AP2K 2007 Assessment Project
Final Report

For the project:
"Assessment of Green House Gas (GHG) Savings Achieved Through The Increased Use Of SCMs"

Prepared for Natural Resources Canada

by

EcoSmart™ Foundation

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INTRODUCTION

In late 2006 the Government of Canada, through Natural Resources Canada, commissioned the EcoSmart Foundation, with the support of an industry-government advisory committee to conduct a qualitative assessment of the use of supplementary cementing materials (SCMs) in Canada. The study looked at a variety of issues, including changes in use of SCMs since a quantitative survey was conducted in 2002[1] and on savings of greenhouse gas (GHG) emissions from increased use of SCMs. The 2007 assessment was carried out through the use of an online survey as well as by a series of consultative meetings with key industry and government stakeholders in nine cities across Canada.

BACKGROUND

The Minerals and Metals Program of Action Plan 2000 (AP2K) under the Supplementary Cementing Materials (SCM) program area had the objective of increasing awareness of the benefits of SCMs both in terms of Green House Gas (GHG) reduction potential and performance of concrete. It is believed that the program, together with industry course of action and other market forces resulted in increased use of SCM in concrete, displacement of Portland cement and therefore GHG reduction.

Members of the program advisory committee have, however, expressed the need for a better and more accurate understanding of the increased use of SCM, as well as additional environmental benefits. The assessment project was intended to address this gap and provide recommendations for future activities in this field. As the assessment activities occurred consecutively with those from a related SCM information dissemination project – also contracted to EcoSmart by Natural Resources Canada – it should be noted that advantage was made of synergies when possible.

The project advisory committee was comprised of representatives from the Cement Association of Canada (CAC), Association of Canadian Industries Recycling Coal Ash, (CIRCA), Canadian Ready-Mixed Concrete Association (CRMCA), EcoSmart Foundation, National Research Council (NRC), Natural Resources Canada (NRCan), Environment Canada and Public Works and Government Services Canada (PWGSC). See **Appendix A** for details on individuals on the Advisory Committee.

PROJECT PURPOSE & OBJECTIVES

The purpose of the project was to develop a mechanism for the assessment of improvement in SCM use and Green House Gas (GHG) savings achieved through the increased use of SCMs in the context of complex market realities.

The project sought to achieve the purpose through two objectives:

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[1] Bouzoubaâ, N. and Fournier, B. "Current Situation of Supplementary Cementitious Materials (SCMs) in Canada" CANMET Report MTL 2003-4 (TR), Natural Resources Canada, Ottawa, April 2003.

- Conducting of a qualitative assessment of SCM use in Canada.
- Evaluation of the change in use of SCMs in concrete since a related survey was conducted in 2002.

Expected benefits of the project included:

1) Setting of a baseline for future activities.
2) Increasing awareness of SCM technology as efficient strategy for enhancing sustainable construction.
3) Increasing awareness of the Green House Gas (GHG) savings achieved through the increased use of SCMs.

The project objectives were achieved through the following activities:

1) Identification of target groups in Canada, amongst key players of the cement, ready-mixed concrete, construction industries and federal, provincial and municipal agencies.
2) Development of assessment methodologies and framework to be used in consultation with target groups.
3) Consultation on attitudes and perceptions regarding SCM use with the identified target groups.
4) Assessment of effectiveness based on the results of the above consultations; in particular understand the influence of market forces, other government programs related to climate change, and other initiatives such as the LEED building rating system.
5) Qualitative assessment of Green House Gas (GHG) savings achieved through the increased use of SCMs.
6) Creation of recommendations based on outcomes of the above activities.
7) Published project results on the websites of project partners: EcoSmart and Natural Resources Canada/CANMET.

PROJECT ACTIVITIES

1) Identification of Target Groups

Target groups amongst key players of the cement, ready-mixed concrete, construction industries and federal, provincial and municipal agencies, were identified initially through research and discussions with the project advisory committee. Through this process, it was determined that the following groups should be targeted for inclusion in the assessment of SCM use in Canada:

- 2002 survey respondents
- Members of advisory committee organizations (eg. CIRCA, CAC, CRMCA)
- Other related industry associations (eg. engineers, architects, contractors, developers, Canada Green Building Council (CaGBC), Canadian chapters of American Concrete Institute (ACI), Canadian Standard Association (CSA) Committee A23.1 and A3000)
- EcoSmart Foundation contacts from related projects (eg. SOS, EcoSmart Concrete, seminar attendees)

- Municipal, provincial and federal government departments (particularly transportation & public works)

2) Development of Assessment Methodologies and Framework

It was determined that the consultation process would be most successful if it included a variety of approaches. Personal, professional and regional differences among targeted stakeholders meant that receptivity toward the same method of consultation would be unlikely. Therefore, the assessment process was developed to include three methods of consultation: general web-based survey, telephone survey, and in-person focus group meetings.

InterVISTAS Consulting was contracted by EcoSmart to gather qualitative information on the use of SCMs across Canada through the use of an online survey and supplementary telephone interviews, focusing on:

- Stakeholders' positions and concerns toward SCMs use
- The level of acceptance of SCM use among stakeholders
- The role and influence of market forces on SCMs use over the past 3 to 5 years
- Recommendations to increase acceptance and use of SCMs
- Estimation of Greenhouse Gas (GHG) reduction benefit

The survey was developed to be a widely accessible web-based tool that could be distributed by email to all target groups. EcoSmart and the advisory committee were consulted throughout the survey development. It had been agreed that advisory committee members would send the survey information out directly to their own member lists, due to concerns over privacy and the release of member information. InterVISTAS provided all advisory committee members with bilingual email text and the link to the online survey for this purpose.

Three additional consultants (AMEC Earth and Environmental, Qualitas Laboratoire de Béton, Levelton Consultants Ltd. were contracted to attend, document and assist with the setting up of consultative meetings with key stakeholders across Canada. The lists of key stakeholders developed by these meeting consultants were used to approach individuals for participation in the survey (both online and telephone) as well as the meetings.

Upon the recommendation of the advisory committee, five main cities were targeted for the meetings: Vancouver, Calgary, Toronto, Montreal and Halifax. An additional five cities were selected to be included if possible: Quebec City, Ottawa, Winnipeg, Regina and Edmonton.

3) Consultation on Attitudes and Perceptions Regarding SCM Use

i) Online and telephone survey

The link to the finalized survey was distributed by email by InterVISTAS, EcoSmart and advisory committee members. The online survey, originally

planned to be posted as a live site for two weeks, was kept open almost two full weeks longer for a total period of February 15 to March 12, 2007. The main reasons for the survey extension were to enable its access during the follow-up telephone calls and to ensure participation of a statistically significant cross-section of stakeholders from across the country.

The follow-up telephone interviews – narrated versions of the online survey – were conducted by InterVISTAS and any information gathered in this way was compiled into the general survey results. Telephone call recipients were selected to ensure all adequate coverage of all regions and industry groups, as well as inclusion of as many of the 2002 survey participants as possible. Additional key contacts identified by the meeting consultants were also targeted for telephone follow-up if it was determined they had not already completed the survey. It should be noted that the follow-up telephone interviews proved to be far less successful in collecting information and primarily served as a reminder for completion of the online survey.

The survey captured 173 completed responses. According to InterVISTAS Consulting, this is a statistically significant figure and the results can be expected to be accurate within a margin of error of plus or minus 7.4% 19 times out of 20. Of the responses, 65% were from designers, 27% were from suppliers and 8% were from builders. The regional distribution was concentrated largely in BC, Ontario, Alberta and Quebec; almost ¾ of respondents were from these four provinces. By contrast, there were only three respondents identified from the north (less than 2%).

The qualitative survey included both prompted (selection of options provided) and open-ended responses.

See below for a summary of findings and **Appendix B** for the full survey report.

ii) Consultative meetings

Meetings with individuals from industry and government took place in all five of the primary target cities as well as in four of the secondary cities. Locations covered were: Vancouver, Calgary, Edmonton, Winnipeg, Toronto, Ottawa, Montreal, Quebec City and Halifax. Severe scheduling constraints meant Regina could not be included.

Eighteen meetings were held with individuals from industry and government in nine cities across Canada. Attendance at each meeting ranged from one to eighteen people and a total of seventy-eight people, including meeting consultants and advisory committee representatives, were directly consulted in this way.

Project representatives included: Michel de Spot of EcoSmart, Nabil Bouzoubaa of CANMET and where possible, representatives of the Advisory Committee and contracted meeting consultants.

Schedule of Consultative Meetings			
Date	**City**	**# of mtgs**	**Organizations represented at meetings**
Tue, Mar 6	Winnipeg	3	Manitoba Infrastructure and Transportation; City of Winnipeg; Wardrop (engineering firm)
Wed, Mar 7	Calgary	1	Breakfast meeting with various industry attendees
Thur, Mar 8	Edmonton	2	Stantec Consulting (engineering firm), City of Edmonton
Mon, Mar 19	Toronto	3	City of Toronto; Ontario Ministry of Transportation; Trow Associates (engineering firm)
Tue, Mar 20	Ottawa	2	City of Ottawa; Canadian Precast/Prestressed Concrete Institute (CPCI)
Wed, Mar 21	Quebec City	1	Quebec Ministry of Transportation
Thur, Mar 22	Montreal	2	Hydro Quebec; City of Montreal
Fri, Mar 23	Halifax	2	Breakfast meeting with various industry & government attendees; lunch meeting with Nova Scotia Ministry of Transportation
Mon, Mar 26	Vancouver	2	Breakfast meeting with various industry attendees; teleconference with BC Ministry of Transportation
Total # of consultative meetings:		**18**	

See below for a summary of findings and **Appendix C** for details of the meetings, participants and meeting consultants.

4) Assessment of Consultations from Survey & Meetings

i) Main Survey Findings

The level of acceptance of SCMs use

Acceptance levels of SCM use are strong, especially among the suppliers (cement manufacturers, ready-mix concrete producers and SCM suppliers). In fact, the majority of stakeholders are currently using or specifying SCMs, largely because of concrete performance and environmental benefits.

- Designers – seven in ten currently specify the use of SCMs.
- Suppliers – all the ready-mix concrete producers use SCMs in concrete.
- Builders – three-quarters of them currently use SCMs in concrete construction.

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Stakeholders' concerns

Although the acceptance levels of SCMs are strong, there are still a variety of barriers that limit SCM use. Barriers suggested by survey respondents are summarized below. It should be noted that for designers and suppliers, the barriers were more technical, whereas, for builders, the barriers were more economic.

- Policy Barriers – 63 policy barriers were listed; 20 respondents stated that there are no policy barriers. The most commonly mentioned policy barriers were:
    - government restrictions on SCMs use (29% of the total policy barriers listed)
    - the use of older specifications/guidelines that do not reflect SCMs benefits (20% of the total policy barriers listed)
- Technical Barriers – 109 technical barriers were listed; 8 respondents stated that there are no technical barriers. The most commonly mentioned technical barriers were:
    - Setting times for strength gain (28% of the total technical barriers)
    - Lack of information, research and education regarding quality (15% of the total technical barriers listed)
- Economic Barriers – 86 economic barriers were listed; 18 respondents stated that there are no economic barriers. The most commonly mentioned economic barriers were:
    - Costs – increased time requirements when using SCMs (22% of the total economic barriers listed)
    - Costs – materials: fly ash (21% of the total economic barriers listed)
- Other Barriers – 75 other barriers were listed; 5 respondents stated that there are none. Other barriers most commonly mentioned were:
    - Lack of information/knowledge of SCMs (17% of the total other barriers listed, mainly mentioned by designers)
    - Resistance to change in marketplace (13% of the total other barriers listed)

The role and influence of market forces on SCMs use

The majority of respondents noticed an increase in SCMs use or specifications over the past 3 to 5 years.

- Designers – About half of them noticed an increase in the specifications for SCMs.
- Suppliers – Nearly eight in ten of the ready-mix concrete producers noticed an increase in the amount of SCMs used in concrete.
- Builders – About two-third of them noticed an increase in the amount of SCMs used in concrete over the past 3 to 5 years.

This increase is thought to be driven by greater education and awareness regarding SCMs; concerns over sustainability and the environment; SCM benefits,

such as durability and enhancing concrete properties; greater acceptance in the marketplace; and the LEED program.

Recommendations to increase acceptance and use of SCMs

Most stakeholders think that something should be done to increase acceptance and use of SCMs, and the most common suggestions are as follows:

- More education on SCMs for contractors, engineers and general public (30%).
- More marketing of SCMs (22%).
- More publications addressing SCM research and performance results (15%).
- Mandatory requirements and legislation for SCM use (7%). This was especially suggested by the suppliers.

It was also mentioned by the majority of stakeholders that workshops, seminars and demonstration projects are generally the most effective types of programs for promoting SCMs.

Assessment of GHG reduction benefit

The vast majority of designers and suppliers are aware that SCM use in concrete can reduce greenhouse gas emissions associated with concrete production. By comparison, just over half of the builders are aware of these greenhouse gas reduction benefits. Most stakeholders are also aware of sustainability benefits in the increased use of SCMs.

ii) Main Consultative Meetings Findings

Most of the organizations met are perceived as very conservative toward the use of SCMs. The current specifications of some of these organisations do not allow the use, for example, of fly ash in some structural elements that are exposed to external environment, or limit its use to 15 to 25% and only during warmer season, usually between May and September. The main reasons given by representatives from these organizations with regard to the conservative attitude are summarized as follows:

Barriers, concerns and market forces working against the use of SCMs

Technical barriers and concerns:

- Increased setting times
- Delay in strength gain
- Scaling
- Curing
- Finishing difficulties due to lack of bleed water
- Lack of skilled labourers/placers/finishers with fly ash concrete' experience.

Policy barriers and concerns:

- Performance specifications are perceived as counterproductive with regard to increased use of SCMs.
- CSA standards are perceived as not severe or not complete regarding concrete incorporating SCMs.

Economic barriers and concerns:

- Lack of financial savings using SCMs
- Concerns over increased costs associated with delays in setting times and strength gain.
- Cost related to transportation.

Other barriers and concerns:

- Regional availability of SCMs
- Concerns over future availability of fly ash if coal fired plants are restricted over environmental concerns
- Variability of sources and its effect on concrete performance
- Scheduling issues: timing of budget and project approvals limiting potential activities and products used (eg. A municipal budget approved in July often means that construction can not commence until September, reducing the amount of fly ash that can be used in colder weather)
- Negative past experience affecting current views on SCMs
- Potential aesthetic issues (eg. colour inconsistencies)

Acceptance of SCM use, including related drivers and markets forces

Although the above barriers and concerns still exist, most of the organizations met have shown openness toward the use of SCMs, and some of these organizations are actually planning to increase the use of SCMs and to loosen their specifications. Theses changes in attitude are mainly driven by the following:

- Environmental benefits (GHG reductions, LEED points, sustainable aspect)
- Technical benefits (workability, cracks reduction, ASR, sulphate resistance, service life and Coulomb values)
- Economic benefits (some of the organisations believe that the use of fly ash will reduce the cost of concrete without affecting its performance)
- Other reasons include:
    - Examples of success in other jurisdictions increases confidence in the use of SCMs
    - Standards and specifications support the use of SCMs (CSA and provincial specifications such as OPSS)
    - Trust in fly ash in blended cement from the plant (standardized vs individual variable mixes from ready-mix suppliers)
    - Ability to have two mixes, adjustable by season

The following is a SWOT Analysis of Consultative Meeting Findings:

SCM Use: General Notes			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
Main user groups are becoming more familiar with SCMs.	Issues remain of mistrust, liability and warranty between main users groups: R/M producers, owners and engineers. Contractors / owners don't always see the benefits.	Address issues of mistrust and liability. Clarify warranty and roles and responsibilities of main user groups. This includes the key role of the contractor vis-à-vis: setting time and costs, durability of the entire system/project and warranty. Develop a tool that looks at a project as an integrated system.	Previous bad experiences; current and previous litigation (such as EOBC); The threat of litigation with new and conventional products is perceived as high.
	Lack of confidence in SCM QA/QC.	Implement SCM QA/QC and make it transparent	Perceived lack of QA and QC and concerns regarding the variability of FA
	Scheduling concerns.	Projects with reduced construction schedules encourage the use of precast concrete (which can include high volumes of SCMs)	Timing of budget and project approvals limits the potential activities and products used. In some jurisdictions, current budget approval schedules limit construction start dates to later in the year, restricting the use of SCMs due to colder weather.
Technical Benefits and Concerns			
Strengths	**Weaknesses**	**Opportunities**	**Threats**

Proven technical benefits include increased resistance to ASR and sulfate and cracks reduction (mainly fly ash).	Technical concerns remain. For example, curing, scaling, finishing and increased setting time require special consideration. Budgets and schedules may be affected.	Develop tools and education programs for all users and a system of checks and balances. These include: develop curing procedures make curing part of the contract, perform site checks develop finishing procedures, train placers and finishers. Develop seasonal mixes to account for variability in environmental conditions for each season. Provide tools to better understand parameters.	Concerns and misinformation regarding curing, scaling, finishing and esthetics exist, perpetuating a negative perception of SCM concrete. Climate and external scheduling factors also affect use of SCMs
GHG and Sustainability			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
Using SCM concrete is seen as a GHG solution.	The environmental benefits of SCMs may not readily be perceived or clearly understood by stakeholder groups.	Promote SCMs as being environmentally beneficial; encourage the supply side of industry to get more involved in sustainability. Some municipal governments are incorporating sustainability into planning, zoning and approval process for projects.	In the short term using FA is sustainable; however, over the long term environmental regulations will limit the use of coal fired power plants.
SCM Supply			

Strengths	Weaknesses	Opportunities	Threats
SCMs are by-products produced in other industries and in this regard supply is available.	Concerns regarding the ease of locating suppliers and quality of product. While supply exists, it may not always be accessible. The number of SCMs suppliers can be limited in a given jurisdiction.		Regional availability of FA can fluctuate and is dependent on market forces. Increased competition for FA in some jurisdictions limits its availability. Production of FA can be lower in the summer when demand is the highest. GGBFS can be costly. Transporting materials to a market/jurisdiction can be high, especially if there are no domestic sources.
LEED			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
LEED and its set of performance criteria promote the use of SCM concrete.	LEED requirements are sometimes misunderstood by user groups. For example, using SCMs without reducing Portland cement content does not fulfill requirements to earn LEED points.	Promote appropriate LEED usage and LEED education program/materials.	Misunderstanding of LEED requirements hampers the use of SCM concrete.
Successes			
Strengths	**Weaknesses**	**Opportunities**	**Threats**

Examples of success in other jurisdictions increase confidence in SCM usage.	Successes are not well publicized and promoted.	Proven success can prompt changes in specification and increase SCM usage. Further testing (including test sections), field experience, case studies, research and demonstration projects are needed. Creating education and marketing programs and supporting existing ones, including workshops, seminars, and demonstration projects to raise awareness. These can be general and focused to specific user groups. Creating more accessible and updated information for all stakeholders.	Decision and policy makers rely on accessible information and data regarding SCMs to make changes. If that is unavailable or unknown, changes will not occur.
Standards and Specifications			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
Standards exist for the use of SCM in construction projects at regulatory and industry levels. For example, OPSS incorporates CSA	In some jurisdictions, regulatory specifications are too conservative regarding the amount of SCM replacements.	Promote adoption of CSA in other jurisdictions and standardized specifications for SCMs. Greater emphasis on the use of appropriate levels of cement replacement where there is a real advantage over a	Lack of a standard that accounts for all SCM needs and upon which regulatory standards can be based ultimately impede the confidence in, acceptance and use of SCM concrete at all stakeholder levels.

		"one size fits all" solution.	
	Performance definition and promotion of performance in CSA is problematic. These are dependent on an entire system being in place.	Develop methodologies to define performances, address in CSA and provide appropriate training for users. Link performance and mix and make performance more measurable.	
Blended Cement			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
Trust and confidence in SCMs in blended cement from the plant.	Lack of product awareness and SCMs availability concerns. Ready-mix users prefer using SCMs as a separate ingredient in order to have the flexibility on the content, thereby creating an industry barrier.	Promote use of blended cement as it incorporates: QA/QC from the plant, can create off-the shelf standard mixes, and raises the average SCM usage. Lower quality SCMs can also be used.	At this time, there appears to be more internal barriers than external barriers to the acceptance of blended cement.

5) Qualitative assessment of Green House Gas (GHG) savings

i) Qualitative assessment of SCM use trends

The survey indicates that 100% of the suppliers (who answered the questionnaire) use SCM in their mix. This is landmark result indicating that the use of SCM is widely – if not universally accepted. A large majority of cement and concrete suppliers - 92% and 78% respectively) have experienced an increased of SCM use as well as blended cement production.

These results clearly show that today the use of SCM has become the norm and is no longer an exception as it was five years ago.

Interviews with selected stakeholders across Canada confirmed this finding:

- Manitoba Infrastructure and Transportation (Paving division) is increasing the level of FA in its specification from 0 to 15%
- The City of Winnipeg is experimenting with a change to 25% FA in city roads and sidewalks.
- Inland Cement is introducing a sulphate resistant blended cement incorporating approximately 30% fly ash.
- The City of Edmonton is prepared to evaluate the results of Inland's blended cement for its own projects.
- The City of Toronto is willing to implement a 2-season mix specification instead of the current one-fits-all to optimize the amount of SCM
- Ontario Ministry of Transportation is open to look at scaling resistance data of concrete incorporating 25% fly ash.
- The city of Ottawa is not opposed to the use of High Volumes of SCM and has no restriction on GGBFS.
- The average FA use in Nova Scotia is approximately 17% to 19% as opposed to 6% (in Atlantic Canada) in 2002.
- Quebec Ministry of transportation specifies ternary blends (~ 25% SCM and ~5% SF) in the summer and Binary blend (with SF) in the winter.
- Hydro Quebec is planning to experiment concrete with increased SCMs level by 10% in some of the applications.
- Ville de Montréal (Montreal City) uses 30% ternary blend in most of their concrete specifications.

Provincial public works offices were traditionally the most conservative and opposed to the use of SCM in their projects. They are now all accepting SCM to various extents. As their specifications are often taken as local references in other projects, their increased acceptance of SCM has a positive influence on the increased use of SCM across Canada.

ii) GHG savings

GHG savings achieved through the increased use of SCMs can be calculated if the following parameters are known at both the base year and the year the saving is calculated.

OPC_p: Annual production of Ordinary Portland cement for use in construction in tonnes per year

OPC_e : GHG emissions associated with the production of one tonne of Ordinary Portland Cement

FA_p: Annual production of fly ash for use in construction in tonnes per year

FA_e : GHG emissions associated with the production of one tonne of Fly ash

BFS_p: Annual production of Ground Granulated Blast Furnace Slag for use in construction in tonnes per year

BFS_e : GHG emissions associated with the production of one tonne of Ground Granulated Blast Furnace Slag.

SF_p : Annual production of Silica Fume for use in construction in tonnes per year

SF_{e0} : GHG emissions associated with the production of one tonne of Ordinary Portland Cement

Unfortunately not all these numbers are readily available.

OPC

NRCan's yearbooks[2] reports that the amount of OPC produced in Canada in the years 2002 and 2005 went from 13.201 Mt to 14.266 or a total increase of 1.065 Mt in three years. Within the same period, the amount used in Canada increased from 8.909 Mt to 9.636 Mt.[3] or a total increase of 0.726 Mt.
Therefore the GHG emissions from cement manufacturing increased significantly. National emissions increased by about one million tonne – on the basis of one tonne of CO2 per tonne of Cement[4]. GHG associated with cement used in local application (production + imports – exports) increased by 726,000 t.
The conclusion is that the replacement of OPC by SCMs was not sufficient to counterbalance the greater demand for cementitious materials and as a result, the absolute GHG emissions went up.

	Unit	2002	2005	Diff	Source
Cement production	Mt/a	13.201	14.267	1.065	NRCan Canada Minerals Yearbook 2002 and 2005
Cement used in Canada	Mt/a	8.909	9.636	0.726	NRCan Canada Minerals Yearbook 2002 and 2005
Total Cement Sale	G$/a	1.39	1.67	+20%	NRCan Canada Minerals Yearbook 2002 and 2005
Cement Sale canada	G$/a	0.98	1.34	+37%	above less export plus import
Fly Ash used in Canada	Mt/a	0.538	0.607	0.069	NRCan Canada Minerals Yearbook 2002 and 2005
BF Slag used in Canada	Mt/a	0.347	not avail.	n/a	NRCan SCM Situation report 2002
Silica Fume used in Canada	Mt/a	0.037	not avail.	n/a	NRCan SCM Situation report 2002
Concrete Production	Mm3/a	24.518	not avail.	n/a	Estimated from OPC sales

Fly Ash

NRCan's yearbook also reports that the use of FA were 538,000 t in 2002 and 607,000 t in 2005 or an increase of 69,000 t. This number is surprisingly small in the view of the national survey and qualitative analysis described above. It is less than 10% of the increase of OPC during the same period. In fact, the ratio FA to OPC stayed at 6% between 2002 and 2005. It would be worthwhile to verify the exactitude of these numbers.

GGBFS

The 2002 CanMet report[5] indicates that 347,000 t of GGFS were used in concrete in 2002. NRCAN's Canada Minerals Yearbook does not report BFS production and use and therefore the 2005 quantities are unknown.

[2] Canadian Minerals Yearbook 2002 and 2005. 2006 was not available at the time of writing this report.
[3] Calculated as OPC produced in Canada minus export plus import
[4] Lafarge. These numbers include process, fuel combustion, electricity and transportation.
[5] 2002 Situation….

Silica Fume
The 2002 CanMet report indicates that 37,000 t of SF were used in concrete in 2002. NRCAN's Canada Minerals Yearbook does not report SF production and use in concrete and therefore the 2005 quantities are unknown.

Although the exact quantities of SCM are unknown at this stage, it can be assumed that these quantities have at least not decreased between 2002 and 2005. These materials are not GHG-free. Transportation, - and electricity for grinding in the case of BFS, associate some GHG value to these materials. Therefore the GHG associated with OPC + SCM used in application in Canada increased by at least 726,000 t between 2002 and 2005.

Concrete
Although it has been demonstrated above that the absolute emissions increased by at least 0.7 Mt, it would be worthwhile to assess the effect of SCM on relative emissions and to find if the use of SCM allowed to produce more concrete with less total GHG emission than on a business as usual (BAU) scenario. In other word, has the GHG signature of concrete decreased due to the increased use of SCM?

The answer requires knowing the quantity of concrete produced in 2002 and 2005 According to industry, these quantities are not measured but estimated from the sale of cement, which make it of course impossible to assess the contribution of SCM in the equation.

Cement sale increased by about 20% in that period, and 36% for cement used locally (minus export plus imports). Statistics Canada shows the average revenue of the concrete industry increases by 9% per year or about 30% in 3 years. Here again the numbers seem to indicate that the increase of concrete production matches a corresponding increase of cement and that the GHG signature of concrete has remained constant.

iii) Emission Factors of SCM

The emissions factors of SCMs designated above as FA_e, BFS_e and SF_e depends on three parameters:

1) Transportation: GHG Emissions from transportation are a function of the distance and the type of transportation (truck, rail, ship) and may vary significantly from case to case.

2) Electricity: GHGs embodied in the electricity consumed for processing the SCM also may vary greatly according to the region, unless the national average is used, which is arguably not an accurate measure. However, only the grinding of BFS will have a significant energy component.

3) Allocated emissions: Fly ash, blast furnace slag and silica fume are all by-products from industries with significant GHG emissions. For example, the Transalta coal fired power plant in Alberta, which is a major source of fly ash, emits more CO2 that the entire cement industry in Canada. How much

emissions can be allocated to electricity versus fly ash - or in the general case of SCM, the main product versus the by-product - is a complex question that will require extensive consideration of many aspects, viewpoints, methodologies and standards. It is however an important issue that will become increasingly critical with upcoming carbon trading programs and assessment of emissions by industry sectors. This should be investigated in the future.

iv) GHG Assessment Conclusions

Based on the collected data, the absolute GHG emissions associated with the use of cementitious materials in Canada increased by at least 700,000 t between 2002 and 2005.

The effect of SCMs on the average GHG signature of concrete is unknown for lack of production data. Improved reporting data collection of concrete and SCM is required.

6) Recommendations based on outcomes of the above activities

One of the main themes that emerged from both the survey and consultative meetings is that there is a need for greater acceptance and use of SCMs. The following are recommendations regarding future activities in a variety of areas to increase the appropriate use of SCMs in Canada.

i) Communication & Education

- Greater overall education and marketing among the public and all industry stakeholders to increase SCM acceptance and use
- Increase in the number of workshops, seminars and demonstration projects to promote SCMs
- Raising awareness of existing programs among some groups, particularly builders and designers
- Creation of more accessible updated information for all stakeholders on durability, uses, benefits, costs, and impacts on construction schedules
- Promotion of SCMs as being environmentally beneficial
- Education focused on the builder and finisher sectors, such as demonstrations at the finisher trade schools
- Greater emphasis on the use of appropriate levels of cement replacement where there is a real advantage over a “one level fits all” solution
- Publicising of SCM successes and sharing positive case studies with a wide range of stakeholders

ii) Program & Policy

- Continuation of existing programs and work done by associations (particularly EcoSmart, LEED, CIRCA, CRMCA, CAC) in promoting the use of SCMs

- Encouragement of the supply side of industry to get more involved in sustainability
- Complete inventorying of concrete and SCM production and use
- Promotion of the use of blended cements
- Address mistrust of ready-mix suppliers and liability/warranty issues
- Promote greater use of seasonal mixes
- Improve curing through contract items, site checks and finishing procedure

iii) Research & Development

- Further testing (including test sections), field experience, case studies, research and demonstration projects
- A need to look at integrated process of a system
- Quality assurance and quality control
- Links between performance and mix need to be known and performance to be made more measurable
- Before the effect of SCMs on the average GHG signature of concrete can be determined, there needs to be greater access to production data (possibly through improved reporting and data collection) and a reassessment of the calculation methods used to determine emission factors

iv) Standards & Specifications

- Standardized specifications for SCMs
- Although the CSA adoption of high volume SCMs is a positive measure, the emphasis on performance concrete is a challenge
- LEED needs to be clarified to eliminate misconceptions and confusion on points gained by reducing Portland cement in concrete through the use of SCMs

7) Published project results on websites of project partners

The results of the project will be published on websites of project partners, EcoSmart and Natural Resources Canada/CANMET, upon approval of the final report.

8) Conclusions

The main purpose of the project was to qualitatively assess SCM use in Canada, focusing on changes since a related study was conducted in 2002 as well as on GHG savings achieved through the increased use of SCMs.

The project sought to achieve its purpose through an online qualitative survey targeting relevant stakeholders among specifiers, suppliers and builders as well as through in-person consultative meetings with key stakeholders across Canada.

Although conducting a quantitative assessment of SCM use was far beyond the scope of the project, additional studies were conducted in an attempt to determine the effect of SCMs on the average GHG signature of concrete.

Both the survey and consultative meetings were designed to determine a variety of factors related to SCMs in Canada:

- current use of SCMs (as well as recent changes in SCM use)
- advantages & disadvantages of the use of SCMs
- barriers to the use of SCMs
- stakeholder concerns regarding the use of SCMs
- recommendations to increase use of SCMs

The online survey developed by InterVISTAS Consulting included up to 19 questions in both multiple choice and long answer formats. Questions were tailored to the category of respondent and in some cases, streamed according to response given. The statistically significant survey response rate (173 completed) is more than satisfactory considering the limited number of possible individuals who could adequately respond to the specialized nature of the topic. Not surprisingly, the regional distribution was concentrated largely in the provinces with the highest rates of concrete production and usage: BC, Ontario, Alberta and Quebec. The large majority of survey responses – over 90% – sufficiently represented groups with the highest level of influence on SCM use: suppliers and specifiers, such as designers.

Eighteen consultative meetings were also held in nine cities across Canada with close to 80 people involved in the process. As with the survey, representation was predominantly from suppliers and specifiers. Government representatives (primarily provincial and municipal) made up almost 40% of individuals consulted in the meetings.

Findings indicate that the survey respondents may be those more open to using SCMs when compared with the organizations targeted in the meetings who have more conservative attitudes toward the use of SCMs. Combined, these studies give a good picture of the current situation of SCMs.

i) Current Use and Acceptance of SCMs

Overall, SCM acceptance and use has risen in recent years and is high among many groups and geographical regions, especially among suppliers (cement manufacturers, ready-mix concrete producers and SCM suppliers). This is less the case among some groups, but it seems that situation is changing. For instance, provincial public works offices, traditionally reluctant to use SCM in their projects, are now all accepting SCMs to various extents.

Concrete performance and environmental benefits were main reasons given for SCM use, although cost was also a key factor. Other factors listed that have or may increase the use of SCMs include: supportive standards and specifications, education and awareness, perceptions of SCM success in other jurisdictions, high trust factor of blended cements containing SCM from cement plants, the ability to

have seasonal concrete mixes, and an overall greater acceptance in the marketplace.

ii) Barriers and Concerns

Although acceptance levels are generally strong, there are still a variety of barriers and concerns that limit SCM use or its increased use. For designers and suppliers, the barriers were more technical, whereas, for builders, the barriers were more economic.

Technical barriers include delays in setting times and strength gain, difficulties in finishing and using SCM in cold weather, scaling and curing, lack of labourers (placers and finishers) with SCM concrete experience and perceptions of inconsistent or inferior quality of SCMs.

Policy barriers include government restrictions on SCMs use, the use of outdated specifications, and the perceptions that performance specifications are perceived counterproductive and CSA standards are not complete.

Economic barriers and concerns include increased costs associated with delay in setting times and strength gain, costs of materials and transportation, and lack of financial savings using SCMs.

Other barriers and concerns include availability of SCMs (especially of those of quality), negative past experiences, potential aesthetic issues (eg. colour inconsistencies) and scheduling concerns.

iii) GHG Assessment

Most survey respondents noted an awareness of GHG reduction benefits of SCMs but it was less clear among meeting participants.

Although it was determined that absolute GHG emissions associated with the use of cementitious materials in Canada increased by at least 700,000 t between 2002 and 2005, the effect of SCMs on the average GHG signature of concrete is unknown for lack of production data.

There needs to be greater access to production data (possibly through improved reporting and data collection) and a reassessment of the calculation methods used to determine emission factors. It is recommended that further research be conducted in this area.

iv) Recommendations for Increasing the Use of SCMs

One of the main themes that emerged from both the survey and consultative meetings is that there is a need to increase the acceptance and use of SCMs. Specific recommendations found in Section 6 of this report, fall into four main categories:

- Communication & Education: better marketing, training for labourers, education for contractors, engineers and general public, etc.
- Program & Policy: mandatory legislation, clarity of standards, etc.

- Research & Development: further testing (including test sections), field experience, case studies, research and demonstration projects, publications addressing SCM research and performance results, etc.
- Standards & Specifications: standardized specifications, clarification of standards, etc.

Stakeholders stated that workshops, seminars, demonstration projects and clearer technical information (such as a guide) would generally be most effective for promoting SCMs.

v) Summary

The dual nature of the qualitative SCM assessment – an online survey complemented by in-person consultative meetings – meant that feedback could be gathered from a variety of stakeholders, regardless of their stance on the use of SCMs. This study thus provides a comprehensive picture of SCM use in Canada, particularly looking at the current levels of acceptance and use, barriers to increased use, influences of market forces, and attitudes and concerns of stakeholders.

While there are still many barriers and misunderstandings about the proper use of SCMs, acceptance levels have increased in recent years and even many of those traditionally resistant are becoming more open to such technologies. There is also an overall recognition among stakeholders that more should be done to increase the level of SCM acceptance and use. Greater education, training, tools, research and clarification of policies and standards are a few of the areas where improvement could be made.