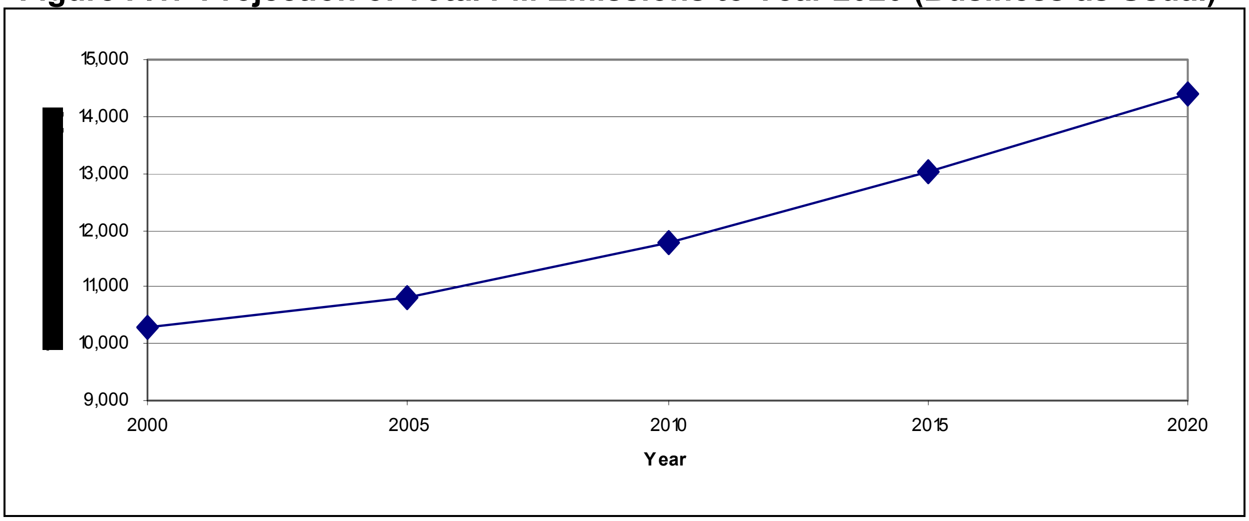
Table T.4: Maximum Achievable Emission Reductions by Province, 2010

Province	Total PM	PM_{10}	$PM_{2.5}$	CO	SO_2	NOx	VOC	CO_2	CH_4	N_2O
Emissions at Current Uptake (tonnes)										
Atlantic	861	265	88	7	10	9	0	10,700	0.2	0.1
Quebec	2,100	642	219	18	28	23	1	28,700	0.6	0.3
Ontario	4,040	1,240	422	36	54	45	2	55,600	1.2	0.5
Manitoba	199	62	20	1	2	2	0	2,130	0.0	0.0
Saskatchewan	255	79	25	2	3	2	0	2,770	0.1	0.0
Alberta	1,640	597	171	15	22	18	1	22,800	0.5	0.2
British Columbia	1,190	363	124	10	16	13	1	16,000	0.4	0.2
Yukon and NWT	NA	NA	NA	NA	NA	NA	NA	N/A	N/A	N/A
Canada	***10,300***	***3,240***	***1,070***	***89***	***134***	***112***	***6***	***139,000***	***3.1***	***1.3***
Emissions at 100% Uptake (tonnes)										
Atlantic	499	138	42	7	11	5	0.45	11,400	0.25	0.11
Quebec	1,420	379	115	22	34	15	1	34,800	1	0.34
Ontario	2,640	705	214	41	63	28	3	64,700	1	1
Manitoba	103	30	9	1	2	1	0.08	2,090	0.05	0.02
Saskatchewan	128	37	11	2	3	1	0.11	2,660	0.06	0.03
Alberta	992	265	80	16	24	10	1	24,500	1	0.24
British Columbia	690	186	57	11	16	7	1	16,700	0.37	0.16
Yukon and NWT	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Canada	***6,470***	***1,740***	***528***	***100***	***152***	***67***	***6***	***157,000***	***3***	***2***
Emission Reductions (tonnes)										
Atlantic	362	128	46	0	-1	4	0	-672	0	0
Quebec	685	263	104	-4	-6	8	0	-6,070	0	0
Ontario	1,410	530	208	-6	-9	17	0	-9,150	0	0
Manitoba	96	32	11	0	0	1	0	44	0	0
Saskatchewan	127	42	14	0	0	1	0	110	0	0
Alberta	645	232	90	-1	-2	8	0	-1,780	0	0
British Columbia	503	177	67	0	-1	6	0	-647	0	0
Yukon and NWT	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Canada	***3,830***	***1,400***	***540***	***-12***	***-18***	***45***	***-1***	***-18,200***	***0***	***0***

Note= Total PM, PM_{10}, $PM_{2.5}$ = filterable.
Figures may not add correctly due to rounding.

A longer-term projection of emissions to the year 2020 was based on the assumption of current emission controls and practices remaining unchanged over the 20-year time horizon. Emissions under this business as usual scenario would increase in direct correspondence with the annual growth in ready-mixed concrete production. The annual rates of growth were based on information provided by the industry and from other sources, and varied over the time horizon. As shown in Figure F.1, total PM filterable emissions would increase up to 40% from the emissions in year 2000.

Figure F.1: Projection of Total PM Emissions to Year 2020 (Business as Usual)



Working with industry representatives and equipment suppliers, the annual capital, installation and operating costs of employing each BAT at a hypothetical medium-sized ready-mixed concrete facility were estimated. Extrapolating these cost estimates to a scenario that assumes a 100% uptake, generates the cost estimates in the following table. The estimated sector-wide costs for the 100% uptake scenario are $32 million. Actual costs may be more or less than the average cost determined for the sector-wide analysis since each facility will have its own particular circumstances.

Table T.5: Total Annual Costs of 100% Uptake Levels, 2010

Technique / Practice	Costs Per Facility				Current Uptake	Assumed Number of Facilities for Uptake	Sector-Wide Annual Cost	Costing Assumptions
	Installed Capital	Annualized Capital	Annual Operating	Total Annual				
Traffic Areas								
Pave high traffic areas.	$31,100	$4,660	$0	$4,660	80%	200	$932,000	• Lifespan of paving = 5 years. • Average production per facility = 64,222m3.
Keep paved areas clean (sweep / vacuum / wash).	$0	$0	$10,000	$10,000	80%	200	$2,000,000	• Sweeping costs per facility = $200/week. • Facility operates 50 weeks/year. • Average concrete production per facility = 50,000m3.
Treat fugitive dust emissions from unpaved areas with: • Water sprays **OR** • Using non-chloride dust suppressants.	$0	$0	$1,600	$1,600	50%	500	$800,000	• Cost estimates for use of non-chloride dust suppressants. • Average concrete production per facility = 56,750m3.
Aggregate Unloading								
Ensure aggregates are received damp and remain so during unloading.	-	-	-	-	80%	200	-	Minimal additional costs.
Use the following methods for dust suppression: • Water misting sprays for existing and new facilities; • Enclose unloading points for new facilities for truck deliveries.	-	-	-	-	20%	800	-	• Design feature. • Uncertain costs for new facilities.

Table T.5: Total Annual Costs of 100% Uptake Levels, 2010 (continued)

Technique / Practice	Costs Per Facility				Current Uptake	Assumed Number of Facilities for Uptake	Sector-Wide Annual Cost	Costing Assumptions
	Installed Capital	Annualized Capital	Annual Operating	Total Annual				
Aggregate Storage								
• Shelter stockpiles from wind. • Install enclosures on at least three sides or use trees or buildings as wind shelters.	$7,400	$1,110	$2,200	$3,310	50%	500	$1,655,000	• Lifespan of partial enclosure = 10 years. • Costs associated with partially enclosing aggregate stockpiles.
Minimize surface area of stockpiles.	-	-	-	-	20%	800	-	Minimal operating costs.
Store aggregates in storage bins.	$38,000	$5,700	$1,130	$6,830	50%	500	$3,415,000	• Cost estimates of a 180 tonne bin with three compartments from manufacturers. • Lifespan of bin = 20 years. • Capital costs include installation costs (including cost of a crane). • Maintenance requirements minimal, includes visual inspections. • Labour costs = 1 hr per week. • Average production per facility = 50,000m3.
Cover stockpiles if needed.	-	-	-	-	0%	1,000	-	• Uncertain costs. • Not currently used in Canada.
Treat stockpiles where winds may cause fugitive dust emissions with: • Water **OR** • Using an approved dust suppressant.	$300	$40	$400	$440	20%	800	$352,000	• Cost estimates for water sprays. • Lifespan of water sprays = 10 years. • Ave. concrete production per facility = 58,333m3.

Table T.5: Total Annual Costs of 100% Uptake Levels, 2010 (continued)

Technique / Practice	Costs Per Facility				Current Uptake	Assumed Number of Facilities for Uptake	Sector-Wide Annual Cost	Costing Assumptions
	Installed Capital	Annualized Capital	Annual Operating	Total Annual				
Cement and SCM Storage Silos								
Install dust collection system to achieve the following PM concentrations:	-	-	-	-	100%	-	-	• One dust collector per cement or SCM silo. • One cement silo and one SCM silo per facility. • Not all facilities have dust collection systems that meet recommended performance standards. • Average concrete production per facility = 50,000m3.
• 50mg/m3 for silos at existing facilities;	$20,000	$3,000	$1,000	$4,000	50%	500	$2,000,000	• Number of dust collectors at cement and SCM storage silos per facility = 2. • Lifespan of dust collection system = 15 years. • Cost estimates for system that can achieve PM concentrations of 50mg/m3.
• 30mg/m3 for silos at new facilities.	-	-	-	-	0%	1,000	-	
Install high level indicator and interlocking audio and/or visual alarms on silos.	$8,600	$1,290	$0	$1,290	20%	800	$1,032,000	• Number of silos per facility = 2. • Lifespan of level indicator and alarm = 20 years. • Average concrete production per facility = 182,040m3.

Table T.5: Total Annual Costs of 100% Uptake Levels, 2010 (continued)

Technique / Practice	Costs Per Facility				Current Uptake	Assumed Number of Facilities for Uptake	Sector-Wide Annual Cost	Costing Assumptions
	Installed Capital	Annualized Capital	Annual Operating	Total Annual				
Conveyor Belts and Transfer Points								
Install covers on conveyor belts.	$40,000	$6,000	$800	$6,800	20%	800	5,440,000	• Average length of conveyor belts per facility = 400ft. • Installed capital costs = $100/ft. • Annual maintenance costs = $2/ft. • Average lifespan of conveyor belt = 10 years.
Install and maintain spill trays under conveyor system.	$20,000	$3,000	$1,500	$4,500	20%	800	$3,600,000	• Lifespan of spill trays = 10 years. • Average concrete production per facility = 75,000m3.
Install belt-scraping devices on the head pulleys of the conveyor belts.	$10,000	$1,500	$7,200	$8,700	20%	800	$6,960,000	• Average length of conveyor belts per facility = 400ft. • Average number of scraping devices per facility = 5. • Installed capital per scraping device = $2,000. • Average lifespan of scraping device = 10 years.
Minimize the drop height between conveyors.	-	-	-	-	20%	800	-	• Design feature. • No additional cost for new facilities.
Minimize the number drop points.	-	-	-	-	20%	800	-	• Design feature. • No additional cost for new facilities.

Table T.5: Total Annual Costs of 100% Uptake Levels, 2010 (continued)

Technique / Practice	Costs Per Facility				Current Uptake	Assumed Number of Facilities for Uptake	Sector-Wide Annual Cost	Costing Assumptions
	Installed Capital	Annualized Capital	Annual Operating	Total Annual				
Aggregate Weigh Hopper								
Minimize drop heights	-		-	-	-	-	-	Design feature. No additional cost for new facilities.
Cement & Supplementary Cementitious Material (SCM) Weigh Hopper								
Install dust collection system that:	-	-	-	-	-	-	-	• One cement and one SCM silo per facility. • Number of dust collection systems at cement and SCM weigh hoppers = 2. • Average concrete production per facility = 50,000m3.
Collects dust, treats and exhausts to atmosphere or vents back to the silos **OR**	$20,000	$3,000	$1,000	$4,000	80%	200	$800,000	• Lifespan of dust collection system = 15 years. • Average concrete production per facility = 50,000m3.
Collects dust and vents back to the silos.	-	-	-	-	80%	200	-	
Install dust tight seals between cement and SCM discharge chutes and weigh hopper.	$600	$90	$1,200	$1,290	100%	-	-	• Standard practice. • Lifespan of seals = 5 years. • Average concrete production per facility = 60,714m3.
Fully enclose delivery systems.	$50,000	$7,500	$0	$7,500	90%	100	$750,000	• Lifespan of enclosures = 10 years. • Ave. concrete production per facility = 50,000m3.
Boilers								
Ensure NOx emissions from new boilers do not exceed 17g/Gj.	$16,290	$2,440	$790	$3,230	10%	900	$2,907,000	• No. of boilers per facility = 1. • Average maximum heat input = 0.5 million BTUs and 15HP. • Lifespan of boiler = 20 years.
						TOTAL ANNUAL COST	**$32,643,000**	

S. 6 Conclusions and Recommendations

S.6.1 Conclusions

The principle findings of this study can be summarized as follows:

1. Particulate matter is the pollutant of most concern from ready-mixed concrete facilities. The contribution of PM from this sector is relatively small in comparison with all of the industrial sector emissions, while the contribution of the other pollutants examined were negligible.
2. The ready-mixed concrete sector contributes an estimated 1.6%, 1.0% and 0.5% respectively to the total quantities of PM, PM_{10} and $PM_{2.5}$ emitted from all industrial sources in Canada.
3. Available control technology and dust suppression practices are documented in this report. When sector-wide emissions are estimated by the application of uniformly applied best available techniques, a reduction up to 45% relative to the emissions in year 2000 would appear possible.
4. Several jurisdictions in Canada have established specific environmental requirements through regulations or operating permits that apply to ready-mixed concrete operations while in other jurisdictions the general provisions in their legislation apply.
5. All provincial associations of the ready-mixed concrete sector have established or are in process of establishing or renewing their environmental best practices guides that member firms are encouraged to adopt.

S.6.2 Recommendations

During the course of the research for this report, some areas of constraints were identified. In the absence of more detailed information and data, broad assumptions were made about the current uptake of emission control technologies and practices and other factors required for the analysis.

To improve some of the analysis, two particular areas could be considered for further research.

1. Emissions Data

The emission estimates developed in this report are based on the AP-42 pollutant emission factors published by the U.S. Environmental Protection Agency, coupled with best estimates and assumptions about the Canadian ready-mixed concrete sector. Although considered the best available information, the AP-42 emission factors are based on little actual test data that may be outdated and not reflective of the best control technologies and management practices currently available. Furthermore, the AP-42 emission factors are often unclear as to the specific control technologies that are associated with each controlled emission factor, adding an extra degree of uncertainty in their application.

A better understanding of emissions performance achievable at Canadian plants would improve the precision of the estimates and reduce the uncertainty in any future analysis of the expected benefits and costs of emission management strategies that jurisdictions may wish to pursue, should such analysis be desired in the future.

It is recommended that a program of field testing of representative facilities be conducted to develop data on PM_{10} and $PM_{2.5}$ emissions, emission factors and the performance of emission control technologies and practices.

2. Emission Controls and Management Practices

Although a limited questionnaire survey was conducted to gather information on current emission control technologies and practices at Canadian ready-mixed concrete facilities, the response was insufficient to adequately define current practices across the 700 or more facilities in the sector.

A more comprehensive understanding of current practices would improve the precision of the emission estimates and reduce the uncertainty in any future analysis of the expected costs and benefits of emissions management strategies that jurisdictions may wish to pursue, should such analysis be desired in the future.

It is recommended that a representative and statistically significant sample of ready-mixed concrete facilities across Canada be surveyed to identify:

1. Current emission control and management practices (including vintage and remaining lifespan);
2. Specific plans to enhance emission control and management practices;
3. Capital and operating costs associated with emission controls and management practices; and
4. Various parameters that, for lack of actual data, had to be assumed in the MERAF analysis (average area of facilities, average onsite VKT, etc.).

The preceding information would enable a more accurate profile to be developed that would establish a baseline against which future changes could be measured and improve the analysis of sector-wide cost impacts if best available techniques were applied. The analysis would generate cost-effectiveness information that would be useful for comparing the cost per tonne of pollutant reductions in the ready-mixed concrete sector to the control costs for the same pollutants in other industry sectors. The impact of control technologies and practices on product costs and profitability would be other important elements in such analyses.