Canadian Institutes of Health Research | Instituts de recherche en santé du Canada

Identifying National Research Priorities for the Environmental Influences on Health:

Context and Options

September 2002

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Executive Summary

This paper outlines the context and some options for identifying national research priorities for the environmental influences on health. It summarizes where we stand today, challenges and opportunities, and possible key research themes and priorities for the future. This paper focuses on academic research and will guide the Canadian Institutes of Health Research (CIHR) in laying a solid foundation for the development of a national research agenda on the relationship between health and the environment.

Where We Stand Today

Over the past 25 years, a global view of the relationship between health and the environment has emerged. This perspective has resulted from, and contributed to, the increasing number of multi-lateral environmental agreements, international organizations, conferences, and global monitoring and surveillance systems. A preliminary review of international organizations and developed countries indicates a research focus on: water quality; chemical risk assessment and management; air quality, climate change and health; monitoring and surveillance, children's environmental health; and toxicological mechanisms and epidemiology.

In Canada, research conducted by academic scientists is funded mostly by the research granting councils, including CIHR, the Social Sciences and Humanities Research Council, and the Natural Sciences and Engineering Research Council. About 27 of the 93 universities in Canada are conducting research on the environmental influences on health, and the environment is one of the major priority areas identified by 53 of the 59 universities participating in the Canada Research Chairs program. Of these 53, only 3 stated that the relationship between health and the environment is a major priority. Furthermore, only 14 of the 627 Canada Research Chairs are related to environmental influences on health and there are only 3 Networks of Centres of Excellence related to research on the environmental influences on health.

In recent years, there has been an increase in the number and size of research partnerships between academic and government scientists, including the Toxic Substances Research Initiative, the Northern Contaminants Program, the emerging Canadian Environmental Science Network, as well as programs at the International Research Development Centre, the Canadian International Development Agency, Canada Mortgage and Housing Corporation, and the Canadian Environmental Assessment Agency.

Research conducted for this paper suggests that current key research themes and priorities in Canada include: outdoor and workplace environments; water and air quality; toxic substances, metals, and endocrine disrupting substances; respiratory health and cancer. These issues are very similar to the priorities of international organizations and other countries. The research also indicates that Canada has capacity in: population health and biomedical research; provincial and university-based research networks; community-based approaches to research; and health databases.

CIHR is committed to supporting research on the environmental influences on health. Evidence of this commitment can be seen in its existing funding mechanisms and plans, including: the open competition; the training programs competition; requests for applications; Institute strategic plans; and the strategic cross-cutting initiatives.

Challenges and Opportunities

There are many challenges to be considered when national research priorities for the environmental influences on health are identified, including needs to: advance research, build the capacity of the research community, strengthen partnerships and collaboration, and enhance knowledge translation. At the same time, the high level of public concern, and the interest and commitment of CIHR and its partner organizations will galvanize a call to action.

A Call to Action: Proposed Research Themes and Priorities

The consultation findings suggest that there is a need for a coherent framework within which research priorities can be developed. This proposed framework contains the following research themes and priorities:

- Consistent with a population health approach, an overarching theme of **key populations**, identified on the basis of age, gender and genetic factors, socio-economic status and culture, and geographic location;

- A theme on **hazards in the environment**, with possible priorities on toxic chemicals, microbiological agents, radiation, climate change, and injuries;

- A theme on **the built environment**, with possible priorities on urban environments, homes, workplaces, educational environments, public places, transportation and environments that promote health; and

- A theme on **cumulative exposures and effects**, with possible priorities on exposures from different types of built environments, different types of hazard, different routes of exposure, chemical mixtures, lifetime exposures, and environmental hypersensitivity and allergies.

Over the winter of 2002, a Request for Applications and a document called "Towards a National Research Agenda for the Environmental Influences on Health" will be released. In the years ahead, CIHR and its partners will work to strengthen research on health and the environment, and to build the capacity of the research community.

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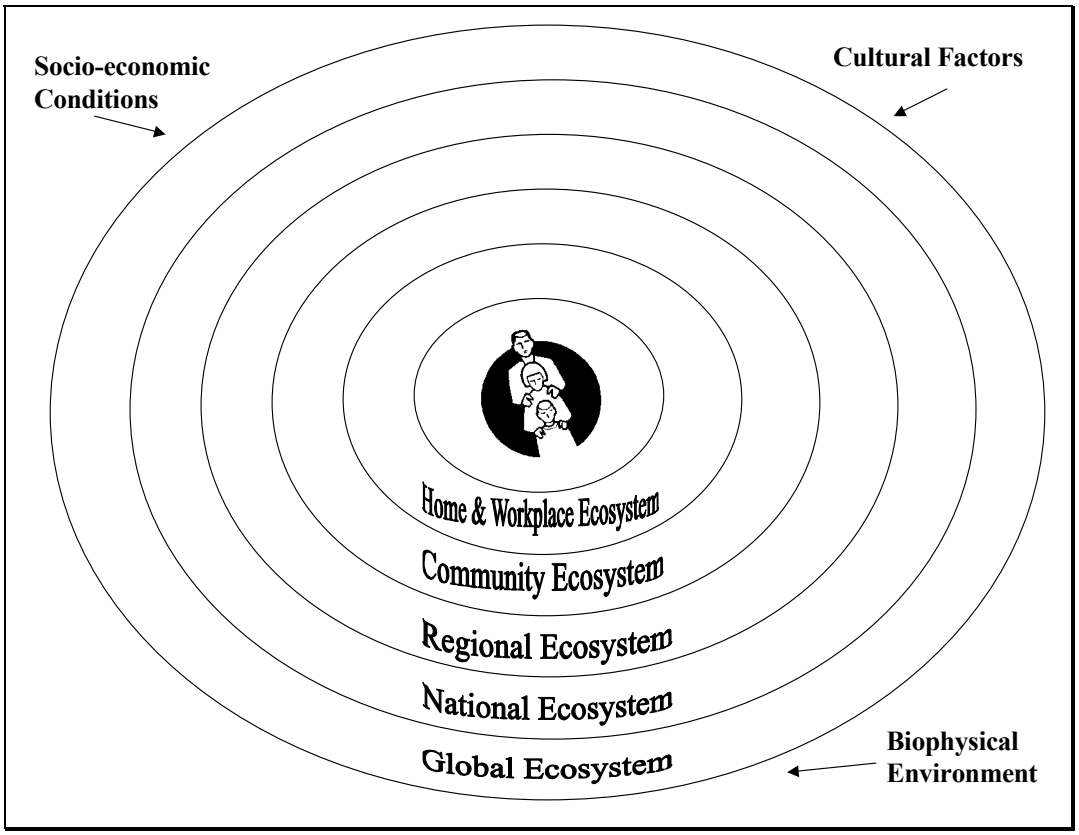
1.Our Environment, Our Health

"Human beings are the center of concern for sustainable development. They are entitled to a healthy and productive life in harmony with nature".
First Principle of the Rio Declaration,
World Conference on Environment and Development, 1992

It is now clear that human health depends on the health of the environment. Without access to clean air and water and safe food, human life cannot be sustained for long. Yet over the past 200 years, humanity has disrupted and degraded the planet's ecological life support systems at an ever-increasing rate. This destruction and its effects on human health and well-being are now regularly catalogued and described in international reports such as the report by the World Health Organisation's Commission on Health and the Environment (WHO Commission on Health and the Environment 1992), the annual reports of the World Resources Institute and its collaborators (see for example, World Resources Institute et al. 2000), and the Worldwatch Institute (see for example, Worldwatch Institute 2002).

A global view of the relationship between health and the environment has only emerged over the last 30 years and it has already contributed to the development of an "ecosystem approach to human health". This approach is an innovative holistic understanding that places human beings at the centre of considerations about development, while seeking to ensure the long-term health and sustainability of the ecosystems of which they are an integral part (Forget and Lebel, 2001). It views the home and workplace, the communities in which we live and work and ultimately the global ecosystem as socio-economic and cultural, as well as biophysical environments. This revolutionary change in perspective is illustrated in Figure 1:

Figure 1: The Ecosystem Approach to Human Health[1]



In Canada, we are blessed with ecosystems that are rich in natural resources to help sustain and enhance human well-being, but there is growing evidence that our health may be affected by environmental degradation occurring in our country and globally. Action from all sectors of Canadian society is urgently needed to protect our health from hazards in the environment and to foster the environmental conditions that are conducive to health. But choosing effective actions requires knowledge – knowledge of the environmental threats we face, knowledge of the best strategies to reduce or eliminate them and knowledge to optimize the health benefits of a healthy and safe environment. Scientific research plays a vital role in generating this knowledge. Without scientific research, we would not know what to do, or how to do it. Research on the environmental influences on health is therefore essential to protect health from environmental hazards and to enhance well-being.

This paper outlines where we stand today, in terms of research on the environmental influences on health, challenges and opportunities, and possible key research themes and

[1] Inspired by an unpublished figure developed by Donna Mergler.

priorities for the future. In preparing this paper, the Canadian Institutes of Health Research (CIHR) is laying a solid foundation for the development of a national research agenda on the relationship between health and the environment.

For the purpose of this paper, the environmental influences on health are defined as: the effects of the biophysical environment, including air, water, food, soil/land, on human health and interactions between the biophysical environment and other determinants of health[2].

This paper focuses on academic research because CIHR's mandate is to support the creation and translation of knowledge on health by researchers in universities and their affiliated institutes and hospitals. This mandate includes funding research projects and building the capacity of the research community.

1.1 The Need for a National Research Agenda

A national research agenda for the environmental influences on health is needed to identify research priorities, encourage collaborative trans-disciplinary research, guide research funding decisions, and facilitate innovative research funding partnerships.

> **"I do not think that there are any clearly articulated national research priorities in environmental health in Canada at the moment."**
> Participant in the consultation

There are several more specific needs, including:

- **Collaborative and integrated research is needed to assess and manage health risks from the environment, and to identify environmental conditions that promote health.** Environmental factors are a crucial determinant of health, for example, air pollution accounts for at least 5,000 premature deaths a year[3] and approximately 11% of all Canadian children have asthma (Canadian Institute for Health Information *et al*. 2001), a disease associated with air pollution. As well, the need for Canada to strengthen and coordinate its research on this subject has been recognized by many organizations including the National Roundtable on the Environment and the Economy (National Roundtable on the Environment and the Economy 2001), the Commissioner of the Environment and Sustainable Development (Commissioner of the Environment and Sustainable Development

[2] The question of how to define this issue was discussed extensively in the Consultation (see section 4 in Appendix B). Over the years, there have been many definitions of environmental health (see http://www.health.gov/environment/DefinitionsofEnvHealth/ehdef2.htm for a list of 28 definitions).
[3] As estimated by the Government of Canada.

1999), the Canadian Public Health Association[4], the International Joint Commission (International Joint Commission 1998), and the Royal Society of Canada (Royal Society of Canada 1995).

- **New environmental health risks are emerging and old ones are re-emerging.** As scientific knowledge increases, new environmental health risks are becoming apparent, for example, recent research has shown that endocrine disrupting substances can affect development and reproduction in wildlife. Studies are now needed to examine the possible effects on human populations. Research is also needed to continue addressing more traditional concerns, such as the microbial quality of drinking water. This need was highlighted by the tragedy in Walkerton, Ontario in 2000 where 7 people died and hundreds became ill because of the presence of *E. coli* in the drinking water[5].

- **Consistent with Canada's Innovation Strategy[6], we must strengthen our scientific and research capacity and ensure that knowledge contributes to building an effective economy that benefits all Canadians.** Strengthening knowledge on health and the environment will position Canada to take a lead role in developing and marketing new products and services that address this subject. To be innovative, Canada also needs to take full advantage of new technologies that are changing research methods on health and the environment such as genomics, proteomics, and geo-spatial analyses.

- **Globalization means that Canada needs research to prevent the introduction of health threats associated with increased trade and migration or to manage them appropriately.** Research is needed to minimize health risks related to increasing population mobility, migration and trade. Diseases, such as Ebola and HIV/AIDS can be easily spread by the traveling public. Research is also needed to support Canada's commitments in international environmental agreements, such as the Stockholm Convention on Persistent Organic Pollutants, international trade agreements, and to help develop international standards and guidelines.

1.2 Developing a National Research Agenda

The situation outlined in section 1.1 suggests that there is a need for a consensus-based national research agenda for the environmental influences on health. Building on the objectives of the EcoResearch Program administered by the Medical Research Council, the Social Sciences and Humanities Research Council, and the Natural Sciences and Engineering Research Council in the 1990s, this initiative could further encourage trans-disciplinary research and capacity building[7].

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[4] See: http://www.cpha.ca/english/policy/resolu/1990s/1999page6.htm.
[5] See: http://www.walkertoninquiry.com/
[6] See: http://www.innovationstrategy.gc.ca/cmb/innovation.nsf/pages/Menu-e
[7] The evaluation of the EcoResearch Program suggested that any new research funding initiative on the environment should (Rideau Strategy Consultants 1996): conduct a needs analysis; be designed with input from the users of the research information; consider potential funding partners and sponsors; be clear about

CIHR is well-positioned to take the lead in facilitating the development of a national research agenda[8]. CIHR is the major federal agency responsible for funding health research in Canada. Its goal is to excel in the creation of health knowledge and its translation into improved health for Canadians, more effective health services and products and a strengthened Canadian health care system.

The *Canadian Institutes of Health Research Act* (2000) states that CIHR will encourage research on **"the health of populations, societal and cultural dimensions of health and environmental influences on health"** (para. 4(d)(ii))

Furthermore, in 2001, CIHR's strategic outlook, *r:evolution*, (Canadian Institutes of Health Research 2001) identified the relationship between the environment and health as an area of cross-cutting research. More recently, CIHR has established research on the environmental influences on health as a strategic initiative that cuts across the work of the 13 individual Institutes.

CIHR is using a three-phase approach to facilitate the development of a national research agenda:

Phase 1: National Consultation:
In March 2002, CIHR launched a national, multi-stakeholder consultation and released a Consultation Paper containing contextual information and soliciting comments and recommendations from a wide range of stakeholders (Davies 2002). Between March and early August, CIHR requested comments from organizations and individuals across the country, representing researchers, professional networks and associations, government departments and agencies, Aboriginal organizations, the private sector, non-governmental organizations, and health professionals[9]. In addition, workshops were held at the Canadian Public Health Association Annual Meeting (Yellowknife), Health Canada (Ottawa), Environment Canada (Toronto and Hull), the South Riverdale Community Health Centre (Toronto), the People and the Planet Conference (Kingston), and an informal discussion group at the International Society for Exposure Assessment/ International Society for Environmental Epidemiologists Annual Symposium (Vancouver).

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the research focus; be clear about the duration of research support; ensure that there is interaction between training and research; involve all relevant disciplines; obtain commitments to the scope of funding; ensure gender balance; pay attention to the experience and attitudes of the peer review committee(s); build in feedback mechanisms; and communicate its expectations to the research community.

[8] See section 2.5 and Appendix C for a summary of CIHR's current support for research on the environmental influences on health.

[9] See Appendix B.

Phase 2: National Forum to Identify Research Priorities:
This paper is based on the findings of the national consultation and commissioned research. As the background paper for the National Forum to Identify Research Priorities for the Environmental Influences on Health, this paper outlines where Canada stands in terms of research on the environmental influences on health, summarises the challenges and opportunities, and proposes a framework for identifying national research priorities.

The National Forum to Identify Research Priorities for the Environmental Influences on Health will be held in Ottawa from September 12-14, 2002. The objectives of this important event are:

1. To provide a forum for stakeholders to validate and reach consensus on major research themes and priorities for the environmental influences on health;

2. To develop the key elements of a multi-disciplinary Request for Applications (RFA) on the Environmental Influences on Health that could be supported by CIHR and funding partners; and

3. To identify the partners, training and infrastructure required to develop an integrated and collaborative national research initiative on the Environmental Influences on Health.

Phase 3: Finalise the Request for Applications and Prepare "Towards a National Research Agenda for the Environmental Influences on Health":
The Request for Applications will be finalized shortly after the National Forum. It will contain a series of "eligible research questions" identified at the National Forum and will be released in the winter of 2002. At approximately the same time, a document called "Towards a National Research Agenda for the Environmental Influences on Health" will be released, also based on the National Forum. This document will provide the basis for a comprehensive long-term strategy for research.

A steering committee[10] with representatives from Health Canada, Environment Canada, academia, health professionals, the private sector, non-governmental organizations, and several CIHR Institutes, has guided the consultation and the planning for the National Forum. The committee will be involved in the preparation of the Request for Applications and the preparation of "Towards a National Research Agenda for the Environmental Influences on Health".

[10] See Appendix A.

2. Where We Stand Today

2.1 International Context

In 1987, the World Commission on Environment and Development's report, "Our Common Future", defined sustainable development as "development that meets the needs of the present, without comprising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987). This definition drew attention to the links between the environment, development and health. It placed human health and well-being as the central objective of development and provided an innovative context and a timely impetus to international and national research on the environmental influences on health.

> **"Recently I was asked why health was not one of these issues (in the report). My answer is: ultimately, the whole report is about health."**
> Gro Harlem Brundtland, Chair of the World Commission on Environment and Development speaking at the World Health Assembly 1988

Building on the concept of sustainable development, participants at the UN Conference on Environment and Development, held in Rio de Janeiro in 1992, agreed to the Rio Declaration and proposed a global agenda for the environment and health called Agenda 21[11]. Health is a major theme in Agenda 21 and several chapters contain commitments to strengthen research, including: Chapter 6 - Protection and Promotion of Human Health; Chapter 19 - Environmentally Sound Management of Toxic Chemicals, Including Prevention of Illegal International Traffic in Toxic and Dangerous Products; Chapter 31- Scientific and Technological Community; and Chapter 35 - Science for Sustainable Development.

Since 1992, Canada has played a key role in several international and regional agreements on health and the environment, including: the Convention on Biological Diversity and its Biosafety Protocol; the North American Agreement on Environmental Cooperation[12]; the Kyoto Protocol; the Protocols on Persistent Organic Pollutants and Heavy Metals under the UN Economic Commission for Europe's Convention on Long-range Transport of Air Pollutants; and the Stockholm Convention on Persistent Organic Pollutants. There is also growing interest in the environmental provisions of the increasing number of multilateral trade agreements.

[11] See: http://www.unep.org.
[12] The North American Agreement on Environmental Cooperation was a "side agreement" under the North American Free Trade Agreement and established the North American Commission for Environmental Cooperation. See: http://www.cec.org.

In late August and early September 2002, representatives of over 100 countries, as well as representatives from non-governmental organizations and the private sector gathered for a global summit on environment and development 10 years after the meeting in Rio. The World Summit on Sustainable Development, held in Johannesburg, provided an opportunity for countries and organizations to adopt concrete steps and identify quantifiable targets for better implementing Agenda 21. As part of its contribution, Canada proposed a global initiative focused on the health and environment linkages. The first step will be to assemble a review of existing knowledge on environmental threats to health. The second step will be to use the synthesis as a tool to strengthen decision-making and build capacity to take action.

A preliminary review of research suggests that international organizations[13] are focusing their research efforts on several issues, including:

- **Water quality and quantity**, especially the risks posed by microbial agents and the future availability of safe drinking water;

- **Chemical risk assessment and management**, including the harmonization of testing requirements, chemical carcinogenesis, and endocrine disrupting substances;

- **Climate change and air pollution**, including prediction, monitoring, effects, and adaptation research; and

- **Monitoring and surveillance**, especially climate change and communicable diseases.

There are many similarities in the research priorities of the countries selected for this review, probably because they are all part of the developed world. Research priorities include:

- **Chemical risk assessment and management**, including pesticides, commercial chemicals, by-products of combustion and industrial processes, and endocrine disrupting substances;

- **Air quality and human health**, with some emphasis on climate change;

- **Water quality**, especially in relation to chemical contaminants;

- **Toxicological mechanisms and epidemiological studies** of exposures and their effects on population health; and

[13] See Appendix D.

- **Children's environmental health**, including exposures and effects.

Commenting on the new global initiative on Healthy Environments for Children, announced at the World Summit on Sustainable Development, Gro Harlem Brundtland, Director-General of the World Health Organization said **"… we need a global movement that can make Healthy Environments for Children one of the highest social and political priorities of this decade."**

Understanding research on the environmental influences on health in international organizations and other countries is essential, if Canada wants to show international leadership. It will also allow us to learn from others, share Canadian research findings abroad, and identify and work with international partners to fund and conduct research. Moreover, understanding the international situation permits Canada to "benchmark" its research priorities and programs on this subject.

Canada has an excellent international reputation for research in several specific areas of the environmental influences on health. Canadian research on the trans-boundary movement and health effects of persistent organic pollutants and heavy metals in the North played a major role in the successful negotiations for the Protocols on Persistent Organic Pollutants and Heavy Metals under the UN Economic Commission for Europe's Convention on Long-range Transport of Air Pollution and the Stockholm Convention on Persistent Organic Pollutants. Furthermore, as a developed country, Canada has a responsibility to contribute to the world's collective knowledge on the environmental influences on health.

2.2 Canada: An Overview

Canada's research on the environmental influences on health is driven by several factors, such as: the creativity and innovation of our researchers; the rapidly increasing body of knowledge about how the environment affects health; and the needs of decision-makers, who need information on how the environment affects health, including governments, health professionals, individuals, communities, and the private sector.

Research on health and the environment can be categorized as follows:

- **Research conducted by academic scientists**. This type of research covers the continuum between policy-oriented research and basic or fundamental research;

- **Partnership research**, conducted jointly by government and academic scientists; and

- **Research conducted by government scientists**, such as Environment Canada's research on wildlife species as early warning systems for human health and

Health Canada's bioregional programs. This type of research tends to be more policy-oriented than the other two types of research.

"The federal government needs a strong internal research capacity, but there is also a need to strengthen the capacity of university researchers. Both are equally important. We should not trade one off against the other".
Participant in the consultation

The consultation findings[14] suggest that there is a need to strengthen research capacity inside government and in universities and their affiliated organizations. Government research can be easily targeted at specific policy needs, and academic research can be investigator initiated and address more general societal needs. As noted in section 1, this paper focuses on academic and partnership research. It does not address priorities for intramural government research.

Research Conducted by Academic Scientists[15]

Research conducted by academic scientists is supported primarily by the research granting councils. The Social Sciences and Humanities Research Council promotes and supports research on, and research training in the social sciences and humanities. It is planning a new large-scale targeted research funding initiative called the "Environment and Sustainability Studies Initiative", in collaboration with Environment Canada and the National Roundtable on the Environment and the Economy.

The Natural Sciences and Engineering Research Council's Ecology and Evolution program supports many environmental research programs with indirect links with health, including several National Centres of Excellence, such as the Centre on Sustainable Forest Management, AquaNet, and Ocean Production Enhancement Network, the International Geosphere Biosphere Program's Joint Global Ocean Flux Study, the North Water Polynya Research Network, the Biocontrol Network, and the BOREAS Program on carbon flows in the boreal forest[16].

About 27 of the 93[17] universities in Canada are conducting research on the environmental influences on health. Recent data[18] shows that the environment is one of the major priority areas identified by 53 of the 59 universities participating in the Canada Research Chairs program. Of these 53, only 3 stated that the relationship between health and the environment is a major priority.

[14] See Appendix B.
[15] See Appendix C.
[16] See: http://www.nserc.ca/programs/real2000/submissions/gsc18_e.htm.
[17] The number of universities in Canada is taken from http://www.aucc.ca/en/acuindex.html
[18] Information provided by the National Roundtable on the Environment and the Economy, that was adapted from: http://www.chairs.gc.ca/english/research/strategic/index.html.

In 2000, the federal government created the Canada Research Chairs program to support the establishment of 2,000 Canada Research Chair positions at universities across Canada by 2005[19] to enable Canadian universities, and affiliated research institutes and hospitals to become world-class research centres in the emerging global, knowledge-based economy. Between December 2000 and June 2002, 627 Canada Research Chairs were awarded. Of these, only 14 (2.2%) are directly or indirectly related to environmental influences on health. The areas of research addressed by the 14 Chairs include water quality, microbial hazards, waste management, and the effects of contaminants on health.

Similarly, only 3 of the 20 funded Networks of Centres of Excellence address research on the environmental influences on health: the Canadian Bacterial Diseases Network; the Canadian Water Network; and the Sustainable Forest Management Network.

Partnership Research

In recent years, there has been an increase in the number and size of programs that support research partnerships between academic and government scientists. A major new initiative, the Federal Innovation Networks of Excellence, is being developed by the federal government[20]. Although not focused on research on health and the environment, this initiative aims to integrate federal research programs into the national system of innovation by establishing federally led research and development networks that bring together multiple science-based departments and agencies, universities and private sector companies. The networks will conduct research to support government decision-making and social and economic development. The idea for the proposed Federal Innovation Networks of Excellence partly originated from the success of 2 existing programs for supporting research partnerships: the Toxic Substances Research Initiative and the Northern Contaminants Program.

The Toxic Substances Research Initiative, managed by Health Canada and Environment Canada, was intended to enhance the knowledge base needed to define and reduce the risk of adverse effects of toxic substances on Canadians and their environments. Its guiding principles were to:

- Contribute to the protection and preservation of human health and the environment for current and future generations of Canadians;

- Emphasize biological and chemical research which would benefit ecosystem health and priority population groups at risk, i.e. children, Aboriginal people and the elderly;

- Encourage and promote multidisciplinary research approaches to address the risks and roles of toxic substances in the complex chain of causation leading to adverse environmental consequences and adverse human health effects;

[19] See: http://www.chairs.gc.ca/english/About/index.html
[20] Personal communication with Charles Haines of Environment Canada.

- Emphasize research partnerships and leveraged resources to meet the rigorous demands of the Canadian and international scientific communities;

- Promote and enhance public understanding of and involvement in toxic substances research by placing emphasis on community consultation, communications, and the use of research results; and

- Apply a target-based approach to research deliverables and determining success through rigorous project evaluation and tracking of indicators of achievement.

The aim of the Northern Contaminants Research Program, managed by the Department of Indian and Northern Affairs, Environment Canada, Health Canada, Fisheries and Oceans Canada, 3 territorial government departments, and 4 Aboriginal organizations, is "to work towards reducing and, where possible, eliminating contaminants in traditionally harvested foods, while providing information that assists decision-making by individuals and communities in their food use"[21]. Phase I (1991/97) focused on determining the main sources of contaminants, their transportation pathways and fate in the Arctic, as well as their temporal and spatial distribution in Arctic ecosystems and humans. Phase II (1998/2003) is expanding research on human health, developing community dialogue, and working on international agreements to control contaminants. Phase II funds research partnerships between government and academic scientists and Northern communities for a total of $5.4 million a year.

As well as participating in the Toxic Substances Research Initiative and the Northern Contaminants program, Environment Canada is developing a Canadian Environmental Science Network[22], which will include academic and government scientists. Nodes of this network will be regionally-based, such as the Atlantic Environmental Science Network[23], and issue-based, including networks on water, air and nature. Health and the environment is one of the priority areas of Environment Canada's Science and Technology Advisory Board.

Other federal departments and agencies with programs to support academic research on the environmental influences on health include the International Development Research Centre, the Canadian International Development Agency, the Canada Mortgage and Housing Corporation, and the Canadian Environmental Assessment Agency.

The International Development Research Centre has a "Program Direction (2000-2005" on the Environment and Natural Resource Management[24]. This program supports research in Asia, Latin America and the Caribbean, sub-Saharan Africa, and North Africa and the Middle East. Key issues include food and water security. The Centre has also initiated a highly successful program on "Ecohealth Training Awards"[25]. This program is

[21] See: http://www.ainc-inac.gc.ca/ncp/index_e.html.
[22] Personal communication with Eileen Johnson of Environment Canada.
[23] Environmental health is a key priority of the Atlantic Environmental Science Network.
[24] See: http://www.idrc.ca/cpf/32_environment.html
[25] See: http://www.idrc.ca/awards/2002Theme1.pdf

intended to strengthen research capacity on human and ecosystem health. The theme of this year's training awards competition (2002) is "building the concepts and tools for assessing human health status outcomes within an ecosystem approach to human health".

The Canadian International Development Agency's programming in health and the environment is focused on knowledge translation on health and environmental issues and includes projects on agriculture, forestry, health systems and services, and water quality. The Agency has programs in Africa, Central America and the Caribbean, and Asia[26].

The Canada Mortgage and Housing Corporation has supported research on housing and environmental hypersensitivity for almost 20 years. Internal research has focused on building materials and how they affect indoor air quality. External research support is provided to help Canadian investigators conduct research on priorities related to housing, with a priority on "healthy housing"[27].

The Canadian Environmental Assessment Agency has a program to support external research and development on environmental assessment. The purpose of the program is to help the federal government meet future challenges and improve the practice of environmental assessment. The budget for the research program is approximately $200,000 a year. One of the priority areas for 2002/03 is "human impact assessment"[28].

2.3 Canada: Current Research Themes and Priorities

Current research themes and priorities on the environmental influences on health in Canada cover a range of issues. Table 1 summarizes the findings of the consultation and the overview of research, described in Appendices B and C, respectively:

[26] Personal communication with Andrew Jones of the Canadian International Development Agency.
[27] See: http://www.cmhc-schl.gc.ca/en/prfias/gr/exrepr_001.cfm
[28] See: http://www.ceaa-acee.gc.ca/0010/0001/0003/cfp_e.htm

Table 1: Current Research Themes and Priorities in Canada

Source of Information	Appendix	Current Research Themes and Priorities
Consultation	B	- Toxic substances, endocrine disrupting substances, and metals in the environment - Air quality and respiratory health - Bioregional research programs - Microbial substances in drinking water
Survey of Canadian Researchers	C	- Toxic substances, endocrine disrupting substances, metals and pesticides - Air quality - Cancer - Respiratory health - Children's environmental health - Water quality and quantity - Workplace health and safety - Population health, biomedical, and clinical research
Review of Key Funding Mechanisms	C	- Capacity building and infrastructure for research on natural sciences and engineering, especially chairs and networks - Infrastructure, especially equipment - Capacity building (Canada Research Chairs) - Research projects on persistent organic pollutants and air quality
Assessment of Applications to CIHR and Funded Research	C	- Outdoor, biophysical and workplace environments - Toxic substances, microbial hazards, and physical/atmospheric hazards - Population health, biomedical, and clinical research - Toxicology and epidemiology
Capacity Building in the Social Sciences and Humanities for Climate Change and Sustainable Development Analysis	C	- Environmental business/economics - Environmental engineering
Health Canada Database on Research on Children's Environmental Health	C	- Hazards: heavy metals, pesticides, indoor air, PCBs, and endocrine disrupting substances - Health outcomes: pregnancy or reproductive effects, asthma, and cancer

This Table suggests that key research themes and priorities in Canada include:

- **Environments and Environmental Media**: Outdoor and workplace environments, and water and air quality;
- **Hazards**: Toxic substances, metals, and endocrine disrupting substances;
- **Outcomes**: Respiratory health and cancer; and
- **Research Pillars**: Population health and biomedical research.

These issues are very similar to the issues identified in the summary of research in selected international organizations and other countries shown in section 2.1.

2.4 Canada: Capacity

The findings of the consultation indicate that Canada has capacity in the following areas of research:

- **Provincial and university-based research networks**, such as the Network of Research in Environmental Health of the FRSQ in Quebec[29], the Canadian Network of Toxicology Centres[30], and the Network for Risk Assessment and Management[31].

> **"Canada's strength in environmental health research is the success of the multi-disciplinary approach that has been adopted by many research networks… These networks have the ability to bring together scientists from diverse backgrounds and interests into research projects that transcend traditional disciplinary barriers. Similarly, projects developed in this way engage diverse stakeholders in the design and interpretation of results."**
> Participant in the consultation

[29] The objective of the Quebec network is "To bring together environmental health researchers in Quebec by encouraging trans-disciplinary collaboration and institutional coordination to improve the quality of research and the competitiveness of researchers". Translated from French at: http://www.rrse.ca.

[30] The research priorities of the Canadian Network of Toxicology Centres for 2002/03 include the eco-toxicology of non-ferrous metals, improving extrapolation across species and levels of biological organization, the effects of chronic low dose exposures, risk assessments of priority substances, field studies on endocrine disrupting substances, and the impact of environmental contaminants on water quality. See: http://www.uoguelph.ca/cntc/research/priority02-03.shtml.

[31] The goal of the Network for Risk Assessment and Management is "to integrate the scientific knowledge and expertise that exists across many diverse disciplines to provide a comprehensive approach to environmental health risk assessment and risk management that supports more effective and efficient environmental protection practices and decision-making in Canada. See: http://www.neram.ca.

- **Community-based approaches to research**, for example, the Northern Contaminants Program and its partners have developed community-based approaches for conducting research in Northern communities, as summarised in the Guidelines for Conducting Responsible Research developed by the Northern Contaminants Program [32], and Health Canada's bioregional programs on health and the environment emphasized community partnerships; and

- **Health databases**, including national, longitudinal health information collected as a result of Canada's publicly-funded health care system, the National Population Health Survey, the Canadian Community Health Survey, and the Canadian Congenital Anomalies Surveillance System.

Table 1 (section 2.3) indicates that Canada is currently investing significantly in capacity building through the establishment of research chairs in areas related to health and the environment.

2.5 The Canadian Institutes of Health Research

CIHR is committed to supporting research on the environmental influences on health. Evidence of this commitment can be seen in its existing funding mechanisms and plans, including:

- **The Open Competition**: The review of applications to CIHR and funded research[33] shows that CIHR funded 54% of the applications it received for research on the environmental influences on health. The review also indicates that only 2% of the applications received through the open competition addressed research on the environmental influences on health directly or indirectly

- **The Training Programs Competition**: There were 51 successful applications in CIHR's recent training programs competition (2002). Of these, 3 were directly related to research training on the environmental influences on health and another 4 were indirectly related. About 14% of the funds dedicated in the competition were allocated to the 7 projects that related directly or indirectly to health and the environment.

- **Requests for Applications**: In May 2002, CIHR released 22 Requests for Applications[34]. Of these, 7 mentioned the environmental influences on health, including the Requests for Applications on: Excellence, Innovation and Advancement in the Study of Obesity and Healthy Body Weight; Global Health:

[32] See: http://www.ainc-inac.gc.ca/ncp/opmgmgui_e.html
[33] See Appendix C.
[34] See: http://www.cihr.ca

Research Program Development and Planning Grants; Needs, Gaps, Opportunities Assessment Grants in Microbial Contamination of Food, Water and Anti-microbial Resistance; the New Emerging Team Grant Program and Gene-environment Interactions; Reducing Health Disparities and Promoting the Health of Vulnerable Populations; the Strategic Initiative on Healthy Gametes and Great Embryos; and Understanding and Addressing the Impacts of Physical and Social Environments on Health: Research Program Development Grants.

- **Institute Strategic Plans**: The environmental influences on health are discussed in 10 of the strategic plans recently prepared by the CIHR Institutes and several plans contain specific priorities or emphasize health and the environment, for example:

  - The Institute of Gender and Health has a research priority on gender and environment;

  - The Institute of Infection and Immunity has several relevant priorities and initiatives, including the microbial safety of food and water, and asthma, allergy, host resistance and innate immunity;

  - The Institute of Population and Public Health's Strategic Directions Outlook (2001/02) and its Preliminary Long-term Plan (2002/07) highlight the need to understand interactions between biological, social, cultural and environmental factors in determining health;

  - The Institute of Human Development, Child and Youth Health identifies environmental determinants as part of its research priority on healthy gametes and great embryos; and

  - The Institute of Aboriginal Peoples' Health identifies environmental health as a critical health issue.

- Strategic Cross-cutting Initiatives: Research on the environmental influences on health is an important element in 4 of the 9[35] strategic cross-cutting strategic initiatives: Rural and Northern Health; Global Health Research; Gene-Environment Interactions[36], and Injuries.

[35] The 9 cross-cutting strategic initiatives are: Rural and Northern Health; Gene-Environment Interactions; Clinician Scientists; Global Health Research; Reducing Health Disparities and Promoting the Health of Vulnerable Populations; Regenerative Medicine; the Environmental Influences on Health; the Tobacco Initiative; and Intentional and Unintentional Injury, Repair and Rehabilitation.

[36] The objective of this cross-cutting strategic initiative is to establish the infrastructure to conduct large multi-centre longitudinal cohort studies to analyse the role of environmental and genetic factors in developmental and aging processes, the cause and evolution of disease, and the utilisation of health care services. It is therefore much more focused than the initiative on the environmental influences on health.

3. Challenges and Opportunities

3.1 Advancing Research

The Challenge:

> **"We recognize that scientific …knowledge is the foundation for effective action in addressing threats to human health and the environment. High on our agenda is a commitment to expand and improve our understanding of the linkages between health and the environment".**
> Ministerial Communique of the Meeting of Health and Environment Ministers of the Americas, March 4-5, 2002. Ottawa.

The Ministerial Communique of the Meeting of Health and Environment Ministers of the Americas contains a strong commitment to strengthen research on the environmental influences on health. This is in accord with the results of public opinion polling showing that the need for more research is recognized by all sectors of Canadian society. For example, a public opinion poll conducted in 2000 found that 96% of those surveyed support more research on toxic chemicals and 90% said that tax revenues should be spent on these studies[37]. Consistent with this, the consultation findings show that there is a strong consensus for more research on this subject. The challenge is to translate this high level of agreement into government decisions and actions.

The findings of the consultation, and the overview of research in Canada suggest that that there are particular needs for:

- Research within and across all four CIHR pillars[38], especially in pillar 3 and cross-pillar, trans-disciplinary studies;

- Research on the social science dimensions of the relationship between health and the environment, in particular, research on how to encourage social and behavioural changes that will protect and enhance health and the environment;

- Research on risk management, reduction and elimination, including studies on prevention and adaptation, effective interventions, policy responses, as well as expanded research on hazard/risk identification and assessment;

[37] Poll conducted by Environics in September, 2000.
[38] CIHR's four pillars of health research are: biomedical research, clinical research, research on health services and systems, and research on population health.

"In areas where there is sufficient knowledge, attention needs to be placed on researching effective policy and program interventions that lead to improvements in human health."
Participant in the consultation

- The development and evaluation of new research methods, including methods for exposure assessment, geo-spatial analysis, field methods for determining contaminant levels in different tissues and media, sub-clinical measures of exposures and effects, and systematic reviews/syntheses of research findings;

- Long-term research to examine health and environmental changes over time and space, as well as short-term research to enable timely responses to immediate problems; and

- Fundamental research to explore basic questions, as well as applied research to meet societal needs.

The Opportunity:
The opportunity is to develop a strategic, national agenda that can be used to advance research. The consultation findings suggest that such an agenda should contain integrated research priorities to guide research funding decisions, encourage coordinated, trans-disciplinary research, and encourage innovative funding partnerships. CIHR is well-positioned to facilitate the development of such a national research agenda because of its core competencies, namely: its national scope; its close relationship with the health research community; its expertise in supporting the creation of knowledge; its mandate to develop integrated, strategic research agendas; and its credibility as an independent and objective source of knowledge about health (Canadian Institutes of Health Research 2002).

CIHR is also proposing to develop a new, targeted research funding program to support more applications to the open competition in this area of research, integrate research on health and the environment into the work of the Institutes and other CIHR programs, and link with other organizations that support research on the environmental influences on health.

3.2 Building Capacity

The Challenge:
The consultation findings and the overview of research indicate that there is an urgent need to increase the capacity of Canadian researchers. The findings also suggest that there are particular needs for:

- **Human resources**, especially neurotoxicologists, immunotoxicologists, environmental epidemiologists, and social scientists with expertise in health and the environment.

- **Infrastructure**, including: local, regional and national networks; longitudinal and geo-spatial data on monitoring and surveillance that can be linked; and laboratories that can analyse a variety of contaminants in different environmental media and human tissues.

- **Funding** to meet the needs for human resources and infrastructure, and to develop, conduct and evaluate research.

These capacity needs are underscored by recent trends, including: increasing competition for bright, young researchers from the private sector and other countries that offer higher salaries, more sophisticated infrastructure and better levels of funding than Canadian universities; and the aging of the health and environment research community in Canada, mirroring the aging of the general population.

The challenge is to attract and retain "the best and the brightest" in Canada, to provide adequate opportunities for training, and to invest in infrastructure that will increase capacity.

The Opportunity:
The opportunity is for researchers to take full advantage of current government programs that provide rewards and incentives for excellence in research. For example, CIHR provides several opportunities for building the capacity of the health and environment research community, including the training programs competition, training awards, and salary support.

There is also an opportunity to ensure that capacity building is one of the key priorities of the emerging national research agenda, and to develop new partnerships for capacity building in Canada and internationally.

3.3 Strengthening Partnerships and Collaboration

The Challenge:

> **"A new vision of environmental health requires…crosscutting research and development and the establishment of linkages between diverse groups, including the medical and public health communities, industry, government, farmers, policy-makers and international groups"**
> Hanna and Coussens, 2001

Consistent with the consultation findings, this statement from the US National Institute of Medicine acknowledges the need to ensure that there are strong relationships between researchers and the broad range of stakeholders interested in the environmental influences on health. It also recognizes that protecting and enhancing health requires the involvement of a variety of other public policy domains and other sectors of society. In 1994, the federal, provincial, territorial Advisory Committee on Population Health stated: "The health sector cannot act alone, because most of the determinants of health fall outside its purview" (Advisory Committee on Population Health 1994). In other words, further improvements in the health of Canadians depend on the decisions and actions taken outside the domain of health policy. For example, economic and fiscal policies affect the health and well-being of Canadians. In the case of environmental issues, housing, agricultural, transportation and energy policies all affect health.

The challenge is to strengthen research partnerships and collaboration from a foundation of disciplinary research, and to do this in the present climate of financial uncertainty.

The consultation findings and the overview of research suggest that that there are particular needs for partnerships and collaboration in the following areas:

- **Trans-disciplinary research teams** within and across CIHR's research pillars[39], especially teams linking biomedical, clinical and population health research (pillars 1, 2 and 4) with research on health services, systems and policy (pillar 3);

- **New partnerships for research**, including partnerships between academic and government researchers, and collaboration between researchers and communities, policy-makers, health professionals, and the private sector. These partnerships will help provide new perspectives on research questions, methods and results, and facilitate knowledge translation[40];

[39] One of the suggestions made during the evaluation of the federal EcoResearch program was that research proposals often involved researchers from several disciplines, but that after the proposals were funded the research and the interpretation of the results was done using traditional disciplinary approaches (Rideau Strategy Consultants 1996).
[40] See section 3.4 on enhancing knowledge translation.

- **Increased collaboration with international organizations and other countries**[41] on research so that Canada can contribute to global knowledge, provide a uniquely Canadian perspective, and help develop effective national and international responses; and

- **Innovative funding partnerships** to support research, including in-kind and financial partnerships, between granting councils, government departments and agencies, communities, foundations, and the private sector.

The Opportunity:
The opportunity is to use the present climate of financial uncertainty to forge new partnerships and collaborations. Times of financial restraint can encourage organizations to work together in ways that may not happen at other times. As potential areas of overlap and duplication among organizations are minimized or eliminated, there is an added impetus for better coordination and integration of research.

CIHR is already exploring several opportunities to develop research funding partnerships, including potential collaborations with: other granting councils; federal departments and agencies; and the private sector.

Within CIHR, there are many opportunities for building partnerships and collaboration. CIHR has already developed several mechanisms for funding research that are intended to encourage partnerships and collaboration, including the Community Alliances for Health Research, the Inter-disciplinary Health Research Teams, and the New Emerging Teams. A review of applications to CIHR[42] suggests that these, and other CIHR funding mechanisms, have not been fully exploited by health and environmental researchers in Canada.

3.4 Enhancing Knowledge Translation[43]

The Challenge:
The challenge is to enhance the translation of knowledge on the environmental influences on health to benefit the health of Canadians. CIHR is already fully committed to strengthening knowledge translation[44]. This commitment is based on the belief that the flow of health knowledge into actions can be accelerated by ensuring that knowledge

[41] An example of this that is currently being discussed in Canada is a possible collaborative partnership between the US, Canada and Mexico on a prospective longitudinal cohort study on children's health and the environment.
[42] See Appendix C.
[43] CIHR defines knowledge translation as "the exchange, synthesis and ethically-sound application of research findings within a complex system of relationships among researchers and knowledge users" (Canadian Institutes of Health Research 2002).
[44] Paragraph 4 of the *Canadian Institutes of Health Research Act* requires CIHR to " excel, according to internationally accepted standards of scientific excellence, in the creation of new knowledge and **its translation** into improved health for Canadians, more effective health services and products and a strengthened Canadian health care system" (emphasis added).

translation is an integral part of the entire research cycle. There is now a need to apply knowledge translation strategies to research findings on health and the environment.

The need to enhance knowledge translation was also a key finding of the consultation. Consultation comments included the need to strengthen the use of what is already known, the need for researchers and policy-makers to develop a common language, and the need for researchers to ensure that the results of their research are widely communicated in accessible and plain language formats.

> **"Environmental health researchers have a social responsibility to communicate the results of their work to the Canadian public".**
> Participant in the consultation

The Opportunity:
The opportunity is to use the widespread interest in research on the environmental influences on health to strengthen knowledge translation strategies on this subject. It is likely that all types of users of knowledge about health and the environment, including other researchers, government and private sector decision makers, health care providers, and civil society organizations, would welcome opportunities to help develop and participate in such strategies.

Within CIHR, there is an opportunity to use research results on the environmental influences on health as a pilot project to demonstrate an early application of CIHR's emerging framework and programs for knowledge translation[45]. This would benefit everyone with interests on this subject, and would provide valuable information on the translation of health knowledge.

CIHR's approach to knowledge translation is fully consistent with the needs and strategies described in this paper. In particular, it emphasizes the benefits of integrating knowledge translation into all stages of the research cycle, promoting knowledge translation across CIHR's research pillars, and working with the full range of potential knowledge uses to contribute to a strengthened health care system, more effective health services and products, and improved population health (Canadian Institutes of Health Research 2002).

[45] See: Canadian Institutes of Health Research (2002).

4. A Call to Action

"The environment is the forgotten determinant of health. Canadians need to understand that health is utterly dependent on the environment. Research has a key role to play in helping all of us to grasp this fact".
Participant in the consultation

4.1 Introduction to the Research Themes and Priorities

One of the main consultation findings was that there is a need for a coherent framework within which research priorities can be developed. This section proposes such a framework, recommends four research themes and suggests broad priorities[46]. The framework, themes and priorities are intended to provide a foundation for the national research agenda.

The framework comprises four research themes, based on the consultation findings and other information presented in this paper. The possible research priorities are based on the following criteria, developed by CIHR's Institute of Human Development, Child and Youth Health:

- Has potential to improve the health of Canadians;
- Builds on areas of strength or strengthens emerging capacity;
- Has potential for significant scientific advance;
- Capitalizes on emerging scientific discoveries or technological advances; and
- Requires a strategic trans-disciplinary approach.

The themes are not mutually exclusive, so that research priorities may fit under two or more of the themes. Indeed, priorities that are relevant to all four themes may be more significant than those that fit under one or two of the themes only.

4.2 Theme: Key Populations

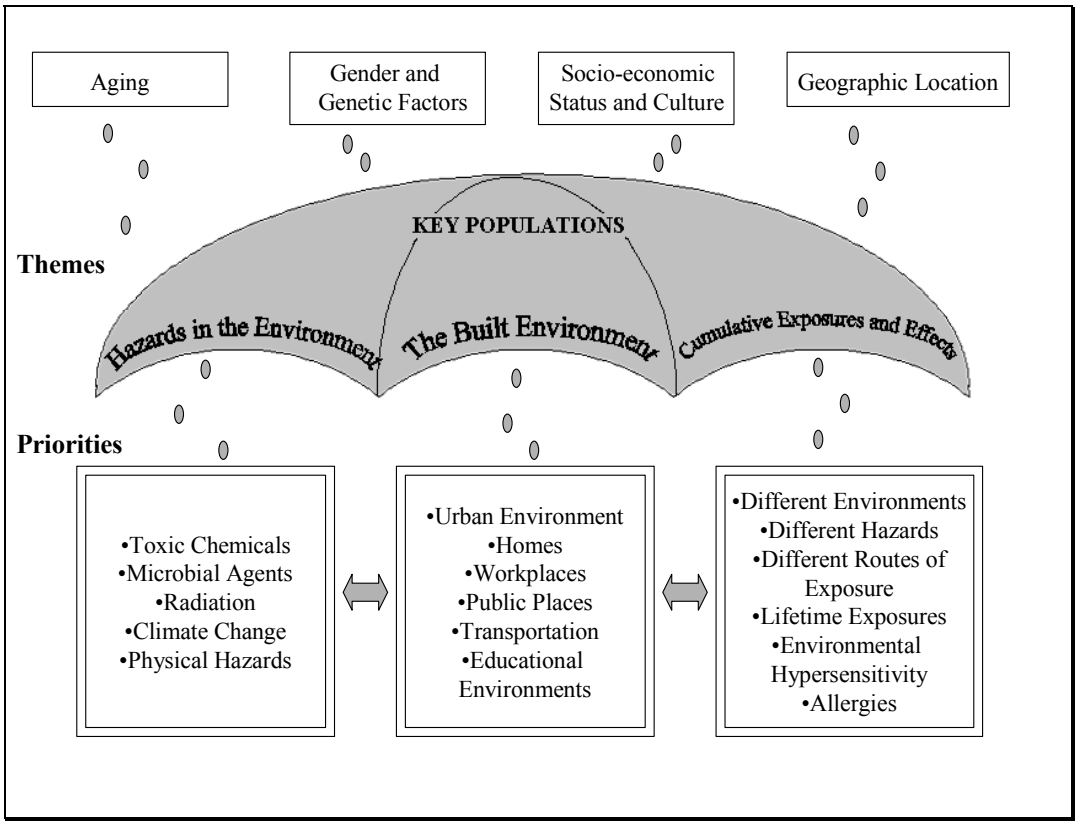
The first theme, key populations, is consistent with a population health approach[47]. CIHR and Health Canada have endorsed a population health approach and the federal, provincial and territorial Advisory Committee on Population Health has recommended that Canadian governments invest in the health and well-being of key population groups

[46] Broadly-based priorities will encourage creative and innovative research applications, while still focusing on research needs.

[47] "The overall goal of a population health approach is to maintain and improve the health of the entire population and to reduce inequities in health between population groups" (Health Canada 1998).

(Advisory Committee on Population Health 1999). Because of the nature of this theme, it is proposed that key populations should be an overarching theme and that the three others (hazards in the environment, the built environment, and cumulative exposures and effects) should be considered in the light of key populations, as shown in Figure 2.

Figure 2: The Framework, Themes and Research Priorities



In other words, it is suggested that research priorities could be developed using the following process:

1. Identify key populations on the basis of the factors listed below; and

2. For each key population, select the most important priorities for each theme. For example, if children are identified as a key population, then for the theme on hazards in the environment, research on toxic substances could be a priority.

Consistent with the consultation findings, CIHR proposes that key populations should be identified on the basis of: age; gender and genetic factors; socio-economic status and culture; and geographic locations that lead, or could lead, to higher than average exposures and/or effects on health. Factors that could be considered for each of these criteria include:

- **Age**:
  - The critical "windows of exposure" to substances that can affect fetal and embryonic development;
  - The implications of exceptionally high growth rates and environmental exposures for the health of adolescents; and
  - The combined consequences of having an increasing proportion of Canadians aged 65 or over, and the effects of lifetime exposures to toxic chemicals[48].

> **"The key priorities, in our view, should include those issues that address Canada's most sensitive population subsets, such as children and the elderly".**
> Participants in the consultation

- **Socio-economic Status and Culture:**
  - Interactions between the biophysical environment and socio-economic status on health, for example people living in poverty can be exposed to higher levels of contaminants[49];
  - Immigrants from Southeast Asia who catch and eat freshwater fish that may be contaminated; and
  - Aboriginal peoples who eat contaminated country foods, including fish, wild meat, and marine mammals.

Geographic Location:

- People living near hazardous sites or industries that release toxic substances;
- Agricultural and rural populations that do not have access to adequately treated drinking water or who may be exposed to agricultural chemicals; and
- Populations who are likely to be disproportionately affected by climate change[50], especially Northern and urban populations.

[48] As noted by CIHR's Institute of Aging "Over the next 25 years the aging of the Canadian population will increase dramatically as baby boomers enter late life. The proportion of the population over the age of 65 will grow from the current 13% to 25% by the year 2026" (Institute of Aging 2002).
[49] Chaudhuri (1998) has shown that children living in poverty can have larger environmental exposures than other children.

- **Gender and Genetic Factors**:
    - Women; there is abundant evidence that environmental factors contribute to many diseases in women, including breast and ovarian cancers, osteoporosis, endometriosis, uterine fibroids and autoimmune diseases [51]; and

> **"Right now, many research results are invalid because they do not properly treat the variables of sex and gender, resulting in inaccurate results for both men and women".**
> Participant in the consultation

    - People with genetic predispositions to environmentally-mediated health conditions, such as asthma[52].

4.3 Theme: Hazards in the Environment

Following the identification of key populations, CIHR proposes that research priorities under the theme of hazards in the environment should be identified for each key population on the basis of:

- **Exposures and effects of toxic chemicals,** such as:
    - Persistent toxic chemicals in food air, water, and perhaps soil[53];
    - The effects on long-range transport and deposition of persistent toxic chemicals on the health of Canadians;
    - Organic and inorganic substances, including endocrine disrupting substances[54], metals, pesticides, and pharmaceuticals and health care products in drinking water;
    - Particulates in air and the effects of smog on health.

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[50] Hancock and Davies (1997) and the Canada Country Study on the effects of global ecological change on the health of Canadians (see: http://www.ec.gc.ca/climate/ccs/ccs_e.htm) have identified these populations.
[51] See the US Federal Interagency Working Group's Report on Women's Health and the Environment at: http://www.4woman.gov/owh/environmental.htm.
[52] See section 2.5 for information on CIHR's cross-cutting strategic initiative on gene-environment interactions.
[53] For most persistent organic pollutants, food accounts for 80-95% of total daily intake, air accounts for 10-15% and water and soil contribute the remainder (Health Canada and the Ontario Ministry of the Environment 1995).
[54] Endocrine disrupting substances is one of the priority areas of research for environment and health identified by the federal, provincial and territorial Advisory Committee on Population Health (Advisory Committee on Population Health 1999). There is also a national research agenda on endocrine disrupting substances (5NR EDS Working Group. 2000).

- **Exposures and effects of microbiological agents in the environment[55],** such as bacteria[56], viruses, prions and protozoa.

- **Exposures and effects of radiation,** including ionizing and non-ionizing radiation, electro-magnetic fields, UV[57], noise, and light pollution.

- **The health effects of climate change** and extreme weather events, including temperature-related morbidity and mortality[58] (Reidel, 2002); and

- **Injuries resulting from environmental hazards[59],** including preventive approaches[60].

4.4 Theme: The Built Environment

The consultation findings indicate that research priorities under the theme of the built environment could be identified for the key populations on the basis of:

- **Urban environments[61],** such as planning and development, infrastructure, building design, personal security, and open spaces and naturalization;

- **Homes,** such as indoor air quality[62], the use of pesticides, and healthy housing.

- **Workplaces,** especially take-home exposures[63] and cumulative exposures and effects to substances present in the workplace and in other environments.

> **"The workplace is often treated as an isolated environment so that research treats workplaces as the only source of exposure for workers. It is important to take a more integrated approach and understand that workplace exposures interact with exposures in the home and other environments."**
> Participant in the consultation

[55] Research priorities on the exposures and effects of microbial agents could be linked to the Institutes of Infection and Immunity's priority on the microbial safety of food and water (see section 3.3).
[56] There are approximately 10,000 reported cases of food borne bacterial illness a year. For each case, Health Canada estimates that up to 100 cases are unreported (Health Canada 1997).
[57] Over the last 15 years incidence of malignant melanoma has doubled in Canada (Health Canada 1997). This is largely attributable to UV exposures.
[58] Health Canada has prepared an unpublished fact sheet on Health Impacts from Climate Change and Variability and Research Priorities (Reidel 2002).
[59] Injuries are the second most expensive health care problem in Canada (Health Canada 1997).
[60] The CIHR cross-cutting strategic initiative on Injuries is focusing on repair and rehabilitation.
[61] Approximately 80% of Canadians live in urban environment and about 90% of our lives are spent indoors (Health Canada 1997).
[62] Almost half of the Canadian population is exposed to environmental tobacco smoke on a daily basis (Health Canada 1997).
[63] The US National Institute for Occupational Safety and Health has recently prepared a report on take-home exposures (National Institute for Occupational Safety and Health 2002).

- **Educational environments**, such as school and day care environments[64].

- **Public places**, such as indoor recreational places, such as ice rinks, hospitals and other health care facilities[65], swimming pools and shopping malls.

- **Transportation**, such as cars[66], buses, and planes.

- **Built environments which promote health and well-being**.

4.5 Theme: Cumulative Exposures and Effects

One of the main findings of the consultation was that there is a need for more research on cumulative exposures and effects. Although some research on the cumulative effects of toxic substances was funded under the Toxic Substances Research Initiative[67], a broader understanding is needed because Canadians are exposed to various types of hazards, in various settings, via different routes of exposure.

Research priorities under the theme of cumulative exposures and effects could be identified for each key population on the basis of:

- **Various types of built environments,** for example, combining exposures at work and at home, or combining exposures at school and at home.

- **Exposures from different types of hazards,** for example, combining microbial and chemical exposures.

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[64] The importance of school environments for children's health is widely recognized, for example see the Healthy Schools-Healthy Children Program at Pollution Probe at: http://www.pollutionprobe.org/whatwedo/Child.htm

[65] Largely unrecognised, the activities of the health sector have very significant impacts on the environment and health: they require the use of large amounts of energy for heating, cooling and other purposes, including operating a sizeable vehicle fleet; the sector uses large amounts of both renewable and non-renewable resources, including many single-use and disposable products and some of the health care sector's operations depend on the use of toxic substances; the sector produces large volumes of solid wastes, liquid effluents and air emissions, and either operates or sends significant amounts of waste to waste incinerators that are important sources of dioxins, mercury and other serious pollutants. A recent study has estimated the "ecological footprint" of a Vancouver hospital is 2,841 hectares, more than 700 times the hospital's actual size. For comparison, the "ecological footprint" of the City of Vancouver is only 180 times its actual size (Germain 2002).

66 There are more than 14 million cars on Canada's roads, releasing an average of more than 4 tonnes of air pollutants a year each. See: http://www.goforgreen.ca/active_transportation/

[67] Cumulative effects was one of the four priority areas under the Toxic Substances Research Initiative. See: http://www.hc-sc.gc.ca.

- **Exposures from different routes of exposure,** for example, combining exposures via food, air, water, and skin (dermal) to produce total exposure risk assessments.

- **Exposures to mixtures of chemicals,** and their synergistic, potentiating, additive, and antagonistic effects.

> **"We know hardly anything about the possible health effects of exposures to chemical mixtures, but we are all exposed to the chemical soup every day. Information about the effects of exposures to individual substances is not enough".**
> Participant in the consultation

- **Long-term cumulative exposures over a lifetime**, to environmental conditions that enhance or adversely affect health.

- **Health conditions attributable to cumulative or multiple exposures,** such as environmental hypersensitivity and allergies[68].

4.6 Next Steps

The proposed next key steps in developing and supporting national research priorities for the environmental influences on health are:

- To hold the National Forum to Identify Research Priorities on the Environmental Influences on Health on September 12-14 in Ottawa;

- To secure new financial resources to support research on the environmental influences on health from CIHR's Governing Council and CIHR's funding partners over the fall of 2002;

- To finalize and release the Request for Applications and the document "Towards a National Research Agenda on the Environmental Influences" in the winter of 2002;

- To develop peer review mechanisms to assess applications submitted to CIHR;

[68] According to one report 11 million Americans may experience chemical sensitivities (see: http://www.environmentalhealth.ca/Jan98report.html) and information from the Canada Mortgage and Housing Corporation indicates that 13% of Canadians experience allergies and sensitivities (see: http://www.cmhc-schl.gc.ca/en/imquaf/hehosu/hoenhy/hoenhy_002.cfm.

- To establish an international, multi-stakeholder panel to provide CIHR with advice on research on the environmental influences on health; and

- To increase CIHR's capacity and knowledge of research on the environmental influences on health in Canada and internationally.

In the years ahead, CIHR and its partners will work to strengthen research on the environmental influences on health and build the capacity of the research community.

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Appendix A: Steering Committee

John ApSimon	Science Advisor, Environment Canada
Tye Arbuckle	Research Scientist, Reproductive Health, Health Canada
Jack Bend	Associate Dean, Research, University of Western Ontario
David Blakey	A/Director, Environmental Health Science, Health Canada
John Challis (chair)	Scientific Director, Institute of Human Development, Child and Youth Health, CIHR
Katherine Davies	Special Advisor, Health/Environment and Knowledge Translation, CIHR
Elizabeth Dickson (co-chair)	CIHR Senior Policy Advisor and Director of Knowledge Translation
John Eyles	Director, Institute of Environment and Health, McMaster University
Diane Finegood	Scientific Director, Institute of Nutrition, Metabolism and Diabetes, CIHR
John Frank	Scientific Director, Institute of Population and Public Health, CIHR
J. Don Johnston	Consultant in Occupational and Environmental Health
Dan Krewski	Professor of Medicine and Professor of Epidemiology and Community Medicine, Institute of Population Health, University of Ottawa
Kevin Keough	Chief Scientist, Health Canada

Nicola McDermott	Assistant Director, Institute of Human Development, Child and Youth Health, CIHR
Sue Milburn-Hopwood	Director, Health Impacts Bureau, Safe Environments Program, Health Canada
Elaine Orrbine	Executive Director, Canadian Association of Pediatric Hospitals
Alita Perry	International Liaison Officer, Research Planning and Resourcing, CIHR
Jeff Reading	Scientific Director, Institute of Aboriginal Peoples' Health, CIHR
Bhagirath Singh	Scientific Director, Institute of Infection and Immunity, CIHR
Miriam Stewart	Scientific Director, Institute of Gender and Health, CIHR
Trevor Hancock	Chair, Canadian Association of Physicians for the Environment
Dawn Walker	Executive Director, Canadian Institute for Child Health

Appendix B: Overview of Consultation

1. Introduction and Approach

CIHR is committed to "partnerships that will advance Canada's health research agenda and engage the Canadian public" (CIHR 2001), and consultation with the broad diversity of stakeholders with interests in health research is a key element of this commitment. Consistent with this, CIHR conducted a national multi-stakeholder consultation on research priorities for the environmental influences on health from March to August 2002. A Consultation Paper (Davies 2002) provided contextual information for the consultation and posed four questions:

- In your view, what are the current major environmental health research priorities in Canada and internationally?
- What do you see as the strengths and capacities of environmental health research in Canada?
- What do you consider to be the key issue-specific and cross-cutting gaps/needs in environmental health research in Canada?
- What should be the key priorities of the National Research Agenda on the Environmental Influences on Health?

The Consultation Paper was sent to a list of 42 organizations across the country and 11 individual leading researchers. The list of organizations and individuals was compiled using existing CIHR lists, lists provided by other organizations, and recommendations from the Steering Committee.

The Paper was presented and discussed at 6 workshops, most of which were national in scope. It was also posted on CIHR's website, with an invitation to provide comments and suggestions.

CIHR's Institutes and Institute Advisory Boards were consulted using a two-track process. First, all of the Institutes' Scientific Directors were sent a copy of the Consultation Paper and invited to provide comments. Second, each Institute Advisory Board was requested to nominate a representative to collect and synthesize its comments.

Members of the Steering Committee were also invited to give their suggestions and recommendations on the Consultation Paper.

Of the 42 organizations and 11 individuals who were requested to provide comments, 23 organizations and 9 individuals responded. There were also 7 sets of comments received

from other organizations and individuals. Participants at all of the workshops provided rich and varied comments.

Given the high level of interest in this initiative, CIHR's commitment to partnerships, and the many other organizations and individuals who could not be included in this process because of time constraints, CIHR views this consultation as an initial step in developing a long-term dialogue. CIHR plans to continue to engage the broad range of stakeholders in ongoing discussions on research priorities for the environmental influences on health.

2. Organizations and Individuals

Federal Departments and Agencies
Agriculture and Agri-Food Canada*
Canada Mortgage and Housing Corporation
Canadian Centre for Occupational Health and Safety
Canadian Environmental Assessment Agency
Canadian International Development Agency*
Canadian Institute for Health Information/Canadian Population Health Initiative*
Department of Indian Affairs and Northern Development*
Environment Canada*
Fisheries and Oceans Canada*
Health Canada*
International Development Research Centre*
National Roundtable on the Environment and the Economy*
Natural Resources Canada*
Natural Sciences and Engineering Research Council*
Social Sciences and Humanities Research Council*

Provinces/Territories and Local Government
Alberta Heritage Foundation for Medical Research
City of Toronto*
Federal/Provincial/Territorial Committee on Environmental and Occupational Health
Federation of Canadian Municipalities
Michael Smith Foundation for Medical Research (BC)
Nova Scotia Health Research Foundation*

Academic Groups, Networks and Associations
Canadian Association for Research on Work and Health
Canadian Society of Epidemiology and Biostatistics
Canadian Network of Toxicology Centres*
Centre of Excellence for Early Childhood Development, Université de Montréal+
Department of Environmental and Occupational Health, Université de Montréal+
McMaster Institute for Applied Radiation Sciences+

Network for Environmental Risk Assessment and Management
Quebec Environmental Health Research Network∗
Toxicology Society of Canada*[69]

Aboriginal Organizations
Akwesasne Task Force on the Environment
Assembly of First Nations
Centre for Indigenous Peoples' Nutrition
Inuit Tapiriit Kanatami

Private Sector
Canadian Chemical Producers' Association*
Endocrine and Environmental Health Industry Coordinating Committee*

Non-governmental Organizations
Canadian Association of Physicians for the Environment*
Canadian Environmental Network (Health Caucus)
Canadian Labour Congress*
Canadian Medical Association
Canadian Nurses Association
Canadian Public Health Association
Learning Disabilities Association of Canada∗

Workshops
Canadian Public Health Association Annual Meeting (July 8, Yellowknife)*
Health Canada (May 28, Ottawa)∗
Environment Canada (July 24, Hull)∗
South Riverdale Community Health Centre (May 1, Toronto) for Toronto-based non-governmental organizations*
The People and the Planet Conference (June 8, Queens University)*
Informal workshop/discussion group (August 11, University of British Columbia)∗

International Organizations
International Joint Commission∗
North American Commission for Environmental Cooperation∗

Individuals
Irene Buka, Misericordia Hospital, Edmonton

[69] Personal comments were received from Sheldon Roth President of the Toxicology Society of Canada, not from the Society itself.

Phillippe Crabbe, University of Ottawa*
Eric Dewailley, Université Laval*
Richard Gilbert, Consultant in Sustainable Transportation+
Mark Goldberg, McGill University*
Pierre Gosselin, Université Laval*
Judy Guernsey, Dalhousie University*
Clyde Hertzmann, University of British Columbia
Steve Hrudey, University of Alberta
Dan Krewski, University of Ottawa*
David Miller, Carleton University+
Van MacDonald, artist and activist+
Donna Mergler, Université Laval*
Norm Rawlings, teacher+
Jack Siemiatycki, Université de Montréal*

3. Comments and Key Findings

Each paragraph below contains comments from an individual organization, person or workshop. They have been edited for brevity and consistency of language, while ensuring that the original ideas expressed have not been altered.

Question 1: In your view, what are the current major environmental health research priorities in Canada and internationally?

Comments:

Indoor air quality and mould; outdoor air quality and health; microbial hazards in water; the movement of contaminants in the food chain; and developmental neurotoxicology.

Geogenic and anthropogenic sources of metals in the environment; the effects of endocrine disrupting chemicals; risk assessment methods that address exposures to chemical mixtures; and the impacts of pharmaceuticals on environmental quality and health.

Neurotoxicology, immunotoxicity and developmental effects of toxic substances; traditional and exotic pathogens in drinking water; the health implications of climate change; urban and indoor air pollution; lead and mercury; skin cancer resulting from ozone depletion; and the effects of consuming contaminated foods on northern Aboriginal peoples.

Toxic substances and occupational health.

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* Organizations and individuals who provided feedback in response to the invitation.
+ Organizations and individuals who voluntarily provided feedback.

Indoor and outdoor air quality; water quality, including drinking and recreational water, as well as microbial and chemical risks; soil quality/land use; food safety; and noise pollution.

The effects of climate change on air, water and other environmental media.

Water, including sampling procedures, the effects of industry on recreational uses, silt, desalinization, the effects of pharmaceuticals and cleaning products on quality, cumulative effects of multiple exposures, septic systems, aquaculture, harvesting algae, privatization of water and water exports; air, including international collaboration on pollution from energy sources, air quality in indoor rinks, home energy sources and pollution, air pollution from the use of construction materials, urban pollutants and health, peri-natal exposures and effects, and the development of an inventory of air pollutants and their effects; land use, including soil quality and health, the links between soil quality and food quality, the effects of recreational vehicles on land and air quality, health effects associated with the manufacture of chemicals in fertilizers and pesticides.

Safe drinking water, and the transfer of toxic metals up the food chain as well as their effects on health.

The effects of global warming on health; the health of marginalized urban populations; water quality; and the increased use of additives in cosmetics.

Tobacco; the health effects of fungi in homes; lead in water and soil; risk assessment methods for environmental contaminants; multiple chemical sensitivities; air quality and respiratory health; water source assessments; mercury; livestock and air quality; sour gas; health effects of landfill sites; leaching of contaminants from plastic toys; policy successes with the precautionary principle; social sciences research and the environment; risk perception; trans-disciplinary research; and ecosystem and bioregional approaches to health and the environment.

Toxic substances and air pollution.

The effects of environmental quality on Aboriginal peoples' health; air quality and health; toxic substances; and bioregional programs that emphasize knowledge translation, such as the now sunsetted Great Lakes Health Effects Program.

The effects of toxic substances and physical and biological environments on health; air and water quality; cancer; population-based approaches, especially for children; the ambient environment; workplace health; and ecosystem approaches.

Children's health, toxic substances, water contaminants, gene-environment interactions, global change, air quality, cancer and cumulative risk assessment.

Children's environmental health including asthma and other respiratory diseases, the effects of toxic chemicals and pesticides. Toxic substances, including effects of multiple

exposures, exposure data, endocrine disrupting substances, developmental/neurological effects, prevention-oriented approaches. Health impacts of climate change.

International environment/health research.

Children's health and the environment; endocrine disrupting substances; particulate matter in urban air; and multiple exposures to chemicals.

Knowledge of low levels of ionizing radiation, and toxic elements, especially lead.

Air quality and respiratory health, cancer and environmental exposures, exposure to toxic substances among Aboriginal peoples. These are stand alone initiatives, not part of a national strategy for enhancing capacity.

Effects of environmental pollutants on children and developing organisms. Impacts on the pregnant, elderly, and those suffering from chronic disease. Including susceptible subpopulations in guidelines.

Key Findings:

1. The people consulted mentioned a wide range of priorities and confirmed that there is no coherent framework for research priorities and capacity building on the environmental influences on health. Many of the current priorities relate to regulatory and policy needs, or to previously unanticipated events, such as the Walkerton incident in 2000 and the presence of exotic pathogens in water.

2. The most frequently mentioned priorities were:
   - Toxic substances, endocrine disrupting substances and metals in the environment;
   - Air quality and respiratory health;
   - Cancer associated with environmental exposures;
   - Bioregional research programs, such as the Great Lakes Health Effects Program[70]; and
   - Microbial substances in drinking water.

3. Other priorities that were mentioned repeatedly include:
   - Climate change;
   - Aboriginal peoples; and
   - Children's environmental health.

Question 2: What do you see as the strengths and capacities of environmental health research in Canada?

[70] Many people expressed regret that most of these programs have sunsetted.

Comments:
Air quality and health; freshwater research; endocrine disrupting substances; and environmental epidemiology.

Information on health problems in the general population.

Research networks that bring together scientists from different backgrounds.

Networks and partnerships; ecosystem initiatives; and participatory and community-based approaches to research.

Knowledge about the environmental characteristics of the Canadian landmass; research on the effects of toxic substances; and the capacity to integrate environmental and health information.

Research on social sciences, the environment and health and participatory approaches.

Research networks in Quebec and at various universities, including the University of Alberta, McMaster University, and the University of British Columbia.

Increasing capacity in reproductive/developmental effects, cardiovascular disease, neurological effects, and indoor environments.

National health statistics that are collected through Canada's publicly-funded health care system.

Some cancers in some environments; air quality and respiratory health; growing strength in climate change and health; risk and exposure assessments; water quality and microbial risks; endocrine disrupting substances and reproductive and developmental effects; cumulative effects of toxic substances in populations; neurological outcomes; sharing science and translating research findings; and geo-spatial analyses.

Academic and governmental research teams in epidemiology, toxiciology, exposure assessment and risk analysis.

Participatory approaches and persistent organic pollutants, especially long-range transport and ecosystem effects.

Basic toxicology; risk assessment; and environmental epidemiology. Networks in environmental health and toxicology.

Competencies in ionizing radiation from computational modelling of fundamental radiation interaction at the molecular level through to experimental and computational work on environmentally important isotopes. Bone lead x-ray fluorescence and neutron activation cadmium measurements.

Epidemiological and risk assessment methodologies. Statistical methodologists. National health databases.

Outstanding scientists and the capacity to train them (but lack of funds).

Key Findings:

1. There was a consensus that Canada needs more strength and capacity to conduct research on the environmental influences on health.

2. Frequently identified strengths and capacities were:
   - Provincial and university-based research networks;
   - Methods for risk assessment, especially toxicological and epidemiological ones;
   - Community-based and participatory approaches to research; and
   - National, longitudinal health information that is collected as a result of Canada's publicly-funded health care system.

Question 3: What do you consider to be the key issue-specific and cross-cutting needs in environmental health research in Canada?

Issue-specific Needs:

Comments:

Exposure assessments; diseases that can be transmitted from wildlife to humans (e.g., rabies); wildlife as indicators of human health; and contaminants in country foods.

Research on gender- and age-specific effects.

Injury prevention and occupational health.

The health effects of climate change; environmental justice for marginalized populations, including Aboriginal and low-income communities, and immigrant communities; the effects of pharmaceuticals and personal care products in drinking water; pre-conception and pre-natal exposures to environmental contaminants.

Biomonitoring of toxic substances in human tissues and biomarkers at the interface of human and the environment. Exposure assessments.

Use an integrated approach to exposure assessment that includes workplace exposures, exposures at home, and recreational exposures. The total load concept should be included.

Children's environmental health; monitoring the health effects of air pollution spatially and temporally; drinking water quality; and monitoring and surveillance programs. Field

methods for determining levels of toxic chemicals in human tissues and environmental media (food, air, water, soil).

Occupational health.

Risk assessment methods.

Engage specialists in geographic information systems and earth and atmospheric scientists on health and environmental issues and study environmental exposures using a life-course perspective.

Occupational health and exposure assessment studies.

Potential problems with sources of drinking water.

Methods for geo-spatial analysis.

The need for systematic reviews and syntheses of research findings, similar to the Cochrane Collaboration's work on clinical trials.

North-south links on the environment and health.

Gender-based analysis; and research on the effects of sub-clinical deficits at a population level.

Research on methods, including standard setting, as well as risk assessment, perception, communication and management.

Link environmental health research with occupational health research.

The protection of children's health; the need for environmental exposure questions on the National Population Health Survey; synergistic effects of chemical mixtures, strategic partnerships; gene-environment interactions; trans-disciplinary research; organic food and naturopathy.

The workplace environment should be included as one of the environments to which people are exposed.

Ecosystem approaches to human health.

Health effects from polluted water, air and contaminated food; occupational health; population exposures to environmental contaminants; and short-term effects of organic volatile chemicals.

Include the variable of gender in all research.

The effects of consuming contaminated fish; shellfish contamination; water quality at bathing beaches; cadmium in oysters and shrimp; First Nations peoples' consumption of whales carrying burcellosis; E.coli in prawns from British Columbia; and the health effects of genetically modified organisms.

Wildlife as vectors of human disease; wildlife as early warning sentinels for human health; the consumption of contaminated fish and meat; wildlife carnivore management; shared landscapes; wildlife health; and the need for a strategy on wildlife health and disease.

Research on the cumulative effects of long-term low doses of toxic substances on health and recovery of health after removal of environmental stressors.

Ecosystem effects on human health.

Risk analysis.

Children's environmental health, effects of toxic substances and prevention-oriented policy approaches.

Effects of hazardous chemicals on health.

Adaptive responses to ionizing radiation, bystander effects, biological radiation dosimetry, tritium in the environment, ecobiodosimetry. Metabolic models of lead, lead as a risk factor for osteoporosis, uptake of lead into children's bones, release of lead from bone, cadmium levels in wild meat, lead and polonium in caribou, sub-clinical effects of occupational manganese exposure, mercury accumulation in people living close to point sources, and aluminum levels in dialysis patients.

Research on environmental degradation in developing countries. The built environment. Bioaerols, bioterrorism and indoor spaces, global emerging infections, workplace health in a broad context, non-cancer and non-respiratory outcomes, occupational health epidemiological studies of women. Dermal exposure. Water quality and chemical contaminants. Pesticides and antibiotics in feed supplements.

Key Findings:

A large number of issue-specific needs were identified. The most frequently identified issues were:

- Research on new methods, including methods for exposure assessment, long-term, low level exposures, biomonitoring and biomarkers, and risk assessment, management, perception and communication, geo-spatial analysis, field methods for determining levels of toxic chemicals in human tissues and environmental media (food, air, water, soil), and conducting systematic reviews and syntheses of research findings, similar to the Cochrane Collaboration's work on clinical trials;

- Health effects in specific sub-populations, such as gender and age-specific effects, as well as effects on workers and marginalized populations; and
- Health effects associated with air, food and water quality, as well as effects of toxic substances, cumulative effects, ecosystem effects on health and the relationships between wildlife, fish and human health.

Cross-cutting Needs:

Comments:

Collaborative research with international agencies and other countries.

A comprehensive surveillance strategy for human exposures and effects. Link health and environmental information.

Do not allocate new federal money to intramural research. Develop more collaborative approaches between university and federal scientists on specific issues.

The federal government should increase funding for research on the environment and health.

Economic and social costs of environmentally-related health effects, including health care costs, lost earnings, school absences, educational costs. For example, what are the costs of not protecting groundwater from contamination?

Overcoming disciplinary fragmentation, and encouraging links between social, natural and health sciences.

More researchers, especially neurotoxicologists.

Intervention research and research with community partners. Build a process for communities to identify their research needs and then match the needs with researchers.

Transparency and accountability of researchers supported with public funds. Research findings should be easily accessible to the public through a 'clearing house'.

Toxicologists needed.

A coherent research framework; data at the individual and population levels; longitudinal data on the effects of the environment on health; capacity; collaboration with international organizations.

Social science research, knowledge translation, and risk management.

Canada is lagging behind other countries in its research on the environment.
Integrate health and environmental data.

An independent research institute that can provide information to MPs.

Focus on the biophysical environment. Do not include occupational environments.

Economic and social analyses of the health effects of environmental quality.

Use the results of risk assessments to design management approaches.

Pay more attention to endocrine and reproductive effects resulting from low doses during embryonic and fetal development. Also, effects from long-term multigenerational exposures.

Need more neurotoxicologists.

Build research networks to achieve a critical mass of researchers.

Applied public health research capacity is needed. Link researchers with government decision-makers.

Researchers who work with people should communicate the results of their research back to the people involved as soon as possible.

Researchers should be required to have community partners and plans for transferring their results to the public.

Incentives and infrastructure to support research. The need to engage relevant organizations to overcome fragmentation.

CIHR needs a peer review committee on environmental health. There is a need for small, local networks for doing research and larger ones to disseminate the findings. Build capacity for environment and health research by re-training researchers from other related disciplines. Link environmental and health information, and develop new surveillance methods.

Exposure assessment methods for indoor environments.

An accessible Canada-wide database containing environmental characteristics and health information.

More research with communities because they are good integrators of research results. Scientists are too reductionist.

The needs for increased research funding, strengthened capacity and to overcome fragmentation.

Inter-disciplinary approaches to integrate human and ecosystem health, and the cumulative effects over a lifetime.

Build international capacity through the development of trans-disciplinary curricula.

Ensure sustained funding for research.

Interactions between socio-cultural conditions and the biophysical environment that affect health.

The need for a common language between researchers and policy-makers. Policy-makers should be included in defining research questions and methods to ensure that research results are used. There is a need to integrate health science and environmental science. Fragmentation is the number one problem facing environmental health in Canada.

Use a "healthy environments" approach to understand what makes people healthy.

Researchers supported by public funds should be publicly accountable to disseminate the results of their research to the public. Research must be independent from industry influence. Peer review committees should include representatives from non-governmental organizations.

How does the precautionary principle fit into the research priorities? There is too much emphasis on genomics. Use existing scientific information more effectively and ensure that the public has access to it.

Population databases on health and social services need to be linked with environmental databases. Link scientists with users of health research information.

Include research on creating environments that support health, as well as research on protecting health.

Use a holistic approach to understanding illness and disease, for example there is a need to train family physicians to recognize health problems that could be occupationally- or environmentally-related.

Convene a CIHR meeting for all Institutes to present the results of their environmental health research. Research informs policies and programs that prevent health effects and reduce health care costs.

Need to consider home, community and the planet as social and physical spaces.

Researchers have a social responsibility to ensure that the findings of their researcher are understood and applied.

Increase funding. Lack of human resources and infrastructure for environmental epidemiology. There is too much emphasis in CIHR on trans-disciplinary research.

Develop a better definition for the environmental influences on health. The definition of research should include fundamental research. Establish a peer review committee on the environmental influences on health. Occupational health is integral to research on health/environment. Need decentralized networks.

Develop infrastructure and capacity. Improve trans-disciplinary research linking social, natural and health sciences.

Increased funding and support, and building capacity for research through scholarships and career awards.

Strengthen trans-disciplinary research and links between social, natural and health sciences, including policy research. Capacity building in environmental and occupational exposure assessment technologies and research. Occupational hygiene. Laboratory infrastructure for occupational and environmental hygiene. Geo-spatial analysis. Support of researchers, trainees and development of new programs; prevent young talent from leaving Canada; and advance training of clinical scientists.

Key Findings:

1. An extremely large number of cross-cutting issues was identified.

2. There is an urgent need to increase research on the environmental influences on health by increasing levels of funding and other support.

3. Canada should strengthen its capacity for research through scholarships, career awards and training programs in many disciplines, especially neurotoxicology, immunotoxicology and environmental epidemiology.

4. Research on interventions and with community partners is needed.

5. Research networks will help build capacity and overcome fragmentation.

6. Researchers should ensure that the results of their work are publicly accessible and easily understandable by the public, policy-makers and others who use research results.

7. Information and databases on health and the environment should be linked and there is a need to improve monitoring and surveillance.

8. There is a need to improve understanding of the economic and social benefits of reducing exposures.

9. Trans-disciplinary partnerships, North-South links, and collaboration between social, natural and health sciences are needed.

10. A key cross-cutting gap is research on environments that support human health.

Question 4: What should be the key priorities of the National Research Agenda on the Environmental Influences on Health?

Comments:

The North and built environments.

Built environments and the effects of endocrine disrupting substances.

Built environments and indoor air quality; children; nutritional status and environmental exposures; and trans-disciplinary research between toxicologists and epidemiologists.

Sensitive sub-populations and exposure pathways.

Children's health and development; urban air pollution; and microbial hazards.

Women's occupational health and women's environmental health.

Environmental tobacco smoke.

Cumulative environmental effects from lifetime exposures in older adults.

The effects on human health of growth hormones given to animals, and drinking water quality and health. Endocrine disrupting substances.

The effects of environmental exposures on DNA and their potential health outcomes; the need to link this initiative with CIHR's Rural Health Initiative; regional disparities and inequities; research on effective policy and program interventions; the need for a global perspective on environmental health; and risk communication.

Critical sub-populations and the effects of global ecological change.

Tracking outbreaks of infectious disease. Microbial contaminants in food and water.

Food contaminants, especially genetically modified organisms.

The effects of in-vehicle air quality, especially on children, and the role of transportation trends on obesity, especially in children.

Biomonitoring.

Water quality.

Indoor air quality.

Children and seniors.

No specific issues should be targeted.

Research on urban populations; integrated risk assessments that assess the combined risks of multiple exposures; translate health research findings for local governments; consistent indicators; better surveillance tools, such as biomarkers; linking environmental exposures with health outcomes; the economic benefits of reducing environmental exposures; and assess the effectiveness of intervention strategies, including social marketing, legislation and regulations, voluntary instruments, at reducing health risks.

The effects of endocrine disrupting substances on development and reproduction.

The health impacts of transportation policies need to be better understood.

Toxic substances; community health; air quality and health; and outreach to health professionals.

Aboriginal health and environmental quality.

The attempt to identify research priorities is mis-guided. Available funds should be ear-marked for capacity building, large-scale long-term cohort studies, and investigator-initiated research.

Funding on fast emerging issues.

Drinking water, cumulative risk, environmental cancer, risk analysis.

Water and water-borne diseases; interactions between health (infectious diseases) and environmental change.

Assessment (toxicological and epidemiological) of health effects associated with drinking water and gene-environment interactions; and development of biomarkers (exposure and effects) for risk assessment and epidemiological studies.

Health effects of low-level exposure to ionising radiation, effects of radon in the built environment, health risks and benefits of different fuel sources for power production. Metabolic models for lead in the human body, use measures of levels of aluminium in the body to study the link between aluminium, Alzheimer's disease and normal bone health, links between levels of inorganic mercury in the body and point sources, risks of cadmium exposure, and risks of chronic exposure to manganese.

Preventive strategies, and services and supports for children and families affected by exposure to tobacco and alcohol.

Rural and remote communities. Workplace health. Water quality.

Funding.

Key Findings:

The most frequently mentioned proposed research priorities were:

- Built environments, urban and indoor air quality, and health effects of transportation;
- Key populations including children, seniors, women, and Aboriginal peoples;
- Exposures and effects of toxic substances, especially endocrine disrupting substances; and
- Microbial hazards in food and water.

4. Summary of the Consultation

CIHR is extremely grateful to everyone who provided comments and suggestions on the Consultation Paper (Davies 2002). The number of responses and the exceptional quality of the comments demonstrates that stakeholders have a high level of interest in research on the environmental influences on health, as well considerable knowledge of the subject. The following key themes emerged from the consultation:

Scope of the National Research Priorities:

There were many comments on how CIHR and its partners should scope national research priorities for the environmental influences on health. Almost everyone agreed that the priorities should focus on the biophysical environment and that it is important to include how the biophysical environment interacts with other determinants of health, especially social, cultural, economic and genetic factors.

In response, for the purposes of this Options Paper, CIHR proposes that the environmental influences on health be defined as:

The effects of the biophysical environment (including air, water, land/soil) on human health and its interactions with other determinants of health.

There was a consensus that the scope of the national research priorities should include research across the four pillars of health research[71]. Many agreed that there is a need to focus on research in pillars 3 and 4. One person stated: "We need to look at what affects health at a population level. There is already plenty of research on toxicological mechanisms and not enough on health itself".

There were also several comments on the need to situate human health within the larger context of ecosystem health. One researcher stated: "We need to develop inter-disciplinary approaches that integrate human health into ecosystem health. Human health depends on ecosystem health". Consistent with this comment, representatives from Environment Canada's Wildlife Service encouraged CIHR and its partners to consider supporting research on the links between wildlife and human health.

Several people recommended that research on environments that contribute to human health is needed, in addition to the traditional emphasis on research that addresses the risks to health.

Research Orientation:

There was a consensus that there is an urgent need for Canada to conduct more research on the environmental influences on health, so that sound decisions can be made by the range of users that rely on health research findings. Many people mentioned the need for research to support "evidence-based decision-making", especially with respect to public policy.

The question of where the research priorities should be situated on the continuum between basic and applied research was discussed at two of the workshops. One participant at an Environment Canada workshop commented that since the 1980s Environment Canada's research has focused on applied research to support legislation, regulations and other types of governmental decision-making mechanisms. On the other hand, it was recognized that the granting councils, including CIHR, are responsible for supporting all types of research – from basic through to applied.

Representatives of non-governmental organizations and health professionals stated that there is a need for research on interventions to protect and promote health, as well as research on assessing risks to health. These people commented that research on the environmental influences on health has traditionally emphasized hazard and risk assessment, rather than research on risk prevention, reduction, and management. It was noted that research on adaptation and behavioural change is underway on climate change and that this approach is needed in the broader context of research on the environmental influences on health.

[71] The four CIHR pillars of health research are biomedical; clinical; research on health services and systems; and the social, cultural and environmental factors that affect the health of populations.

Many researchers provided comments on the need for research on methods, especially methods for determining exposures and effects.

Research Priorities:

There was a consensus that the research priorities[72] proposed in the Consultation Paper (Davies 2002) were valid, although many provided suggestions for additional priorities, often based on their own areas of expertise. Thus, there was no consensus on what the actual research priorities should be. It also became apparent that there is a need for a framework in which to locate specific research priorities.

In response, CIHR proposes a framework for research priorities on the environmental influences on health comprising:

- Key populations, defined on the basis of age, gender/genetics, socio-economic status, culture, and geography;
- Exposures and effects resulting from hazards in the environment, including chemicals, microbes, radiation, physical hazards, and climate change/extreme weather events;
- The built environment, including urban, residential, workplace and educational environments, public places, and different modes of transportation; and
- Cumulative exposures and effects, including chemical mixtures.

These four elements are inter-connected and mutually reinforcing, rather than mutually exclusive.

The Need to Increase Research Capacity:

There was a consensus that Canada should increase its capacity to conduct research on the environmental influences on health. Three types of capacity were singled out as being especially important:

- The need for more researchers, including immunotoxicologists, neurotoxicologists, and environmental epidemiologists;
- The need for more infrastructure, including linked health and environmental databases, laboratories, and research networks; and
- The need to increase resources for research, especially levels of funding.

[72] Children's environmental health, the effects of toxic substances in the environment on health, the effects of microbial hazards on health, indoor environments and their effects on health, gene-environment interactions, and the effects of global ecological change on health.

Partnerships and Collaboration:

There was a consensus among government representatives that there is a need to build partnerships and collaboration, including:

- Mechanisms for joint funding of research projects between CIHR, other granting councils, and government departments[73];
- Trans-disciplinary research teams, especially ones comprising health and social scientists[74];
- Research partnerships between academics and communities (see the section on Knowledge Translation); and
- Joint research projects with other countries and international organizations.

Knowledge Translation:

Many of the people consulted commented that research findings should be translated more effectively to ensure that they are used. One non-governmental representative went so far as to say: "We have to use the science we already have, and not get tied up in bettering it". Non-governmental representatives also emphasized the need for public accessibility to research results in plain language formats, and suggested the creation of an information clearing-house. A government representative highlighted the need for two-way dialogue between researchers and users of research results. He emphasized the need for researchers and policy-makers "to develop a common language", and that "policy-makers should be included in defining research questions so as to ensure that research results are used and applied".

There was also widespread recognition of the benefits of partnerships between communities and academic researchers. The example of CIHR's Community Alliances for Health Research program was mentioned. It was generally agreed that academic-community research partnerships help promote knowledge translation.

5. References

CIHR, 2001. r:evolution – CIHR: Towards a National Health Research Agenda. MR21-30/2001. ISBN 0-662-66164-8. Ottawa, Ontario.

[73] It should be noted that representatives from non-governmental organizations stated that they would be opposed to any funding partnerships between the private sector and CIHR. In contrast, private sector representatives indicated that they supported research funding partnerships with CIHR, in theory.

[74] A few researchers said that they are uncomfortable with the increasing emphasis of trans-disciplinary research.

Davies, K. 2002. Consultation Paper for the Proposed National Research Agenda on the Environmental Influences on Health. Draft. Prepared on behalf of the Canadian Institutes of Health Research. Ottawa, Ontario.

Appendix C: Overview of Research

1. Introduction and Approach

This overview of research on the environmental influences on health has been prepared to help inform the development of national research priorities. For the purpose of this document, the environmental influences on health are defined as the effects of the biophysical environment (including air, water, land/soil) on human health and its interactions with other determinants of health (section 1 of the main paper).

The overview focuses on academic researchers and research conducted in Canada. Although there is a significant capacity for research on the environmental influences on health within Canadian government departments and agencies, the private sector and communities, CIHR's primary focus is on supporting researchers in universities and their affiliated institutions and hospitals.

Three main projects provided the background information for this overview:

- A survey of Canadian academic researchers active in health and environment research;
- A review of the key mechanisms for funding research on health and the environment; and
- Assessments of research applications made to CIHR that address the environmental influences on health, and research currently being supported by CIHR.

The methods and key findings of each project are described below.

Several additional sources of information were reviewed including the Overview of Consultations (Appendix B), a study on Capacity Building in the Social Sciences and the Humanities for Climate Change and Sustainable Development Analysis in Canada (Crabbe 2002), and a Health Canada database on Canadian researchers and laboratory capacity on children's environmental health (Health Canada 2002). CIHR plans to expand and update this review of Canadian research on the environmental influences on health in the coming years.

2. Survey of Canadian Researchers: Method and Findings

Method:

The objectives of this project were to prepare a database of Canadian researchers and their current projects.[75], and then to analyse the database to determine the main research interests of the researchers. The world-wide web served as the primary source of information for identifying researchers. Initially, searches were conducted of each of the 53 Canadian university web sites, focusing on research expertise listed under key terms such as environmental health, toxicology and environment, ecosystem and human health, and environmental contaminants.

Subsequently, a letter and a survey response form (in English and French) were e mailed to individuals identified through the web searches. The survey response form comprised the following fields: professor's name, affiliation, phone and fax numbers, e-mail, web address (if available), research interests, current research project(s), funding and key terms. The letter and survey response form were also sent to additional people known to the team working on this project. Additional names were obtained via responses from those researchers initially contacted, as well as through additional searches of Canadian environmental websites.

Following a three week interval, individuals who did not respond were contacted in a second e mail, reminding them of the project and asking if they would like to submit personal profiles for the database. Those who did not respond to the first or second e mails, or responded in a negative fashion were excluded from the database. A third e mail was then sent to all of those who replied with submissions, requesting their permission to include personal e-mail and mailing addresses in the database. Grants of permission have been saved and filed.

A total of 295 researchers were contacted, 108 provided information for inclusion in the database, 5 declined to provide information, and 187 did not respond, giving a response rate of 37%. Thus, this database is not comprehensive and may not be representative of the Canadian health and environment research community or their research interests.

The final phase of database development involved recording information on each of the responding researchers in a spreadsheet format under the following headings: researcher's name, institution, e-mail address, title(s) and description(s) of current research project(s), funding and key terms. Select key terms have been established based on common interests among the researchers. The database will be made searchable by name, institution, and key term(s), and is intended to be publicly accessible. There are plans to expand the database to include government, private sector and community researchers. It is hoped that the database will be updatable by researchers on-line.

[75] The database was compiled by Allison Wagg of the McMaster Institute of Environment and Health.

Findings:

Initially, the database was reviewed to identify which of CIHR's research pillars best represents each researcher's interests. The results are shown in Table C-1 below.

Table C-1: Proportion of Health/Environment Researchers in Each of CIHR's Research Pillars

Research Pillar	# of Researchers n = 108	% of Researchers n = 108
1. Biomedical research	28	26%
2. Clinical research	8	7%
3. Research on health systems and services[76]	4	4%
4. Research on populations[77]	59	55%
Research across pillars	6	6%
Unknown	3	3%

This Table shows that the majority of health/environment researchers (55%) who responded to the survey conduct research on populations. At the other end of the scale, only a small proportion (4%) of the responding researchers carry out research on health systems and services. Similarly, only a small proportion (6%) are conducting research across CIHR's pillars. This trans-disciplinary research crosses pillars 1 and 2 (biomedical and clinical research), 1 and 4 (biomedical research and research on populations), or pillars 3 and 4 (research health services and systems and populations).

These findings suggest that Canada may have capacity in population health research on the environmental influences on health. This capacity is likely to comprise environmental epidemiologists and researchers working on exposure assessment. The findings also indicate that Canada has some strength in biomedical research, probably mostly environmental toxicologists. Notably, only 4 of the responding researchers have research interests in health systems and services. This suggests that there is very little research to support public policy and health care decisions relating to health and the environment.

A more detailed analysis of the database shows that Canadian researchers are engaged in a broad range of studies on the environmental influences on health. Some of the issues addressed are shown in Table C-2 below:

[76] This includes research on health policy.
[77] This includes research on population-based exposure assessment.

Table C-2: Selected Health and Environment Issues Addressed by Canadian Researchers

Issue	# of Researchers[78]
Exposures and Media:	
Air quality	28
Water quality/quantity	17
Biomarkers/enzymes	7
Gene-environment interactions	7
Food quality	6
Methods for exposure assessment	3
Hazards:	
Toxic substances, endocrine disrupting substances, metals, and pesticides	33
Microbial	8
Climate change	8
Radiation	4
Sites:	
Workplace health and safety	17
Indoor environment	7
International	7
Bioregional studies	4
Agriculture or rural	4

[78] The sum of the number of researchers in this table exceeds the total number in the database because many researchers described more than one project and some projects address more than one of the issues listed above.

Issue	# of Researchers
Health outcomes:	
Cancer	18
Respiratory	18
Reproductive	14
Cardiovascular	4
Mortality	2
Environmental hypersensitivity	2
Neuro/developmental	1
Key Populations:	
Children	18
Aboriginal	3
Women[79]	2
Other:	
Social science	
Ecosystem approach	13
Health promotion	5
Lifespan approach	3
	1

This Table suggests that Canadian academic researchers have strengths in: toxic substances, endocrine disrupting substances, metals, and pesticides; air quality, cancer; respiratory health; children's environmental health; water quality/quantity; and workplace health and safety.

The Table suggests that Canadian researchers focus on identifying and understanding the risks and effects of the biophysical environment on health. There appear to be few researchers working on risk management strategies to reduce or eliminate exposures. As a result, Canada may be weak in research that supports evidence-based decision-making for risk management. This observation is consistent with the findings from Table C- 1, suggesting that there is little research in Canada on health systems and services (pillar 3). The Table also indicates that there is little research on environmental conditions and practices that promote health.

[79] This number does not include research on reproductive outcomes.

3. Review of Key Funding Mechanisms: Method and Findings[80]

Method:

The objective of this project was to identify key funding mechanisms for research on the environmental influences on health in Canada and to review the types of research that are being supported. The project was limited to mechanisms that fund research conducted by the academic community in Canada, including federal programs that support collaborative research between government scientists and academic researchers. Similar to the survey of Canadian researchers described above, this review is not comprehensive and may not be representative of existing funding mechanisms.

The following types of key funding mechanisms were identified:

- Federal and provincial government, including the granting councils;
- Foundations; and
- The private sector.

Several approaches were used to collect information on each identified funding mechanism, including web searches, and meetings, discussions and e mail correspondence with the relevant organizations and individuals.

Findings[81]:

Table C-3 shows several funding mechanisms for research on the environmental influences on health, including government granting councils and agencies, and private foundations. These organizations support research activities that are congruent with their respective roles and responsibilities, with some focusing on capacity building programs, such as training and career support, and others addressing infrastructure and individual research projects. The numbers in **bold** represent the totals for that organization for the year shown.

[80] This review of key funding mechanisms is based on research conducted by Crescentia Dakubo.
[81] See also section 2.2 of the main paper.

Table C-3: Funding Mechanisms for Academic Research on the Environmental Influences on Health in Canada[82,83]

Org'n	Program Title/ Research Focus	Funding Period[84]	Award Length (y)	Amount($/y)	Total ($)
Social Sciences Humanities Research Council [85]	Research Development Initiatives	2001/02 - 2003/04	3	31,400	
	Major Collaborative Research Initiatives (Coasts Under Stress)[86]	2000/01 - 2004/05	5	499,734	
	Society, Culture, and Health II	2001/02 - 2003/04	3	219,567	
		2000/01 2001/02 2002/03 2003/04	N/A	N/A	499,734 750,701 750,701 750,701

[82] References for the Table: Alberta Heritage Foundation for Medical Research, http://www.ahfmr.ab.ca/programs.html; Canadian Environmental Assessment Agency, http://www.ceaa-acee.gc.ca/0010/0001/0004/2001_e.htm; Canadian Foundation for Innovation. http://www.innovation.ca/projects/index.cfm; Canada Mortgage and Housing, http://www.cmhc-schl.gc.ca/en/imquaf/hehosu/hoenhy/hoenhy_003.cfm; Canadian Network of Toxicology Centres, http://www.uoguelph.ca/cntc/research/priority02-04.shtml; Canada Research Chairs, http://www.chairs.gc.ca/english/Media/news/index.html; Climate Change Action Fund, http://www.nrcan.gc.ca/css/imb/hqlib/200117eb.htm; International Development Research Centre (Ecohealth Program). http://www.idrc.ca/research/xecohealth_e.html; Laidlaw Foundation. http://www.laidlawfdn.org/; McConnell Family Foundation, http://www.mcconnellfoundation.ca/grants.e/2001.html; Michael Smith Foundation for Health Research, http://www.msfhr.org/sub-about-people-award-career-2002.htm; Natural Sciences and Engineering Research Council of Canada, http://www.nserc.ca/programs/funding_dec_e.htm; Networks of Centers of Excellence, http://www.nce.gc.ca/nets_e.htm; Northern Contaminants Program, http://www.ainc-inac.gc.ca/NCP/abt/index_e.html; Occupational Health and Safety Research Institute Robert-Sauvé, Quebec, http://www.irsst.qc.ca/htmen/Communiques/010823.htm; Salamander Foundation, http://www.salamanderfoundation.org/grants.htm; Social Sciences Humanities Research Council, http://www.sshrc.ca/english/programinfo/competition-results.html; Toxic Substances Research Initiative, http://www.hc-sc.gc.ca/ehp/ehd/tsri/funding_1999_2000.htm.

[83] Amounts for future years represented commitments that have already been made.

[84] Most of the years are fiscal years, a calendar year is denoted by CY.

[85] SSHRC's mandate is to promote and support research and research training in the social sciences and humanities in Canada.

[86] The impact of social and environmental restructuring on environmental and human health is a five-year $6.2 million project partially funded by SSHRC ($2,498,672) under its Major Collaborative Research Initiatives, and NSERC ($3,690,356) under its Research Networks Program.

Org'n	Program Title/ Research Focus	Funding Period[84]	Award Length (y)	Amount($/y)	Total ($)
Natural Sciences and Engineering Research Council[87]	Research Networks Program (Coasts Under Stress)[88]	2000/01 – 2004/05	5	738,071	
	Northern Research Chair Programs[89]	2002/03 – 2006/07	5	150,000	
	NSERC-OPG Industrial Research Chair in Atmospheric Sciences[90]	2002/03 – 2006/07	5	350,000	
		2000/01 2001/02 2002/03 2003/04 2004/05 2005/06 2006/07	N/A	N/A	738,07 738,071 1,238,071 1,238,071 1,238,071 500,000 500,000
Canadian Foundation for Innovation[91]	New Opportunities Fund	2000/01 2001/02 2002/03	N/A	N/A	66,277 435,749 137,022
	Innovation Fund	2000/01 2002/03			1,409,080 1,323891
	College Research Development Fund	2000/01 2001/02 2002/03			243,230 210,811 210,236
	Canada Research Chairs Infrastructure Fund	2000/01 2001/02 2002/03	N/A	N/A	1,718,587 646,560 1,671,149

[87] NSERC's mandate is to make investments in people, discovery and innovation for the benefit of Canadians

[88] The impact of social and environmental restructuring on environmental and human health is a five-year $6.2 million project partially funded by SSHRC ($2,498,672) under its Major Collaborative Research Initiatives, and NSERC ($3,690,356) under its Research Networks Program.

[89] A total of $750,000 over a five-year term; 150,000/year.

[90] A five-year joint initiative by NSERC (1,750,000) and Ontario Power Generation ($1,500,000) will focus on air pollution research.

[91] CFI's mandate is to provide infrastructure support to new academic staff in areas that are essential to the institution's research development

Org'n	Program Title/ Research Focus	Funding Period[92]	Award Length (y)	Amount ($/y)	Total ($)
Canada Research Chairs[93]	Tier 1 Chairs[94]	2000/01	7	200,000	1,400,000
		2001/02	7	600,000	4,200,000
		2002/03	7	800,000	5,600,000
	Tier 2 Chairs	2001/02	5	100,000	500,000
		2002/03	5	200,000	1,000,000
		2000/01	N/A	N/A	1,400,000
		2001/02			4,700,000
		2002/03			6,600,000
Networks of Centres of Excellence[95]	Canadian Bacterial Diseases Network	2002/03 - 2004/05	3	N/A	11,400,000
	Canadian Water Network	2000/01- 2004/05	5		14,900,000
	Sustainable Forest Management Network	1999/00 – 2005/06	7		25,442,000
		2000/01	N/A	N/A	6,615
		2001/02			6,615
		2002/03			10,415
		2003/04			10,415
		2004/05			10,415
		2005/06			3,635
Canadian Network of Toxicology Centres[96]	Research Program Projects:				
	-Reproductive and Endocrine Toxicology	2002-03	N/A	N/A	N/A
	-Risk Assessment Methodologies	2002-03			
	-Metals Speciation	2002-03			

[92] Most of the years are fiscal years, a calendar year is denoted by CY.

[93] CRC's mandate is to enable Canadian universities and their affiliated research institutes and hospitals achieve the highest levels of research excellence

[94] Tier 1Chairs receive $200,000/year for a seven-year term and Tier 2 Chairs receive $100,000/year for a five-year term.

[95] The NCEs have the mandate to mobilize Canada's research talent in the academic, private and public sectors and apply it to the task of developing the economy and improving the quality of life of Canadians.

[96] CNTC's mandate is to address Canada's needs in the understanding of toxic substances in the most efficient and coordinated manner.

Org'n	Program Title/ Research Focus	Funding Period[97]	Award Length (y)	Amount ($/y)	Total ($)
Toxic Substances Research Initiative[98]	Persistent Organic Pollutants	1999/2000 2000/01	N/A	N/A	928,000 1,489,600
	Metals	1999/2000 2000/01			656,000 752,400
	Endocrine Disrupting Chemicals	1999/2000 2000/01			950,400 869, 400
	Air Quality	1999/2000 2000/01			1,927,200 2,182,700
	Cumulative Effects	1999/2000 2000/01			1,065,600 1,565,000
		1999/2000 2000/01	N/A	N/A	5,527,200 6,859,100
Northern Contaminants Program[99]	Human Health	2000/01 2001/02 2002/03[100]	N/A	N/A	769,968 769,968
		2000/01 2001/02	N/A	N/A	769,968 769,968
Climate Change Action Fund[101]	Human Impacts and Adaptation (Health)	2001 2002/03[102]	N/A	N/A	219,260
International Development Research Centre (Ecohealth Program)[103]	Ecosystems Approaches to Human Health Training Awards [104]	2001 2002	N/A	N/A	90,000 75,000
	Global Health Research Program Development and Planning Grants[105]	2002/03	N/A	N/A	N/A

[97] Most of the years are fiscal years, a calendar year is denoted by CY.
[98] TSRI's mandate is to enhance the knowledge base needed to define and reduce the risk of adverse effects of toxic substances on Canadians and their environment.
[99] NCP's mandate is to work towards the reduction and elimination of contaminants in traditionally harvested foods, while providing information that helps informed decision-making by individuals and communities in their food use
[100] A call for funding proposals for the 2002/03 fiscal year ended on January 7th 2002.
[101] CCAF's mandate is to help Canada meet its commitments under the Kyoto Protocol.
[102] A call for funding proposals for the 2002/03 fiscal year are due on September 12th, 2002.
[103] The mandate of IDRC's Ecohealth Program is to support research on ecosystem management to improve human health and well-being.
[104] At $15,000 per student, the program gave out six awards in 2001 and five in 2002.
[105] The first of a two-grant program established by Canada's coalition for global health research, including CIHR, CIDA, IDRC and Health Canada. The Research Program Development Grant is up to $100,000 and the Planning Grant is up to $50,000 for researchers based in a single university, and up to $75,000 in multiple universities.

Org'n	Program Title/ Research Focus	Funding Period[106]	Award Length (y)	Amount ($/y)	Total ($)
Canadian Environm'l Assessment Agency[107]	Research and Development Program	2002/03[108]	N/A	N/A	N/A
Canada Mortgage and Housing[109]	External Research Program (Indoor Air Quality, Environmentally Hypersensitivity)	N/A	N/A	N/A	N/A
Occupational Health and Safety Research Institute Robert Sauvé, Quebec[110]	New Researcher Salary Award (Bioaerosols and the work environment)	2001 2002 2003	N/A	N/A	35,000 35,000 35, 000
Alberta Heritage Foundation for Medical Research[111]	Health Research Fund	2001 2002 2003 2004	N/A	N/A	50,000 50,000 50,000 50,000
Michael Smith Foundation for Health Research in BC[112]	Trainee Awards (Population Health)[113]	2002 2003	N/A	N/A	20,000 22,500
Laidlaw Foundation[114]	Environment Program - Children's Environmental Health Partnerships	2001 [CY]	N/A	N/A	10,000

[106] Most of the years are fiscal years, a calendar year is denoted by CY.
[107] CEAA's mandate is to help the federal government meet future challenges and improve the practice of environmental assessment in a manner that is efficient and encourages innovation and excellence.
[108] For the 2002-2003 call for proposals, approximately $200,000 has been set aside to fund research in a number of priority areas in environmental assessment including human impact assessment.
[109] CMH's mandate is to help Canadians understand and improve the technical, economic, environmental and social aspects of housing
[110] IRSST's mandate is to develop and disseminate scientific knowledge for the prevention of occupational injuries and diseases and the rehabilitation of affected workers
[111] AHFMR's mandate is to support a community of researchers who generate knowledge that improves the health and quality of life of Albertans and people throughout the world.
[112] MSFHR's mandate is to build British Columbia's capacity for excellence in health research.
[113] $20,000/yr stipend and 2,500/y for research and travel, up to 2 y for Masters and 5 y for doctoral.
[114] The Laidlaw Foundation's mandate is to build healthy environments to help children and youth achieve their potential.

Org'n	Program Title/ Research Focus	Funding Period[115]	Award Length (y)	Amount ($/y)	Total ($)
Salamander Foundation[116]	Health and the Environment	2001 2002 2003 2004	N/A	N/A	177,500 59,500 59,500 59,500
McConnell Family Foundation[117]	Foundation Initiatives (Ecosystem Health Program)	2001	N/A	N/A	175,000[118]

The Table shows that federal granting councils, such as the Social Sciences Humanities Research Council, the Natural Sciences and Engineering Research Council of Canada, and the Networks of Centres of Excellence, support individual research projects, capacity building, and infrastructure development. Other federal programs, including the Canadian Foundation for Innovation and the Canada Research Chairs program focus on capacity building and infrastructure development by providing salary support and funds to purchase equipment.

Federal programs such as, the Toxic Substances Research Initiative, the Northern Contaminants Program, the Canadian Foundation for Climate and Atmospheric Sciences, the Climate Change Action Fund, and the Canadian Environmental Assessment Agency, focus on specific research projects. The Climate Change Action Fund and the Canadian Environmental Assessment Agency also support public education and training programs, respectively.

Provincial granting councils such as Quebec's Occupational Health and Safety Research Institute, Alberta Heritage Foundation for Medical Research, and British Columbia's Michael Smith Foundation for Health Research focus on issues pertaining to the province's health research priorities. These granting councils support specific research projects, as well as capacity building programs.

Several private foundations support environment and health research initiatives. Most of these initiatives are community-based projects, and projects that foster university-community partnerships. Some also support projects on public education and outreach.

Using the funding totals for each organization by year in Table C-3, Table C-4 shows the total funding by year for all the organizations combined for research on the environmental influences on health.

[115] Most of the years are fiscal years, a calendar year is denoted by CY.
[116] The Salamander Foundation's mandate is to recognize forms, functions and interactions of natural systems and to promote continuity and discovery in the arts and in culture.
[117] The McConnell Family Foundation's mandate is to enhance the ability of Canadians to understand, adapt, and respond creatively to the underlying forces which are transforming Canadian society and the world.
[118] Partial payment of a multi-year grant.

Table C-4: Total Funding by Fiscal Year for All Organizations in Table C-3 Combined[119]

Fiscal Year	Funding Total ($)
2000/01	11,992,075
2001/02	8,368,675
2002/03	10,509,836
2003/04	1,999,187
2004/05	1,357,986
2005/06	503,635
2006/07	500,00

These amounts represent less than 1% of the funds spent on health research in Canada every year.

Table C-3 also suggests that the funding organizations are focusing on the following types of support:

- Capacity building and infrastructure for research on natural sciences and engineering, especially chairs and networks (NSERC);
- Infrastructure, especially equipment (CFI);
- Capacity building (Canada Research Chairs); and
- Research projects on persistent organic pollutants and air quality.

[119] Amounts for future years represent commitments that have already been made.

This does not include CIHR support because the funds spent and allocated for research on the environmental influences on health.

4. Review of Applications to CIHR and Funded Research: Method and Findings[120]

Method:

The objective of this project was to establish a database of information on applications submitted to CIHR for research on the environmental influences on health and successful proposals funded by CIHR. The scope of the project covered open competitions and competitions for operating grants. Applications submitted to September competitions in 1999[121], 2000 and 2001 were reviewed. As well, all funded proposals as of April 1, 2002 were reviewed. Unfortunately, the review could not be completed before this paper was finalized. As a result, this review contains the findings on 5099 (67%) proposals and the total unconfirmed number of proposals is 7592. Proposals that directly or indirectly related to the environmental influences on health were selected and the following types of information were extracted from them (when available) and used to compile the database:

- The type(s) of environment being studied;
- The environmental issues being addressed;
- The health outcomes being investigated;
- The stage of the human lifecycle being researched;
- Which of the CIHR research pillars the proposal relates to; and
- The disciplines represented in the research team.

Findings:

The findings show that 107 of the 5099 proposals address the environmental influences on health directly or indirectly. The overall success rate of the 107 applications is 54%. This compares with an overall success rate of 66%. Table C-5 below summarises the review's findings. It was not possible to calculate the total funds spent or allocated to projects on the environmental influences on health before this paper was finalised.

[120] This assessment of applications to CIHR and funded research is based on research conducted by Tiffany Brockwell, André Coté, Brad Defazio, Derek Fougere, Kristian Goulet, Natalie Gravelle, Courtney Harbord, Brandon Labelle, Marissa McGuire, Katie Morgan, Craig Savill, and Ben Waterman.

[121] CIHR was established as the successor to the Medical Research Council (MRC) in 2000. Applications submitted in 2000 were therefore received and reviewed by the MRC, not CIHR.

Table C-5: Summary of the Review of Applications to CIHR and Funded Research on the Environmental Influences on Health

	All		Funded	
	#	%[122]	#	%[123]
Environments:				
Workplace	25	23	14	24
Biophysical only	34	32	19	33
Biophysical/interactions[124]	16	15	7	12
Indoor	20	19	17	29
Outdoor	49	46	27	47
Urban	12	11	6	10
Rural/Northern	6	6	2	3
Other	7	7	5	3
N/A	2	2	1	2
Hazards:				
Toxic chemicals	44	41	25	43
Microbiological	34	32	22	38
Physical/atmospheric	19	18	9	16
Radiation/noise	11	10	4	7
Other	17	16	11	19
Outcomes:				
Cancer	22	21	9	16
Cardiovascular	5	5	2	3
Developmental	8	7	2	3
Respiratory	35	33	20	34
Mortality	6	6	4	7
Neurological	6	6	3	5
Environmental sensitivity	12	11	9	16
Other	26	24	14	24
N/A	5	5	3	5
Stage of lifecycle:				
Prenatal	8	7	4	7
0-18 years	14	13	6	10
Reproductive health	3	3	1	2
19-60 years	16	15	5	9
60+ years	7	7	2	3
N/A	73	68	44	76

[122] Percentages total more than 100% because proposals often address more than one item in each category.
[123] Percentages total more than 100% because proposals often address more than one item in each category.
[124] This item includes interactions between the biophysical environment and other determinants of health.

	All		Funded	
	#	%[125]	#	%[126]
Research pillar:				
Biomedical	48	45	29	50
Clinical	23	22	13	22
Health system and services	8	7	4	7
Population health	50	47	24	41
Unsure	2	2	2	3
Discipline:				
Toxicology	23	22	13	22
Epidemiology	38	36	19	33
Risk assessment/management	17	16	8	14
Genetics	11	10	6	10
Economics	2	2	1	2
Social science	15	14	7	12
Other	63	59	31	53
N/A	5	5	4	7

This Table shows that the most applications were received on the following items:

Environment: Outdoor, biophysical environment only, and the workplace;
Hazards: Toxic chemicals, microbiological, and physical/atmospheric;
Outcomes: Respiratory, other[127], and cancer;
Stage of lifecycle: Not applicable, 19-60 years, and 0-18 years;
Research pillar: Population health, biomedical, and clinical; and
Discipline: Other, epidemiology, and toxicology.

This Table also shows that the most funded applications were on the following items:

- **Environment:** Outdoor, biophysical environment only, and the workplace;
- **Hazards:** Toxic chemicals, microbiological, and other[128];
- **Outcomes:** Respiratory, other[129], and cancer;
- **Stage of lifecycle:** Not applicable, 0-18 years, and 19-60 years;
- **Research pillar:** Biomedical, population health, and clinical; and
- **Discipline:** Other, epidemiology, and toxicology.

These results are quite similar to the results shown in Table C-2 on selected health and environmental issues addressed by Canadian researchers, which suggested that Canadian researchers have strengths in research on toxic substances, cancer, respiratory health, children's environmental health, and biomedical research (pillar 1) and research on

[125] Percentages total more than 100% because proposals often address more than one item in each category.
[126] Percentages total more than 100% because proposals often address more than one item in each category.
[127] Other outcomes include allergies, injuries and unspecified infections.
[128] Other hazards include dust, allergens, particulates, and personal safety.
[129] Other outcomes include allergies, injuries and unspecified infections.

populations (pillar 4). This suggests that the findings of this study and the analysis of the database of Canadian researchers are valid.

5. Additional Sources of Information

Overview of Consultation Findings (Appendix B)

The key findings of the consultation include:

- The most frequently mentioned research priorities included:
  - Toxic substances, endocrine disrupting substances and metals in the environment;
  - Air quality and respiratory health;
  - Cancer associated with environmental exposures;
  - Bioregional research programs, such as the Great Lakes Health Effects Program; and
  - Microbial substances in drinking water.
- Other priorities that were mentioned repeatedly included:
  - Climate change;
  - Aboriginal peoples; and
  - Children's environmental health.
- Frequently identified strengths and capacities included
  - Provincial and university-based research networks;
  - Methods for risk assessment, especially toxicological and epidemiological ones;
  - Community-based and participatory approaches to research; and
  - National, longitudinal health information that is collected as a result of Canada's publicly-funded health care system.

Capacity Building in the Social Sciences and the Humanities for Climate Change and Sustainable Development Analysis in Canada (Crabbe 2002)

This report and database were prepared to address the joint concerns of Natural Resources Canada and the Social Sciences and Humanities Research Council about the need to build Canadian capacity in the social sciences and humanities for climate change, and more generally, for the environment and sustainable development.

As part of this study, 614 names were identified in all Canadian universities listed in the Association of Universities and Colleges Council Website. The breakdown by discipline is indicated in Table C-6, taken from Crabbe's report.

Table C-6: Breakdown of Expertise in Canadian Universities by Discipline

Discipline	# of Researchers
Environmental Business/Economics	176
Environmental Engineering	153
Environmental Studies	33
Environmental Geography	148
Environmental History	18
Environmental Law	57
Environmental Philosophy/Ethics	19
Environmental Political Science	61
Environmental Psychology	8
Environmental Sociology	48
Other Environmental	46

This Table suggests that researchers at Canadian universities have expertise in many areas related to the environmental dimensions of the social sciences and engineering. Particular strengths include environmental business/economic, environmental engineering, and environmental geography. Environmental psychology may be an area that requires additional capacity, as many of the solutions to environmental problems require behaviour changes and environmental psychologists are needed to help design effective strategies to encourage behavioural change.

The study also identified 20 university environmental technology research centres. These centres are located in 15 universities across the country and address a range of technology issues from technology development and technology transfer to society, technology and values.

The report concludes that "Canadian academic expertise in the disciplinary fields of Social Sciences and Humanities related to the Environment is not negligible. However, potential disciplinary and interdisciplinary synergies have not been sufficiently engaged,

in particular, in the service of environmental public policy and, more broadly, sustainable development".

Health Canada's Database on Canadian Researchers and Laboratory Capacity on Children's Environmental Health

This database contains the names and research interests of 133 Canadian government and academic researchers, as well as information on the capacity of 30 public, academic and private laboratories across Canada. It was developed as part of the preliminary work associated with Canada's possible participation in the proposed Longitudinal Cohort Study of Environmental Influences on Child Health and Development.

An analysis of the database by researchers' interests shows that the following environmental hazards and health outcomes were frequently mentioned:

Table C-7: Environmental Hazards and Health Outcomes Frequently Mentioned by Canadian Researchers on Children's Environmental Health

Environmental Hazard:	# of Researchers
Air pollution	20
Chemicals	16
Disinfection by-products	15
Endocrine disrupting substances	24
Heavy metals	36
Indoor air	26
Ionizing radiations	15
PCBs	25
Pesticides	36

Health Outcomes:	
Asthma	26
Cancer	23
Cognitive function	12
Fertility	14
Fetal development	14
Neurological disorders	14
Pregnancy or reproductive outcomes	45
Respiratory system	9

This Table shows that the environmental hazards most frequently mentioned by researchers on children's environmental health were heavy metals, pesticides, indoor air, PCBs, and endocrine disrupting substances. The most frequently mentioned health outcomes were pregnancy or reproductive effects, asthma, and cancer. This suggests that these are the areas with the most capacity with respect to children's environmental health.

These findings are slightly dissimilar from the results of the survey of Canadian researchers described in Table C-2, recognizing that the categories of hazards and outcomes in the Health Canada database (Table C-7) are somewhat different from those in Table C-2. Noticeable distinctions include an emphasis on heavy metals and pesticides among researchers on children's environmental health, and a greater emphasis on toxic substances in general, cancer, and biomarkers/enzyme induction and metabolism among environmental health researchers in general.

Health Canada's survey of laboratory capacity on children's environmental health shows that 20 of the 30 laboratories that provided information are accredited. Table C-8 shows the analytical capacity reported:

Table C-8: Analytical Capacity of Laboratories Researching Issues Relating to Children's Environmental Health

Analytical Capacity	# of Laboratories
Chemical	18
Biological	6
Clinical	3
Other	5

This Table suggests that Canadian laboratories researching issues relating to children's environmental health have capacity in chemical analysis, and less strength in biological and clinical analyses.

6. References

Crabbe, P. 2002. Capacity Building in the Social Sciences and the Humanities for Climate Change and Sustainable Development Analysis in Canada. Final Report. Submitted to Natural Resources Canada and the Social Sciences and Humanities Research Council.

Health Canada. 2002. Surveys of Canadian Researchers and Laboratory Capacity. Accessed at: http://www.hc-sc.gc.ca/pphb-dgspsp/cehs-esm/index.html on July 30, 2002

Appendix D: Overview of Research in Selected International Organizations and Other Countries[130]

1. Introduction and Methods

This Appendix contains information on the research priorities and projects of selected international organizations and countries. International organizations were selected on the basis of their roles and responsibilities. Other countries were selected on the basis of their acknowledged strengths in research on the environmental influences on health, their similarities to Canada in terms of population size, and their proximity. For these reasons, all of the selected countries are in the "developed world". This review is not comprehensive, even for the organizations and countries selected. This is because there are many activities that could come under the general rubric of research on the environmental influences on health and it would be impossible to summarize all of them in this brief review.

The main methods for obtaining information were web searches and personal communications. Obtaining information was, in several instances, quite challenging. Some international organizations and countries dedicate specific units to research on the environmental influences on health. For others, research is dispersed among different divisions, laboratories, and units, and is not identified as research on health and the environment. In some international organizations and countries, research is very limited.

2. Selected International Organizations

The World Health Organization

1. The Organization on Health and Environment - Overview

The World Health Organization's (WHO) Organization on Health and Environment (OHE) sponsors some research, although its primary roles are to develop information, tools, strategies and methodologies for countries to use, and to provide technical assistance and programs. The OHE incorporates social, built and biophysical environments, as well as economic considerations, into its understanding of the environment.

OHE publishes the Global Burden of Disease report, within which is a section on the Environmental Burden of Disease (www.who.int/peh/burden/burdenindex.htm) that assesses the global disease burden associated with occupational exposures, ambient air pollution, indoor air pollution, environmental exposure to lead, water, sanitation and

[130] This Appendix was prepared by Joy Carlson of Carlson Consulting.

hygiene, and climate change. OHE initiatives will focus on the following issues in the next few years:

- **Water, Sanitation, and Health**: Work on this issue will include program and technical assistance, and some research studies. The cost effectiveness of sanitation strategies will be analyzed, and research on emerging pathogens in drinking water will be conducted. Other research will address disinfectants, and the development of a conceptual framework for the provision of safe drinking water. (Personal communication with Dr. Richard Helmer, Director OEH).

- **The Built Environment**: Activities on this issue will concentrate on the cost effectiveness of interventions for indoor air pollution control, including stove design. Research on outdoor air quality and health in urban environments has resulted in the development of WHO air quality guidelines for over 30 different chemicals. Future work will give attention to developing guidelines for particulate matter. (Personal communication with Dr. Richard Helmer, Director OEH).

- **Occupational Health**: Work on occupational health will focus on policies and legislation to address risk factors and health consequences, and capacity building at the country level. Key issues will include: the identification of health risks and the development of protective technologies for adolescent workers; occupational and environmental health risks of women and children in the home; and the contribution of children's environmental health and occupational child health to the national studies on the environmental burden of disease. Research is not expected to play a major role in this work. (WHO Internal Report, Health and Environment, Programme Summary)

- **Radiation Health**: Initiatives on this issue cover ionizing and non-ionizing radiation, electro-magnetic fields, UV radiation, and special issues such as depleted uranium. There is on-going epidemiological research on child thyroid cancer in Russia, and the effects of UV radiation on health. There are plans to study the application of the precautionary principle to radiation issues, particularly electro-magnetic fields. (WHO Internal Report, Health and Environment, Programme Summary, and personal communication with Dr. Richard Helmer, Director OEH).

2. OHE's International Programme on Chemical Safety (www.who.int/pcs)

The International Programme on Chemical Safety (IPCS) conducts chemical risk assessments to provide a scientific basis for individual counties to develop national chemical safety measures. Several hundred assessments have been prepared. (Personal communication with Dr.Terri Damstra, WHO). Planned activities include:

- Chemical risk assessments to facilitate the development of WHO guidelines for: chemicals in drinking water and disinfectants; air pollutants (indoor and outdoor); persistent organic pollutants; chemical risks resulting from climate change; and the assessment of pesticides for public health; and

- Research on the harmonization of risk assessment methodologies.

(WHO Internal Report, Health and Environment, Programme Summary, and personal communication with Dr. Richard Helmer, Director OEH).

3. OHE's Initiatives on Global Environmental Change

OHE serves as a focal point for activities on global environmental change through two key instruments:

a) The Intergovernmental Panel on Climate Change (www.ipcc.ch/about/about.htm)

The role of the Intergovernmental Panel on Climate Change (IPCC) is to assess the scientific, technical, and socio-economic information relevant for the understanding of the risk of human-induced climate change. The IPCC was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). It does not carry out research or monitor climate-related data or other relevant parameters. Instead, the IPCC bases its assessments on peer reviewed scientific and technical literature. The IPCC's reports have improved understanding global climate change and facilitated the development of the Kyoto Protocol.

The most recent IPCC report is Climate Change 2001: Synthesis Report -
A contribution of Working Groups I, II and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Watson, R.T. and the Core Writing Team (Eds.) (The report is available from Cambridge University Press, The Edinburgh Building Shaftesbury Road, Cambridge CB2 2RU England.)

b) The Millennium Ecosystem Assessment (www.millenniumassessment.org)

The Millennium Ecosystem Assessment (MEA) was initiated in April 2001 by the United Nations Development Programme, the United Nations Environment Programme, the World Bank, and the World Resources Institute. The MEA will assess the capacity of ecosystems to provide goods and services important for human development. By providing an economic analysis and an analysis of biodiversity and sustainability, the MEA will strengthen the capacity of regional and national institutions to develop appropriate strategies for sustainable economic growth.

The MEA will synthesize the findings of existing research and make them available in a form that is relevant to current policy questions. Some additional research will be conducted to provide a policy-relevant picture of current scientific findings. For example, the MEA will probably organize and support research groups to develop regional and global scenarios exploring potential changes to the goods and services provided by ecosystems.

The MEA is expected to be completed by 2005.

4. The Intergovernmental Forum on Chemical Safety (www.who.int/ifcs)

The Intergovernmental Forum on Chemical Safety (IFCS) is a non-institutional mechanism for representatives from governments and non-governmental and intergovernmental organizations to explore and provide advice on the environmentally sound management and the reduction of risks from chemicals. (Intergovernmental Forum on Chemical Safety, Forum III, Annex 6-1, at www.who.int/ifcs).

The Priorities for Action Beyond 2000 (Annex 6 of the Intergovernmental Forum on Chemical Safety, Forum III) contains the Forum's priorities, including:

- Assessing the hazards of an additional 1000 chemicals by 2004;
- Providing information to the public in a timely manner; and
- Enlisting cooperation from developing countries and countries with economies in transition in obtaining relevant exposure data.

IFCS does not have specific research priorities. (Personal communication with Dr. Judy Strober, Executive Secretary, IFCS).

5. The International Agency for Research on Cancer (www.iarc.fr)

The International Agency for Research on Cancer's (IARC) mission is to coordinate and conduct research on the causes of human cancer, the mechanisms of carcinogenesis, and develop scientific strategies for cancer control. The Agency conducts epidemiological and laboratory research, and disseminates scientific information through publications, meetings, courses, and fellowships. There are nine Research Units, three of which are relevant to research on the environmental influences on health.

a) The Environmental Cancer Epidemiology Research Unit

The Unit investigates environmental factors involved in cancer in human populations and their interaction with genetic factors, with the aim of contributing to primary prevention. This objective is achieved through collaborative international epidemiological studies. Current research issues include:

- Occupational cancers;

- The etiology and mechanism of lung cancer;
- The etiology and mechanism of cancers of the upper aero-digestive tract;
- Studies of lymphomas and related malignancies, including non-Hodgkin's lymphoma in Europe; and
- Meta-analyses of epidemiological studies, such as the cancer risk from asbestos exposure, and tobacco smoking and the risk of bladder cancer.

b*) Gene- Environment Interactions Research Unit*
This Research Unit seeks to:

- Elucidate the molecular mechanisms of genes responsible for DNA damage response, signal transduction and cell-cell communication, in regulating genomic stability, cell proliferation and neoplastic transformation; and
- Study cancer susceptibility and the relationship between particular genetic mutations and exposure to carcinogenic or genotoxic agents.

c) Radiation and Cancer Research Unit
This Unit studies the carcinogenic effects of radiation, in particular, low doses of ionizing radiation, in relation to the type of radiation, patterns of exposure, and host and environmental factors. Because the influence of biological factors on the risk of radiation-induced cancers is largely unknown, the aim of this work is twofold: to strengthen the scientific basis of radiation protection (ionizing and non-ionizing), and to increase our understanding of biological mechanisms of carcinogenesis.

The Pan-American Health Organization (www.paho.org)

The Pan-American Health Organization (PAHO) is the WHO's Regional Office for the Americas. PAHO's Division of Health and the Environment focuses on basic sanitation and environmental quality to identify, evaluate, prevent, and control environmental risks for public health, with particular emphasis on the most vulnerable groups.

PAHO does not have any named research priorities on the environmental influences on health, although there is a Research Grants Program that funds selected research projects targeted at relevant public health problems in the region. Research grants listed on the PAHO website do not appear to be oriented towards health and the environment.

PAHO publishes guidance documents on policies and programs, and provides technical assistance on issues such as water quality, radiation, air pollution, chemical safety, disasters, drinking water, environmental health, global environmental changes, health in housing, health, environment and sustainable development, solid waste management, wastewater, water pollution, and workers' health.

The United Nations Environment Programme (www.unep.org)

The United Nations Environment Programme (UNEP) encourages sustainable development through sound environmental practices globally. Its activities cover a wide range of issues, from atmosphere and terrestrial ecosystems, the promotion of environmental science and information, to an early warning and emergency response capacity to deal with environmental disasters and emergencies. UNEP's priorities include:

- Environmental information, assessment and research, including environmental emergency response capacity and strengthening of early warning and assessment functions;
- Enhanced coordination of environmental conventions and development of policy instruments;
- Fresh water;
- Technology transfer and industry; and
- Support to Africa.

UNEP does not conduct primary research, but it does prepare assessments of environmental conditions, develop programs, organize international meetings, and promote the exchange of information among governments, and other organizations.

The Organization for Economic Coordination and Development (www.oecd.org/env)

The emphasis of the Organization for Economic Coordination and Development's (OECD) Environment, Health and Safety Division is to harmonize regulations and to coordinate the program on testing guidelines. OECD does not conduct research and does not have research priorities.

In 2001, the OECD identified 10 Environmental Indicators, including: climate change; ozone layer; air quality; waste generation; freshwater quality; forest resources; fish resources; energy resources; and biodiversity. Also in 2001, the Environment Ministers of OECD countries adopted a new strategy for the first decade of the 21st century that emphasizes the health of ecosystems and humans as key elements within the ten environmental indicators. (Personal communication with Mr. Rob Visser, Head, Environment, Health and Safety Division, OECD)

The North American Commission for Environmental Cooperation (www.cec.org)

The North American Commission for Environmental Cooperation (CEC) is an international organization established by Canada, Mexico and the US under the North American Agreement on Environmental Cooperation. This Agreement complements the North American Free Trade Agreement.

The CEC addresses regional environmental concerns, helps prevent potential trade and environmental conflicts, and promotes the effective enforcement of environmental law. Several CEC programs deal specifically with health and the environment, including:

- **The Sound Management of Chemicals**: The Sound Management of Chemicals (SMOC) project is an ongoing intergovernmental initiative to reduce the risks of toxic substances to human health and the environment. The priority has been to address persistent, bioaccumulative toxic substances. The project provides a forum for: a) identifying priority chemical pollution issues of regional concern; b) developing North American Regional Action Plans (NARAPs) to address these priority issues; c) overseeing the implementation of approved NARAPs; and d) facilitating and encouraging capacity building in support of the overall goals of SMOC, with emphasis on the implementation of NARAPs.

  Currently the SMOC program is implementing NARAPs for: DDT, mercury, PCBs, and environmental monitoring and assessment. A NARAP on chlordane has recently been completed, and a NARAP on dioxins, furans and hexachlorobenzene is in preparation. A NARAP on lindane will be started in the coming months. (Personal communication with Marilou Nichols and Vic Shantora, CEC).

- **Children's Health and the Environment**: This initiative is promoting a cooperative agenda between Canada, Mexico and the US on children's environmental health issues of common concern. An expert Advisory Board urged the CEC's Council to place a high priority on policies that will prevent environmental exposures and risks to children in the places in which they live, play and learn, and via food, water and products. The Board also called for the application of the precautionary principle in policy and decision making, stressing that protective actions must be taken even in the absence of full scientific certainty.

3. Selected Countries

Australia

There is no national research agenda on the environmental influences on health in Australia. Some research is being conducted on air quality, including studies on fine particles, photochemical reaction, a four city study on benzene and volatile organic compounds (VOCs), domestic solid fuel burning appliance, indoor air pollutants, and transportation alterations including a nitrogen oxide catalyst, and hydrogen fuels cell bus trials. Children's health is being studied in a pilot project comparing a standard school with a recently constructed low allergen school. (Personal communication with Sue May, Atmosphere and Sustainable Transport Branch, Environment Australia).

In 2000, the Environmental Health Section of the Department of Health and Aged Care published its National Environmental Health Strategy Implementation Plan. The Plan has sections on environmental health justice, environmental health systems, including research, and the human-environment interface, including air, the built environment, vector borne disease, drinking water and recreational water. There is also a multi-sectoral enHealth Council, with representatives from the environment and public health communities, Indigenous peoples, and other stakeholder groups. (http://enhealth.nphp.gov.au/.

There are seven universities where research on the environmental influences on health is being conducted, including the University of Western Sydney, the Australian National University, Queensland University of Technology, the University of Sunshine Coast, the Commonwealth Scientific and Industrial Research Organisation, the Southern Cross Institute of Health Research, and the Edith Cowan University. Areas of interest include indicators, datasets, inequalities, and air pollution. (Personal communication with Dr. Helen Cameron, Department of Health and Ageing).

Denmark

The National Environmental Research Institute in the Ministry of the Environment in Denmark conducts research on the environmental influences on health in the following areas:

- **Pesticides and Agriculture**, including research on pesticides and their effects on the environment, research on microbial pesticides (biopesticides), research to develop ecological risk assessment methods for genetically modified plants;

- **Industrial Chemicals,** including oil, tar and tar derivatives, dioxins and endocrine disrupting substances with hormone-like effects and their effects on the environment, as well as micro-organisms that can metabolize them; and

- **Transportation,** including research on trends in transportation and air pollution, especially atmospheric chemistry and the development of mathematical models to

map air pollution, calculate its consequences and forecast future levels. (www.mem.dk/organisation/ukorg/ukdmu.htm)

United Kingdom (UK)/England

There is no coordinated research agenda on the environmental influences on health, although several government agencies fund environmental research. There is a UK Sustainable Development Strategy (1999) and there have also been preliminary discussions about developing a UK Environment Research Funder's Forum. (Personal communications with John Mueller, Health & Environment Branch, Department of Health, and Brandon Smith, Department of Health).

There are two main government agencies that support research in this area:

The Department of Health

Commissioned research includes the protection of the public from diseases caused by a range of pathogens and an understanding of the physical environmental impacts on health, lifestyle issues, inequalities in health, and social determinants of ill health.

Currently, the Department's internal research program focuses on: Creutzfeld Jacobs disease, air pollution, hepatitis C, UV radiation, vaccines, hospital acquired infection, fluoridation, anti microbial resistance, smoking, alcohol and substance misuse, sexual health, HIV/AIDS, nutrition and accidents, inequalities in health, health promotion approaches, and health impact assessment. (Personal communication with John Muller, Department of Health and www.doh.gov.uk/research)

The Department's Environmental Chemicals Unit funds research in the following areas:

- Male reproductive health, including fertility and hypospadias and the possible effects of chemicals, jointly funded with the Department of Environment, Food and Rural Affairs, the Health and Safety Executive and the European Chemical Industry Council;

- Low level exposure to organophosphate chemicals and the risks of chronic health effects (jointly funded by the Department of Health, the Health and Safety Executive and the Department of Environment, Food and Rural Affairs);

- A comprehensive meta-analysis of epidemiology studies investigating the link between ingestion of alcoholic beverages and breast cancer; and

- Development of molecular markers of non-genotoxic carcinogens.

(Personal communication with Carol Dobson, Environmental Chemicals Unit, Department of Health).

The Air and Noise Pollution Unit has funded research on indoor and outdoor air pollution and the effect of noise, and is in the process of launching a new research program on air pollution. (Personal communication with Emma Jenkins, Air and Noise Pollution Unit, Department of Health). Details will be available at http://www.doh.gov.uk/hef/airpol/researchprojects.htm).

The Medical Research Council
The Medical Research Council (MRC) is the main Government agency for research into the causes of and treatments for disease, and had a budget of £337 million in 1999/2000 (see: www. doh.gov.uk/research, under other funders). MRC has its own internal capacity to conduct research within its thirteen Research Divisions. (www.mrc.ac.uk/index/current_research/currentoverview/current_13_research_divisions/current-unassigned_research.htm)

MRC does not have a specific research agenda on health and the environment, but studies on this issue may be conducted under its six main research areas, including: people and population studies; neuroscience and mental health and infection; genetics; molecular structure and dynamics; cell biology, development and growth; and physiology and disease processes. (www.mrc.ac.uk/index/current_research/current-overview/currentsix_main_research_areas.htm)

The National Environmental Research Council was established in 1997 and its agreement with the Department of Health outlines areas of common interest and roles and responsibilities. The issues of scientific interest include:

Generic issues:

- Improved methods of exposure measurement and modelling including the identification of molecular, cellular and functional markers of early health effects;
- Assessment of risks of low level and complex environmental exposures;
- Interactions between environmental and other factors on human health in the aetiology of human diseases;
- Genomics-environment interactions;
- Identification of damage causing mechanisms;
- Improved integration of environmental and epidemiological databases, including better interpretation and modelling of baseline date;
- Public understanding and perception of health risks from the environment; and
- International collaboration, particularly in relation to European programs on environment and health.

Specific issues:

- Air quality and health including both indoor and outdoor air pollution levels and their impact;
- The effect of toxic substances, for example, radon, allergens, carcinogens etc on human health;
- Environmental contamination of drinking water;
- The potential impact of climate change on disease burdens; and
- Ionizing and non-ionizing radiations.

(www.doh.gov.uk/research go to Other Funders then Research Councils).

In April 2001, the Department of Health issued a Research and Development Strategy for Public Health that recommends the establishment of a research and development funders group to provide better coordination of research funding, identify gaps, and enable cross-cutting research to be funded. (Executive Summary, Research and Development Strategy for Public Health available at www.doh.gov).

European Commission

In May 2002, the European Commission approved the 6th Framework Programme for Priorities in Research (2002-2006), with a budget of Euro 17.5 billion. Relevant priorities of the Framework Programme include: genomics and biotechnology for health, information society technologies, nanotechnologies, food safety and health risks, sustainable development, and citizens and governance. (http://europa.eu.int/comm/research/fp6/index_en.html)

The European Commission supported research on endocrine disrupting substances in the 4th and 5th Framework Programmes, and in May 2002, it announced that researchers with expertise on the effects of endocrine disrupting substances on human and wildlife health will be brought together under a new research cluster. (Personal communication with Veronique Angot, Directorate General Environment European Commission, and http://europa.eu.int/comm/research/press/2002/pr1505en.html).

France

There is no strategic plan for research on the environmental influences on health in France, however, in 2000 the government issued a series of requests for proposals for research in the following areas: water, air, soil, food; and the built environment and health.

Issues of interest under air, soil, water and food included: dioxins, PCBs, persistent organic pollutants, nitrates, nitrites, heavy metals, radiation, mycotoxins, and antibiotics.

For the built environment and health issues of interest included: multiple exposures including allergens, microbiologicals, and chemical pollutants; sick building syndrome and other indoor environmental considerations. (www.environnment.gouv.fr/actua/proposit/2000/environment-et-sante.htm)

Currently, a new French agency for environmental health and safety (Agence Française de Sécurité Sanitaire Environnementale) is under development, and should be fully operational by the end of 2002. The Agency will be responsible for all environmental health issues including research. (Personal communication with Dr. Benoit Vergriette, Ministry of Environment, France)

Germany

In June 1999, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the Federal Ministry for Health published an Action Program on Environment and Health. The Program recognizes the importance of research and identifies the following priority areas:

- Environmentally associated health impairments;
- Children, the environment and health;
- Health–oriented assessments of significant exposures and optimization of exposure models;
- Evaluation of diagnostic and therapeutic procedures in environmental medicine;
- Improvement and evaluation of risk assessment and risk management methods;
- Evaluation of registering and monitoring systems; and
- Practically-oriented risk communication and evaluation of models for public participation.

In 2002, the Program's activities and focus were updated, but materials are only available in German. (Personal communication with Eva Roth, Ministry of Environment)

Italy

The Instituto Superiore di Sanita has 14 thematic areas of research, of which 7 could have implications for the environmental influences on health, including: mental and neurological disorders; tumours; metabolic, chronic degenerative and cardiovascular diseases; human genetics; health and environment; radiation; food, and nutrition and veterinary public health. (Personal communication with Dr. Giovanni Alfredo Zapponi, Director, Laboratory for Environmental Hygiene of the National Health Institute).

Relevant current research projects include:

- An epidemiological study on the etiology of lympho-haematopoietic tumours and neuroblastoma in infants, with special reference to magnetic fields;

- A study on human exposure to xenobiotics with potential endocrine activity and an assessment of the risks for reproduction and childhood. (www.iss.it/english/ricerca/progetti/prorich.htm);

- Small area epidemiological studies on industrial and agricultural areas including
- studies on asbestos and vinyl chloride, exposures in the urban environment, and exposures to chemicals used in agriculture;

- Exposures and risks related to dioxins and dioxin-like PCBs, polycyclic aromatic hydrocarbons, and endocrine disrupting substances and other priority chemicals;

- Air, drinking water, and soil quality, their health effects and remedial actions;

- Carcinogenic and toxicological risk assessment;

- Risk evaluation and management for waste products;

- Toxicological studies on cancer, mutagenesis, reproductive toxicology, metabolism, and ecotoxicological effects;

- Individual susceptibility to toxic and carcinogenic agents;

- Molecular epidemiology, biomarkers of exposure and early effects; and

- Mathematical modelling, and bioinformatics.

(Personal communication with Dr. Giovanni Alfredo Zapponi)

Japan

The National Institute for Environmental Studies in the Ministry of the Environment is the primary institution for research on the environmental influences on health in the Japanese government. (www.nies.go.jp). It has Research Divisions on: Social and Environmental Systems, including economics, geographic information systems, and international agreements; Environmental Chemistry; Environmental Health Sciences, including endocrine disrupting substances, mercury, and UV radiation; the Atmospheric Environment; Water and Soil Environments; and Environmental Biology. The Institute also has several centres, including: the Research Centre for Material Cycles and Waste Management; the Research Centre for Environmental Risk; the Centre for Global Environmental Research; the Environmental Information Centre; and the Laboratory of Intellectual Fundamentals for Environmental Studies.

The Institute has identified several relevant priority areas for research including: climate change; the ozone layer; endocrine disrupting substances and dioxins; and particulate matter (PM 2.5) and diesel exhaust. Japan is a leader in the area of endocrine disruptor and dioxin research.

There is also a National Institute for Minamata Disease that is part of the Ministry of the Environment.

Netherlands

The National Institute for Public Health and the Environment, located in the Ministry of Public Health, Welfare and Sport, is the primary agency for research on the environmental influences on health. Working through its numerous laboratories and sections the Institute addresses the following research areas:

- Food safety including natural toxins and nitrosamines;
- Drinking and recreational water quality, especially heavy metals;
- Pesticides and organic pollutants such as polycyclic aromatic hydrocarbons, dioxins, and pesticides found in soil, water, air, sludge, waste products, and fly ash;
- Risks associated with ionizing and non-ionizing radiation;
- Consumer exposures to: products containing hazardous agents, such as phthalates in baby toys, coal tar in shampoo, active ingredients in pesticides; persistent organic pollutants; noise; air pollution, especially health effects on children and the elderly. (There is a birth cohort study on the long term effects of traffic related air pollution on the development of asthma and a cancer cohort looking at long term air pollution exposure and mortality); air traffic, including the effects of air traffic on health;
- Surveillance of body burdens in the general population;
- Air pollution, especially exposure to fine air-borne particles and subsequent health effects including cancer, cardio-pulmonary disease and infectious disease;
- Dietary and lifestyle factors, including nutrients, hormone preparations, lifestyle drugs, chronic stress, and noise; and
- Research on alternative testing methods for reproductive effects of substances.

The Institute is the European Topic Centre for Air and Climate Change to support the European Union's policy on air pollution and climate change. (www.rivm.nl/index_en.html)

New Zealand

Several years ago, New Zealand conducted a Foresight exercise to guide public investment in research, science and technology from the year 2000. Several research areas were identified, including: environmental health; occupational health and safety; the socio-economic determinants of health; biotechnology; and food, nutrition and health.

Since then, a new Joint Research Portfolio in Environmental Health has been established. Its priorities include:

- **Indoor Air and Impacts on Health,** including: the impact of building quality on health, including factors such as temperature, dampness and heating fuels; the effects of building contaminants on health, for example lead, asbestos and formaldehyde; the relationships between environmental tobacco smoke and cardiovascular disease, respiratory illnesses and cancers;

- **Outdoor Air and Impacts on Health,** including: the effects of urban air quality on health and the relationships between air pollution from industry, motor vehicles, home heating and naturally-occurring sulphur compounds in Rotorua, and diseases such as cardiovascular and respiratory diseases and cancers; and the impacts of rural air quality on health, such as the health effects of agricultural sprays;

- **Climate Change,** including: temperature-related morbidity and mortality; health effects of extreme weather events; air-pollution-related health effects; water- and food-borne diseases; vector-borne diseases; and variations in UV radiation at the Earth's surface and the incidence of skin cancers across the globe;

- **Food Safety,** including: the relationship between soil contamination and food safety; and the relationship between food contamination and human health. This includes shellfish contamination and the safety of commercial, traditional and domestic food preservation methods; and

- **Water Quality,** including: the impact of stormwater and wastewater management on human health, particularly in relation to water-borne communicable diseases; the effects of drinking water quality on health, especially the impact contaminants such as Giardia, Campylobacter, Cryptosporidium, Legionella and chemicals such as heavy metals, corrosion metals, disinfection by-products, arsenic, boron and nitrate; exposure assessments of water resources and the potential effects on health, such as exposures to toxic algal blooms, exotic vectors and the degradation of waterways by run-off from farms, urban streets and subdivisions, and industrial discharges.

In 2002, a request for proposal on air pollution was released to support research on the links between sources of air pollution, their effects on human health and the estimated costs of the effects. Successful applications are in the areas of: air quality and emissions data analyses; exposure assessment; analysis of health effects and econometric analyses. (Personal communication with Dr. Michelle Sullivan, Health Research Council of New Zealand, and www.hrc.govt.nz).

United States

There are many federal agencies that support research on the environmental influences on health. This brief summary highlights the 5 most important ones, as well as 3 inter-agency research programs.

Federal Agencies – The Environmental Protection Agency (www.epa.gov)

The Environmental Protection Agency devotes millions of dollars to intramural and extramural research, ranging from basic research to exposure assessment and monitoring, to clinical and epidemiological studies. The Office of Research and Development's Strategic Plan 2000 outlines the following areas related to research on the environmental influencers on health (www.epa.gov/ORD/SP/sp_toc.htm:

- **Clean Air,** with a primary focus on particulate matter including its sources, the characteristics that produce toxicity, its interactions with other pollutants to produce health effects, and its effects on sensitive sub-populations;

- **Clean and Safe Water,** including drinking water, focusing on contaminants of greatest concern and their health effects, analytical methods to estimate the occurrence of contaminants, identification of the levels of exposure and characterization of risks, and cost effective treatment methods;

- **Global Change,** especially vector-and water-borne agents, weather-related morbidity and health effects related to air pollution, including tropospheric ozone and particulate matter;

- **Human Health Risk Assessment and Management,** emphasizing improvements in mechanistic understandings of toxicity and susceptibility in the general population and high risk populations such as children, the elderly and persons with pre-existing diseases; identification of relevant biomarkers and their relationships; the biological basis of health effects in children, particularly asthma; interactive effects from exposures to chemical mixtures with common or different modes of action; and research to evaluate the consequences of environmental risk management decisions on public health;

- **Endocrine Disrupting Substances,** addressing exposure of human and wildlife populations to endocrine disrupting substances and their health effects; dose

response characteristics, and major sources and environmental fates of endocrine disrupting substances; and

- **Pollution Prevention and New Technologies,** including the use of pollution prevention technologies in various economic sectors, and the development of industrial and consumer products to advance environmentally-sound processes and cleaner technologies.

Current research supported by the Office of Research and Development includes research on:

- **Air**: the Biogenic Emissions Inventory System, the Environmental Monitoring for Public Access and Community Tracking Site, and the Ultraviolet Monitoring Program;

- **Soil:** the Ecotoxicology Database, the Environmental Monitoring Assessment Program, and remote sensing and geographic data;

- **Human Health:** The Children's Environmental Health & Safety Inventory of Research, the Consolidated Human Activity Database, the Human Exposure Database System, the Regional Vulnerability Assessment Program, and the Total Human Exposure Risk Database and the Advanced Simulation Environment;

- **Multimedia**: the Integrated Risk Information System, the Office of Research and Development's Technology Transfer Highlights, and the Environmental Technology Verification Program;

- **Water:** the Environmental Monitoring Assessment Program, and the Interagency Coordinating Committee for U.S./Mexico Border Environmental Health Home Page; and

- **Waste**: the Characterization & Monitoring of Hazardous Waste Sites Program, and the Superfund Innovative Technology Evaluation Program.

Federal Agencies – The National Center for Environmental Health (www.cdc.gov/nceh/)
The National Center for Environmental Health is part of the Centers for Disease Control and Prevention. Its mission is to provide national leadership through science and service that promotes health and quality of life by preventing or controlling those diseases, birth defects, disabilities, or deaths that result from interactions between people and their environment.

The Health Studies Branch investigates human health effects with an emphasis on: pesticides, endocrine disrupting substances, and other toxic substances; harmful algal blooms; confined animal feeding operations and their potential effects on human health; US/Mexico border environmental health issues; drinking water and water-related issues; noise; preventing lead poisoning in young children; radiation studies; the health effects of

chemical exposures during the Gulf War; environmental public health tracking; and mould.

The Division of Laboratory Sciences has developed biomonitoring methods to measure more than 200 substances in human blood, serum, and urine. A National Report on Human Exposure to Environmental Chemicals is now issued yearly. The Division also supports research on tobacco and smoking, genetics and neural tube defects and conducts the National Health and Nutrition Examination Survey.

Global Health Initiatives include: childhood lead poisoning; water, sanitation, and hygiene; urban health and mega-cities; micro-nutrient malnutrition; pesticides; birth defects (etiology and prevention); gene-environment interactions; child development, abilities and health (including landmines); and radiation.

The Centers for Disease Control and Prevention also has an Office of Genomics and Disease Prevention, as well as a National Center on Birth Defects and Developmental Disabilities.

Federal Agencies - Agency for Toxic Substances and Disease Registry (www.atsdr.cdc.gov/)
The Agency for Toxic Substances and Disease Registry is one of the principal federal public health agencies with responsibility for evaluating the human health effects of exposure to hazardous substances. Three of the Agency's goals are to:

1. Evaluate human health risks from toxic sites and releases and take action in a timely and responsive public health manner.

2. Ascertain the relationship between exposure to toxic substances and disease.

3. Develop and provide reliable, understandable information for people in affected communities and tribes and for other stakeholders.

It has developed an Environmental Public Health Research Agenda 2002-2010 with the following recommended research projects.

- **Exposure Assessment**: Improve methods to measure and characterize human exposures to odorous and hazardous substances in the air; determine total human exposure from exposure to hazardous substances from all pathways using new approaches; and review methods and develop reference ranges for body burden measurements and biomarkers of exposure for priority hazardous substances;

- **Chemical Mixtures:** Review existing information to characterize toxic chemical mixtures commonly found at hazardous waste sites and identify possible health outcome relationships; conduct dose-response and mechanistic studies to predict human health outcomes from exposure to toxic chemical mixtures; evaluate adverse health outcomes in children and other susceptible populations from

exposures to toxic chemical mixtures; and provide a solid basis of toxicity information for human health assessment;

- **Susceptible Populations:** Establish a database of exposure information in children residing near hazardous waste sites; assess long-term exposure to hazardous substances and latent health effects in the elderly; explore differences in genetic susceptibility to hazardous substances; identify and study contaminants in the environment, subsistence resources, and people in Alaska's Native populations;

- **Communities and Tribal Involvement:** Develop community-based approaches to identify and evaluate sources of environmental exposure and potentially exposed populations; evaluate the potential impact of community cultural practices on exposure to hazardous substances and adverse health outcomes; develop methods and new approaches for evaluating environmental exposure and human health risks in small populations; identify essential factors for successful community involvement in public health activities focused on hazardous waste sites; and

- **Evaluation and Surveillance of Health Effects:** Conduct epidemiologic investigations on the relationship between exposure to environmental contaminants and selected priority health conditions; assess and prevent childhood asthma attacks related to odorous and hazardous air pollutants from specific point sources; conduct epidemiologic investigations of the relationship between exposure to environmental contaminants and adverse pregnancy outcomes and developmental disabilities in specific minority communities; evaluate adverse health effects in communities exposed to asbestos contaminated vermiculite including respiratory and carcinogenic effects; develop and enhance surveillance systems for diseases or conditions that can be used to monitor trends and assist studies in evaluating environmental causes.

A list of current specific research projects by topic and state are available on the Agency's website, including three special initiatives on child health, the Alaskan traditional diets, and the Great Lakes.

Federal Agencies – the National Cancer Institute (www.nci.nih.gov)
The National Cancer Institute is the pre-eminent cancer research agency in the US, with a budget of over $5.5 billion US. Relevant research priorities include:

- **Gene-Environment Interactions:** Discover genetic, environmental, and lifestyle factors and their interactions that define cancer risk and inform strategies for cancer control. Current research is focusing on identifying previously unsuspected carcinogens through the study of newly discovered genes that predispose people to cancer, and learning how certain environmental exposures increase the cancer risk for genetically susceptible subgroups; and

- **Tobacco and Tobacco-related Cancer Research:** Basic biological research on the effects of tobacco exposures and on community-based studies of smoking prevention and cessation programs.

The National Institute for Environmental Health Sciences (www.niehs.nih.gov)
The National Institute for Environmental Health Sciences (NIEHS) is the institute within the National Institutes for Health that focuses on research on the environmental influences on health. Other Institutes and Centers in the National Institutes of Health support research on this issue to a lesser degree. For example, the Fogarty International Center, which is responsible for international health research, is launching a new initiative on building research capacity on health, the environment, and economic development.

With a budget of almost $620 million US, the NIEHS funds hundreds of research projects, from basic research to community-based participatory research, that address the environmental influences on health. Currently, it sponsors 22 university-based Centers of Excellence in Environmental Health Research located throughout the US that foster interdisciplinary coordination and collaboration, and community outreach.

The Institute's website lists the following scientific research programs:

- NIEHS Intramural Research Programs: Environmental Genome Single Nucleotide Polymorphism Database; National Center for Toxicogenomics; Microarray Center; Fibroid Growth Study; Health and Safety NIEHS Research Initiatives; Technology Transfer Program;

- NIEHS Extramural and Cooperative Research Programs: Center Program; Environmental Genome Project; Training Program; Superfund Basic Research Program; Worker Education & Training Program; Health Disparities Research; Electromagnetic Field Research Program; US/Vietnam Cooperative Research Program;

- National Toxicology Program: NTP Center for the Evaluation of Risks to Human Reproduction; Interagency Coordinating Committee for the Validation of Alternative Methods;

- New Research Initiatives:
  General: Natural Exposures (Pfiesteria); Health Disparities and Environmental Justice; Breast Cancer - The Sister Study; Herbal Medicines; Parkinson's, Alzheimer's, and Other Neurodegenerative Diseases; Nutrition Initiative; High-Throughput Testing Methods; Eliminating Health Disparities; New Pfiesteria Grants; Helping Couples Conceive (Fertility); and Improving the Relevance of Regulatory Standards

  New Initiatives - Women's Health: Sister Study on Breast Cancer;

Autoimmune Diseases; Agricultural Health Study; and Polycystic Ovarian Syndrome.

New Initiatives - Children's Health: Childhood Cancer; Attention Deficit/Hyperactivity Disorder (ADHD); Children's Health - Pesticide Residues in Food; Asthma; Juvenile Diabetes; Cleft Palate Birth Defects; Children's Environmental Health Initiative

Scientific Advances: From Mother to Daughter to Granddaughter - The Legacy of DES; Reducing Calories Reduces Cancer Risks - But How?; Low Birth Weight Relates to the Mother's Lead Burden; Defective Gene Responsible for Ataxia Telangiectasia Gives Insight into Tumor Suppression (ATM); Gene-Gene-Environment -- New Insight into Smoking-Induced Bladder Cancer; Test Methods Developed That Use Fewer Animals; and Facts About Environment-Related Diseases and Health Risks.

The National Institute for Environmental Sciences participates in several inter-agency programs.

Inter-Agency Programs – The Children's Environmental Health and Safety Inventory of Research (http://www.epa.gov/chehsir)
The Children's Environmental Health and Safety Inventory of Research is a publicly accessible web-based database created to ensure that federal research agencies, researchers at universities, community groups, and the public have access to information on all research conducted or funded by the federal government that is related to the adverse health risks in children resulting from exposure to environmental agents and safety risks.

The Inventory is searchable by any combination of environmental health or safety topic, geographical area, funding agency, institution, principal investigator, etc. Eighteen agencies participate in the Inventory including the National Institutes of Health, the Environmental Protection Agency, the Centers for Disease Control and Prevention, the Department of Housing and Urban Development, the Consumer Products Safety Commission, the Agency for Toxic Substances and Disease Registry, and the Department of Commerce.

Inter-Agency Programs – Children's Environmental Health and Disease Prevention Research Centers
(http://www.niehs.nih.gov/dert/programs/translat/children/children.htm)
There are currently 12 multi-disciplinary university-based Centers that conduct basic and applied research on the causes and mechanisms of children's disorders having an environmental etiology, and community-based prevention research. Additional goals include identifying relevant environmental exposures, intervening to reduce hazardous exposures and their health effects, and to decrease the prevalence, morbidity and mortality of environmentally-related childhood diseases, eventually.

Each of the Centers focuses on a particular issue, including: pesticides, asthma, growth and development, neurobehavioral issues, and autism. Sponsored by the National Institute of Environmental Health Science, the Environmental Protection Agency, and the Centers for Disease Control and Prevention, funding for 8 of the 12 Centers expires in 2003 and it is unclear whether new funding will be available to continue research at these and other Centers.

Inter-Agency Programs – The National Children's Study
(http://nationalchildrensstudy.gov/)

The National Institute for Child Health and Human Development, the National Institute for Environmental Health Science, the Centers for Disease Control and Prevention, the Environmental Protection Agency, and several other federal agencies are collaborating on the planning of a 20 year cohort study to follow 100,000 children pre-natally through to age 21. The National Children's Study is a long-term study of environmental influences on children's health and development. This study will explore a broad range of environmental factors, both helpful and harmful, that influence the health and well-being of children. For this study, environment is broadly defined to include chemical, physical, social and behavioral influences on children, and to better understand the role of these factors on health and disease. The estimated cost of the study is $1.9 billion US over a 30 year period. The US Congress has allotted initial funds for planning although future funding and program development are not secure.