
Acknowledgments

This report has been prepared by Ian Morton of Pollution Probe and Jay Kassirer of Cullbridge™ Marketing and Communications.

We gratefully acknowledge and appreciate the work of Bruce Small, Dianne Humphries, Natasha Teoli, and Ken Ogilvie in the preparation of this report, as well as our families who supported this project on a daily basis over a long period.

Project Funding was provided by:

- Canada Mortgage and Housing Corporation
- Venmar Ventilation, Inc.
- NIKE, Inc.
- Health Canada
- Interface Flooring Systems (Canada) Inc.
- Lever Pond's

The project's Advisory Committee included:

- René Dionne, Venmar Ventilation
- Thomas Green, Canada Mortgage and Housing Corporation
- Barry Jessiman, Heather Logan, Pierrette Miron, Health Canada
- Rahumathulla Marikkar, Interface Flooring Systems (Canada) Inc.
- Ruth Richardson, Lever Pond's

Expert advice was provided by:

- Gord Cooke, Air Solutions Inc.
- Nils Larsson, Natural Resources Canada
- Ed Lowans, Lowans and Stephen Environmental Consultants
- Dr. Alan Abelsohn, Ontario College of Family Physicians
- Bruce Small, Envirodesic™ Certification Programme
- Tex McLeod, McLeod Associates
- Hal Levin, Hal Levin and Associates
- Mary Smith, United States Environmental Protection Agency
- Vaidy Vaidyanathan, Public Works and Government Services Canada
- Carlton Vogt, Cutter Information Corp.
- Jim White, System Science Associates Ltd.

Additional reviewers included:

- Dr. John Shaw, National Research Council
- Dr. David Miller, Health Canada
- Nita Chaudhuri, South Riverdale Community Health Centre
- Jiri Skopek, Building Research Establishment's Environmental Assessment Method
- Louis Marmen, Natural Resources Canada
- Gerry Granek
- Dr. Jim Robar, Canada Mortgage and Housing Corporation
- Ken Ogilvie, Pollution Probe

We are also pleased to acknowledge the following contributors to specific sections of the report. Bruce Small on *Part I — Achieving Healthy Indoor Environments*, Joe Castrilli on *Appendix III — The Legal Aspects of Indoor Air Quality*, and Natasha Teoli on *Appendix II — Case Studies*. Special thanks goes to Rande Holmes for editing and Natasha Teoli and Krista Friesen for technical and design assistance in the preparation of the report.

The Market Analysis section of the report draws on work originally funded by Industry Canada, Canada Mortgage and Housing Corporation, and the Ontario Government's Green Industry Office, as presented in the publication *Characterization of the Canadian Indoor Environment* (December 22, 1994). We are pleased to acknowledge the contribution of the project managers for that work: Philippe Lalonde, Geoff Green, Jim White and Jacque Maund. We are also pleased to acknowledge the important contribution of the following colleagues who helped in identifying relevant companies across Canada and/or reviewed various sections of the draft report:

- Dara Bowser, Bowser Technical Inc.
- Gord Cooke, Air Solutions Inc.
- Andre Fauteux, La Maison du 21^è siècle
- Steve Hart, Canadian Environment Industry Association
- Brian Holmes, B.W. Holmes and Associates
- Nils Larsson, Natural Resources Canada
- Kash Ram, Environment Canada
- David Rousseau, Archemy Consulting Ltd.
- Bruce Small, Envirodesic™ Certification Programme
- Douglas Walkinshaw, Indoor Air Technologies Inc.

Our appreciation is also extended to the many businesses, industry associations and government specialists who were so generous with their time and insights in the preparation of the report.

Table of Contents

EXECUTIVE SUMMARY	5
RECOMMENDATIONS	8
PART I — ACHIEVING HEALTHY INDOOR ENVIRONMENTS	13
1.1 Government Regulations vs. Voluntary Initiatives	16
1.2 Key Elements of Indoor Environment Voluntary Initiatives	19
1.2.1 Integrated Approach	20
1.2.2 Proactive Building Monitoring and Maintenance	21
1.2.3 Meaningful Participation: Putting People Back in the Loop	21
1.2.4 Broader Understanding and Awareness	21
1.2.5 Authority and Influence	22
1.2.6 Accountability	22
1.2.7 Performance Verification	23
1.2.8 Leaders and Catalysts	23
1.2.9 Legal Structures and Responsibilities	23
1.3 A New Strategy of Maximum Voluntary Initiatives (MVI)	24
1.3.1 Voluntary Initiatives	24
1.3.2 Regulatory Powers	24
1.3.3 New Forms of Communication	25
1.4 New Communication Structures	25
1.5 Conclusions	29
PART II — SUMMARY OF KEY FINDINGS, RECOMMENDATIONS AND RESEARCH NEEDS FROM CASE STUDIES	30
2.1 Buildings	30
2.1.1 Findings	31
2.1.2 Recommended Options	32
2.2 Products	32
2.2.1 Findings	33
2.2.2 Recommended Options	34
2.3 Services	34
2.3.1 Findings	35
2.3.2 Recommended Options	35
2.4 Processes	35
2.4.1 Findings	36
2.4.2 Recommended Options	36
2.5 Cross-Cutting Findings and Recommendations	37
2.5.1 Findings	37
2.5.2 Recommended Options	38
2.6 Conclusions	38

PART III — SUMMARY OF LEGAL ASPECTS OF INDOOR AIR QUALITY**39**

3.1	Constitutional Authority — Division of Powers	39
3.2	The Charter of Rights and Freedoms	39
3.3	Common Law	39
3.4	Negligence and Product Liability	40
	3.4.1 Existing Legislation	41
3.5	Recent Parliamentary Attempts to Legislate Progress	41
3.6	Findings	42
3.7	Recommended Options	43

PART IV — CHARACTERIZATION OF CANADIAN INDOOR ENVIRONMENT INDUSTRIES**44**

4.1	Turning Our Challenges into Opportunities	44
4.2	Industry Overview	44
	4.2.1 Company Groupings	45
4.3	Size and Growth	46
4.4	Market Drivers	46
	4.4.1 Regulations	46
	4.4.2 Guidelines and Product Labelling Programmes	47
	4.4.3 Requirements of Other Certification Programmes	48
	4.4.4 Requirements by Insurance and Mortgage Companies	48
	4.4.5 Legal Liability	48
	4.4.6 Perception of Market Demand for Better Indoor Air Quality	49
	4.4.7 Summary of Market Drivers	49
4.5	Barriers to Growth	54
4.6	Findings	56
4.7	Recommended Options	58

LIST OF ABBREVIATIONS AND ACRONYMS**59****END NOTES****60****APPENDICES**

Appendix I	New Directions Group: Criteria and Principles	67
Appendix II	Case Studies	77
Appendix III	Legal Aspects of Indoor Air Quality in Canada	158
Appendix IV	Key Informant Interviews — Response Summary	225

Executive Summary

There is convincing evidence that indoor environments are damaging the health of people working and living in them. Increases in asthma, allergy, and multiple chemical sensitivity have all been linked to the quality of our indoor environments.¹ In fact, the situation is critical enough that the United States (U.S.) Environmental Protection Agency (EPA) has rated poor indoor air quality (IAQ) — to which it has attributed the annual loss of billions of dollars in health-care costs and productivity — among the top environmental risks to human health.²

The purpose of this report is to identify promising options for addressing this problem in Canada. These options are the starting point for the next phase of our work — a cross-Canada stakeholder consultation and alliance-building process. The authors hope that this report

- provides consultation participants with a common, basic level of information and analysis of the issues involved and options available;
- stimulates the expression of additional perspectives and options; and
- contributes to the process of refining, prioritizing and moving forward with selected options.

Background

Canadians have been slow to recognize that indoor environments have real impacts on our health, our environment and our economy. With the exception of toxic exposures in the workplace, attention to indoor pollution issues generally did not begin until the late 1970s and early 1980s. And while progress has been made on some issues (e.g., smoking in public places), many

indoor environments in Canada remain as polluted as they were twenty years ago.

In general, Canadians labour under the misconception that air pollution is an outdoor phenomenon. Yet we live indoors most of the time, whether inside vehicles, offices, factories, restaurants, shopping malls, skating rinks or homes. Indoor environments have been shown to be many times more polluted than the outdoor environment. While some improvements have been made to the quality of the ambient environment, the nature and significance of our indoor environments have received relatively little attention.

The foundations for much greater progress are now being laid. Leaders in industry manufacture and market products that have demonstrable benefits to indoor environmental quality. New building designs, improved ventilation, filtration technologies and low-emission products are fuelling the rapid growth in Canada of an indoor environment industry currently valued at one billion dollars a year.

However, more could be done to create healthier indoor environments. Consumers could be better informed about the health risks associated with the products they buy or use, and about available alternatives that can help minimize these risks, for example, through improved product labelling. Purchasers could be further helped in making meaningful performance comparisons among competing products. Service professionals who diagnose and treat indoor environment problems could be kept current about healthier solutions, and certified in ways that recognize this expertise. Voluntary standards could be put in place to encourage and recognize buildings that are operated and maintained in ways that improve indoor environmental health.

This report was prepared in response to opportunities to improve indoor environmental quality in Canada. It brings together, for the first

time, components of the indoor environment issue that were previously treated separately, namely, legal aspects, best practices in the field, and the market for indoor environmental products and services. The report also draws upon the expertise of leading government and industry players and explores the question of whether government regulations or voluntary initiatives are more appropriate for solving indoor environment problems. Complex problems involving multiple jurisdictions over private property and individual rights suggest that voluntary initiatives could be the most effective way to improve the quality of the indoor environment.

Report Structure and Summary

The report is organized into four parts. The first part briefly outlines why progress has been slow on resolving indoor environment issues, identifies key elements of effective indoor voluntary initiatives and describes a new strategy of “Maximum Voluntary Initiatives.” The strategy calls for use of new communication structures described as “committed action networks” or “candleholder networks,” which are informal alliances of interested persons and organizations designed to promote action in many venues. The strategy also proposes making more extensive use of electronic technology to facilitate communication among all parties.

The second part of the report provides an in-depth review of twenty voluntary initiative case studies. Detailed analysis of the relative success of these initiatives points the way to the role of supportive policy that could enhance existing voluntary initiatives and fill in the gaps. In particular, quantification of the costs of unhealthy indoor environments and the benefits of healthier environments would be a motivator for action. While each of the initiatives has inherent limitations, they all have achieved some degree of success. They have also harnessed

creative energy and enterprise that might not have been applied if the indoor environment was controlled solely by regulation. It is accurate to conclude that voluntary initiatives have been part of the IAQ landscape since first awareness of the problem, and there is every reason to believe that such initiatives will continue to occur and have beneficial effects on indoor environments

The third part of the report provides a summary of the legal aspects of IAQ (a comprehensive review is presented in Appendix III). The legal review concludes that with some exceptions, such as the workplace environment, there is little existing legislation that explicitly addresses the control of indoor pollution. Legislation that does exist covers few issues of concern. At the same time, the range of legislative provisions potentially applicable to IAQ is enormous. It is apparent that a wide variety of ministries, departments and agencies at the federal, provincial and municipal levels of government have some authority for addressing different aspects of the problem.

The fourth part of the report contains an overview of the Canadian indoor environment industries, including the identification of market drivers and key barriers to further industry development. This section contains recommendations for supporting local suppliers of products and services to the indoor environment. It warns that Canada has a limited window of opportunity for capitalizing on exports for healthier indoor environment products and services, and that such exports are important since they help Canadian companies maintain their ability to supply the Canadian market.

Each part of the report recommends options for creating healthier indoor environments in Canada. At the core of the recommendations, and of the ideas reflected in the report, is the need for a comprehensive strategy to address the indoor environment issues in Canada.

Next Steps

To move this issue forward, Pollution Probe and its partners are proposing a cross-country stakeholder consultation and alliance-building process. This process will bring leading researchers, policy makers, academics, and industry together to develop a comprehensive, multi-stakeholder plan for achieving healthy indoor environments in Canada. Using this document as a starting point, participants will help build, refine and prioritize a list of available options. In addition, organizations and individuals will be identified who are committed to championing progress on selected options. Each of these champions will be supported in developing candleholder networks with other stakeholders across the country interested in promoting further action on the option being championed.

An open and transparent process is envisaged involving:

- identification of key stakeholder groups and individuals to be consulted;
- circulation of this report to those stakeholders, with an invitation to provide comments;
- posting of stakeholders' comments on a Web-based discussion forum with a summary of this report;
- public and trade announcements and news coverage of the consultation process and work to date, with an invitation for interested parties to join the process;
- facilitated workshops, held in three cities across Canada, that will build on the Web-based discussion forum by posting proceedings to it;
- continued on-line discussion of opportunities after the three workshops, as the consultation report and recommendations are being finalized;
- identification of organizations and individuals who are (a) committed to championing and/or (b) interested in promoting progress on each recommendation; and
- identification of areas requiring further clarification and/or research.

Recommendations

Achieving Healthy Indoor Environments: A Review of Canadian Options is a call to action on the need for a comprehensive strategy to address indoor pollution. It is clear that indoor environments are damaging the health of people living and working in them. Yet, despite possessing the knowledge to build and maintain healthy energy-efficient buildings, we rarely do so. It is time for the various governments and industries responsible to identify, refine, and prioritize possible options to address this important public health issue. As a first step, Pollution Probe proposes the following recommendations for achieving healthy indoor environments in Canada.

The federal government should assign lead responsibility to Health Canada for coordinating issues related to the indoor environment. A wide range of government ministries, departments, and agencies have responsibilities for various aspects of the indoor environment. The diversity of agencies involved in this area creates fragmentation of authority and ineffectiveness in responding to the range of indoor environment issues that require attention. Health Canada should be given the lead role to coordinate Federal and Provincial activities related to the indoor environment. There are a number of reasons for this recommendation. First, Health Canada has the legislative authority (e.g., Hazardous Products Act, Pest Control Products Act, Tobacco Act, Exposure Guidelines for Residential Indoor Air Quality and the Canadian Environmental Protection Act) to take action. Second, Health Canada has previously shown leadership around the issue, by chairing Federal-Provincial Working Groups on IAQ, producing educational guides and funding research in the area of indoor environmental health. Third, three recent Private Members' Bills and Motions on Indoor Air Quality identified Health Canada as the appropriate Federal Agency for developing a

coordinated response to the indoor environment issue. Coordinated activities might include: research, standard setting, code development, and communication. Finally, in preparing this research document, the authors consulted with leading experts in the area who supported a possible leadership role for Health Canada in developing a comprehensive and coordinated strategy to address the indoor environment issue in Canada.

Health Canada should require labelling that discloses data (e.g., emissions, health information, product constituents, etc.) on consumer products, building materials and furnishings. Product labelling provides important information to consumers on a variety of products used within the indoor environment, and has led to product improvements in other jurisdictions. Under the Hazardous Products Act, Health Canada has the authority to prohibit, restrict or impose conditions on the sale of products that may pose a risk to human health. The federal government has used this statute previously to prevent certain contaminants (e.g., formaldehyde) from entering the indoor environment. Health Canada should use its regulatory authority to require product labelling on consumer products, building materials, furnishings and other materials that may pose a risk to human health and pollute the indoor environment. It should also investigate how to facilitate wider adoption of Canadian voluntary certification programmes which recognize “*best in class*” products that minimize indoor pollution and associated health risks.

The national and provincial building codes should specifically address indoor environment issues. Initiatives such as Envirohome, R-2000, and Healthy Housing have demonstrated the benefit of healthy and energy efficient construction in Canada. Unfortunately, few of these advancements have been applied to the national or provincial building codes. In some cases, changes to the codes (e.g., removal of heat recovery ventilators, and reduced basement insulation requirements,

etc.) have reversed health and energy efficiency gains. At the federal level, the building code is a guideline and has no legal effect unless specifically incorporated by reference in a particular federal statute. While provincial building codes have tended to be promulgated as regulations under provincial building code legislation, they have not been overly specific about designing, building, selecting materials, etc., to avoid indoor environment problems. Public input to the code development process is virtually nonexistent, and the complicated “prescriptive” language makes it difficult to interpret and enforce. Federal and provincial agencies (National Research Council (NRC), Natural Resources Canada (NRCan), Canada Mortgage and Housing Corporation (CMHC), Municipalities, Municipal Affairs and Housing, etc.) responsible for developing building codes should promulgate codes that maximize the quality of the indoor environment. For example, establish an indoor environment objective that specifies low emission materials, heat recovery ventilators, high performance windows, insulation requirements etc.

Natural Resources Canada should encourage and support building performance assessments on all commercial, institutional and residential buildings. Building performance assessments lead to improvements, but are underutilized in Canada. In the United Kingdom (U.K.), for example, BREEAM has assessed over 25% of the office space constructed since its launch, has influenced training programmes, and has resulted in documented benefits. BREEAM and competing assessment systems have not been widely adopted in Canada outside of government buildings. The Buildings Issue Table: [Commercial/Institutional Section Options Report](#) recognizes the need for the development and promulgation of rating and labelling systems. NRCan should encourage building performance assessments on all new commercial and institutional buildings, and work with industry associations such as BOMA to promote

the benefits of these programmes to senior decision-makers in the property development, management and insurance industries, and in the companies who use the buildings.

Voluntary initiatives require supportive policy to succeed. Issues such as jurisdiction over private property and individual rights make indoor environment problems challenging to regulate and therefore are better suited to the use of voluntary initiatives. At the same time, the lack of supportive policy (e.g., regulations, economic incentives, rewards, promotional support, etc.) has limited the number and range of voluntary initiatives targeted at the indoor environment. It is clear that without this supportive policy, voluntary initiatives may not occur to the extent possible, or sometimes not at all. Those voluntary initiatives that do exist may not meet their full potential and will suffer from a lack of public confidence. Governments should commit to developing supportive policy, particularly in the areas of

- healthy housing
- product labelling
- emission guidelines
- codes of practice for services
- health claims
- exposure standards

Educate and engage professionals on indoor environment issues. Professionals in a variety of occupations should be engaged in order to effectively address and resolve issues relating to indoor environments and human health. Outreach and education should be targeted to health professionals, physicians, teachers, parents and building professionals. In the U.S., the American Medical Association, the American Lung Association, the Consumer Product Safety Commission and the EPA have produced an excellent document on IAQ information for health care professionals.³ The American Academy of Pediatrics has recently produced a book⁴ on environmental health for pediatricians. Similar efforts need to be made in Canada by Health Canada, the Canadian

Institute of Child Health, The Lung Association, Canadian Association of Physicians for the Environment, provincial public health associations, and provincial medical associations such as the Ontario College of Family Physicians.

Governments should commit more resources to research. Research by Health Canada, Canada Mortgage and Housing Corporation, National Research Council, Natural Resources Canada and others has led to notable progress in understanding indoor pollution and in devising ways to mitigate the problem. Consumer products and building materials have been reformulated, educational materials have been produced, and Canada has pioneered research and development in the area of healthy housing. However, many gaps remain in our understanding of the problem. Research needs to be expanded in the following areas:

- the number, significance and sources of indoor pollutants;
- the mechanisms by which people are exposed to them;
- the health effects resulting from prolonged and intermittent exposure to low-level concentrations of chemical and biological pollutants as well as complex pollutant mixtures;
- the health effects for at-risk populations such as children and seniors; and
- the most cost-effective strategies for reducing pollutant sources, exposures and consequent health effects.

Research funding should also be directed toward epidemiological and clinical health studies on the impacts of poor IAQ on productivity and health. Governments should commit more resources to research to address these knowledge gaps.

Health Canada should review and revise, if necessary, the Exposure Guidelines for Residential Indoor Air Quality. The Exposure Guidelines for Residential Indoor Air Quality were developed in 1987. The existing guidelines were not designed to protect vulnerable segments of the population such as children and people living with lung disease and other chronic illnesses — groups that typically spend the most time indoors. Recent scientific evidence suggests that there may be no safe threshold for certain contaminants (e.g., O₃ and PM_{10-2.5}). In some cases, ambient guidelines are actually lower than the indoor guidelines for some contaminants despite the high percentage of time to exposure ratios found within the indoor environment. For example, Canada's guideline for radon is five times higher than the radon standard in the U.S. Health Canada should review the adequacy of existing standards/guidelines to ensure that children and other sensitive members of the population are protected.

Health Canada should revise the radon guideline. Radon is a radioactive gas that is known to cause lung cancer. It occurs naturally in soil and most commonly enters homes through cracks in the foundation. In the U.S., the National Research Council reiterated its long-standing concern regarding the health effects of radon in its BEIR-VI report (February 1998) stating that “about 1 in 10 to 1 in 7 lung cancer deaths in the U.S. can be attributed to radon.” In April 1998, the Harvard School of Public Health evaluated relative risk in the home and determined that radon was the number one health risk in the U.S. In August 1999 the Centers for Disease Control in Atlanta stated that “about 10 – 14% of all U.S. lung cancer deaths are attributable to radon exposure — making it the second-leading cause of lung cancer death after smoking.”⁵ Health Canada has been relatively silent on the issue of radon and has set the guideline for radon in homes at 800 becquerels per cubic metre (Bq/m³) of air —

five times higher than the action guideline of 160 Bq/m³ adopted by the World Health Organization and the U.S. EPA. Health Canada should revise the radon guideline for homes and introduce preventative strategies to mitigate exposure. One option would be to require homeowners, as a condition of sale, to disclose to purchasers whether the home has had a radon problem and what corrective actions were taken to eliminate the problem. This would be similar to what is currently done for urea formaldehyde foam insulation (UFFI).

Health Canada should develop a cost-benefit analytical framework for assessing indoor environment quality.

The use of cost-benefit analysis for determining optimal air quality conditions has gained considerable acceptance over the last ten years with respect to outdoor air quality. This acceptance now needs to be broadened to include the examination of IAQ problems. Large health costs to society may be accumulating due to the health impacts from poor indoor environment quality. Cost-benefit analysis could lead to informed decisions by policy makers, builders, health-care professionals and others with respect to indoor environment issues. Health Canada should invest in developing the appropriate cost-benefit framework to assess the indoor environment.

Collective attention should be given to school-based voluntary initiatives. Such initiatives can provide great leverage for influencing public opinion and support. People are generally more concerned about risks to their children's health than they are about risks to their own.⁶ Furthermore, while government is rightfully wary of intruding into what happens within an individual's home, most people are supportive of governments taking corrective actions within school environments. A number

of the case studies illustrate the effectiveness of such programmes, and the popular support and momentum they seem to be able to garner.

Government and industry need to develop quality assurance programmes, certification programmes, and/or codes of practice for targeted services (e.g., housekeeping, HVAC, carpet and duct cleaning). Most services targeted at indoor environments in Canada do not have certification, quality assurance or codes of practice. As a result there is very little protection for consumers and no regulations preventing false claims related to indoor environment improvements from services. The various service industries and appropriate government agencies need to work together to develop the appropriate set of policy tools (e.g., incentives, quality assurance criteria, codes of practice, certification) for this sector of the market.

Government to provide resources to support the development of information and knowledge infrastructure for indoor environments. The 1999 Governor General's *Speech from the Throne* commits the government to "new types of infrastructure" for improving the health of Canadians. New communication structures are arising that may prove useful in solving indoor environment problems in Canada. Interactive databases provide valuable information to the public, government and industry. Both searchable databases and Web page technology hold the promise of providing up-to-date, well-indexed, easily searched, economically accessible, multi-disciplinary approaches to indoor environment issues. The Government of Canada should dedicate resources to support the development and implementation of information and knowledge infrastructure (e.g., the "candle" concept outlined in this report) for indoor environments.

Part I — The State of the Indoor Environment in Canada

Over the past twenty years the problem of poor indoor air quality (IAQ) in Canadian buildings of all types has received intermittent attention from a variety of government agencies, corporations, other organizations and individuals. Conferences have been organized and numerous reports have been written stating the need for research and action. And while progress has been made on some issues (e.g., smoking in public places), many indoor environments in Canada remain as polluted as they were twenty years ago. Incidents of sick building syndrome are still common. Many building materials, furnishings and commercial products continue to pollute our indoor environments. And new buildings are still being designed, built and maintained without adequate attention to IAQ issues. At the same time, we have no clear structures or national strategies for addressing these problems, and, with very few exceptions, no acknowledged government or community leadership on these complex issues. Though there are some very encouraging developments, in total we have made insufficient progress over the past several decades, and many situations are getting worse rather than better in terms of indoor pollution and adverse health effects.

So, why has the state of the indoor environment not advanced more significantly over the last two decades? In general, Canadians labour under the misconception that air pollution is an outdoor phenomenon. Yet we live indoors most of the time, whether inside vehicles, offices, factories, restaurants, shopping malls, skating rinks or homes.⁷ Indoor environments have been shown to be many times more polluted than the outdoor environment.⁸ While improvements have been made to the quality of our ambient environment, the nature and significance of our

indoor environments have received relatively little attention by comparison.

Specific challenges in the indoor environment (e.g., toxic mould in school portables) appear to have been addressed on a crisis-by-crisis basis. Disjointed and ad hoc government policies may have aggravated this tendency.

The growth in market-based solutions and consumer awareness, however, suggests that real progress is possible. We already know how to design and build healthy and energy-efficient buildings. What seems to be missing at this stage is the will by various responsible parties to do so.

The following factors may also have inhibited progress with respect to indoor pollution:

Lack of Accountability. There is no accountability framework for indoor pollution by those responsible for the problem. In every province across Canada, there are several government ministries (e.g., Health, Labour, Environment, Housing, Consumer and Corporate Affairs) with partial involvement in indoor environment issues. In addition to these ministries, federal and municipal levels of government also have varying degrees of involvement and authority in the area. Each level of government has different responsibilities and degrees of involvement, but, except in the case of occupational health and safety, no one agency appears to have the mandate to regulate, remediate or take the lead role in indoor environment problems.⁹ Frequently, provincial ministries turn to the federal government for leadership on issues over which it has limited jurisdiction. This lack of clarity on roles and responsibilities makes it difficult to resolve problems that occur in the indoor environment. It is also inefficient and costly to the economy.

Industry's overall response to the indoor environment issue has also been weak. Some manufacturers of building materials, consumer

products and furnishings have even denied a link between their products and indoor pollution.¹⁰ Because of the range of industries involved in a typical building process, there is a lot of opportunity to shirk responsibility and little capacity to arrive at a common or collective solution.

The medical community has also been relatively silent, and at times reactive against the linkages between indoor exposures and adverse health effects. Although there is little epidemiological evidence on the health effects of indoor pollutants, concentrations of many contaminants have been found at much higher levels indoors than outdoors. Health research has been minimal or in some cases ignored (e.g., health effects related to exposure to mould, radon and products of combustion). A possible reason for this problem is the lack of information on indoor environments and human health for health-care providers. In the U.S., the American Medical Association, the American Lung Association, the Consumer Product Safety Commission and the EPA have produced an excellent document on IAQ for health-care professionals. The American Academy of Pediatrics has recently produced a book on environmental health for pediatricians. There are no parallel efforts in Canada.

Lack of Protection. Current indoor air quality guidelines may be inadequate to provide protection for all populations. Health Canada's Exposure Guidelines for Residential Indoor Air Quality were established based on adult male occupational exposures.¹¹ It was recognized at the time (1987) that the guidelines might not provide adequate protection for at-risk populations such as allergic or asthmatic people.¹² Since that time, new scientific evidence has emerged that suggests that there may be no safe threshold for certain contaminants (e.g., O₃ and PM_{10-2.5}).¹³ For some contaminants ambient air guidelines are actually lower than the indoor guidelines (if they exist), despite the high percentage of time to exposure ratios found within the indoor environment. For example, Canada's guideline for radon is five

times higher than the radon standard in the U.S.¹⁴ This situation is made worse by the lack of monitoring and limited data collection on problem buildings.

Similarly, building codes and standards (e.g., ASHRAE 62-1989) have been more focused on issues such as energy conservation than on indoor environment quality and may not provide adequate protection for all populations. While codes and standards both strive for "tolerable" or "acceptable" IAQ, there is no enforcement agency to verify that this has been achieved once the building is occupied. In some cases, recent changes to building codes (e.g., in Ontario, the removal of heat recovery ventilators and basement insulation requirements) could have a detrimental impact on the quality of the indoor environment. Building codes are intended to dictate minimum requirements, not optimal ones, and are usually years behind current knowledge in building science. Public access and input to the code development process at federal and provincial levels are virtually nonexistent. The complicated "prescriptive" language used in the codes makes them difficult to understand and enforce.

Lack of Disclosure. Successful product labelling programmes in Europe and California suggest that clear disclosure of product constituents and other environmental indicators influences consumer purchasing behaviour, leads to product improvements and may have a positive impact on the indoor environment.¹⁵ Although workplace information provided by Material Safety Data Sheets (MSDS) is available for commercial products, consumer products are essentially exempt from this process. Consumers have in some cases experienced great difficulty in obtaining product ingredient information. Some products, such as pesticides, are not required to list all primary or secondary ingredients. Similarly, proprietary or trade secret exemptions remove vast amounts of toxic materials from regulation and restrict access to information.¹⁶ The federal government should

require adequate product labelling on consumer products, building materials, furnishings and other materials that may pose risks to human health and pollute the indoor environment.

Lack of Integration. Indoor environments are complex systems. Ventilation, light, energy, moisture, building materials, and a variety of contaminants interact with occupants and affect their environmental health. Buildings also have an intimate connection with “natural” systems using energy, materials, water, and land in their development and operation. Despite the strong interrelationships among buildings, the environment and human health, we have tended to focus on the individual parts, rather than the whole. As a result, we really don’t have a clear understanding of how the entire system functions. At times solutions are promoted with the implicit assumption that a single change has a single effect. Decisions are frequently made on this basis. For example, one assumes that turning on the exhaust fan will improve the air quality of the home. However, when the house is considered as a system, it becomes evident that turning on an exhaust fan could sometimes result in a significant reduction in IAQ. This can happen, for example, when negative pressure draws soil gases from below grade or causes back-drafting of combustion gases from a furnace. An integrated approach takes the view that the individual things we do inside our homes usually have a number of consequences.

Finally, the issue of indoor environments has not yet been properly integrated with other related issues. For example, the co-benefits of retrofitting a building include the reduction of greenhouse gas emissions, air pollutants such as CO, NO_x, PAHs, and PM₁₀, and water consumption and pollution, as well as the improvement of IAQ and comfort. Integrating approaches also means bringing together the various knowledgeable parties (e.g., architects, health professionals and engineers) to design and control buildings to achieve these benefits. This rarely happens in Canada. Using an

integrated approach will assist us in developing the requisite interdisciplinary responses necessary to create healthy indoor environments.

Inaccurate Assumptions. Some commonly held assumptions have limited progress toward healthy indoor environments. For example, a myth still exists that improved energy efficiency means poor indoor environment health. This is not necessarily true. Well-designed and operated energy-efficient buildings can have good IAQ and comfort. This was demonstrated in CMHC studies in Wallaceburg, Ontario where energy-inefficient homes had the poorest IAQ.¹⁷ Another inaccurate assumption is that installing air quality related equipment will solve problems related to poor IAQ. For example, some products marketed as “purifying” air do so by adding ozone (a known contaminant) into the indoor environment. These products actually pollute rather than clean indoor air.¹⁸ Despite the rapid growth of the air cleaning industry, there is surprisingly little data to substantiate the performance and health claims made by the manufacturers. In some cases, statements made by manufacturers may actually confuse or mislead consumers.¹⁹ This confusion is worsened by the lack of understandable, meaningful and applicable performance standards for residential air devices. A better alternative to adding equipment would be to find the source of contamination and remove it.

Another assumption is that a room has to smell clean to be clean, or that a floor has to look shiny to be hygienic. Scents and polishes usually contain volatile compounds. Some of these pollutants enter the air immediately, while others do so over a longer period of time.²⁰ Either way, many such consumer products actually pollute the indoor environment while purporting to clean it. Not much is known about the impacts of low levels of this type of pollution on human health. But it is inaccurate to assume that these products are safe. Recent research suggests that extremely low-level exposures to a variety of organic chemicals or toxic metals can lead to

chronic illness, decrease higher brain function, especially learning, and impair fetal and childhood development.²¹ In most cases safer and cleaner alternatives to these products exist.

Unfortunately, many such misconceptions have distracted attention away from the air quality problem and the need to act. The lack of public information and government regulations related to IAQ allows these misconceptions to persist.

Size of the Problem. The extent and scale of polluted indoor environments is significant. The World Health Organization estimates that between 30 and 40 percent of commercial buildings that were designed, retrofitted, or operated for energy conservation and comfort have consequently suffered from an increase in IAQ problems.²² Similar estimates have been made for the residential sector.²³ This data is worrisome for a number of reasons. First, we spend the majority of our time inside, with some at-risk groups (children, seniors, people living with disease) spending virtually all of their time indoors.²⁴ Second, most contaminants are found at much higher levels indoors than outdoors.²⁵ Third, a variety of adverse health effects have been linked to polluted indoor environments.²⁶ People living with asthma, allergies, or chemical sensitivities may react particularly severely, even when exposed to an extremely small amount of a particular contaminant.²⁷ The magnitude and complexity of the problem and the lack of a comprehensive response has slowed progress in resolving the challenge.

Poverty. Poverty and poor indoor environmental health are closely linked.²⁸ Poor people tend to reside in older homes or low-rent housing that exposes them to higher levels of both chemical and biological contaminants. Old furnishings (e.g., carpets), environmental tobacco smoke and old paint can expose occupants to lead, pesticides and other contaminants.²⁹ Poor housing conditions may also lead to infestations of cockroaches or rodents. The urine and feces from these animals contain potent allergens, and

insecticides used to control them may also be problematic. Substandard housing (i.e., cracked foundation, damp walls and damaged materials) can also lead to mould problems. Certain moulds found in damp houses are now recognized to be both toxigenic and allergenic, increasing the risk and frequency of asthma attacks.³⁰

We have been slow to recognize that our indoor environments have real impacts on our health, our environment and our economy. Lack of progress is the combined result of neglect, limited resources, confused public policy, medical community indifference, incomplete research, and competing agendas. Building it right the first time sometimes costs more up front, but quickly pays off in lower energy bills and improved health. While this requires forethought and collaboration, it results in better buildings.

1.1 Government Regulations vs. Voluntary Initiatives

Concern with the indoor environment is very recent in Canada. With the exception of toxic exposures in the workplace, attention to indoor environment issues generally did not begin until the late 1970s and the early 1980s, unlike attention to outdoor pollution, which gained prominence starting in the 1960s. Responding to public outrage over gross examples of industrial pollution, governments introduced regulatory regimes that were backed up by extensive scientific research and environmental monitoring infrastructures. Recently, the traditional command and control regulatory approach to resolving environmental problems has been supplemented by a growing interest in market mechanisms and voluntary initiatives.³¹

In contrast to outdoor environment issues, government policy in the form of regulations toward the indoor environment is limited and fragmented. There is a relatively well developed policy framework for outdoor environment

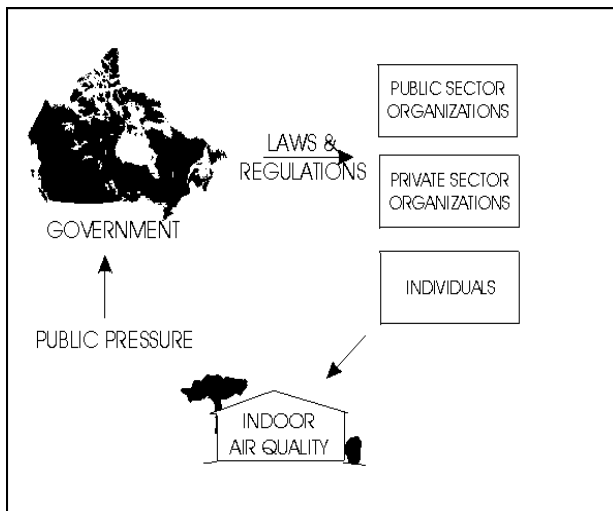


Diagram 1: Exclusively Government Regulation

issues, with specific government ministries at the federal and provincial levels assigned legal authority, resources and responsibility to promote improvements in environmental quality. The same situation does not exist for most indoor environments, including homes, schools, and indoor recreational spaces.

Regulatory approaches however, have been used in Canada to control some indoor environment problems. For example, at the beginning of the 1980s, the federal government led by Health and Welfare Canada banned the use of urea formaldehyde foam insulation (UFFI) because of gaseous emissions attributed to the product. This was followed by an extensive building research programme, spearheaded initially by the National Research Council of Canada on the UFFI issue, and later by CMHC on indoor air quality more generally. A more recent example, is the effort by municipalities across Canada to ban smoking in public places

Diagram 1 depicts a traditional model of government regulation, whereby government initiative in the form of laws and regulations imposes requirements on public and private sector organizations and individuals.

In general, voluntary initiatives (low emission building products, education campaigns on indoor air quality, codes of practice, voluntary guidelines, etc.) have been the dominant approach for addressing indoor environment issues in Canada. One explanation might be the fact that no specific government agency is solely responsible for protecting the quality of indoor environments. As a result, there is no legal authority, resources or responsibility to improve indoor environments — a situation made more complicated by issues of private property and individual rights. As the indoor environment issue has evolved, it has become evident that a single agency or level of government cannot possibly deal with the full range of issues needing to be addressed. In addition, the corporate and non-government sector has assumed a broader role through various voluntary initiatives targeted at housing, schools and other indoor settings. This broadening of responsibility and involvement suggests that voluntary approaches may be the most effective tools for addressing the indoor environment issue.

Examples of voluntary initiatives are discussed in detail in Appendix II. Those initiatives reviewed that have originated in Canada include:

- eco-classrooms in Waterloo, Ontario schools, undertaken to reintegrate environmentally sensitive students who might otherwise have to work at home because of reactivity to common indoor pollutants in schools;
- the “no scents” policy of the Halifax Regional School Board, whereby a proposal has been made to use scent-free cleaning products in some places and to prohibit students and staff from wearing scents. To date, the vast majority of schools in Halifax have initiated scent-free programmes of varying strictness;
- the Envirodesic Certification Program, a private sector initiative to encourage the

building of healthier indoor environments, by influencing builders and manufacturers to improve their buildings and make lower-emission products;

- *Exposure Guidelines for Residential Indoor Air Quality*, a government initiative defining “acceptable air quality” for domestic premises, undertaken by the Federal-Provincial Working Group on Indoor Air Quality;
- the development by Interface Flooring Systems (Canada) Inc. of a low-emission carpet for commercial and health-care applications, which also includes control of microbiological contamination through inclusion of a special antimicrobial compound in the carpet substrate;
- CMHC’s Healthy Housing Concept, which included a Canada-wide competition that resulted in demonstration houses being built in Vancouver and Toronto; and,
- The Lung Association’s “C.A.N. DO — The Movement for Clean Air Now” Campaign that provides real things people can do to make a difference to the air quality inside their homes.

Diagram 2 depicts a traditional model of voluntary initiatives, whereby public and private sector organizations and individuals undertake beneficial activities of their own accord.

While each of these initiatives has inherent limitations, they all have achieved some degree of success. They also have harnessed individual energy and initiative that might not have been applied if the indoor environment was controlled purely by regulation. Voluntary initiatives have been part of the indoor environment landscape

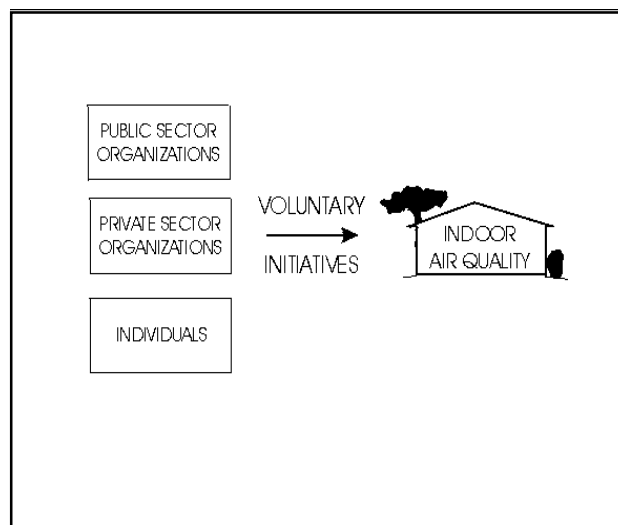


Diagram 2: Exclusively Voluntary Initiatives

since first awareness of the problem, and there is every reason to believe that they may continue to occur and to have beneficial effects on indoor environments.

Achieving healthy indoor environments will require a comprehensive strategy based upon a variety of policy tools (e.g., regulation, economic incentives and voluntary agreements). Of these options, voluntary approaches may be the most effective way of addressing and resolving indoor environment issues. With the amendment of many regulations in Canada and cutbacks in resources, industry and governments are relying more and more on voluntary commitments to improve the environment. Regulations have not proven to be highly effective and the time and cost associated with promulgating them limits the value of exclusively relying on this approach. In addition, complex problems involving multiple jurisdictions, private property and individual rights suggest that voluntary initiatives could be the quickest way to achieve beneficial results to our indoor environments.

1.2 Key Elements of Indoor Environment Voluntary Initiatives

There is no widely accepted definition of what constitutes a voluntary initiative. This causes confusion and can be a barrier to the appropriate use of such initiatives. In addition, because there are so many different approaches targeted at the indoor environment, it is reasonable to assume that a single definition may never emerge. Therefore it is helpful to use a broad definition in concert with a general typology of various forms of voluntary initiatives.³²

The definition of voluntary initiatives used in this report has been adapted from a recent Government of Canada publication titled, *Voluntary Codes: A Guide for their Development and Use*.³³ This definition is also consistent with the one used by Pollution Probe in *Towards Credible and Effective Environmental Voluntary Initiatives: Lessons Learned*.³⁴ The definition is as follows:

A non-legislatively required commitment, agreed to by one or more entities, designed to influence, shape, control or benchmark behaviour and performance, and applied in a consistent manner or to reach a defined outcome.

This definition needs to be supplemented by a more purposeful statement of the overall outcome that is desired. In this context, voluntary initiatives should ideally contribute to transforming industry into more socially, environmentally responsible and sustainable enterprises. Such initiatives should not be just about meeting and exceeding existing or anticipated environmental standards. They should be part of the ongoing quest for global environmental sustainability, as well as social and economic well being. Industry leaders and others have begun to call this the “triple bottom line.”³⁵

There are many different views on how to categorize voluntary initiatives. The United Nations Environment Program (UNEP) has used the following simple typology as an organizing framework.³⁶

Industry — in which industry has exclusive management responsibilities and government does not have a formal role.

Government — in which governments have management responsibilities, including monitoring results. Industry is likely to be consulted or involved in the design of the programme. Third parties may have advisory or indirect roles.

Joint government/industry — in which government and industry co-manage the initiative, sharing responsibility for implementing and monitoring. Third parties may have indirect advisory roles.

Third party — in which third parties, such as standard setting organizations, non-government groups, and citizen groups, develop and run the initiative. Individual companies may be involved. Governments are likely to be limited to indirect or formal roles.

The UNEP typology is a useful framework, even if it does not fully capture the range and complexity of voluntary initiatives designed to improve the indoor environment. The approach, however, is valuable as a starting point, particularly for international comparisons. While much has been written on how voluntary initiatives can achieve environmental policy objectives, nothing specifically has been focused around the indoor environment. To address this gap, Pollution Probe has created the following categorization to supplement the UNEP typology.

Buildings — This includes voluntary initiatives designed and implemented to improve the environmental health of various indoor settings (schools, recreational facilities, office buildings

and housing). An example would be the U.S. EPA's *Tools For Schools*, Building Environmental Performance Analysis Club (BEPAC), and Building Research Establishment Environmental Assessment Method (BREEAM).

Products — This includes voluntary codes of practice (e.g., labelling programmes, emission guidelines and performance standards) established for products (e.g., building materials, furnishings and maintenance products like cleaners) and used within various indoor environment settings. An example would be the Envirodesic certification program.

Services — This includes voluntary codes of practice (e.g., certification, quality assurance, labelling) established for services (e.g., duct cleaning, furnace maintenance, building inspections) delivered to various indoor environment settings. An example would be the National Association of Duct Cleaners of America's (NADCA) indoor air quality certification program.

Processes — This includes the contribution of multi-stakeholder committees, task forces and other processes that have been undertaken to address indoor environment issues. An example would be the Material Emissions Task Force, and the Green Building Challenge.

Standards — This includes overall performance standards for indoor environments. An example would be Health Canada's, *Exposure Guidelines for Residential Indoor Air Quality*.

As a framework for indoor voluntary initiatives, Pollution Probe is promoting the following elements that introduce or amend those aspects that have been lacking in previous approaches. They include:

- integrated approach
- proactive building monitoring and maintenance
- meaningful participation: putting people

back in the loop

- broader understanding and awareness
- authority and influence
- accountability
- performance verification
- leaders and catalysts
- legal structures and responsibilities

These elements build upon the voluntary initiative criteria developed by the New Directions Group (Appendix I) and by Pollution Probe as outlined in *Towards Credible and Effective Voluntary Initiatives: Lessons Learned* — but with a particular focus on the indoor environment. While voluntary in nature, these elements bring together parts of the indoor environment (e.g., building design and control, buildings themselves, and the groups of people who occupy them) that are, at present, treated separately. By integrated building design, healthy building management with the people who occupy them or who are about to occupy them, we believe these elements set the foundation for creating healthier indoor environments in Canada.

1.2.1 Integrated Approach

In the past, building design and management, the buildings themselves, and the people who occupied them, were often handled separately. To be effective, these three elements need to be integrated.

If consistently high-quality building is to be achieved across the country, while still meeting local design conditions and specific occupant goals, building design and building management activities must take place on many levels simultaneously, from the general to the specific. For example, it could be national policy that all buildings have optimum IAQ and be maintained in such a way as to avoid causing further indoor pollution. Local building standards or provincial building codes could dictate the amount and generic type of insulation required or recommended for a given climatic region, and the most appropriate wall structures to be used. Detailed

building designs could specify the materials allowed to be used on the floors, walls and ceilings of a given building. Organizational policies could specify the building cleaning and maintenance standards and materials to be used in a given setting.

Ideally, the policy processes noted above would be open rather than closed. This would allow for continued access to, and scrutiny of, discussions, proposals, conclusions and decisions by interested participants and would add other viewpoints necessary to make building design and management more integrated. All those with a vested interest, including building occupants, would be represented and all factors impinging upon the results would be considered in the design and management of the building.

This might also mean that the design process would need to continue long past completion of the building; feedback on the performance of the building design over time could be continually received. Conversely, the building management process might need to start long before the completion of the building, so that maintenance and cleaning equipment and materials could be directly suited to new designs rather than old practices. Building management would be flexible and open enough to allow adjustment of methods and materials as required over time. And throughout the process, continual and complete access to information would satisfy “right-to-know” requirements and promote accountability at all levels.

1.2.2 Proactive Building Monitoring and Maintenance

Canadian buildings are dynamic rather than static, and should be considered as active, evolving systems along with the occupants they protect and shelter and the processes used to design and manage them. Buildings require maintenance and appropriate flows of water, waste, energy, air and materials in order to function properly for long periods of time. They

cannot by themselves provide adequate IAQ, but must be maintained and operated in ways that minimize indoor air pollution. Proactive maintenance and well-monitored operations are required to ensure healthier indoor environments for all occupants.

1.2.3 Meaningful Participation: Putting People Back in the Loop

The diversity of the living and working habits of the Canadian population is considerable, and needs to be better taken into account in the design, operation and maintenance of Canadian buildings. Most buildings in Canada today do not meet the diversity of occupants’ needs.³⁷ At least 15 percent of the Canadian population has some form of sensitivity to environmental factors significant enough to affect their lifestyle. Over 40 percent of Canadian households contain at least one individual who is more sensitive than most people.³⁸ A huge percentage of the Canadian population suffers from intermittent and chronic ailments whose direct causes have not been determined. A comprehensive assessment has not yet been performed which would determine the proportion of this illness that is directly related to indoor environmental contaminants. Participation by potential occupants in the design and day-to-day operation and maintenance of Canadian buildings would accelerate consideration of IAQ as an important design factor. People must be in the feedback loop to keep buildings and occupants healthy.

1.2.4 Broader Understanding and Awareness

Those who design and manage Canadian indoor environments need the broadest possible understanding of how building environments work, how specific local conditions affect or restrict building design and operation, and how building environments connect to other systems. Further, they must understand how to consider both the occupants and the processes for design and management of buildings as integral ongoing

components of the building. They must also have good access to, or be able to commission, specific building research — not only on individual building components, but also on the performance of the building as a whole.

Too often in the past we have accepted partial understanding as sufficient. For example, under previous practices, if a wooden composite floor joist for residential use meets strength and deflection criteria, it would appear suitable for inclusion in housing design. If, however, the gaseous emissions of the composite joist were noxious, residents of the building might suffer health complaints. Clearly other criteria besides strength and deflection must be included in our building choices. To create healthier environments, in addition to understanding more limited aspects of the building's components, it is necessary to understand a building as a system, operating together with its occupants. Without such an understanding, our designs may not meet all our human needs, including the need for clean indoor air.

1.2.5 Authority and Influence

Directly or indirectly, those who design and control Canadian buildings and their indoor environments must have sufficient authority and influence to make things happen. For example, if our indoor environments are to be healthy for Canadians and responsive to their specific needs, multiple stakeholders must have input into the processes of design and control. Therefore, those who design and control buildings must be given the authority to access these many viewpoints, and especially the views of potential users of those buildings.

Fortunately, accessing all the people who are involved in or affected by a particular building is becoming easier and less expensive with the advent of new electronic communications technology.

Directly or indirectly, those who design and control Canadian buildings must also be able to

formulate, recommend or influence broad policies that will lead to healthier indoor environments. Some will make specific decisions or recommendations about suitable building designs and operational procedures, and will contribute new ideas to any necessary codes, standards or regulations. All must be able to effect or recommend methods of assuring compliance with policies, guidelines, standards, regulations and good practices, and be assured that someone is taking responsibility for enforcement.

In our current society, there are several different types of public pressures that can lead industries or individuals to comply with health-related standards and practices. The first is that of legal requirements in the forms of laws, regulations, standards and codes, along with the penalties levied for not conforming. The second involves the use of less formal methods of influence, including public disclosure and networking. Public disclosure of poor indoor environmental quality can result in embarrassment or loss of market share. Networking brings personal contact and powers of persuasion into play to influence decisions. In the recommended approach, it is recognized that both legal and less formal methods of promoting “compliance” are needed.

1.2.6 Accountability

Directly or indirectly, those who design and control Canadian buildings must become accountable for the results of their actions in terms of the health and effectiveness of indoor environments in meeting the various needs of Canadians.

Pollution Probe's proposed “Maximum Voluntary Initiative” strategy is built on the premise that the entire process of design and building management should be “open” in whatever way is appropriate at each level. For example, for policy-making, minutes and records of virtual or live policy networks should be publicly available, as should all research and other information relating to our society's

understanding of IAQ and building systems. For detailed building design and operation, all aspects should be available to the relevant stakeholders, including occupants of the building. For regulations, standards, and guidelines, there should be public access to all reasoning and data that underlie such compliance measures.

1.2.7 Performance Verification

A process is not accountable unless there is public knowledge of the outcomes of the initiative. It would make sense to make evaluation of outcomes (e.g., IAQ, occupant health, productivity and satisfaction, and other performance measures of a finished building) a necessary and ongoing process for every building or building type. Such evaluation could also become part of an important feedback loop that continually modifies design and control towards more optimum practices. Evaluation is accepted as an essential component of effective change, yet it is not common practice regarding buildings in Canada.

An auditing role might be considered at many levels, whereby “commissioners” or others with sufficient independence would be brought in to evaluate the operation and performance of all aspects of Canada’s building systems, including how well the design and building management functions have worked. Auditing needs to become the rule rather than the exception, so that indoor environments in Canada can continuously evolve into healthier spaces, and the methods used to achieve these ends can evolve towards greater efficiency and effectiveness. Methods for auditing or verifying performance must be matched to the individual situation. Sufficient resources will be required to carry out this function.

1.2.8 Leaders and Catalysts

Concepts and functions as described above for addressing the complex problems of the indoor environment cannot be implemented through words alone. To make voluntary initiatives work,

we need individual human beings who have a high degree of leadership and initiative, and a wide range of skills and knowledge. To create new approaches that will gradually replace existing practices (which have been less than fully effective) we need a large number of human “catalysts.” Such individuals are the driving force for conversion from old ways of doing things to newer ones more suited to the times.

1.2.9 Legal Structures and Responsibilities

Voluntary initiatives need to build upon existing legal structures and powers in Canada. The systems or integrated approach, with direct participation from the many parties involved in Canadian buildings, is designed to harness the leadership of individuals (catalysts) in many roles and organizations to minimize dependency on government action, including laws and regulations. In this approach, government powers are seen as responsible for filling the gaps where voluntary initiatives are not adequate or fast enough to preserve public health and safety. While public policy is welcome and badly needed, voluntary action independent of government can play an effective role in creating healthy indoor environments.

Voluntary initiatives are critical to improving indoor environments in Canada. To be effective they should incorporate the key elements outlined in this section, and have clearly stated and publicly supported goals, targets and timelines. Their performance should be measured and reported. Outstanding issues should be addressed and resolved in a timely manner with the participation of affected stakeholders. In every case, verification should occur to ensure the objectives of each initiative have been attained, and that performance is publicly recognized and rewarded. Finally, voluntary initiatives should not be a substitute for appropriate policy, leadership, or individual responsibility in creating healthier indoor environments.

It is our hope that these key elements will create better benchmarks for everyone to follow in creating and operating healthier buildings in Canada, as well as for tackling other complex multidisciplinary problems where progress needs to be accelerated.

1.3 A New Strategy of Maximum Voluntary Initiatives (MVI)

Is there a clear national strategy for solving indoor environment problems in Canada? Have government responsibility, control and regulation worked? Have voluntary initiatives by industry and individuals worked? Is one approach to voluntary initiatives preferable to another? Are there other options? What approach *will* work?

Pollution Probe believes that a mix of policy tools will be required to create healthy indoor environments. But if voluntary initiatives were to be a cornerstone of a Canadian national strategy on the indoor environment that combines voluntary initiative as well as regulatory action, what kinds of initiatives would be required, and who would initiate and manage them? Should anyone be at the helm, or are existing methods of cooperation and communication sufficient to instigate appropriate action?

To address these questions, Pollution Probe is proposing a strategy called Maximum Voluntary Initiatives (MVI). It is a three-tiered approach designed to promote action on the indoor environment issue. The first tier of the strategy (1.3.1) involves encouraging the establishment of the maximum number of voluntary initiatives possible through a committed action network (C.A.N.). The second tier (1.3.2) involves working with key influencers in a distributed leadership environment (D.L.E.) to support and push for supportive policy. The third tier (1.3.3) involves the establishment of new forms of communication that will enhance the public's

ability to drive the agenda and verify the result. Pollution Probe details these three tiers for such a strategy as follows:

1.3.1 Voluntary Initiatives

On the part of industry, public and private agencies, other organizations and individuals, encourage the maximum number of voluntary initiatives on indoor environment issues by collectively:

1. publicizing existing voluntary initiatives;
2. strengthening public education on indoor environment issues;
3. discussing the increased use of voluntary initiatives among stakeholders;
4. supporting public advocacy for voluntary initiatives on specific issues; and,
5. developing government policy support for voluntary initiatives on specific issues.

1.3.2 Regulatory Powers

Encourage complementary government initiatives on indoor environment issues by collectively:

1. better publicizing existing government initiatives and research data;
2. promoting public discussion of possible future government initiatives;
3. supporting public advocacy for government initiatives on specific issues;
4. creating an effective means of inter-government coordination on the indoor environment; and,
5. developing specific legislation, regulation and/or organization structures, as required.

1.3.3 New Forms of Communication

Create new forms of communication structures to help accomplish the above by collectively:

1. forming Committed Action Networks to move specific indoor environment issues forward;
2. providing more public access and transparency to information on indoor environment issues;
3. forming connections and alliances among interested parties (Distributed Leadership Environment); and,
4. creating formal interagency action committees for detailed implementation.

The maximum voluntary initiative approach offers the possibility of making a significant impact on the health of buildings in Canada and elsewhere. In an age characterized by electronic connection and new types of networks and alliances, it would appear appropriate to think of multiple driving forces, increased public scrutiny, and new forms of cooperation and communication as necessary to implement such a strategy.

This new voluntary strategy is also designed to take advantage of existing resources and current legal structures and powers. Diagram 3 depicts the proposed combination of voluntary initiative and government regulatory action, together with new forms of communication structures to drive and monitor the process.

1.4 New Communication Structures

New communication structures may prove useful in solving indoor environment problems in Canada. We know, for example, that many individuals interested in solving indoor environment problems are part of organizations that can be considered “stakeholders” in indoor environment issues and initiatives. Evidence from recent events (e.g., much of the pre-Seattle coalition building for the 1999 World Trade Organization Meeting between labour, health, environment, citizen groups and others was done by e-mail) suggests that interest groups of individuals can band together relatively informally to move the indoor environment agenda ahead in their organizations and in the public arena. Such groups of individuals do not necessarily constitute official committees, but

rather what might be called “committed action networks.” They have no line of authority with a single leader, but rather create among themselves what might be called a “distributed leadership environment.”

A good example would be the Interagency Group on Pollution and Education in Schools that paved the way in the mid-1980s for present-day concern about IAQ in schools. The group included participation by (then) Metro Toronto area school boards and citizen groups, who together conducted public seminars on the nature and importance of IAQ in schools. Without

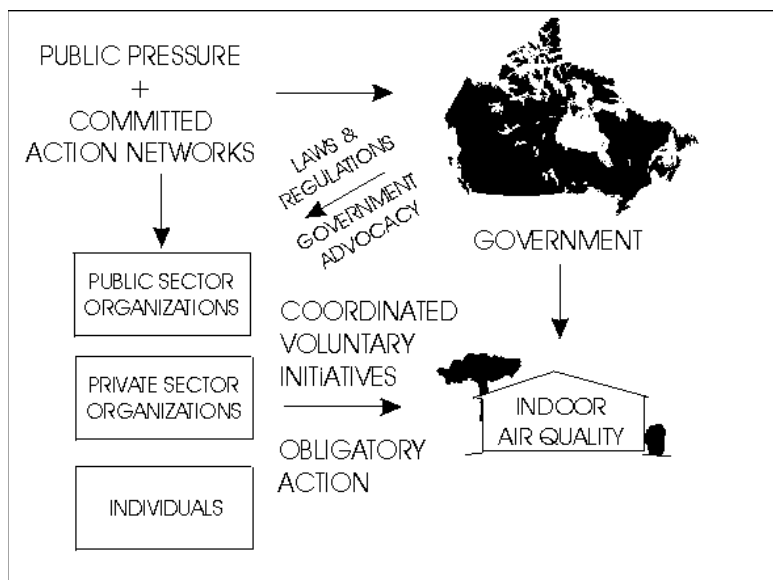


Diagram 3: Maximum Voluntary Initiatives Strategy

a specific mandate or any direct line of authority, the group nonetheless facilitated communication among school boards and the public on indoor environment issues.

A similar model is employed by the University of Toronto Centre for Health Promotion in its network of affiliates. Through regular gatherings and other forms of communication, informally constituted, the Centre carries on its work of health promotion locally and worldwide and inspires others to participate and contribute. CMHC's Material Emissions Task Force used a variation of this approach in the coordination of issues related to pollutant emissions from building materials in the mid-1990s. Recently, Pollution Probe's Healthy Schools — Healthy Children initiative has brought a wide number of participants together (school boards, labour organizations, parents, teachers, health professionals, industry etc.) to develop an indoor environment management plan. Contributions and support for the initiative have come from a variety of sources. Pollution Probe's role is to coordinate and facilitate action on indoor pollution, not control the process. As a result, an effective partnership between people and organizations interested in creating healthy schools is making change happen.

Combining the concept of a committed action network with that of a distributed leadership environment, we created the acronym C.A.N.D.L.E. As an extension of this we came up with the more graphic term "candleholder" to complement and expand on the concept of stakeholder. The term candleholder embodies the concept of "light," in the sense of lighting the way for or lighting a fire under, government agencies and others who fail to take needed action on specific issues. The term implies a "flame of commitment" and a passion for solving specific problems that comes from individual drive and concern that transcends a person's current job description. In the past, candleholders were typically catalysts for action within their individual fields and organizations. By informally joining together

with others, they gain needed information and support to promote specific action within their own local sphere of influence, and to communicate with the public.

In the examples cited, most individuals who have acted as candleholders have had some level of support and implicit endorsement from the organizations of which they are a part, but they may not have been designated as official representatives or delegates with a line of authority to speak on behalf of their organization.

Candleholders are currently flourishing in the Internet environment as it enables inexpensive and instant communication, even at great distances, with little need for in-person meetings, hard copy records, or extensive time commitments. This technological development makes candleholder networks possible with little or no budget, and allows for the inclusion of interested contributors both locally and globally.

Candleholder networks are not easily extinguished. One organization belonging to the network can opt out of an initiative, and a quorum of leadership, initiative and continuity can remain intact to move the issue agenda forward. The peer nature of such forums also allows initiatives and ideas to arise and be considered without prejudice to their origins in organizational hierarchies. No special status, experience, wealth, size of organization, job title or position is required in order to be heard or to have influence.

C.A.N.D.L.E.s do not replace existing organizations, authorities, legislative powers or formal committees. They are merely another "front-end" means of generating initiative and accelerating the issue agenda. They must be complemented by appropriate organizational structures and actions, public and private sector resources and initiative, government legislation and regulation, and formal stakeholder committees and alliances for implementation of specific solutions.

Diagram 4 depicts the structure of official stakeholder committees. This can be compared with the structure of C.A.N.D.L.Es as outlined in Diagram 5.

Within C.A.N.D.L.Es, participants provide one another with a built-in personal support system for leading change within the many organizations they represent or wish to influence.

In the MVI strategy, there is no single lead agency or hierarchy of control. Success is largely dependent on the individual voluntary initiative, but is independent of any one source. As for the network of computers upon which the Internet is based, a maximum voluntary initiative strategy will not likely come to an end if any one player or stakeholder decides to no longer participate. While the strategy must maximally utilize the powers offered by stakeholder organizations, it must at the same time remain sufficiently flexible to be reasonably effective even without the participation of otherwise key parties.

Unlike previous approaches to achieve healthier indoor environments in Canada, the MVI strategy is predicated upon a high degree of linkage among relevant stakeholders and other interested parties, particularly through electronic means including e-mail, e-groups, and the World Wide Web.

As such the MVI strategy is not necessarily restricted geographically or by national boundaries, and can draw upon and exchange expertise with others around the world. The strategy is also generic; for example, the same approach, structures and electronic formats used to create a coordinated national strategy on indoor environment issues can also be used in a detailed design consultation for a new local school or hospital.

Commonly used virtual structures, as via the Internet, will be useful in beginning to establish an MVI strategy for addressing indoor environment issues in Canada, and ultimately for addressing other complex multi-disciplinary problems facing our society. In addition to action committees, which meet live at intermittent

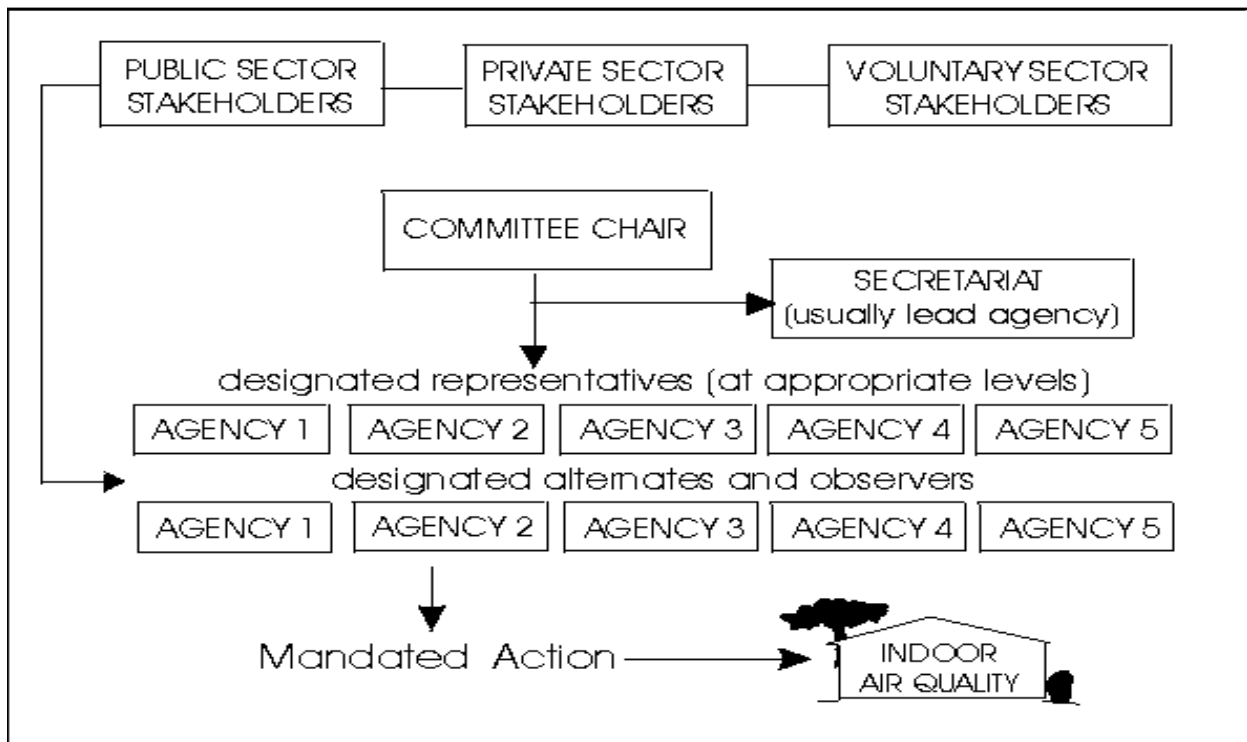


Diagram 4: Official Stakeholder Committees

intervals to carry out specific formal mandates, we envision Internet-based committed action networks of individuals interested in research, policy, design and operations.

The committed action network can be structured and maintained in such way that a high degree of communication is upheld continuously while people grasp, debate and negotiate solutions to problems in indoor environments.

Replacing dusty shelves filled with unread voluminous documents, interactive electronic databases are proposed to support the work of individuals involved in formal action committees and more informal “candleholder networks”. These databases must be well organized, up-to-date, well-indexed, easily searched, and economically accessible. Wherever appropriate, searchable databases and Web page technology can be combined to provide as much public access as possible, to maintain accountability, and to ensure sufficient expert scrutiny to guarantee that the process will evolve honestly and effectively over time.

The MVI strategy enables wider participation, more scrutiny, and more comprehensive viewpoints than traditional approaches to various aspects of the indoor environment issue. It proposes to utilize the latest electronic communications technology, thereby considerably reducing costs as compared to what traditionally would have been incurred to achieve such a high level of interaction and coordination. It proposes to make full use of existing legal structures and powers, but acknowledges that indoor environment problems are not the sole domain of any one group, agency or government department. It acknowledges the importance and power of individual human beings acting as catalysts for change in their own unique and creative ways, as well as the power of formally mandated action committees. We have seen forms of committed action networks that have worked reasonably well in the recent past (e.g., 1999 World Trade Organization meeting in Seattle) and view this as a cost-effective and flexible way for addressing indoor environment issues in Canada.

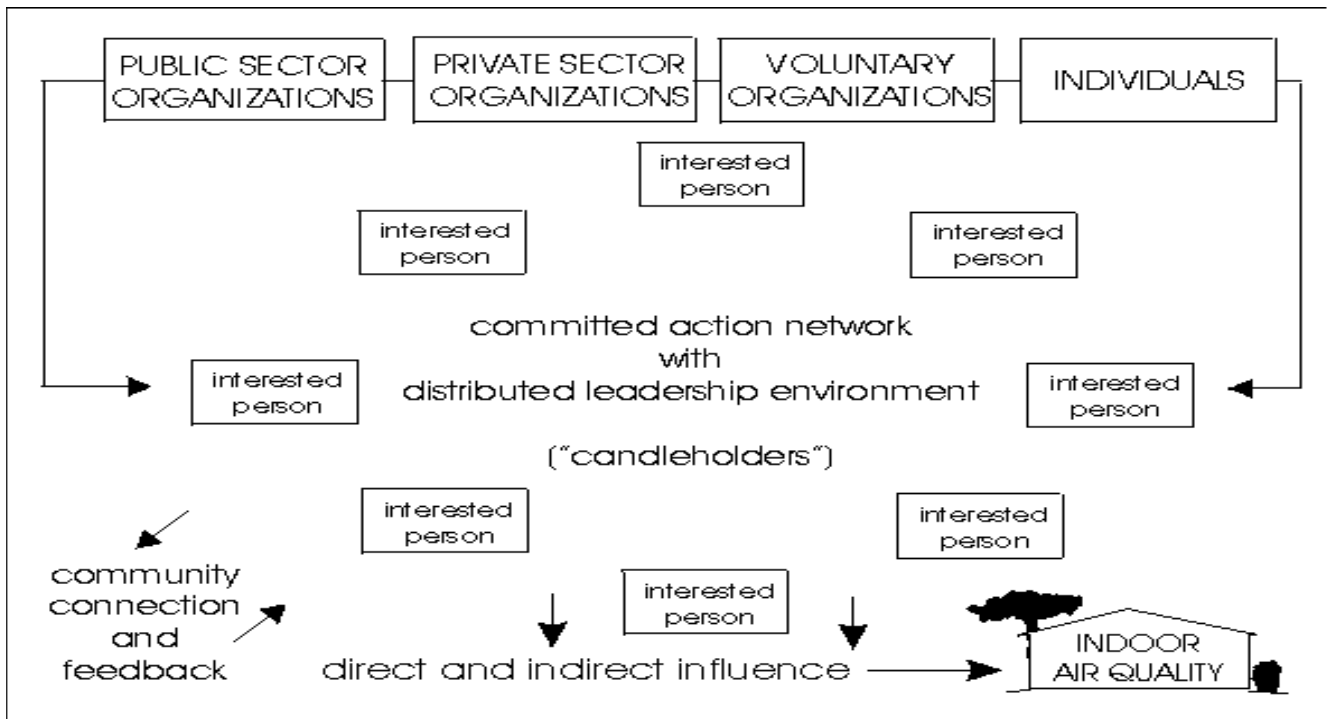


Diagram 5: C.A.N.D.L.Es

1.5 Conclusion

In the first section of the report, we concluded that the present state of indoor environments in Canada still leaves much to be desired. We concluded further that the present piecemeal approach was not sufficient to create adequate progress on problems as complex and inherently multidisciplinary as the indoor environment. Under the circumstances, we decided that not only is a new approach urgently needed, but that any new approach needs to depart significantly from old models and old assumptions. Furthermore, a new approach should be compatible with the most up-to-date physical and social world views and should take maximum advantage of the rapidly developing communication technology that is reshaping our entire social fabric.

In section 1.3 we describe a new voluntary approach that proposes a specific structure for addressing indoor air quality through “committed networks” of individuals from a variety of organizations and interest bases. This approach builds upon the existing legal structures and powers in Canada, and emphasizes a systems or integrated approach to indoor environment problems. It is structured like a network, using newly available Internet technology, and is designed to harness the leadership and initiative of individuals (“catalysts”) in many roles or organizations, while maintaining its stability independent of the participation of individual agencies and without requiring any one agency to play an overall line control or leadership role. It is meant to provide an open process subject to as much public access and expert scrutiny as possible, to promote an honest and effective evolution over time. While its overall emphasis is voluntary in approach, it can also utilize existing government, industry and other legal powers to enforce compliance with specific guidelines, standards, regulations or best practices wherever appropriate to maintain public health.

This new voluntary approach includes ways of introducing those aspects that have been lacking in the current approach to indoor environments (integrated approach, leadership, resources, accountability and wider participation). It is also designed to take full advantage of the new information technology that is widely available across Canada (including computers, e-mail and World Wide Web access through the Internet). It recognizes inherently that the problems of indoor air pollution and the health damage it causes are larger than what can be addressed by any one stakeholder involved in the issues. “committed action networks” provide a convenient low-cost vehicle for interested stakeholders to plug into and a forum wherein they can carry on their own responsibilities for healthier indoor environments with the support and collaboration of many others with related interests and responsibilities.

The new approach is by its very nature transitional. In the high-speed communications environment emerging in the twenty-first century, little is certain, and change takes place quickly. The authors are using “committed action networks” as a means of bridging between our present relatively ineffective situation, to a future situation, as yet undefined in any detail, wherein healthier indoor environments will have become reality. In the process, it is our hope that this approach will create better benchmarks for everyone to follow in creating and operating healthier buildings in Canada, as well as for tackling other complex multidisciplinary problems where progress needs to be accelerated. The authors of this report are confident that an MVI strategy will work better than the current uncoordinated approach to the indoor environment issue, provided that new communication structures are allowed to develop within the emerging electronic environment. Pollution Probe is applying this approach in the development of an indoor environment plan for Ontario schools and invites interested stakeholders to participate in the process.

Part II — Summary of Key Findings, Recommendations and Research Needs from Case Studies

In Canada, the number of voluntary initiatives targeted at indoor environments is quite small. One explanation could be the lack of public awareness (on the part of the medical community, parents, builders and operators for example) of the benefits of healthy indoor environments — a situation compounded by the dearth of research in the area. Another reason for there being few voluntary initiatives focused on IAQ might be the lack of policy to complement voluntary initiatives in general. Whatever the reason, it is clear that in most areas of this issue (with the exception, perhaps, of building science research) Canada is falling behind Europe and the U.S., which have each initiated a wide range of initiatives to address this issue.

Of the voluntary initiatives that do exist in Canada, Pollution Probe reviewed twenty case studies of initiatives designed to achieve healthy indoor environments. (Each initiative is described in detail in Appendix II.) These ranged from low-emission consumer products to healthy housing projects to processes focused on improving indoor environmental health. The initiatives have had varying degrees of success, and provide valuable insight into what is required to support future efforts in this area. Data for the case studies were acquired through literature reviews, Internet searches, and interviews with staff or others

familiar with the initiatives. To ensure the accuracy of the findings, the case studies were peer reviewed by experts in the areas of indoor environmental health, business and policy. This section provides a summary of the key findings, recommendations and research needs from the case study review.

The initiatives examined as part of the case studies have been organized into four categories: buildings, products, services and processes. Key findings of each category are discussed and recommended options for action are outlined. Findings and recommended options which span across more than one category are also examined.

2.1 Buildings

Canadians have pioneered the research and development of healthy and energy-efficient housing. Unfortunately, this knowledge is not typically applied to the way our buildings are designed, constructed or assessed for performance. For example, building assessments are rarely conducted in Canada. In contrast, 25 percent of the UK's commercial building stock has been assessed, resulting in documented benefits. As another example, Canadian voluntary housing initiatives such as Healthy Housing, EnviroHome, and R-2000 have captured only a marginal share of the market. In some cases, advancements have been lost due to opposition from the building industry. More work is needed to determine the appropriate mix of policy tools and other incentives that is required to support those voluntary initiatives that have been designed to ensure that our buildings are healthy and energy efficient.

2.1.1 Findings

The sectors described in the following tables are as follows:

C — Commercial

I — Industrial

R — Residential

Sector	Findings
C, I	Building performance assessments lead to improvements, but are under-utilized in Canada. In the U.K. for example, BREEAM has assessed over 25 percent of the office space constructed since its launch, has influenced training programmes, and has resulted in documented benefits. BREEAM and competing assessment systems have not been widely adopted in Canada outside of government buildings. Such initiatives require high-level government or industry support.
C, I	Fears of increased legal exposure may hinder voluntary management plans. According to the Building Air Quality Alliance (BAQA), the legal departments in many U.S. companies resist instituting indoor environment management plans because they fear the possibility of litigation by sick employees who discover that their buildings were supposed to be following specific plans of action regarding IAQ.
I	Healthy Classrooms have thrived and influenced board policy. The fact that healthy classrooms have remained operational, and have even proliferated in the current Ontario climate of budget cuts, is a testament to their success. The Waterloo eco-classroom, which has been studied internationally, has resulted in a new building approach for all new school buildings in the region. On an anecdotal level, students and teachers report feeling healthier and more attentive.
R	Healthy Housing initiatives have increased trade and consumer awareness and influenced standards/building code improvements. They have also been responsible for a small but significant increase in demand for the healthier products they require (e.g., low-emission building products, coatings and furnishings), particularly in the U.S. However, there have been few measurements of the health impacts of these homes.
R	The housing industry is starting to show interest in IAQ. This can be seen not only in the popularity of the healthy housing initiatives themselves, but also in the successful seminars that are being held on IAQ for industry professionals.
R, C, I	The benefits of healthier buildings are unclear to buyers and renters. Those responsible for buying and maintaining homes and other buildings have a limited understanding of the benefits of healthier buildings. In the commercial and multi-unit residential sectors this is further complicated by the fact that the bulk of benefits (such as increased health and productivity) directly impact those who rent the space, not those who build, buy or maintain it. Those who rent the space also have a limited understanding of the benefits of healthier buildings; until they demand healthier homes and workplaces there is little incentive for building owners and managers to make related improvements.

2.1.2 Recommended Options

Sector	Recommended Options
	<i>Initiatives that Drive Demand and/or Identify Suitable Buildings</i>
C, I	Support building performance assessment initiatives. Government and industry associations should endorse and promote the benefits of these programmes to senior decision-makers in the property development, management and insurance industries, and in the companies that use the buildings.
C, I	Require or encourage facilities over a certain size to develop and implement adequate indoor environment management plans. These plans should include inspection and maintenance components. A multi-stakeholder committee, composed of government, building industry and health organizations should look at the voluntary options, starting with public buildings. The voluntary option would likely require significant incentives in the short term, provided by both industry and government, and would need to address concerns about increased liability risks.
I	Support the organization and proliferation of school and other institutional initiatives such as <i>Healthy Classrooms</i>. Successful initiatives should be documented and then promoted among relevant stakeholder groups.
R	Establish a voluntary agreement that defines a “healthy house.” There are a variety of “healthy housing” products in the marketplace. Industry, government and relevant associations need to work together to establish healthy housing criteria — the elements which make a house healthy (i.e., products, materials, furnishings, coatings). This is needed to harmonize offerings and avoid dilution of the product. This effort may require supportive policy to prevent some conventional builders from marketing healthy houses that have not met industry criteria.
	<i>Research Needs</i>
R, C, I	Further quantify the productivity and other benefits of improving the quality of the indoor environment. It should be determined, for example, the savings that will result from a healthier commercial building, as compared to a traditional building, due to increased productivity, decreased sick days, decreased maintenance costs and increased life span of equipment. Similarly, the impact of healthy housing on building occupants should be documented.
C, I	Determine appropriate mix of policy and other incentives and components necessary to drive implementation of IAQ management plans.

2.2 Products

Consumer products, building materials and furnishings (“products”) can all pollute the indoor environment. A number of voluntary initiatives have been designed to lower the emissions of volatile organic compounds from these products into the indoor environment. Some, like Benjamin Moore’s Pristine Paints, have had limited market success (albeit profound impacts on the production of paint).

Others, like Interface’s low-emission carpet, have experienced solid growth. The popularity of product emission guidelines and labelling requirements in Europe could have an impact on Canadian exporters in the future.

Labelling requirements that disclose material data (e.g., emissions, product constituents, health information) have led to product improvements. In addition, the testing procedures used to grant labels have been applied by industry to

improve their products. The Danish Labelling Program (ICL) has received strong government support and is recommended by the Danish national building code. The Canadian Envirodesic programme has received much less government support, and involves fewer products and a

smaller share of the market. More effort needs to be made by regulatory authorities and industry to research, prototype and market new or improved products that reduce emissions or otherwise significantly reduce indoor pollution.

2.2.1 Findings

Sector	Findings
R, C, I	Improvements have been made by industry. Some industries (e.g., paints) have dramatically reduced the emissions of volatile organic compounds from their products.
R, C, I	Labelling leads to product improvement, but is under-utilized in Canada. Labelling requirements that disclose material data (e.g., emissions) have led to product improvements. In addition, the testing procedures used to grant labels are often used by industry to improve products. The Danish Labelling Program (ICL) has received strong government support, and is recommended by the Danish national building code. The Canadian (Envirodesic) programme has received much less government support, and involves fewer products and a smaller share of the market.
C, I	Procurement policies encourage industry involvement. In the U.S., federal agencies follow environmental guidelines in the procurement of products and services, and these incorporate some indoor environment considerations. Many states and local governments have followed suit. Industry has responded by providing the environmental products and services that are being demanded.
I	Public awareness can drive voluntary approaches in schools. Public support and action has been key to the adoption of a scent-free policy in a number of schools across Canada. These programmes, largely found in Nova Scotia, have been adopted without supporting government policy or enforcement mechanisms, and have supported the growth of manufacturers supplying scent-free products. However, other institutional indoor environments (e.g., recreational skating rinks and libraries) have been slow to implement such initiatives.
R, C, I	Voluntary initiatives influence industry practices. Voluntary product reformulations that result in low-emission products tend to influence suppliers of product components or materials (e.g., paint, carpet and adhesives) to improve their practices.
R, C, I	The indoor environment benefits of low-emission products are unclear to buyers. Buyers have a limited understanding of the impact that product emissions can have on the quality of the indoor environment.
R	The consumer market for products that improve indoor environments is currently small in Canada. Except in niche markets, product differentiation based on indoor environmental performance does not seem to influence consumer purchasing decisions.

2.2.2 Recommended Options

Sector	Recommended Options
	<i>Initiatives that Drive Demand</i>
I	Support the organization and proliferation of school and other institutional IAQ initiatives. Public interest health and environment organizations should document successful initiatives, and promote them among relevant stakeholder groups. Governments should financially help and support these interest groups to ensure that parents, students, teachers and others have access to information on the health impacts of the products being used in their buildings.
C, I	Integrate indoor environment considerations into environmentally preferable procurement protocols. A model protocol that can be used as a guideline for modifying existing protocols should be developed. Governments and other large purchasers could endorse and support this effort by participating in its development, and by committing to implement it.
R, C, I	Recommend the use of labelled products in the Model National Building Code. The ICL is recommended in the Danish national building code. Such an inclusion in the Model National Building Code would raise the profile of indoor environments and possibly contribute to public buy-in. However, in order to accomplish this in Canada, a more inclusive approach to product labelling, covering more available products, would need to be developed.
	<i>Initiatives that Identify Suitable Products</i>
R, C, I	Support Canadian product labelling initiatives. Labelling initiatives, such as Envirodesic, should be promoted both to buyers and to potential suppliers (e.g., government, participating manufacturers).
R, C, I	Develop a database of targeted products that meet minimum off-gassing or other health criteria. Lists of these products could then be distributed to industries, government, schools etc., interested in purchasing and using these products.
	<i>Initiatives that Drive Supply</i>
R, C, I	Create incentives for industry growth. Provide potential solution-providers with Funding support/tax incentives and technical assistance for researching, prototyping, and marketing new or improved products that reduce emissions or otherwise significantly reduce indoor pollution.
	<i>Research Needs</i>
R, C, I	Commit resources to conduct further research. Research should be conducted on the concerns, causes, health effects and abatement strategies for pollutants released by personal care products, cleaning products, and building/maintenance products. The federal government, manufacturers and national public interest organizations could play a role in informing the general public of the results.

2.3 Services

There are surprisingly few indoor environment voluntary initiatives underway in the service sector of the economy (e.g., duct cleaning, carpet maintenance, housekeeping). This gap is made worse by the lack of certification or codes of practice for those that do exist. As a result there

is very little protection for consumers and no regulations preventing false claims related to indoor environment improvements from services. The service industries and appropriate government agencies need to work together to develop an appropriate set of policy tools (e.g., incentives, quality assurance criteria, codes of practice, certification) for this sector of the market.

2.3.1 Findings

Sector	Findings
R, C, I	There is little protection or quality assurance for purchasers. There are no regulations in Canada preventing false claims from being made related to indoor environment improvements from services (e.g., duct cleaning, carpet cleaning).
R, C, I	Certification programmes and codes of practice lead to quality assurance. The process of certifying service providers raises performance standards. Certification can also lead to the implementation of regulated licensing requirements to ensure minimum quality assurance to customers. However, with a few notable exceptions, including the National Air Duct Cleaners Association, certification and codes of practice have not been developed for indoor environment services. In addition, no certification process exists for indoor environment professionals.

2.3.2 Recommended Options

Sector	Recommended Options
R, C, I	Develop quality assurance certification programmes/codes of practice for targeted services (e.g., carpet cleaning). These should be created through multi-stakeholder processes led by the service organizations involved.

2.4 Processes

Multi-stakeholder consensus-building processes related to indoor environment issues have been used infrequently. The Material Emissions Task Force (1994 – 1998) was one of the last major face-to-face multi-stakeholder processes related to indoor environments in Canada. In contrast, the U.S. EPA has initiated several multi-stakeholder processes related to a variety of indoor environment issues, such as product emissions, schools and issue strategy. In Canada, public

access and input to building code development or the establishment of IAQ exposure guidelines at the federal and provincial level is virtually nonexistent. More effort needs to be made by responsible federal and provincial agencies to establish processes to address the various aspects of indoor environmental health (e.g., standard setting, product emission guidelines, labelling, codes of practice).

2.4.1 Findings

Sector	Findings
R, C, I	Measurable objectives track success of programme. Many voluntary initiatives lack the tools to measure their success — making it difficult to track progress. The Indoor Environment Program adheres to the ‘Government Performance and Results Act’ (GPRA), which requires that all federal agencies set measurable Outcomes and goals to track progress. Establishing clear goals and benchmarks — such as 15% of U.S. schools using the ‘Tools for Schools’ kit by 2005 — allows the IEP to gauge its success. Note, however, that this indicator does not measure the health or environmental improvements from a programme.
R, I	National networks serve as a vehicle to educate schools, parents. Major credible networks, such as the EPA’s Indoor Environment Program, can work on a national scale to disseminate important information to schools and parents regarding the health effects of indoor contaminants.
R, C, I	Inter-governmental committees have succeeded in developing national guidelines. Such committees developed the Emissions Guidelines for Residential Indoor Air Quality (1987) and IAQ in Office Buildings: A Technical Guide (1993). However, the latter guide does not suggest target levels for indoor pollutants; the former sets targets that are appropriate for healthy adult males and not for ‘high risk’ individuals such as children.
R, C, I	Few multi-stakeholder processes exist in Canada. The Material Emissions Task Force was one of the last major face-to-face multi-stakeholder processes related to indoor environments in Canada. The National Housing Research Committee has recently enabled any interested party to comment on needs for housing research through its Web site. However, to date, this process has engaged few participants.

2.4.2 Recommended Options

Sector	Recommended Options
R, C, I	Establish inter-governmental committees to update and expand the use of national guidelines, such as <i>Emissions Guidelines for Residential Indoor Air Quality and IAQ in Office Buildings: A Technical Guide</i>. Such committees should include multi-stakeholder (e.g., non-government) representation. They should provide target levels for indoor pollutants, and should address the needs of “high-risk” individuals such as children, rather than only healthy adult males. In addition, the committee could recommend how guidelines can be actively promoted and used for more than only educational purposes (e.g., how to use guidelines as a basis for IAQ management plans in public buildings).
R, C, I	Establish methods for measuring success. There is a need to develop reliable methods of measuring success of initiatives relating to improved health. In schools for example, success of initiatives is largely anecdotal. More work is required to measure and quantify the effects that a healthier indoor environment has on students (e.g., fewer sick days, better academics, improved attention span) and people in other settings.

2.5 Cross-cutting Findings and Recommendations

Several “cross-cutting” themes emerged from the case studies. These included: senior level commitment toward the voluntary initiative, the importance of engaging health professionals and significantly increasing research efforts on various aspects of the indoor environment.

Research for example, is needed to quantify the costs and benefits of improving indoor environments. As the financial benefits, relative to costs, become associated with healthy indoor environments — increased demand for these buildings should result. Thus, more research is needed to better define the relationship between our indoor environment and human health.

2.5.1 Findings

Sector	Findings
R, C, I	Costs and benefits are rarely measured. There have been limited attempts at defining the costs and benefits associated with healthier indoor environments. For example, the benefits associated with reduced absenteeism, improved productivity, and reduced medication use have not been measured in a uniform manner, if at all.
R, C, I	Medical professionals need to be more fully engaged. Health professionals need information and training to help them diagnose and treat indoor environment-related illness.
C, I	There are many unknowns related to certain indoor environments. Little if anything is known about certain indoor settings and their impact on occupant health. For example, very little is known about the indoor environments in vehicles. This knowledge gap is particularly significant for multi-use institutional, commercial and commuting settings where use and occupant composition fluctuates widely (i.e., seniors, children, people living with asthma and allergies).
R, C, I	Senior level commitment is vital to voluntary initiative success. CEO or minister level commitment to indoor environmental health is critical to initiatives as diverse as low-emission carpeting, healthy housing, building rating systems and exposure guidelines. Motivation for this commitment varies significantly among sectors and includes public pressure/demand, profit, and personal interest or concern for healthier indoor environments/sustainability. One of the barriers for the building sector, for example, is the divided responsibility between owners, operators and occupants.
R, C, I	Partnerships are key to the success of voluntary initiatives. Partnerships consisting of relevant stakeholders ensure the relevance and success of voluntary initiatives. Successful initiatives such as labelling schemes, healthy housing, scent-free initiatives and product procurement guidelines all involve the input of strong networks of partners — each of which benefit from the success of the initiative.

2.5.2 Recommended Options

Sector	Recommended Options
R, C, I	<p>Create a standard set of indoor environment “health indicators” that can be used to gauge the “health value” of all elements of the indoor environment. This approach is used in other disciplines to measure complex outcomes from many contributing factors (e.g., quality of life and standard of living indicators), and in some building performance assessment systems. A multi-stakeholder group headed by a health authority and including government, industry and other public interest organizations should design these indicators. Such a standardized set of indicators would allow for comparisons of different materials as well as allow for the calculation of the overall health of buildings. These indicators should be harmonized with similar efforts taking place internationally.</p>
R, C, I	<p>Develop a health database focused on indoor environments. A database should be developed to provide information on health issues related to indoor exposures, frequency of complaints and problem buildings to assist diagnosis and treatment.</p>
R, C, I	<p>Conduct more research into the impacts of low pollutant levels on human health. Dose/response data related to low-level concentrations of pollutants in the indoor environment require clarification. The impacts of moulds and fragrances should be included.</p> <p>There is a dearth of knowledge about environmental sensitivities and the ways that different environmental factors can impact on health and behaviour. This lack of knowledge is often cited as a main factor slowing progress in the area of creating healthy indoor environments. There is also a need to develop acceptable methods of assessing whether someone is environmentally hypersensitive and what constitutes a healthy or unhealthy environment.</p>
R, C, I	<p>Develop a cost-benefit measurement system. Industry and government need to develop better models and tools for accurately measuring the costs and benefits associated with indoor environments (e.g., for quantifying the financial cost of lost productivity due to poor IAQ).</p>

2.6 Conclusions

Voluntary initiatives have played an important role in advancing indoor environmental health in Canada. They have introduced low-emission products, raised awareness about IAQ, demonstrated healthy housing and led to the development of a new sector of the economy (see Part IV, Characterization of Canadian Indoor Environment Industries). Unfortunately, the overall impact has been small. One of the major challenges facing each of the categories (buildings, products, services and processes) is the fact that there is little data on the costs and benefits associated with healthier indoor

environments. One common finding from most of the case studies was that performance is rarely measured in a uniform manner. A dedicated effort needs to be made by government, industry and other key stakeholders to develop a standard set of indoor environment “health indicators.” Such a standardized set of indicators would allow for comparisons of different materials as well as for the assessment of the overall health of buildings. These efforts should be harmonized with similar efforts taking place internationally.

Part III — Summary of Legal Aspects of Indoor Air Quality

This summary of the legal aspects of indoor environment issues is based upon a report prepared by Joseph Castrilli for Pollution Probe entitled, *Legal Aspects of Indoor Air Quality in Canada*. The entire report can be found in Appendix III, and should be referred to for a detailed analysis of the constitutional, common law and legislative frameworks pertaining to indoor air pollution in Canada.

The legislative and legal system in Canada has largely ignored issues related to indoor pollution. A complex distribution of authority between federal and provincial levels of government has, with the exception of workplace occupational health and safety, resulted in little or no legislation targeted at residential, commercial or institutional indoor environments. In theory, if the federal government believed that indoor air posed a significant risk to health, it could use its constitutional authority in criminal law to develop legislation in this area. However, because the provinces have legal authority over some aspects of the issue, an integrated federal-provincial approach to the issue may be the most effective way of addressing indoor pollution in Canada.

3.1 Constitutional Authority — Division of Powers

The Canadian Constitution distributes the legislative basis for environmental regulation between the federal and provincial governments. With respect to division of powers, the constitution grants spending power to the federal government. In theory, Parliament could spend or lend funds to any government, institution or

individual it wishes, for any purpose it chooses, and may attach to any grant or loan any condition it chooses, including conditions it could not directly legislate. Under this provision, any federal agency with the proper statutory enabling legislation could provide conditional loans or grants to the provinces for the construction of buildings (e.g., houses, schools, hospitals) that took into account the need to control indoor air pollution.

3.2 The Charter of Rights and Freedoms

The Charter of Rights and Freedoms entrenches certain fundamental liberties in the Canadian Constitution by limiting the right of government to interfere with those liberties, except to the extent that government can show that such interference is demonstrably justified in a free and democratic society. Under Section 15 of the charter “every individual is equal before and under the law and has the right to the equal protection and equal benefit of the law without discrimination and, in particular, without discrimination based on sex, age or physical disability.” It is possible that federal or provincial laws, programmes or activities that protect the average Canadian, but that fail to protect women, children, the elderly, or those suffering from special chemical sensitivities in the indoor environment context, might run afoul of the charter’s equality rights provision.

3.3 Common Law

Common law (judge-made law) may also provide a basis for providing relief to those who have suffered damage or injury as a result of exposure to indoor air pollutants. In the context of this discussion, students, tenants and patients could all be potential plaintiffs. Potentially liable parties may include owners, architects, contractors, manufacturers and engineers. The

liability of these defendants may arise in tort or contract law. However, proving causation and avoiding other litigation pitfalls may be difficult for injured plaintiffs.

3.4 Negligence and Product Liability

There are a number of tort theories of liability that may be available to plaintiffs who have been injured by indoor air pollutants. While there have been few reported judgments in Canadian courts to date regarding liability for indoor air pollution, tort theories of liability are available to address problems where they arise. The theories of liability applicable to indoor environments include negligence and product liability.

Negligence is conduct that breaches a standard of care owed to a person who is harmed by that conduct. The elements to be proved by the plaintiff include (1) the plaintiff is within a class of persons to whom the defendant owed a duty of care; (2) the defendant's conduct fell below the standard required of a reasonable person engaged in the particular activity; and (3) foreseeable damage (i.e., damage that is not too remote and that is caused in fact by the conduct) resulted from the breach of duty.

Negligence also is available against public authorities where harmful conduct is approved or where agency officials fail to take steps to prevent harm where they know or ought to have known that harm would result. This may be particularly relevant to schools, since principals and school boards owe a "duty of care" to the students, and failing to address indoor environment problems could constitute negligence.

Where manufacturers, processors, sellers, or others make products that injure the person or property of a buyer or a third party, they may be liable in negligence. The negligence theory of

product liability is similar to ordinary negligence law in that the liability of a defendant often will hinge on whether there has been a failure to meet an appropriate standard of care. Builders could be liable, for example, if it were shown that failure to take reasonable care in constructing a home, school or hospital resulted in defects that posed a substantial danger to the health and safety of the occupants. The standard of care associated with product liability also includes a duty to warn potential consumers of the danger associated with the use of the product. Providing a warning, however, does not exonerate a manufacturer from the obligation not to manufacture a defective product in the first place. In Canada, product liability law, therefore, is based upon a showing of fault; that is, manufacturers and others have a duty to use reasonable care in producing products.

Overall, product liability provides a potentially strong legal basis for imposing liability on a wide array of defendants responsible for creating indoor air pollution problems, though highly complex problems of scientific and medical proof still must be overcome to succeed under this cause of action. This issue is made more challenging by the prohibitive expense and complexity of civil litigation. Moreover, in civil litigation in Ontario unsuccessful plaintiffs not only have to pay the costs of their own lawyers and experts but also a portion of such costs incurred by successful defendants. This can have a chilling effect on the ability and willingness of victims to take on such litigation. On the other hand, civil litigation may be the only way to raise legitimate problems and achieve a remedy where government agencies have failed to act. It can also heighten the profile of the IAQ problem with the public, the legislature, and the media, and provide a decision-making forum less prone to political pressures.

Several provinces now authorize class actions or proceedings, whereby numerous persons having a common interest and injury may combine to sue a defendant(s) for damages in a single

action. This measure may permit plaintiffs to offset the often prohibitive costs of lawyers and expert witnesses associated with civil litigation by combining resources for a case. By redressing injuries sustained from indoor air pollution, filling gaps in the legislative regime, and providing a stimulus to the development of more comprehensive legislative schemes, civil litigation can make a meaningful contribution to solving the IAQ problem in Canada.

3.4.1 Existing Legislation

There is a wide range of federal and Ontario legislation potentially applicable to indoor environment issues. The range includes laws pertaining to toxic substances, energy conservation, health promotion and protection, human rights, housing, building codes, product safety, radiation protection, occupational health and safety, workers' compensation, pesticides and tobacco control. The diversity of laws relevant to indoor pollution is matched by the wide variety of ministries, departments and agencies at the federal, provincial and municipal levels of government administering various pieces of legislation. This wide mix of legislative authority has frequently resulted in fragmentation, conflicting mandates and little progress in advancing healthy indoor environments in Canada. This supports the need for a lead agency responsible for the indoor environment issue.

3.5 Recent Parliamentary Attempts to Legislate Progress

Recently, there have been several unsuccessful private members' bills relating to IAQ. Each focused on the need for research, public education and standards, as well as providing authority to one agency. All of the bills, however, demonstrated a cautious and limited view of the scope of federal jurisdiction in this area. The proposed national standards on IAQ only would apply nationally, for example, if provincial governments entered into agreements with the federal government to adopt them as law in their respective jurisdictions. The bills appeared to rely on federal spending power to act as the prime inducement to provincial legislative action, but left unstated what would happen if the provinces did not enter into agreements with the federal government to legislate on the IAQ issue.

As drafted, the bills had the potential to accumulate federal research, development and education, but remained silent on federal regulatory intervention, except perhaps for federal public property, institutions and workplaces. Neither the bills, nor the parliamentary debates on them, explored an independent federal role — perhaps based on the criminal law power pertaining to health — should the provinces, for whatever reason, fail to act. However, had this piece of legislation been passed, it would have been the first step toward a national strategy on indoor environments in Canada.

3.6 Findings

Sector	Findings
R, C, I	<p>There is an absence of legislation specifically focused on indoor environments. With few exceptions, such as the workplace environment, there is little or no legislation that explicitly addresses the control of indoor air pollution in residential, commercial or institutional indoor environments. The legal system in Canada has largely ignored the problem of indoor air pollution. Moreover, where legislation does exist, the standards that have been developed cover few substances of concern.</p>
R, C, I	<p>No level of government is responsible for indoor environments. A wide variety of government ministries, departments and agencies have partial responsibilities for some aspects of the indoor environment, but none have the legislative authority or accountability to act.</p>
R, C, I	<p><i>Criminal law provides the constitutional authority for federal legislation.</i> Given the health risks posed by indoor pollution, the primary constitutional authority for federal legislation in this area is criminal law. Health threats such as environmental tobacco smoke, toxic substances and hazardous products are matters that the courts have viewed as capable of justifying resort to the criminal law power to support federal legislation. Health Canada, for example, could use this regulatory authority to require product labelling on consumer products, building materials, furnishings and other materials that may pose a risk to human health and pollute the indoor environment.</p>
R, C, I	<p>Provincial legislatures can legislate to improve indoor environments. Provincial governments can make laws based on “property and civil rights.” This power is regarded as the most important head of provincial power and is the authority for supporting enactment of environmental legislation. This would be the primary basis for supporting the constitutionality of indoor air pollution legislation. This authority might constitute the basis for the development of provincial indoor air pollution legislation in the future. Similarly, the provincial head of power relating to municipal institutions in the province could permit the provinces to amend existing, or enact new, provisions under municipal legislation that would allow municipalities to implement delegated authority from the provinces to control indoor air pollution in specific settings at the local level.</p>
R, C, I	<p>Common law (judge-made law) provides a basis for providing relief to those who have suffered damage or injury as a result of exposure to indoor air pollutants. Liability may arise in tort or contract law, and may include owners, architects, contractors, manufacturers and engineers. Proving causation and avoiding other litigation pitfalls are significant barriers for injured plaintiffs. While there have been few reported judgments in Canadian courts to date regarding liability for indoor air pollution, tort theories of liability, including negligence, products liability, fraud and misrepresentation, and to a lesser extent strict liability and battery, are available to address problems where they arise.</p>
R, C, I	<p>Parliament has recognized that indoor air pollution is a problem. Parliamentary debates over private members’ bills on indoor air pollution have recognized the importance of the problem. The consensus ended, however, with respect to whether programmes already in place were adequate to address the problem.</p>
R, C, I	<p>Federal spending power could be used as leverage to create healthy buildings. This power enables Parliament to spend or lend funds to any government,</p>

3.7 Recommended Options

Sector	Recommended Options
R, C, I	<p>Assign lead responsibility for indoor environment issues to Health Canada. Health Canada should be assigned responsibility and accountability for indoor environment issues. Health Canada should be given the authority to (1) conduct research and studies into all aspects of indoor air contamination including causes, sources, effects, extent, detection, control and abatement; and (2) develop methods, technologies or processes for the detection, correction or prevention of indoor air contamination. The Minister of Health should have the authority to (1) formulate comprehensive plans and designs for control and abatement of indoor air contamination, establish demonstration projects and publicize and make these projects available for demonstration; (2) promote, through public education and discussion, an awareness of the hazards of indoor air contamination to human health; and (3) develop and disseminate informational materials relating to indoor air contamination that would serve to inform the public concerning all aspects of the quality of indoor air and of the control and abatement of indoor air contamination. Health Canada should be given the lead to co-ordinate federal and provincial activities related to the indoor environment because it has the legislative authority (e.g., Hazardous Products Act, Pest Control Product Act, Tobacco Act, <i>Exposure Guidelines for Indoor Air Quality</i>, Canadian Environmental Protection Act) to take action. Second, Health Canada has previously shown leadership around the issue, by chairing federal-provincial working groups on IAQ, producing educational guides and funding research in the area of indoor environmental health. Third, three recent private members' bills and motions on IAQ identified Health Canada as the appropriate federal agency for developing a coordinated response to the indoor environment issue. Coordinated activities might include research, standard setting, code development and communication.</p>

Part IV — Characterization of Canadian Indoor Environment Industries

This chapter is based on work conducted by Cullbridge Marketing and Communications and funded by Industry Canada, Canada Mortgage and Housing Corporation and the Ontario Government's Green Industry Office, as presented in the publication *Characterization of the Canadian Indoor Environment* (December 22, 1994). That work involved a literature review, expert interviews, and a self-administered survey responded to by three hundred qualified Canadian companies. This section provides an overview of the indoor environment industries, and recommendations for advancing sector growth. The entire report is available from kassirer@cullbridge.com.

- What sorts of products and services are available for creating healthier indoor environments, and what drives the businesses that provide them?
- Is there a viable market for them? In Canada, or abroad?
- Is Canada missing its window of opportunity for gaining international market share?
- What can be done to support Canadian suppliers?

4.1 Turning Our Challenges into Opportunities

Canadians have learned to tighten up building envelopes in order to reduce heating costs. However, we have been slower at learning to ventilate better and to minimize sources of indoor pollution. The resulting indoor pollution problems are challenging. At the same time, they

are spawning the development of new or improved products and services that promote healthier indoor environments.

There are two major types of market opportunities presented by these products and services:

1. **Improved international competitiveness and standard of living** — Indoor pollution contributes significantly to poorer health, increased absenteeism and decreased productivity.³⁹ Conversely, healthier indoor environments can reduce the associated productivity losses and health-care costs. Development and implementation of these products and services can help make Canada more competitive internationally, and can help raise our standard of living. For more detail, please see the section below on market drivers.
2. **Export opportunities** — Canada has been a world leader in recognizing the problems associated with indoor pollution, and in developing and implementing solutions. Many of our companies are well positioned to respond to the growing international demand for these products and services, as is evidenced by their export performance. However, other countries are not standing still. Canada has a window of opportunity to build on its lead and capture a significant share of this growing world market.

4.2 Industry Overview

The companies that make up the indoor environment industries provide technologies, processes, products and services which

- monitor and assess the nature and pathways of indoor pollutants and waste streams;
- prevent indoor pollution by minimizing or eliminating sources of indoor pollution;

- control indoor pollution, for example by ventilation and filtration; and/or,
- clean up and restore indoor environments which have been degraded, including such services as asbestos removal and the remediation of sick buildings.

This sector is multidisciplinary in nature and involves a number of industries that may have previously been considered separately. It draws together some emerging industries (e.g., electronic devices for measuring gas and particle levels) with more traditional ones (e.g., the building, building design and consulting engineering industries), spawning the development of new products and services (e.g., intelligent building ventilation systems) and the improvement of already existing ones (e.g., low-emission adhesives, paints and carpets).

4.2.1 Company Groupings

These various companies can be grouped, according to the products and services they provide, as follows:

Low-pollution Building Products, Materials and Technologies

- HEPA, near-HEPA and central vacuum cleaners
- low-emission adhesives
- low-emission carpets
- low-emission cabinets and vanities
- low-emission hard flooring
- low-emission paints, sealers and varnishes
- low-emission wall coverings
- other emission wood products
- low-pollution prefabricated modular housing units
- new technologies for keeping buildings dry and mould-free

Ventilation, Air Conditioning, and Air Filtration Equipment and Systems

- air conditioners
- air exchangers
- air purification media
- air louvres, grilles and diffusers
- ceiling and bathroom exhaust fans
- other fans
- dehumidifiers
- differential pressure (VAV) valves
- duct work
- heat recovery ventilators (HRVs)
- humidifiers
- range and fume hoods
- stand-alone (room) air purifiers and filters
- system (building) air purifiers and filters
- ventilators and parts
- flotation/air purification media, including catalysts for removal of specific pollutants
- workstation ventilation control units
- other low pollution HVAC systems

Healthier Lighting Systems

- filters for lighting and for computer monitors
- full-spectrum lighting
- high-frequency fluorescent lighting

Inspection, Monitoring, and Control Equipment and Systems

- do-it-yourself test devices for home and industrial, commercial and institutional (ICI) markets
- equipment for measuring and balancing air flow
- exposure monitoring badges
- measuring devices, on-line sensors and test kits
- related data logging systems
- smart HVAC control systems that process information from on-line gas sensors

Related Services

- commissioning of buildings
- decontamination of polluted soil around buildings
- healthier building design and engineering services
- legal services and expert witnesses specializing in indoor environments
- marketing and communications services specializing in the indoor environment industries
- other related research services
- related laboratory services
- related education and training
- remediation of IAQ problems
- screening of cleaning and maintenance products
- screening of products and materials used in construction and renovation
- “sick building” diagnosing services

4.3 Size and Growth

According to our study, the Canadian indoor environment industries employed more than five thousand people in 1993, and had annual revenues of more than a billion dollars, growing at rate of about 10 percent a year.⁴⁰ At \$330 million, exports represented about one third of these revenues, and were growing at a rate of about 25 percent per year. Three years later these exports had increased to about \$570 million and continue to grow quickly at about 28 percent per year.⁴¹ For more detail on specific market segments, please refer to the full report.⁴²

4.4 Market Drivers

The following drivers are fuelling the growth of the indoor environment industries as a whole.

4.4.1 Regulations

As with most of the environmental industries, regulations are a key driver for expansion in this sector. Examples of pertinent regulations include:

Building codes. Ontario used to require the installation of heat recovery ventilators in all new electrically heated houses. Ontario also requires carbon monoxide detectors in all new dwellings with a working fireplace.

City ordinances/by-laws. The cities of Chicago and Kingston, New York require carbon monoxide detectors in all residences.

Note that while prescriptive regulations may be a powerful driver of product and service revenues, the more prescriptive the regulations are, the more new product innovation is

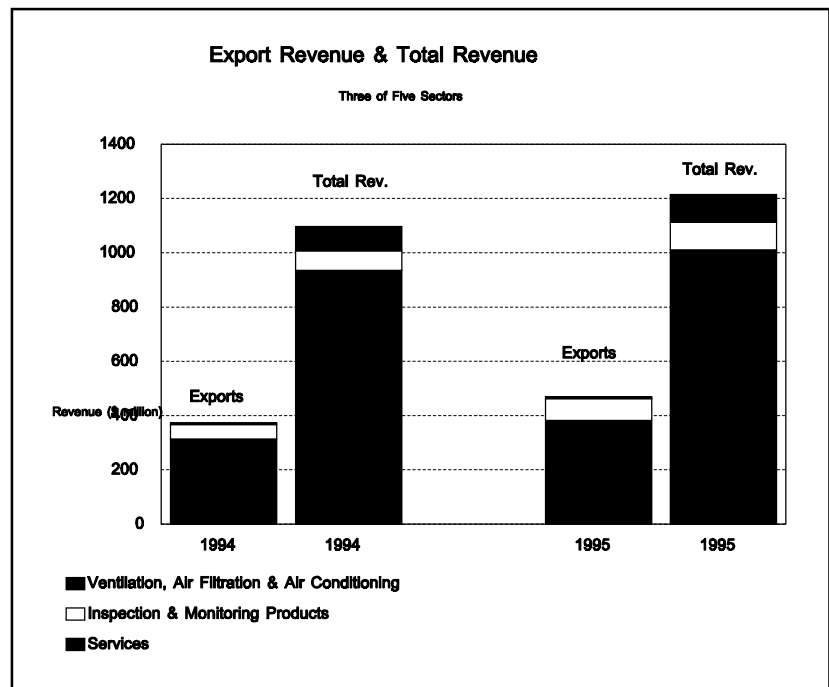


Diagram 6: Export Revenue & Total Revenue

discouraged. In contrast, regulations that are less prescriptive, for example those based on performance standards, leave more room for innovation.

As an example, the requirement to have a carbon monoxide detector in every residence is largely performance based; any type of equipment that will reliably alert residents to dangerous levels of the gas (i.e., that meet certain accuracy and sensitivity requirements) would meet the performance criterion.

As another illustration, the *Exposure Guidelines for Residential Indoor Air Quality*, issued by Health Canada, are primarily performance guidelines in that they allow, for example, the formaldehyde criteria to be achieved through any combination of source emission reductions, ventilation and air cleaning.⁴³ In applying such performance standards, manufacturers could be required to establish and identify the emission rates of certain listed chemicals (or chemical categories, as with total volatile organic compounds). Building designers would then be able to choose an appropriate mix of building products, ventilation systems and air cleaning processes that would meet the required performance standards.

In contrast, a more prescriptive approach would be to set specific formaldehyde emission criteria for various building products and furnishings (e.g., particleboard). Similarly, Part 9 (the housing section) of the Canadian National Building Code is mainly a prescriptive standard. It is simple to apply, and eliminates the need for any design work by the builder. However, as an engineer's stamp is required for any alternative approach to be passed by a building inspector, it also restricts innovation to those who are willing and able to spend more money than the competition.

4.4.2 Guidelines and Product Labelling Programmes

Guidelines set by professional organizations. The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) sets ventilation standards that are recommended professional practices, and that are widely adhered to across North America. If a ventilation company were to be taken to court as a result of an indoor health issue, the company would be on good grounds if they had followed the ASHRAE standards. If they had not, they would likely have to justify the alternative that they had followed.

ASHRAE standard 62 is in the process of being revised. The new version may better define options for taking the design route (as opposed to following prescriptive measures). This would stimulate increased demand for design and testing products and services.

Guidelines and specifications set by purchasing, architectural and engineering departments of businesses and government organizations. An increasing number of governments, institutions and large corporations, are rewriting their guidelines and specifications to require or give preference to products and services that promote healthier indoor environments. Often this is part of an overall initiative to exercise environmental stewardship.

The Ontario Realty Corporation's Environmentally Conscious Building Design Guidelines. These guidelines state that

- furnishings and finishings will be selected to produce a minimum of off-gassing;
- data from manufacturers on off-gassing of their products will be requested prior to selection;

- building automation systems with carbon dioxide detectors will be used to control adequate flow of fresh air to buildings; and
- the amount of control exercised by the occupant of his/her local microclimate will be maximized.

Product labelling. The U.S. and Canadian Carpet Institute have introduced a carpet labelling programme that indicates those carpets that meet certain emission standards. Similarly, the Environmental Choice Ecologo identifies those paints that meet certain standards for volatile organic compound emissions. Perhaps the strongest drivers of this type are labelling programmes that provide a rating system. Germany, for example, required its particleboard manufacturers to label their boards as low, medium or high emitters of formaldehyde. Other variables that can be handled in this manner include dust and fire hazards, and susceptibility to mould.

4.4.3 Requirements of Other Certification Programmes

ISO 14000 requires companies to conduct and keep records of periodic environmental audits, which must address certain aspects related to indoor environments.

The Canadian R-2000 programme has been one of the key drivers of the growth of heat recovery ventilators (HRVs), since these are currently the only practical and widely available products that meet the programme's ventilation and energy requirements.

4.4.4 Requirements by Insurance and Mortgage Companies

Phase one environmental assessments are often required by mortgage and insurance companies in North America before they will finance or insure larger buildings. Some require a more thorough investigation of potential indoor

environment pollutants. These services assess the likelihood of problems recurring with certain pollutants. As a result they often raise indoor environment issues that require further investigation and/or remediation.

4.4.5 Legal Liability

Recent lawsuits in the U.S. have imposed multi-million-dollar damage awards on manufacturers, building design professionals and others whose actions contributed to an indoor pollution problem.

These legal actions have involved, for example,

- exposure to specific materials or products deemed to cause health problems, such as asbestos, environmental tobacco smoke, and gasoline and oil leaks around and under basements;
- faulty building designs;
- inadequate building equipment;
- inadequate building and equipment maintenance; and,
- inadequate clean up after a sewer backup, flood or fire.

In addition, recent changes in some jurisdictions have made it easier to press charges. Ontario residents can now file related class action suits with the assistance of lawyers paid on a contingency fee basis. Because these suits can not be settled out of court once they have been filed, defendants are likely to take complaints more seriously than in the past.

The best preparation for possible court actions of this sort is to be able to show that due diligence has been taken, in accord with accepted professional practices, in an effort to pro-actively avoid the problems. This approach to risk management is starting to drive an increase in related proactive measures — such as

low-pollution design, adequate commissioning and ongoing monitoring programmes — by building owners and managers, builders, design professionals and manufacturers.

4.4.6 Perception of Market Demand for Better Indoor Air Quality

Developers, builders, building owners and managers, and manufacturers, among others, are becoming aware of the growing market demand for healthier indoor environments, and an increasing number are beginning to respond accordingly.

4.4.7 Summary of Market Drivers

While the above drivers are directly responsible for the bulk of expansion in the indoor environment industries, they in turn are propelled by other factors that continue to push industry stakeholders beyond the status quo. These are discussed below.

There is increasing recognition by the international medical and scientific communities of the link between indoor environmental issues and health problems.

The U.S. National Academy of Science's Institute of Medicine advised in a 1993 publication that

among the various health issues facing the citizens of the U.S., the problem of indoor airborne allergens is one of the more serious. A high percentage of the population becomes sensitive to indoor allergens and suffers chronic or intermittent allergic disease. Most of the disease conditions can be classified as mild or moderate, but many are severe, and some are fatal.⁴⁴

Beyond traditional allergic reactions, indoor pollutants are being implicated as contributors to a wide range of illnesses. It is now well accepted that potentially harmful air pollutants are often found in much higher concentrations indoors than outdoors. According to Canada Mortgage and Housing (CMHC) "one of the most serious environmental threats is indoor air pollution in our homes, workplaces, shopping malls and other buildings."⁴⁵

In a similar vein, the U.S. EPA has stated that the major sources exposing people to harmful environmental contaminants have not been industry, autos, incinerators, landfills and hazardous waste sites but, rather, have been sources small and close to the person, usually inside his or her home.⁴⁶

The American Medical Association, Consumer Product Safety Commission, U.S. EPA, and American Lung Association published a booklet together, to assist health professionals in recognizing symptoms of a wide range of indoor pollutants, including tobacco smoke, combustion gases, animal dander, moulds, dust mites, VOCs and the dust of heavy metals.⁴⁷

There is also increasing understanding of the nature of the building problems related to indoor pollution. CMHC has been a world pioneer in this area. Its ongoing and extensive studies have played a key role in identifying related problems and solutions, and in communicating them to a wide range of stakeholders.

While there is currently no conclusive data on the actual number of homes with poor IAQ, a recent questionnaire-based study by Health and Welfare Canada of fifteen thousand homes across the country suggests the extent of the problems associated with moulds and dampness alone.

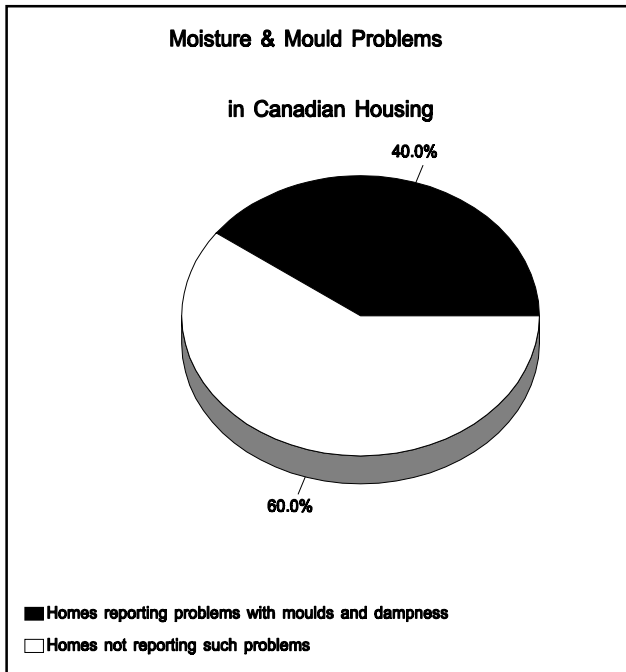


Diagram 7: Moisture and Mould Problems in Canadian Housing

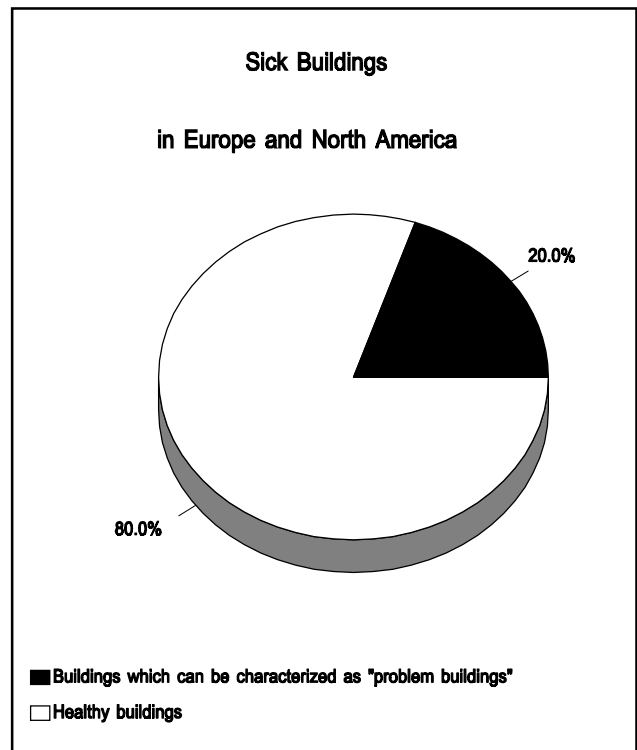


Diagram 8: Sick Buildings in Europe and North America

Roughly 40 percent of the fifteen thousand homes surveyed were reported (Diagram 7) to have moisture or mould problems, and the children living in these homes were 32 to 89 percent more likely to have respiratory illnesses (the percentage varied according to the symptom being measured).⁴⁸

Research on commercial and institutional buildings also suggests a high incidence of poor indoor environments. It is now generally assumed that 20 to 30 percent of the existing building stock in Europe and North America may be characterized as problem buildings.⁴⁹ The WHO estimates that one third of all new and remodeled buildings have unhealthy air.⁵⁰ As shown in Diagram 8, over 20 percent of the existing building stock in Europe and North America may be characterized as “sick”. At the same time, diseases related to poor indoor environments are on the rise.

Asthma is the only treatable, lifelong condition in the Western world with a rising death rate, and is now the most common chronic disease of both adults and children in the developed world. As another example, the prevalence of allergic

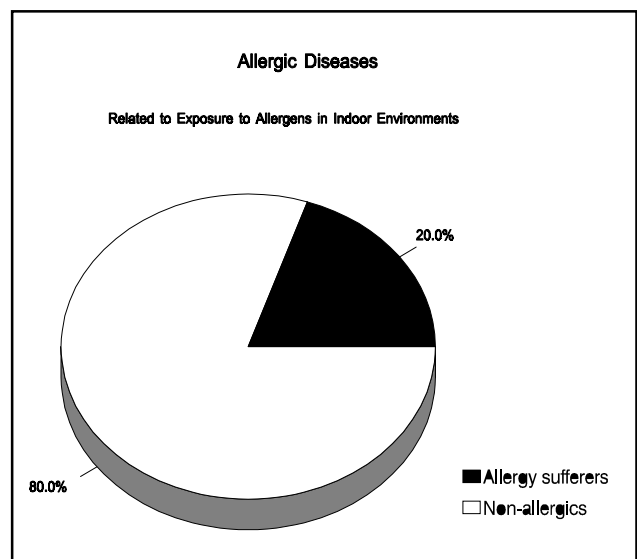


Diagram 9: Allergic Diseases Related to Exposure to Allergens in Indoor Environments

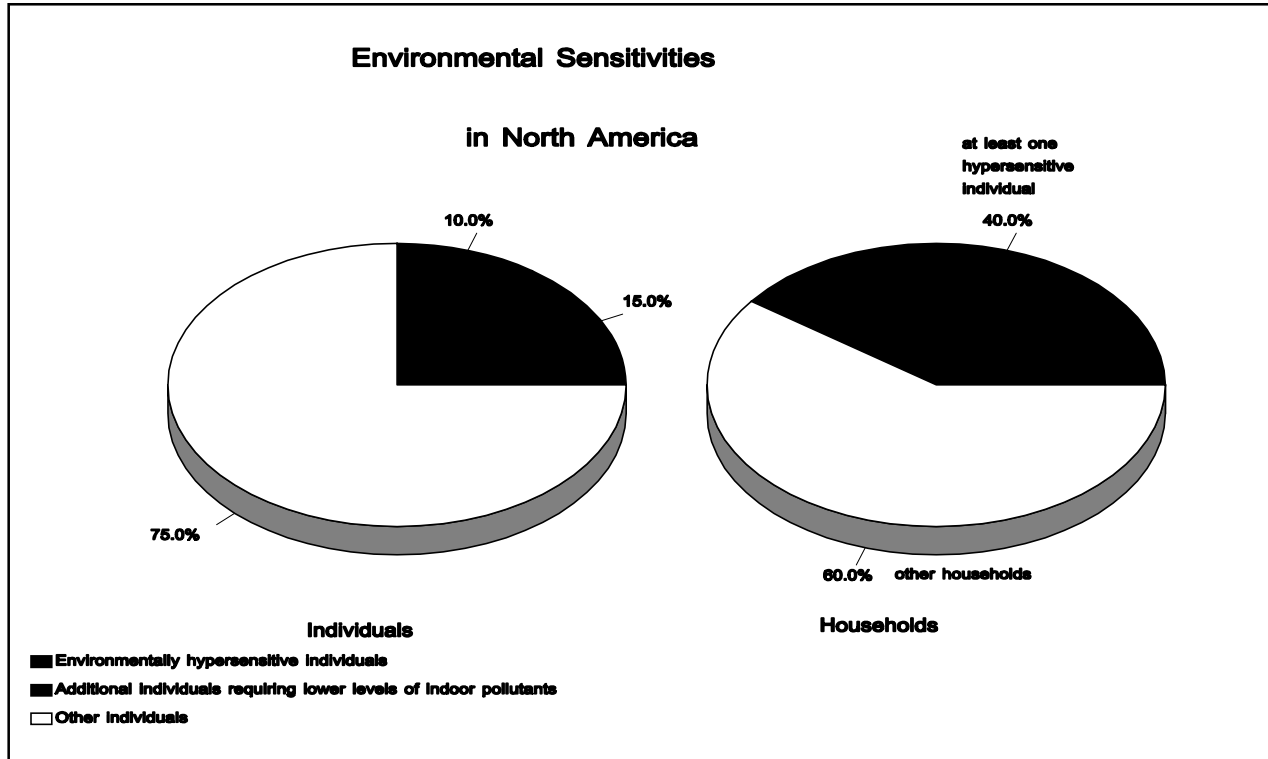


Diagram 10: Environmental Sensitivities in North America

rhinitis (hay fever) also appears to be rising, and now afflicts 15 to 20 percent of the U.S. population.⁵¹ As shown in Diagram 9, one out of five Americans suffer from allergic rhinitis (hay fever) and other allergenic diseases, many of which are related to allergens in indoor environments.⁵²

Sick building syndrome and environmental hypersensitivity illnesses are currently not well understood. There are no standard methods of diagnosis that are widely accepted by the mainstream medical community. There are, however, many health professionals who hold that these diseases are also increasing in both incidence and severity.

Roughly 15 percent of North Americans are environmentally hypersensitive, and over 40 percent of all households contain at least one such individual.⁵³ (Diagram 10)

More than 25 percent of the population have some sensitivity or medical condition (e.g., heart

disease, young age, pregnancy) which requires lower exposures to specific chemicals (e.g., carbon monoxide, nitrogen oxides, volatile organic compounds) to maintain health.⁵⁴

The focus on energy conservation has forced the issue of air quality.

The increasing focus in North America on energy conservation has resulted in a tightening of the building envelope, which has exacerbated indoor pollution problems and related health problems. This has further raised the profile of these issues, and has engaged proponents of energy-efficient buildings in the development and marketing of solutions to remedy the situation.

The dollar cost of poor IAQ is beginning to be recognized.

It is estimated that Canadians spend more than \$600 million each year to treat asthma conditions alone, when medical care, drugs and economic costs, such as lost work days, are factored in.⁵⁵

The U.S. EPA estimates that in the U.S. each year indoor air pollution is responsible for:

- over \$1 billion in medical care for major illnesses;
- \$4.7 to \$5.4 billion in productivity losses associated with major illnesses; and,
- as much as \$60 billion in productivity losses on the job and increased leave time.⁵⁶

Employers, health insurers, health administrators, and the general public are all taking note.

A wide range of stakeholders are pushing for healthier indoor environments.

Health care professionals are increasingly advising “environmental control,” where appropriate, as an important element of their treatment and prevention programmes.

Similarly, health groups such as the American and Canadian Lung Associations, and the Canadian Allergy/Asthma Information Association are raising the profile of indoor environment issues through related public education programmes.

Government organizations, such as CMHC, NRC, and more recently NRCan, the U.S. EPA, the U.S. Consumer Product Safety Commission, and the U.S. National Academy of Sciences, have played a major role in pushing for healthier indoor environments. The profile of their efforts continues to mount, and they are being joined by additional government agencies and other stakeholders.

Unions are asking for healthier indoor environments as well, because their members are demanding it. For example, the primary health and safety issue that the U.S. Service Employees International Union hears about from its one million members is sick buildings.⁵⁷

The public profile of indoor health issues is continually rising.

The profile of indoor environment issues continues to be raised by the above factors and through the work of the media. Most North Americans have heard of sick building syndrome and of off-gassing from carpets. Many claim to have personally experienced sick building syndrome, or know people who have experienced it. In addition, public sensitization to outdoor air pollution problems is carrying over to indoor air concerns. As companies advertise their related products and services, further momentum is generated.

It is a buyers’/renters’ real estate market in many areas of North America.

In many areas of North America there is excess space available to lease and tremendous competition for those few who wish to buy in both the ICI and residential markets. This competition is making building owners and managers pay serious attention to tenant complaints; no one wants to have their property labeled as a “sick building.” The competition is also encouraging them, as well as builders and related design professionals, to offer healthier building features in order to add value to their properties and differentiate themselves in the market.

Many companies want to be seen as good corporate citizens.

In some instances a key reason for having an inspection, remediating a problem, or taking preventative measures is a company’s desire for good public relations with its employees, unions, customers and other stakeholders.

The demand for environmentally responsible building materials is increasing.

The ground swell for environmentally responsible building materials is extending to indoor environment concerns. People are

demanding that these products be good for the indoor environment, not simply recycled or low in embodied energy, for example.

“Cocooning” is putting an increased emphasis on home, health and safety.

North Americans are retreating to the safety of their homes, with a correspondingly growing interest in the home, protecting oneself, and protecting one’s investments.⁵⁸

The worldwide demand for frame housing is growing.

Interviews with industry and government specialists indicate that the international demand for frame housing is growing due to advantages in cost and speed of erection. Canada is a world leader in producing quality homes of this sort, particularly for cold climates. One of our strengths is the ability to produce homes that are well insulated and conserve energy, and which must therefore also attend to related ventilation, moisture and other IAQ issues.

As Canada continues to promote and expand the export of Canadian-designed frame construction homes and prefabricated housing, demand for these products will in turn drive demand for the Canadian component products and systems within them, and the related consulting, training and other service expertise that accompanies these products and systems.

Indoor environment assessments are driving related industries.

The increasing number of indoor environment assessments being conducted is driving an increase in the sales of products and other services required to conduct these assessments (e.g., testing equipment, related lab services and continuous monitoring devices), and remediate problems (e.g., ventilation products and services).

Solutions to indoor pollution problems are being identified and becoming more affordable.

CMHC’s ongoing and extensive study of IAQ problems in homes has helped to identify solutions to these problems, and to communicate these solutions widely. Other organizations in Canada and abroad are also making significant contributions to finding practical solutions.

Furthermore, many solutions are becoming less expensive. Affordable on-line sensors are just now becoming available for monitoring and responding to a wide range of indoor pollutants. Carbon dioxide and carbon monoxide alarms are now priced for mass consumption and are available at hardware stores. Interviews with industry indicate that humidity sensors have dropped 80 percent in price in the past ten years. These factors work hand-in-glove with regulations and voluntary measures. But regulations and voluntary measures are not practical if affordable solutions are not available. Conversely, regulations and voluntary measures can increase demand, driving further innovation and increasing volumes and thereby contributing to lower pricing.

The low value of the Canadian dollar is also helping to increase related exports and reduce related imports.

The exchange rate has helped make our indoor environment industries more competitive and/or more profitable.

The North American Free Trade Agreement (NAFTA).

Canadian companies are gaining better access to U.S. and Mexican markets as related duties (e.g., for occupational health and safety equipment) are dropped as a result of free trade.

Proximity to major population centres, and a similarity in building designs, codes, and

standards, have already made the U.S. Canada's most important export market for indoor environment products and services.

Countries outside of North America also have a need for related products and services.

In terms of export opportunities, the above discussion has focussed only on the U.S. However, many of the drivers discussed also operate in other countries. Furthermore, there are additional drivers that, while not significant in Canada, are fuelling demand abroad.

In summary, all of these market drivers will ensure the continued growth of indoor environment industries over the coming decade. New regulations and legal precedents will continue to promote products and services that reduce indoor pollution, and will safeguard the advances that are being made. As relatively economical solutions to indoor pollution problems become increasingly available, people will choose products and services that do not put them at risk. Furthermore, consumers, workers and unions that have become better informed about the potential risks and what can be done to reduce them, will be resistant to reverting to less healthy alternatives.

4.5 Barriers to Growth

The industry is fragmented.

Indoor environment industries are relatively fragmented. However, it is often an integration of various industry offerings that provides cost-effective solutions for creating healthier indoor environments and, therefore, maximum value in the marketplace.

This may involve bringing various components together into one system, as is being done by heat recovery ventilator manufacturers who are

integrating their ventilation systems with new devices that can monitor volatile organic compound levels. A similar example would be the integration of monitoring and control systems in controlling HVAC systems in larger buildings. This may also involve packaging various systems together, as with the R-2000 Program.

Canadian researchers and building design professionals are world leaders in taking this sort of an integrative approach. The term "the house as a system" was conceived of and introduced by CMHC. However, fragmentation of the industry, in combination with fragmentation at both provincial and federal levels for related responsibilities, is not supportive of the types of synergistic partnerships discussed above.

This barrier can be overcome by helping bring together researchers, designers, builders and manufacturers to develop and market integrated products, systems and programmes (such as R-2000).

Medical and scientific understanding in the area is still limited.

Although related medical and scientific understanding is now sufficient to draw attention to indoor environment problems in general, there are many gaps related to the health risks of exposure to various chemicals at various concentrations, in varying combinations, over varying time periods. This makes it hard for manufacturers to differentiate themselves and to promote their products and services on the basis of health benefits.

For example, one group of Canadian manufacturers had come out with products that reduced emissions of one particular chemical that had been targeted as a potential problem. Their competitors claimed that there was no conclusive evidence that the improvement actually made the product healthier, and threatened court action on the basis of misleading advertising. The product manufacturers being challenged chose to withdraw their claims.

Barriers to evaluation and testing also make it difficult to substantiate the performance of products and services.

Another barrier is the difficulty that Canadian companies face in having their indoor environment products and services tested in order to substantiate performance claims. The obstacles can include:

- cost
- assistance programmes that are only applicable to products in their first year of production
- lack of one government department (or working group of departments) with the mandate to proactively test and promote indoor environment products for both residential and ICI markets
- lack of awareness by industry of the assistance that is available, the indoor environment products that are covered, and the organization or individual to contact. The industry consists of many small firms that have a hard time learning about and keeping up with assistance programmes

Most health care professionals do not fully appreciate the extent to which exposure to indoor pollutants can affect health.

While medical and scientific researchers are now recognizing the extent to which exposure to indoor pollutants can affect health, this understanding has not yet been imparted to the bulk of health care professionals.

In the U.S. this has prompted the American Medical Association to join with the EPA, Consumer Product Safety Commission, and American Lung Association to publish and

distribute a twenty-seven-page booklet on diagnosing signs and symptoms that could be related to indoor pollution problems, and suggestions for appropriate remedial action. In Canada an educational workshop on the health affects of poor IAQ has been organized for health care professionals by Health Canada, CMHC and NRCan.

Canadian manufacturers tend to be smaller in size, and to have less access to true “risk” capital, than their international competitors.

As is often the case in other industries, Canadian companies are less able than their American competitors to suffer large losses in the short term in order to make large profits in the long term. In addition, the smaller size of Canadian companies tends to restrict the availability of internal funding for start-up and expansion endeavors. This has tended to put Canadian manufacturers at a disadvantage in terms of available resources for research and development, investment in more efficient production facilities, and marketing (including packaging and promotion).

The disadvantages that result from small size can be overcome to some extent through the use of strategic partnerships/consortia.

Foreign control often has a dampening effect on Canadian efforts.

While Canadians have been successful in penetrating the residential ventilation market with such products as heat recovery ventilators, we have been much less successful with ventilation equipment for the ICI market. The HVAC industry is dominated by a few multinationals. Furthermore, many of the related decisions about design and purchasing for large Canadian buildings are made in the U.S. and tend to favour American firms.

4.6 Findings

Sector	Key Findings
R, C, I	<p>Indoor pollution contributes significantly to poor health, increased absenteeism and decreased productivity. Conversely, healthier indoor environments can reduce the associated productivity losses and health care costs. Development and implementation of these products and services can help make Canada more competitive internationally raise our standard of living.</p>
R, C, I	<p>The Canadian indoor environment industries employed over five thousand people in 1993, and had annual revenues of over a billion dollars, growing at about 10 percent a year. Exports represented about a third of these revenues at \$330 million, and were growing at a rate of about 25 percent annually. Three years later, in 1996, these exports had increased to about \$570 million and were still growing quickly at approximately 28 percent annually.</p>
R C I	<p>Canada now has a window of opportunity for capitalizing on healthier products and services. Canada has been a world leader in recognizing the problems associated with indoor pollution, and in developing and implementing solutions. Many of our companies are well positioned to respond to the growing international demand for these products and services, as is evidenced by their export performance. However other countries are not standing still. We have a window of opportunity to build on our lead and capture a significant share of this growing world market.</p>
R, C, I	<p>Market drivers include</p> <ul style="list-style-type: none"> • building codes • guidelines set by professional organizations • guidelines and specifications set by purchasing, architectural and engineering departments of businesses and government organizations • product labelling systems • certification systems such as ISO 14000 • indoor environment assessments, including Phase One environment assessments required by an increasing number of mortgage/insurance companies • legal liability • increasing recognition by the international medical and scientific communities of the link between indoor environmental issues and health problems • the rise of diseases related to poor indoor environments • a tightening of the building envelope for energy conservation, which has often exacerbated indoor pollution problems and related health problems • increasing recognition of the dollar cost of poor IAQ • the rising public profile of indoor health issues • companies wanting to be seen as good corporate citizens • increasing demand for environmentally responsible building materials • "cocooning", which is putting an increased emphasis on home, health and safety • evolving solutions to indoor pollution problems, which are being identified and becoming more affordable • NAFTA and the low value of the Canadian dollar, which are also helping to increase related exports

R, C, I	<p>While prescriptive regulations may be a powerful driver of product and service revenues, the more prescriptive the regulations are, the more new product innovation is discouraged. In contrast, regulations that are less prescriptive, for example those based on performance standards, leave more room for innovation.</p>
R, C, I	<p>Barriers to growth include the following:</p> <ul style="list-style-type: none"> • Indoor environment industries are relatively fragmented. However, it is often an integration of the various industry offerings that provides cost-effective solutions for creating healthier indoor environments, and therefore maximum value in the marketplace. • Although related medical and scientific understanding is now sufficient to draw attention to indoor environment problems in general, there are many gaps related to the health risks of exposure to various chemicals at various concentrations, in varying combinations, over varying time periods. This makes it harder for manufacturers to differentiate themselves and to promote their products and services on the basis of health benefits. • While medical and scientific researchers are now recognizing the extent to which exposure to indoor pollutants can affect health, this understanding has not yet been imparted to the bulk of health care professionals. • Canadian manufacturers tend to be smaller in size, and to have less access to true "risk" capital, than their international competitors. • Foreign control often has a dampening effect on Canadian efforts. While Canadians have been successful in penetrating the residential ventilation market with such products as heat recovery ventilators, we have been much less successful with ventilation equipment for the ICI market. The HVAC industry is dominated by a few multinationals. Furthermore, many of the related decisions about design and purchasing for large Canadian buildings are made in the U.S. and tend to favor American firms.
R, C, I	<p>Barriers to evaluation and testing also make it difficult to substantiate the performance of products and services. The obstacles can include</p> <ul style="list-style-type: none"> • cost • assistance programmes that are only applicable to products in their first year of production • lack of one government department (or working group of departments) with the mandate to proactively test and promote indoor environment products for both residential and ICI markets • lack of awareness by industry of the assistance that is available, the indoor environment products that are covered, and the organization or individual to contact. The industry consists of many small firms that have a hard time learning about and keeping up with assistance programmes

4.7 Recommended Options

Sector	Recommended Options
R, C, I	Provide export assistance tailored to Canadian suppliers of healthier products and services. This will help them thrive and maintain their ability to supply the Canadian market.
R, C, I	Support the development and growth of existing building performance assessment initiatives and product labelling and certification programmes.
R, C, I	Revise the Model National Building Code to promote healthier indoor environments. For example, the code could recommend the use of labelled products.
R, C, I	Base regulations and guidelines on performance standards, rather than prescriptive measures, wherever possible.
R, C, I	Require or encourage facilities over a certain size to develop and implement adequate indoor environment management plans, with inspection and maintenance components.
C, I	Promote the productivity and other benefits of improving the quality of the indoor environment.
I	Integrate indoor environment considerations into environmentally preferable procurement protocols.
C, I	Provide awards for advanced guidelines and specifications set by purchasing, architectural and engineering departments of businesses and government organizations. Publicize the winning ones, so others can learn from them.
C, I	Ensure that Phase One Environmental Assessments contain adequate testing for possible indoor environment problems.
R, C, I	Develop quality assurance certification programmes and codes of practice for targeted services.
R, C, I	Assist suppliers in substantiating the performance of their products and services.
R, C, I	Bring together researchers, designers, builders and manufacturers to develop and market integrated products, systems and programmes (such as R-2000). This could include some face-to-face opportunities, a Web-based mechanism for sharing industry news and promoting collaboration, and funding for collaborative projects that will result in new or improved products and services.
R, C, I	Engage medical professionals more fully. Health professionals need information and training to help them diagnose and treat indoor environment related illness.
	<i>Research Needs</i>
R, C, I	Conduct more research into the impacts of low pollutant levels on human health. Dose/response data, at the often low concentrations of pollutants in the indoor environment, require clarification. The impacts of moulds and fragrances should be included. There is a dearth of knowledge about environmental sensitivities and the ways that different environmental factors can impact on health and behaviour. This lack of knowledge is often cited as a main factor slowing progress in the area of creating healthy indoor environments. There is also a need to develop acceptable methods of assessing whether someone is environmentally hypersensitive.
R, C, I	Develop a cost-benefit measurement system, and further quantify the productivity and other benefits of improving the quality of indoor environment

List of Abbreviations and Acronyms

ASHRAE	The American Society of Heating and Air Conditioning Engineers
CEIA	The Canadian Environment Industry Association
EPA	U.S. Environmental Protection Agency
HEPA	High Efficiency Particulate Arrester (A term applied to filters capable of removing at least 99.9% of particles 0.3 microns in size)
HRV	Heat recovery ventilator
HVAC	Heating, ventilation and air conditioning
HVACR	Heating, ventilation, air conditioning and refrigeration
IAQ	Indoor air quality
ICI	Industrial, commercial, and institutional (markets)
IE	Indoor environment
MOEE	Ontario Ministry of Energy and Environment
OSHA	The U.S. Occupational Safety and Health Administration

End Notes

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