MEETING THE CHALLENGES OF CONTINENTAL POLLUTANT PATHWAYS:
Towards a Framework for Trinational Cooperation and Action

prepared by
The North American Expert Panel on Continental Pollutant Pathways

Draft Interim Report submitted March 12, 1997 to the Secretariat of the Commission for Environmental Cooperation pursuant to Article 13 of the North American Agreement on Environmental Cooperation

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COMMISSION FOR
ENVIRONMENTAL COOPERATION

March 13, 1997

Mr. Victor Lichtinger
Executive Director, the Secretariat,
Commission for Environmental Cooperation
393 St. Jacques Street West, Suite 200
Montreal (Quebec) Canada H2Y 1NY

CC: Ms. Janine Ferretti, Director
Mr. Greg Block, Director

Dear Mr. Lichtinger:

We are pleased to submit, for consideration by the Secretariat of the Commission for Environmental Cooperation (CEC), Volume I of our draft interim report on Continental Pollutant Pathways for consideration and comment. This volume is a report prepared by the North American Expert Advisory Panel on Continental Pollutant Pathways (Panel) which was established and first met on December 18th, 1996. It is, in part, a synthesis of the more detailed case studies included in Volume II.

We expect to submit an interim draft Volume II of the draft interim report to you by March 24. Volumes I and II will each contain a complete "Table of Contents" listing the sections of both volumes. The members and alternates on this Panel as well as the staff and consultants who have assisted in the preparation of this report are listed in an annex to each volume. Individuals who assisted in the preparation of each of the specific case examples will be listed at the beginning of each case study.

The report is draft because while all members and alternates have had an opportunity to contribute to this report they have not had an opportunity to review this latest draft. It is interim in that this report will be revised after all members and alternates have had an opportunity to review and comment on this draft and after the Secretariat and others, as appropriate, have had an opportunity to offer their suggestions. At the time of writing it is our expectation that an important part of this review will take place at the second meeting of the North American Consultative Group on Continental Pollutant Pathways (Consultative Group) which is scheduled to be held on April 15th, 1997 and that on the following day our Panel will meet to consider comments, incorporate agreed-upon revisions and to determine the steps required to complete a final report for submission to the Secretariat.

The Panel had a very short time to prepare this report. Its work was concentrated around three meetings. The first was held December 18th, 1996 in Montreal the day following the initial meeting of the Consultative Group to consider terms of reference and to develop an initial outline for the Panel's report and to agree on some initial drafting assignments. The second was held February 3rd, 4th and 5th in El Paso (February 3) and Ciudad Juarez (February 4th and 5th) partly in conjunction with the Paso del Norte Task Force and the International Air Quality Advisory Board of the International Joint Commission. The primary purpose of this meeting was to consider, revise

and in some cases draft initial sections and case examples, and to refine the outline and organization of the report. The third meeting which was held March 3rd and 4th in Silver Spring Maryland was a very intensive drafting session where the Panel 'work groups' reviewed and revised key sections of Volumes I and II of this report.

The periods between meetings were only slightly less hectic. Members, alternates and CEC staff and consultants continued to prepare and revise drafts and the "Bureau" consisting of the three Co-chairs assisted by Andrew Hamilton and Danielle Cantin of the Secretariat and consultants David Dilks, Sally Leppard, Lynn Betts and Abigail Curkeet was established to assist with the management of this initiative. The Co-chairs also participated on February 24th in a meeting of the policy group convened by the Secretariat and as well met on February 25 in preparation for the March meeting of the Panel.

The Bureau members maintained contact with one another and with other Panel members and alternates through numerous telephone and conference calls, and through the transmission of faxes and e-mail messages and drafts of documents.

On behalf of our fellow members of the "North American Expert Advisory Panel on Continental Pollutant Pathways" we would like to thank you for this opportunity to provide our inputs to this very important issue. The time frame and scope of our task were challenging, but the importance of the initiative and our belief that we had something to contribute made for a very hard working and active group. We would also like to thank our colleagues who served as members and alternates on the Panel, who without exception, made major contributions to this trinational cooperative effort.

We hope that this draft interim report as well as and our final report will be of use to the Secretariat as it prepares its own Article 13 report for presentation to the Council of the Commission for Environmental Cooperation. We look forward to receiving Secretariat comments on this draft interim report so that they can be incorporated in the Panel's final report. Also if the Secretariat finds that it needs further clarification of matters raised within this draft interim report we would be pleased to attempt to provide the needed clarification.

Yours sincerely

Bruce Hicks	Carlos Santos-Burgoa	James W. S. Young
Co-chair, United States	Co-chair, Mexico	Co-chair, Canada

We cannot direct the wind... but we can adjust the sails.

John C. Maxwell, 1995

Nul n'est une île.

Khalil Gibran

REPORT PURPOSE

To strive for a readable and informative document that will provide the technical and non-technical reader with a sense of the nature, extent, complexity and - especially - the importance of "Continental Pollutant Pathways"; to demonstrate and inform as to the importance of these pathways to the North American Ecosystem and to the health and well-being of its citizens; to contribute to informed and responsible decisions and actions at national, corporate and local levels so as to prevent and reduce the exposure of humans and the environment to pollutants released to, formed within, or transported through the atmosphere; to recognize the systemic cross-media nature of pollutant pathways while at the same time focusing primarily on the atmospheric pathways which carry chemical pollutants across boundaries and across continents where the pollutants so carried can enter aquatic, terrestrial and food-web pathways; and finally to provide a number of case studies that, collectively, are broadly representative of many of the unique and generic characteristics of continental pollutant pathways and the risks and challenges that will be the subject of many pertinent policy debates in 1997 and beyond.

MEETING THE CHALLENGES OF CONTINENTAL POLLUTANT PATHWAYS: TOWARDS A FRAMEWORK FOR TRINATIONAL COOPERATION AND ACTION

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A VISION FOR THE FUTURE

Society and governments are increasingly challenged by the global realities of ecological and economic interdependence. Issues that synthesize the complexity of these realities centre around the well being of people and the healthy condition of ecological systems. Harmonizing the relationships between these two components of the sustainability equation constitutes the most critical challenge society and governments face today and into the twenty-first century. In this equation the integration of human and ecological systems becomes a necessary condition to confront and mitigate the deleterious effects of "global change". That is, the full range of transformations and interactions concerning the global environment, natural and human-induced, which may alter the capacity of Earth to sustain life (i.e., alterations in climate, land management and productivity, oceans or water resources, atmospheric chemistry and ecological systems). Understanding and managing these drivers of change has become a common global mission and the most important task for achieving the sustainability of ecosystems and ensuring the well being of people and society."

Denver P. Burns (1996)

A1: ESTABLISHING THE CONTEXT

In North America, our continental environment is carrying the unmistakable imprint of society's actions. It is disrupted by our presence, and we are faced with a future that threatens additional disruption. The pristine state that our society inherited is long gone. A return to it is not conceivable, nor desirable -- in fact, our current environment is often far more benign than that which history might offer. As an obvious example, we might well remember that the area surrounding Washington D.C. started as a mosquito-ridden swamp. To return to this historic state would not be accepted by the population now inhabiting the area. The modern challenge is not to move towards some natural state of the distant past, but rather to manage our interactions with our environment so that the future is more sustainable than the present. The scope and scale of this formidable challenge is aptly expressed in the above quotation taken from the opening lines of the preface to the proceedings of the "North American Workshop on Monitoring for the Assessment of Terrestrial and Aquatic Ecosystems" which was held September 18 - 22, 1995 in Mexico City.

Addressing this challenge necessarily involves regional, continental, and global-scale consideration of discharges from society and their consequences. In practice, mitigating the transport of chemicals over continental distances constitutes a major challenge to the policies of nations. The identification and management of significant risks requires a recognition of the locations of releases into the environment, the pathways of continental transport, the transformations that occur in the environment, and the routes of human and ecological exposure. It is recognized that emissions in any country may affect its neighbours in some way, and that our societies and economies are intimately related.

We hold as a matter of fundamental faith that we will each work together to avoid the risk of national policies that adversely affect our neighbours, and that we must each base our independent actions on a continental-scale understanding of the complex environmental problems that we confront. With proper planning, all of our economies will benefit from avoiding the burden of ineffective pollution controls or the damage resulting from a lack of coordinated action.

In North America, we have an opportunity to progress to an enlightened state of cohabitation with our environment. The North American Agreement on Environmental Cooperation, (NAAEC) negotiated as a parallel side agreement to the North American Free Trade Agreement, provides a mandate and an opportunity for Canada, Mexico and the United States to work together to promote a common level of understanding, to support the goal of pollution prevention, to explore the opportunities that arise, and to debate the central issues of controls and regulation at a multi-national level. This report to be submitted to the Secretariat of the Commission for Environmental Cooperation (CEC) is part of a Secretariat initiative arising from Article 13 of that Agreement which enables the Secretariat to report to the Council of the CEC on matters falling within the scope of the Agreement. It is the Panel's hope that its report will be seen as an important contribution to the Article 13 initiative, an initiative that has potential for global influence and of becoming a bold and important step into the next century of international environmental cooperation that will leave "business as usual" behind as we address complicated problems that will affect us all.

The present document is intended to inject the concept of "Continental Pollutant Pathways" into the environmental debate. We refer to continental pollutant pathways in North America and to the different modes by which pollutants are transported, transformed and deposited from their sources to their ultimate receptors. These pathways, whether human or biotic, are examined at a trinational level, although local, regional or global interrelationships will also be explored.

The pathways will vary according to the physical-chemical characteristics of the substance, the origin of manufacturing, its use or release into the environment, the characteristics of receiving ecosystems, the mechanisms of transport, the potential for interactions with other pollutants or components of the environment and their persistence in different media (air, water, land, biota, etc.). The importance of each pathway will depend on many factors including the toxicity and persistence of the pollutant and the potential exposure of humans and biota, considering all routes of exposure.

The aim is to protect the right of every human being to have a healthy and productive life in harmony with nature. Environmental cooperation on "continental pollutant pathways" in North America, can facilitate understanding and prevent or reduce the exposure of humans and the environment to "continental pollutants" and at the same time be sensitive to the need for equity (including intergenerational equity), justice and balance within and between the countries of North America.

A2: MODES OF TRANSPORT

The framework of any transport and fate analysis of chemical pollutants must reflect their life-cycle (cradle to grave). Four distinct transport mechanisms/pathways can typically be identified for any given pollutant.

Mechanism I involves the extraction of raw materials from the environment and the transport of these as input to specific production facilities. Small amounts of potentially harmful chemicals may be released during manufacture or production of chemical intermediates. This is an active process, regulated either by regional and national governments under legal or voluntary compliance programs. These activities usually involve point source controls.

The bulk of the raw materials is repackaged as chemical products and redistributed through continental and regional marketing systems (Mechanism II). This is also an active process regulated by market economies and currently influenced only by environmental and transportation laws for hazardous chemicals. The emerging concepts of "product stewardship" (as already practised in Europe and North America), the "responsible care program" (of the chemical industry), for example, internalize corporate responsibilities and encourage safe products.

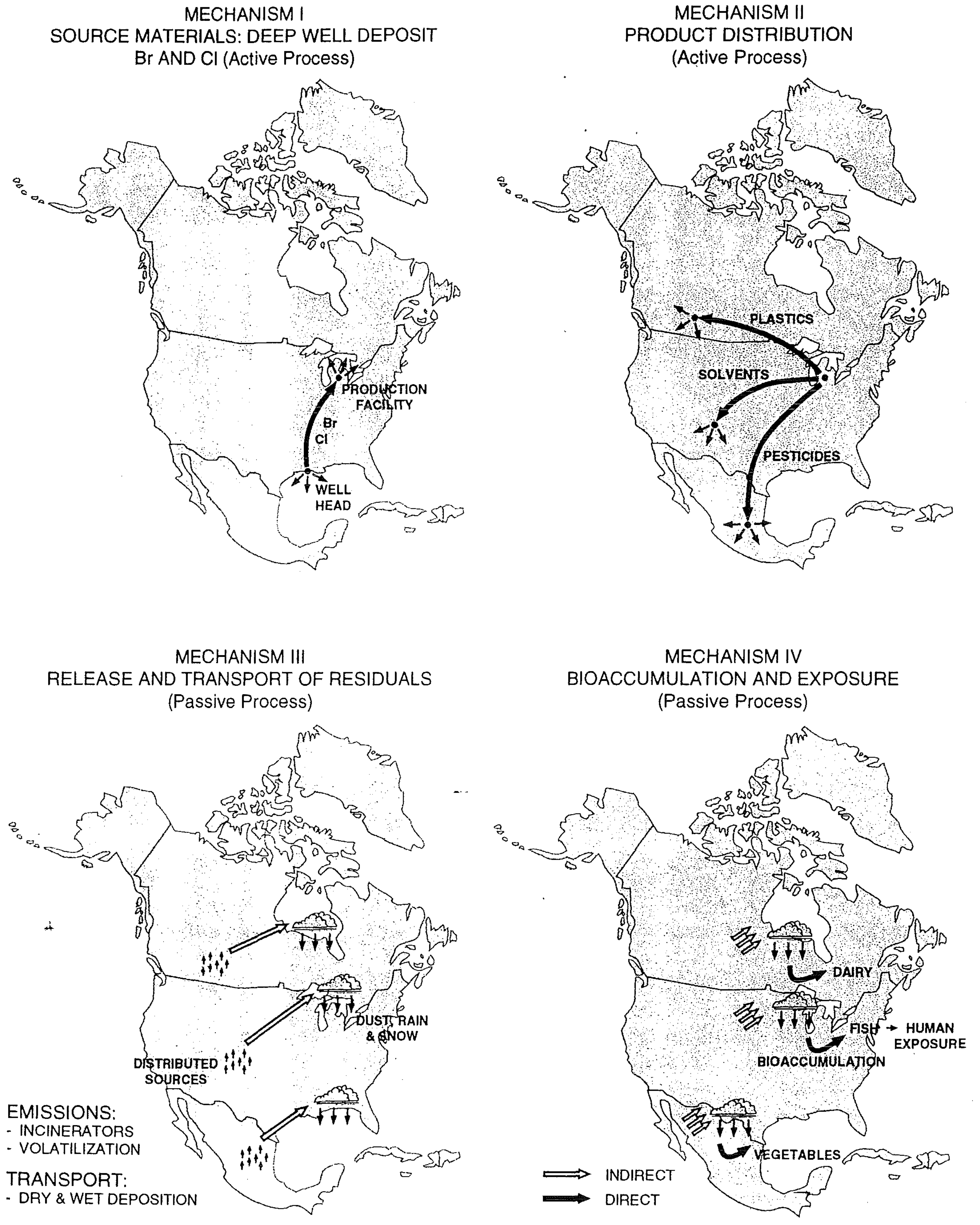
During and after use of the product, unwanted by-products may enter the air or water either from volatilization and/or incineration. The redistribution by atmospheric (or aquatic) transport is often a passive process and the sources are often considered non-point sources for regulatory purposes (Mechanism III). Remediation at this stage is much more difficult if possible at all.

In general, concentrations decrease as transport moves pollutants away from source regions, eventually to levels below those of concern. The rate at which concentrations diminish varies with location, but generally air is not an acutely toxic medium when it contains persistent organic pollutants and mercury; however, these passively reconcentrate in aquatic and terrestrial food chains (Mechanism IV). The exposures of concern are then via human consumption of dairy products, vegetables and fish and similar food-chain exposures for other animal populations.

For respirable particulate pollutants as well as for ozone and its precursors, air can sometimes be considered as a toxic medium. These do not bioaccumulate, but represent a hazard to the cardio-pulmonary performance and health of humans and other air breathing organisms.

A3: THINK CONTINENTALLY, ACT REGIONALLY

The continent is not uniform and pollutant pathways and the resulting exposure of humans and ecosystems are directly affected by local conditions and the sensitivity of local ecosystems. An improved and more comparable inventory of releases to the environment will improve our ability to understand and predict regional as well as continental implications of policy alternatives especially if this information is coupled with improved knowledge of continental air circulation and oceanic interactions. The availability of emission inventories and meteorological information is quite different for Mexico, the United States, and Canada and may require


MECHANISM I
SOURCE MATERIALS: DEEP WELL DEPOSIT
Br AND Cl (Active Process)
PRODUCTION FACILITY
Br
Cl
WELL HEAD
MECHANISM II
PRODUCT DISTRIBUTION
(Active Process)
PLASTICS
SOLVENTS
PESTICIDES
MECHANISM III
RELEASE AND TRANSPORT OF RESIDUALS
(Passive Process)
DUST, RAIN & SNOW
DISTRIBUTED SOURCES
EMISSIONS:
- INCINERATORS
- VOLATILIZATION
TRANSPORT:
- DRY & WET DEPOSITION
MECHANISM IV
BIOACCUMULATION AND EXPOSURE
(Passive Process)
DAIRY
FISH
HUMAN EXPOSURE
BIOACCUMULATION
VEGETABLES
INDIRECT
DIRECT
SENES

trinational cooperation to develop a homogeneous source inventory, as well as joint monitoring of the pollutants, their products and their transport and eventual deposition in different locations.

We know that there are exchanges of pollutants from south to north and vice-versa that depend on the specific site, season, and even time of day. These exchanges may be highly variable depending on the scale of interest. While considering the continental level we should not forget that the local and regional impacts, in many cases, are not well understood.

Integrated ecological monitoring and exposure assessment will improve our ability to assess the potential multimedia exposure by human populations and affected biota to pollutants. For all these pollutants, it is important to understand the uncertainties and assumptions made at the local, regional or continental level. An inventory of information and research resources in the three nations would be a useful tool for planning trinational action.

Intergovernmental approaches and agreements as well as relevant national, state and provincial legislation will increasingly reflect these regional differences in the way pollutant pathways are manifested. Also the active participation of interested groups, including nongovernmental organizations and academia can be expected as well as continuing concerns related to environmental equity and social justice.

In addition to risk, a related view, sometimes called life-cycle (or cradle-to-grave), might be an even better approach. If the ultimate disposal of any product or by-product is going to be difficult, then the product or by-product should not be made in the first place. This may emerge to be the approach of choice, since environmental risks from emissions and disposal will be eliminated, with the economic factors internalized in the decision-making process.

Some pollutants may pose a greater impact on the environment or may pose a greater concern for public health. A knowledge of the mechanisms for their transport, transformation or creation (as in the case of photochemical oxidants or acidic species) is an important input to predicting their impact on humans and the environment. Air pollutants may be widely distributed, exposing large numbers of people or ecosystems on a regional scale.

Finally, while the atmospheric pathway is the main topic of this report, a multimedia approach is critical if we want to preserve overall environmental quality. In the case of persistent organic pollutants and mercury there is a great potential for the pollutants migrating from one medium to another and ultimately bioaccumulating in biota or the human population causing adverse effects. Many specis of migratory birds and mammals can accumulate high concentrations of chemical pollutants and then after migration be consumed by humans and other biota. The effects will vary depending on many things including the chemical and toxicological characteristics of the pollutant, the amount and timing of the exposure and individual sensitivity. The demographic characteristics of the population at risk may also be an important consideration during the problem definition.

A4: EMERGING CONCERNS

Alternative concepts on pollutant pathways also need to be addressed, such as the case of airborne transport of biological agents, as well as, pollution transfer resulting from the export of contaminated goods or manufacturing technologies which produce toxic by-products.

A4.1: Airborne Transport of Biological Pests and Pathogens

The continental transport of biological pests and pathogens (viruses, bacteria, fungi, weeds, insects, etc.) constitutes a threat to the sustainable development of all nation states. Increasingly, it is becoming apparent that pests and pathogens are being transported by the winds. Small spores, seeds, etc., are passively transported through convection, wind flows and deposition (see Volume II – POPs Case Study). Others are transported by the migratory activity of host organisms (see Volume II – Mercury Case Study). Flying insects and birds carry pathogens and parasites. The movements of insect transmitted diseases from waterfowl, the invasion of diseases in the shrimp aquaculture and the dispersion of insect pests in agriculture all illustrate the importance of aerial transport of biological pollutants. Many pathogens, including human pathogens, are also spread by the movement of people on the world network of commercial aircraft.

There is a significant difference in the remediation or regulation of chemical versus biological airborne pollutants. Chemical pollutants must usually move more-or-less continuously and in mass to constitute a significant environmental risk. Biological agents can migrate infrequently in small numbers and, once established, can reproduce to the point of the outbreak of an epidemic. The transport of biological agents constitutes a most difficult problem for regulatory agencies.

A4.2: Exporting Goods or Manufacturing Technologies

The transfer of technology that produces toxic by-products may be very hazardous in terms of exposure by the receptor population. Mexico's "maquiladora" industries, located near the United States border, may provide an exemple of where the reality does not agree with the accords that have been signed. An example provided in the bilateral agreement states that goods with added value should be returned to the original country along with any included hazardous wastes generated during the manufacturing processes. In such cases, this "de facto importation" of hazardous wastes poses a great potential for exposure by the receiving population.

A4.3: Endocrine Disrupters

This is an emerging issue that is being extensively studied at this time. The issue needs to be monitored at the trinational level, and the information used to design continental-scale programs to reduce the threats to society and the environment.

A4.4: Climate Change Impacts

The continent is susceptible to changes both in the average climate it experiences and in the frequency and duration of severe events -- floods, hurricanes, tornadoes, tsunamis, etc. Both aspects of climate change are relevant in the present context. Scientists of the three nations must work together to generate a continental view of the susceptibility of different regions and processes to the changes that climate change will bring, whether man-induced or due to natural variability. This is an example of a case in which consideration of mean values alone is not adequate to address the questions that will arise. Uncertainty and natural variability enter as prime considerations.

A4.5: Integrated Monitoring

The environmental issues of the future will be increasingly complex, requiring inputs from many disciplines in designing and adapting strategies for preventing and mitigating unwanted outcomes. The acid rain issue is an example of the kind of multimedia and trans-disciplinary problem that is anticipated to become more frequent as population and societal pressure on the environment continues to increase.

Integrated monitoring is a new approach to studying the issues. Integrated monitoring extends and builds upon the fundamental rule of classical "routine" monitoring, that imposes uniform protocols and instrumentation on all locations. The central concept is that society will profit where monitoring locations operate at an advanced level, where monitoring and research activities are brought together. The intention is to build a more reliable time record from the more advanced research instrumentation available, and to ensure that ongoing research is yielding the basic understanding necessary about why observed changes actually occur. Canada has an ongoing integrated monitoring infrastructure in place. An embryonic activity in the USA is starting to grow. **There is need to endorse the concept on a continental scale, with compatible sampling protocols and scientific approaches. The three nations of North America must work together to design a nested integrated monitoring network capable of detecting continental trends and supplemented with site-specific reference sampling stations in representative region of the continent.**

A4.6: Socio-economic and Public Health Issues

The social, economic and public health concerns are very complex, but common concerns about benefits or cost of environmental policies, or their lack, include the reasonable determination of environmental quality impacts, their economic implications, and the understanding of specific exposures to determine health, welfare and ecological impacts.

In some instances the growth of the population and its demand for energy, transportation and other consumables has overwhelmed the reductions in emissions. Alternative practices to pollution control have been proposed that use economic incentives (or disincentives) or establishing policies that share the opportunities arising. Harmonization of regulations among the three participating nations may be a goal to strive for, but local constraints and conditions will influence the outcome. **Clearly multilateral cooperation in the development of shared goals and objectives provides one means to facilitate the harmonization of standards and regulations to meet these shared goals and objectives.**

Additionally, it is important that the three nations promote cooperation to ensure the availability of new or alternative technologies, including process modifications, controls at the end of the pipe, continuous process monitoring and life cycle analysis to provide an understanding of the full and lasting effects of technological alternatives and retrofitting to prevent and reduce the generation of pollutants.

Health effects and comparative risk analyses also have to be addressed. In terms of demography, the populations of the three nations are significantly different and the end health points may need to be addressed in alternative, more comprehensive, ways. For example, the population of Mexico is, in general, a younger population. In this case, reproductive toxicology may be affecting a greater proportion of the population than end-point carcinogenicity. The size and age profile of the population may play an important role in the health outcomes to be addressed.

Characterizing such issues may lead to an understanding of (1) the social and economic opportunities arising from pollution prevention and control; (2) the overall equity of the proposed measurements (with the individuals and nations involved); and (3) the environmental justice of each one. Environmental justice should include past and present contributions (physical or through trade) for both the current situation, as well as any future conditions that may arise. **Improved means of developing and assessing the consequences of different emission control "scenarios" is a key to this process.**

A4.7: Past Strategies

Air quality scientists and pollution control authorities of the 1950-1980 era were essentially dealing within the bounds of technologies that were on the brink of a tremendous surge of development. Scientists, working in the field and in the laboratory, were able to assess the effects of the common pollutants, such as sulfur dioxide, thus enabling regulators to set what appeared to be acceptable standards. At the same time, atmospheric scientists, using a variety of pollutant dispersion models, could estimate the maximum allowable emission rates which could be permitted while still maintaining an "acceptable" air quality. Thus, industry (and other pollutant generators) was able to determine an appropriate combination of control equipment to limit emissions so that downwind concentrations satisfied the demands placed on them by regulators.

While early activities were undertaken with the best of intentions and the most up-to-date techniques then available, they have proven to be inadequate in a number of instances. For example, sulfur dioxide and nitrogen dioxide were both known to be toxic gases, and due care was taken to ensure that ground level concentrations did not harm human health, vegetation or materials. Unfortunately, it was generally assumed that these pollutants, when dispersed in minute quantities over long distances, were quite harmless -- "the solution to pollution is dilution". It is now well known that the consequences of the tall-stack approach to reducing local ground-level concentrations was to spread the pollutants to much greater distances, where they acidified rain. The well-known acid rain phenomenon has demonstrated the danger of failure to recognize the limitations of scientific understanding. Another example relates to the current issue of CFCs (chlorofluorocarbons), and their deleterious effect on the stratospheric ozone layer. When these compounds were introduced a few decades ago, they replaced more noxious gases, and were hailed as environmentally benign.

We can now detect pollutants at concentrations so low that their potential for biological damage cannot be easily assessed. We know that these contaminants are present and we can usually measure their emission rates. But we are also finding that nature often produces and releases the same "pollutant." For example, atmospheric methane arises from many natural biological sources, as well as from industrial activity. Even so, the incremental additions from human activity must be given serious consideration. From the continental perspective, there must be attention to what humans are adding to natural environmental systems.

This paper is focussed on the atmospheric pathway more than on other media, but clearly there is need to consider the interactions among the media and to pay special attention to the way in which controls and regulations affecting one medium affect another.

A5: THE VISION

It is the vision of Canada, the United States and Mexico that releases to the environment of anthropogenic compounds that are shown to be harmful to the environment and to society should be continually reduced. The ultimate goal may be to eliminate all discharges.

or:

[That anthropogenic releases to the environment of substances and classes of substances which singly or in combination are, based on the weight of evidence, deemed to be harmful to the environment and society be continually reduced and where circumstances warrant be virtually eliminated through phase-outs, bans, process changes and other means]

A5.1: <u>Moving in the right direction:</u>

Policy and regulations should be aimed at reducing emissions and/or risk based on today's technology, and simultaneously driving the technology to achieve greater reductions. In concert, the needed scientific investigation should be undertaken. This approach needs to be implemented in a cyclical fashion until the emissions reductions are achieved and the scientific understanding of thresholds come into harmony.

On the one hand, advocacy groups promote driving towards adopting a "zero (or minimal)-emissions" target. This argument concludes that since we don't know enough to establish a safe threshold, set the threshold at zero. Zero would be a long term goal, rather than an immediate fix, and one that is preceded by an in-depth analysis of environmental protection, economic opportunities and/or impacts and social repercussions. The approach is visualized as a stepwise path towards an ultimate goal which may never be reached for certain pollutants. In this example the assumption is that the pollutant is guilty unless proven otherwise.

An alternative argument can be constructed that states that no regulation should occur until complete understanding is at hand. This is a facile argument that assumes that complete understanding is possible in a reasonable length of time. At its extreme this argument is based on the assumption that a potential pollutant is innocent until proven guilty.

Thus there are widely divergent approaches to the question of how best to structure control strategies. Either of the two examples that follow could, in concept, be promoted to solve some specific problem:

- **Focus on the need to reduce all emissions:** adopt whatever methodologies are feasible to reduce emissions, based on the assumption that reduction of emissions is to the benefit of the environment as a whole.

- **Target emission reduction strategies on what can be best achieved:** minimize adverse effect and maximize environmental benefits.

Some argue that the goal of minimal emissions is a utopian dream, not technically achievable in the near future, and certainly economically and thus socially unacceptable according to our current understanding. Others argue that for some pollutants the zero-emission option is optimal, and is necessary for health or ecosystem protection. The fact remains that we now recognize our inability to predict the long term effects of the release of relatively small quantities of any given contaminant with any degree of certainty. Science is working on improving the state of understanding. The goal is to develop a new integrated regulatory philosophy.

As time progresses, it is becoming more and more apparent that naive solutions to complicated environmental problems can have unexpected consequences, not always positive. Society is increasingly intolerant of regulatory mistakes, nor can it risk aggravating spatially or temporally distant situations by imposing simple solutions to local problems. It is obvious that the air recognizes no international boundaries, and that air pollution decisions made in any jurisdiction will affect the air quality of its neighbours.

The complexity of the multiple-pollutant and multiple-receptor problem is daunting and action along this path may be difficult. However, we should not reduce the vigilance of efforts to deal with such critical issues.

A5.2: A specific suggestion

NAAEC/CEC can provide a forum for debating the various options arising in specific circumstances, and for the present serves as a vehicle for the scientific community and others to examine these options on a continental basis.

The environmental problems of the future will involve considerations that have not yet been addressed, including regional and continental-scale transport of pollutants and their products. Transport of pollutants over continental distances constitutes a major challenge to the policies of nations. The identification and management of significant risks requires a recognition of the locations of releases into the environment, the pathways of continental transport, and the routes of human and ecological exposure.

We must each work together to avoid the risk of national policies that adversely affect our neighbours. We also hold as self evident that better understanding is required, since it is now clear that society cannot address any single environmental "problem" without risking consequences on others.

DEFINING THE PROBLEM

B1: INTRODUCTION

> *... Humankind has not woven the web of life. We are but one thread within it. Whatever we do to the web we do to ourselves. All things are bound together. All things connect. Whatever befalls the Earth befalls the children of the earth.*
>
> *Chief Seathl (Duwamish-Suquamish), 1854*

There are many examples in our world today of lives that have changed because paths have crossed. There are more and more scientific connections being made between distant sources of pollution and local receptors - from dust that enters a house from the construction site next door, through Saharan dust found thousands of kilometres away, to released radioactive particles from Chernobyl that travelled around the globe in about two weeks.

The existence of "Continental Pollutant Pathways" among three neighbouring countries is well known to atmospheric scientists in those countries but may be a new concept for decision makers and politicians who are more in tune with sovereignty and national boundaries.

The purpose of this section is to elucidate the geographical extent of atmospheric pathways in order to put some context into "general policy" decision making.

B2: GEOGRAPHICAL BOUNDARIES

> *Everything's a circle. We're each responsible for our own actions. It will come back.*
>
> *Betty Laverdure (Ojibway), 1993.*

The term "airshed" has been used in the air pollution context in a way that immediately conjures up an analogy with the term "watershed" commonly used for water flows. However, no strict definition of the term airshed appears in meteorological or air pollution glossaries so it is useful to examine the definition of watershed. Even the term "watershed" has evolved from its original usage as a "divide" defined as "*the line following the ridges of summits that form the exterior boundary of a watershed or river basin*". From such a ridge line or divide, water would shed off in two directions hence the name watershed. The common current usage of the term watershed is to define the "river basin" itself as "*the total area drained by a river and its tributaries*", that is, the area enclosed by the divide.

A watershed is thus fixed in space by topographical features, but there is no direct analogy in the atmosphere because air flows over hills. There are a few special cases where the atmosphere is partially constrained by a combination of local topography and meteorology (temperature inversions, land-water breeze circulations), for example, in the Los Angeles basin. However, in general, the air is free to move without physical constraints.

The effective airshed of any point in North America depends on three factors:

(a) the previous history of the air arriving at the point;

(b) the location of sources which inject the pollutants into the atmosphere (both local to and upwind of the point); and

(c) the lifetime of the pollutants in the atmosphere which in turn is dependent upon the rate of depletion by wet (rain, snow, fog) or dry (fallout, impaction) deposition processes or by conversion into other chemical species (atmospheric chemistry), or by absorption onto surfaces or particles and then re-entering via volatilization.

Factor (c) varies considerably among chemical species. For example, large dust particles (historically one of the major problems in urban areas) have a high settling velocity and, therefore, a lifetime of minutes to a few hours in the atmosphere and thus only a local influence close to sources. At the other end of the spectrum, freons (implicated in the "ozone hole") have lifetimes of many decades and can travel through the atmosphere of the whole globe. Many of the pollutants that are a concern in North America have intermediate lifetimes - of the order of several hours to a few days and stay in the atmosphere long enough to cross political boundaries. A good example of this is sulfur dioxide (SO_2) which has an average lifetime in the mid-latitudes, before being deposited or converted to sulphate, of about one day. Thus, gaseous pollution from any SO_2 source that can arrive with the wind within a travel time of several hours will have a strong relative influence on the receptor, while a source of equivalent strength beyond the travel time of a couple of days will only have a small relative influence on the receptor. The situation is actually much more complex in that SO_2 converts to a fine respirable particulate SO_4 which can travel in the atmosphere from days to weeks, and will influence different receptors in different ways.

It is obvious from the above discussion that there are no fixed geographic bounds that define an airshed. The bounds can only be expressed for a given travel time and in terms of the probability of the air arriving at a receptor having come from within a specified region around the receptor.

Each point in North America has its own "airshed". Figure B1 indicates the most likely airsheds for 1 through 5 days of travel time to a location in each of Mexico, the United States and Canada. The lines are the median locations of air parcel starting points one to five days prior to arriving at each location. The 3-day line indicates that half of the air arriving at a receptor would have originated within that line and half of the time beyond it.

The most significant result is that, for pollutants that have lifetimes in the atmosphere of more than two days (and this is the case for many of the priority toxic chemicals and fine respirable particulates), sources well away from the receptor have a potential to impact on that receptor. Some of the pollutants being monitored in Mexico City today could have originated from distances beyond 600 km away, yesterday, or beyond 2,400 km away five days ago.

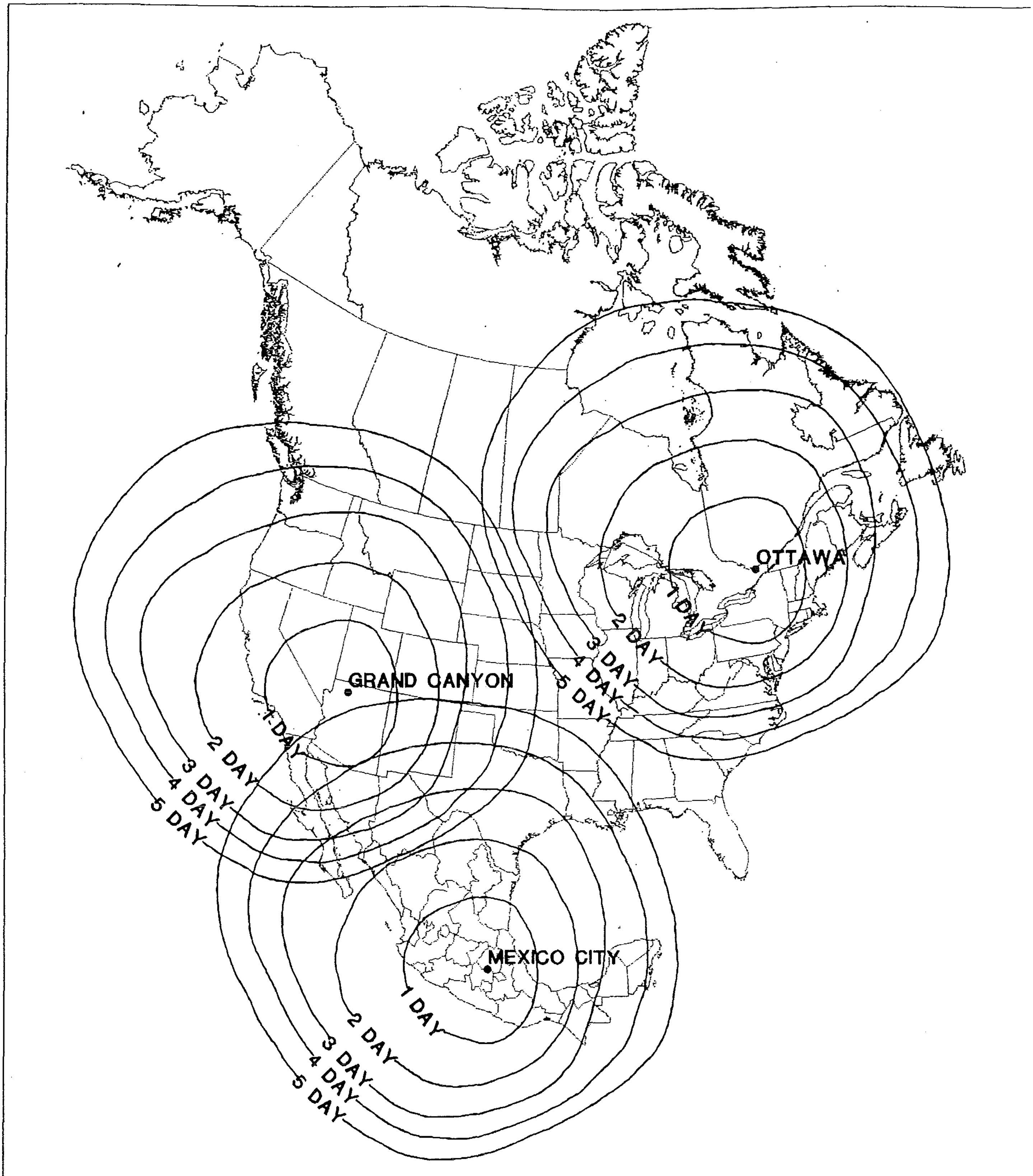


FIGURE B1

APPROXIMATE ATMOSPHERIC REGIONS OF INFLUENCE

800 0 800 1600 2400 kilometres

SCALE 1:40 000 000

131-2/05MAR97/XRF_FB1.DWG/M.T.N.

As indicated graphically in Figure B1 we will, when considering southern Mexico or Northern Canada, eventually need to redefine our area of concern / interest to be more global than the geographic bounds of North American. This report, however, deals only with the 3 politically bounded countries of Mexico, USA and Canada.

B3: CONTINENTAL PATHWAYS

B3.1: General

The Atmosphere

From a thermodynamic point of view, the atmosphere may be regarded as a *heat engine* which absorbs net heat at a high-temperature *reservoir* in the tropics and gives up heat to low-temperature reservoirs in the polar regions. In this manner, radiation generates potential energy which in turn is partially converted into kinetic energy which does work against friction.

On average, the net solar energy absorbed by the atmosphere and the earth must equal the infrared radiated back to space by the planet. However, solar heating is strongly dependent on latitude, with a maximum at the equator and a minimum at the poles. The outgoing infrared radiation, on the other hand, is only weakly latitude dependent. Thus, there is a radiation excess in the equatorial region and a deficit in the polar regions. This differential heating creates a pole to equator temperature gradient, and hence produces a growing store of zonal mean available potential energy. However, at some point the zonal thermal wind becomes unstable, and therefore, heat is transported northward. The heat transport will intensify until it is sufficient to balance the radiation deficit in the polar regions so that the pole-to-equator temperature gradient ceases to grow. At the same time, these perturbations convert potential energy into kinetic energy, thereby maintaining the kinetic energy of the atmosphere (in the form of winds) against the effects of frictional dissipation.

The Environment

The environment is a complex system of interacting media as shown in Figure B2. Pollutants do not stay in the medium where they originate, they move across environmental phase boundaries. The distribution of pollutants throughout the various environmental compartments, in which air, water, soil and biota are included, is the result of complex physical, chemical and biological processes. The resulting environmental and human health risks depend upon the degree of human exposure to pollutants via multiple pathways. Therefore, environmental pollution has to be considered a multimedia problem. For example, Persistent Organic Pollutants (POPs), which form part of the Volatile Organic Compounds (VOCs), are very mobile compounds in the environment, and when initially present in soil or water media can readily volatilize to the atmosphere where they can be transported over long distances from their sources.

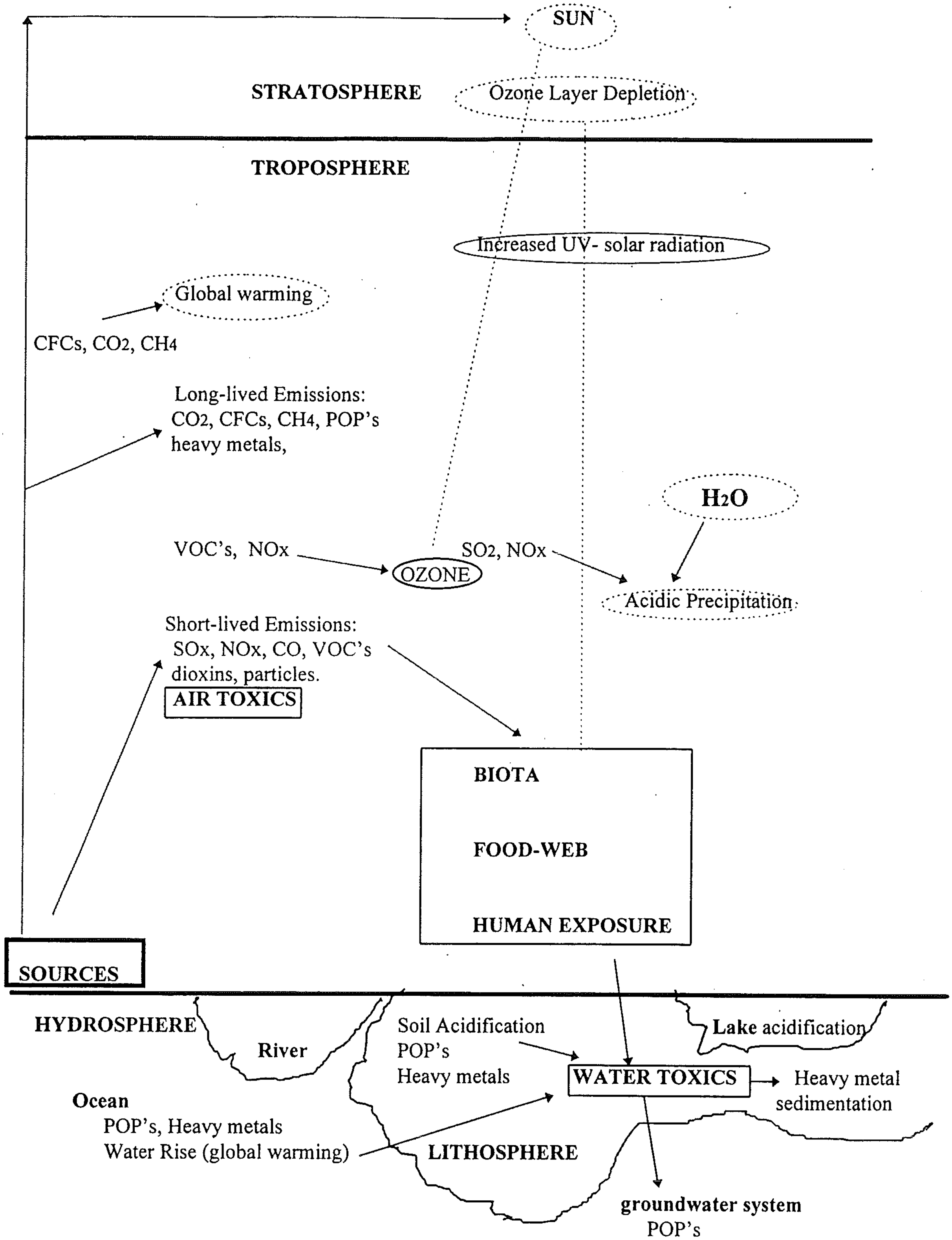


Figure B.2 **Pathways of continentally transported pollutants**

Major air emissions pathways

Emissions can travel through multiple pathways, they can pollute directly the air, participate in secondary reactions and can create environmental impacts and risks such as: public nuisances, materials damages, biota damages, human health effects, changes of genoma by mutations, carcinogenesis and teratogenesis, and ecological effects such as acid rain, depletion the ozone layer, global warming, vegetation and crops damage, sea rise and others.

Pollutants of short-life: SOx, NOx, CO, VOC's and others air toxics such as polyciclic aromatics hydrocarbons (PAH's), polyclhorinated biphenyls (PCB's), dioxins and furans, can affect the human health as well as biota by direct exposure.

Pollutants, also can go into the food web, through exposure direct of biota, the absorption/adsorption of them in the vegetation and the transfer to animals and humans in the food chain.

Pollutants of long-life such as methane, carbon dioxide, **chlorofluorocarbons** and pesticides, can create long-term atmospheric changes such as global warming and stratospheric ozone depletion, which in turn increase the ultraviolet solar radiation, the ozone formation as secondary pollutant, and affects human health, and biota.

Pollutants can affect multimedia, through formation of secondary aerosols, nitrates and sulfates, from sulfur an nitrogen oxides, that when are washed by rain, can cause by wet deposition acidification of soil and water bodies, lakes and rivers, including sediments in lakes and the groundwater table.

Toxic chemicals can also be deposited in the soil and enter in the food chain or into the groundwater.

B3.2: What is a Transfer Matrix Model?

For the purposes of estimating changes in concentration and depositions due to emission changes, the output of long range transport models can be conveniently expressed by an atmospheric "transfer matrix". The matrix formulation assumes that the deposition at a receptor location is the sum of partial contributions, each of which is proportional to the emissions from a source or a group of sources. The coefficient of proportionality connects the source region with the receptor. The array of coefficients connecting deposition at a receptor with a unit of emission in a source region constitutes a unit transfer matrix and indicates the strength of the atmospheric linkage between the source and the receptor.

B3.3 A Preliminary Unit Transfer Matrix for North America

Definition of Receptors

Since the focus of this document is primarily a scoping of the atmospheric pathways, the receptors examined have been arbitrarily set at the geographical centre of each state and province to represent the approximate impact of various sources to these political entities.

Definition of Sources

The sources of pollutants for the example used in this study were selected as the emission weighted centroids in Canada, the United States. and as the major urban areas of Mexico.

Application in North America

An extract from the complete transfer matrix presented in Volume II "Source-Receptor Case Study" is outlined in Table B1. It presents connections among eight source regions in North America as shown in the top matrix of Table B1 and Figure B3 and nine selected receptors as shown in Figure B.4.

The nine receptors selected demonstrate the source-receptor relationships among the Yucatan (R29), Mexico City (R19), Sonora (R2), California (R42), Vermont (R39), West Virginia (R56), Quebec (R86), Ontario (R84) and the Northwest Territories (R82).

B3.4 What Does this Material Tell Us About Atmospheric Pathways Among the Three Countries?

The bottom matrix of Table B1 indicates, for the actual SO_2 emitted in the eight source areas, the wet sulphate loading received at the nine receptors (in kg/ha/year) before a background of 4.8 kg/ha/year is added. The table confirms that the closest sources have the largest impact (see the impact of the State of Mexico on Mexico City), and that sources as far away as Arizona and Hermilloso can impact on Ontario, Canada.

Table B1

Excerpt from the North American Unit Source-Receptor Matrix
Receptor SO_4 Wet Depositions (in kg/ha/year) per gram/second of SO_2 emitted

Receptor No.	Receptor Name	AZ	CA	MO	SASK	TX	WY	MEX	HER	NOTES
R82	NWT	3E-12	0E+00	0E+00	0E+00	4E-11	0E+00	1E-11	0E+00	Sensitive Arctic Ecosystem
R84	Ontario	2E-05	1E-06	5E-06	9E-06	3E-10	7E-06	8E-11	8E-06	Forests
R86	Quebec	3E-06	8E-07	0E+00	2E-09	7E-07	3E-06	2E-11	7E-08	Maple Trees
R39	Vermont	4E-07	1E-06	2E-08	2E-06	9E-08	7E-06	4E-11	2E-07	Sensitive Watersheds
R56	West Virginia	9E-07	2E-06	0E+00	6E-11	4E-10	7E-06	1E-10	6E-07	Appalacians
R42	California	6E-11	3E-08	0E+00	0E+00	6E-10	0E+00	1E-10	8E-10	Redwoods & Mojave Desert
R29	Yucatan	4E-11	0E+00	0E+00	0E+00	4E-10	0E+00	1E-10	0E+00	Mayan Ruins
R19	Mexico City	5E-11	2E-09	0E+00	0E+00	5E-10	0E+00	2E-05	4E-10	Large Urban Population
R2	Sonora	1E-10	2E-07	0E+00	0E+00	1E-09	2E-10	2E-10	2E-06	El Pinacate y El Desierto de Altar

	AZ	CA	MO	SASK	TX	WY	MEX	HER	Total (grams / second)
SO_2 EMISSIONS (g/s)	9666	5868	20626	3044	37397	3797	2380	6246	89024
Total North America									789750
% North American Total									11.3%

ACTUAL MODELLED WET DEPOSITION (kilograms per hectare per year)

No.	Name	AZ	CA	MO	SASK	TX	WY	MEX	HER	Total from Eight Sources[1]
R82	NWT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
R84	Ontario	0.2049	0.0062	0.0932	0.0284	0.0000	0.0279	0.0000	0.0525	0.41
R86	Quebec	0.0321	0.0047	0.0000	0.0000	0.0258	0.0126	0.0000	0.0004	0.08
R39	Vermont	0.0039	0.0063	0.0004	0.0068	0.0032	0.0282	0.0000	0.0013	0.05
R56	West Virginia	0.0091	0.0144	0.0000	0.0000	0.0000	0.0260	0.0000	0.0035	0.05
R42	California	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
R29	Yucatan	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
R19	Mexico City	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0538	0.0000	0.05
R2	Sonora	0.0000	0.0010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0112	0.01

[1] Background of approximately 4.8 kg/ha/yr not included

FIGURE B3

EXAMPLE SOURCE LOCATIONS

700 0 700 1400 2100 kilometres

SCALE 1:35 000 000

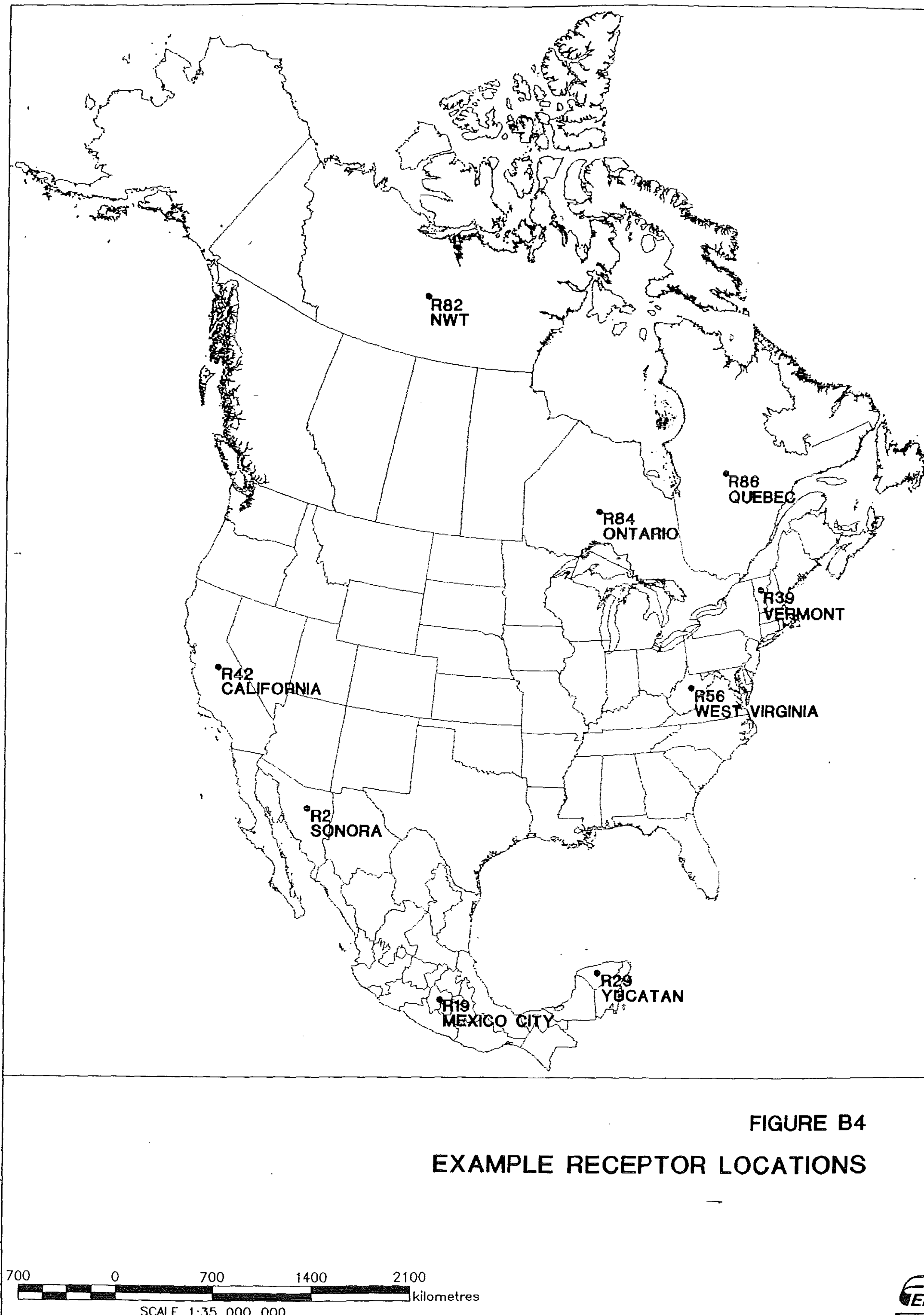


FIGURE B4

EXAMPLE RECEPTOR LOCATIONS

32131-2/06MAR97/XRF_FB4.DWG/M.T.N.

B4: POLLUTANTS OF CONCERN

B4.1: Introduction

In general, for the purposes of this review of "Continental Pollutant Pathways" we are concerned about any pollutants or their precursors that can reside in the atmosphere for more than two days. This residence time is the factor which defines that a pollutant is part of a "continental pathway". Table B2 presents the atmospheric residence times for the pollutants considered in this project

Table B2
ATMOSPHERIC RESIDENCE TIMES FOR VARIOUS POLLUTANTS

Pollutant	Atmospheric Residence* Time in Days	Notes
VOC	0.1 – 7+	Species-specific ranging from minutes (isoprene) through days (butane) to years (methane)
POPs	1 – 30+	Vapour pressure and temperature dependent
Dioxins	3 – 7	Tetra - penta chlorinated
Hg	30+	
SO_2	1 – 2	
$SO_4^{=}$	3 – 10+	
NO_y	1 – 5	Species-specific
NO_3^-	3 – 10+	
O_3	3 – 5	
Large particulates	<1	
Fine particulates	8 – 10	< 2.5 Tm

* Determined by conversion, coagulation, absorption, adsorption, deposition, impaction, etc.

While there are many examples of pollutants that are transported over short and medium ranges – the substances listed in Table B2 will help us understand the regional – continental – global movements of pollutants within, from, and to North America.

B4.2: Acid Rain

Problem Statement

The case of wet and dry acidic deposition has brought together first the scientific community and then governmental bodies of both the United States and Canada to address the issue at a binational level. This case is paradigmatic in various ways. First, the sources of acidic deposition have been established in both nations, along with the transformation mechanisms for the released pollutants and the ultimate impacting species on the environment, including their deposition rates. The impact or potential impact on the different biota have been measured or predicted, as in the case of low alkalinity lakes and low cation exchange capacity soils.

The case is also broadly illustrative of the general continental-scale pollution problem in the way in which human intervention is required to remedy the problems as they are recognized.

The same components in acidic deposition are present in acidic fogs or acidic particles that are responsible for acute health effects in sensitive populations at a local or regional level, emphasizing the need for controlling the sources of such pollutants.

Acid rain is a good example of an issue that has moved part way through the stages of problem identification, control program design and implementation and benefits monitoring. Many lessons can be learned from this experience that can be applied in addressing other complex issues, such as climate change and mercury cycling.

Sources, Pathways, Receptors

Anthropogenic SO_2 emissions represent over 2/3 of the total SO_2 emissions to the troposphere and the emissions in the northern hemisphere alone represent an estimated 81% of the total sulfur emissions. The pathways from emission sources (natural or anthropogenic) are controlled by the atmospheric circulation patterns. When conditions allow, precipitation produces acid rain. Acid rain affects ecosystems and monuments as well as affecting the food chain (see Volume II, case studies on acid rain and impact of air pollutants on forest ecosytems).

Acid rain has been well characterized in Canada and the USA. Preliminary evidence indicates problems in Mexico and these need to be documented with regard to severity and extent.

Generic Characteristics

Acid rain is the product of introducing precursors, SO_x, NO_x into the atmospheric system (clouds) where these chemicals are transformed into H_2SO_4 and HNO_3 (the principle components of acid rain). These acids reduce the normal pH of rain to values less than 5.6.

Acid rain is controlled in each of the three countries using different approaches. In the US, the Clean Air Act (1990) takes a nationwide approach to reducing acid rain. It has set up a market-based system designed to lower SO_2 levels. By the year 2000, annual releases of SO_2 will be 40% lower than the 1980 levels. Further the United States EPA will require NO_x reductions from power plants and new cars. Canada has used the targeted emission reduction approach and is currently exploring the market-based system for additional reductions. Mexico does not at this date have any specific control strategies for reducing acid forming emissions, although acid rain has been detected in several regions of the country.

B4.3: Dioxins

Problem Statement

Consumption of milk, dairy products and beef are probably the most significant sources of dioxin exposure for the general population. The presence of dioxin in these foods arises as a result of dioxin entering feed-crop vegetation, primarily from the air. Thus, air emission sources of dioxin are of crucial importance to the exposure of humans to dioxin. A significant fraction of the dioxin emitted to the air from a given source will eventually be deposited back to the earth's surface – even though it may be dispersed over 100s or 1,000s or even 10,000s of kilometres – and deposition to vegetation is a relatively significant pathway. A portion of the dioxin so-deposited is incorporated into animal feed crops. Dairy cows, beef cattle, and other animals eat these contaminated feed crops, and dioxin bioaccumulates in their milk and/or fatty tissues. In this way, the properties of dioxin, its atmospheric fate and transport, and the characteristics of agricultural ecosystems combine to efficiently capture dioxin emitted to the air and transmit it to the human population.

Sources, Pathways, Receptors

Dioxin is not produced intentionally but is formed as an unwanted by-product in many different types of processes, and is generated naturally during combustion of organic materials. The two most important formation situations are: (1) combustion processes (e.g. waste incineration, fuel combustion, metallurgical processes); and (2) solution-phase processes (e.g. pulp bleaching with chlorine or chlorine-containing compounds, chlorinated organic chemical manufacturing, chlorine production). Because of the widespread distribution of sources and the persistence and transport of dioxin in the environment, it is an ubiquitous contaminant in food, water, air, soil and vegetation.

Dioxin, formed from combustion processes, is capable of long-range atmospheric transport, and so these critical exposure pathways are contributed to by continental-scale emissions and environmental phenomena. The presence of relatively high levels in fish result from bioaccumulation after dioxin enters aquatic ecosystems (through direct discharge to the water or through atmospheric deposition). The role of continental pollutant pathways in this exposure route is less clear[1]. National and international trade in dioxin sources, precursors and in dioxin-contaminated food materials are other ways in which human exposure to dioxin is influenced by actions over a continental scale.

The current background exposure of the general population appears to be high enough to warrant concern about carcinogenic, developmental and endocrine disruption effects. More highly exposed populations (e.g. nursing infants, subsistence fisherman, certain occupational situations) are of even greater concern.

Generic Characteristics

Higher chlorinated dioxin congeners (i.e. those with 6, 7 and 8 chlorines) are expected to exist largely associated with small particles in the atmosphere, and will have atmospheric lifetimes of roughly one week. Significant fractions of the more toxic tetra- and penta-chloro dioxin congeners are expected to exist in both the vapour and particle phases in the atmosphere. Their

1 This perhaps depends somewhat on migration patterns of fish. That is, fish can become highly contaminated in highly contaminated waters (e.g. coastal regions receiving effluent from large cities) and then swim somewhere else, get caught and be eaten.

atmospheric lifetimes are expected to be on the order of a few days to a week. Over such periods, dioxins can be transported in the atmosphere over regional and continental scales.

Dioxin enters crops largely from the air; it is not generally taken up by plants from soil or groundwater. Dry deposition of vapour-phase material may be the dominant mechanism by which dioxin enters vegetation. The more toxic tetra- and penta-chloro dioxin congeners are relatively volatile and exist to a greater extent in the vapour phase in the atmosphere than do the less toxic higher-chlorinated congeners. Thus, it is "unfortunate" that vapour-phase dioxins appear to be more efficiently transferred to vegetation.

B4.4: Mercury

Problem Statement

Case studies have been prepared for both mercury and dioxin. In practice, they have a number of commonalties that simplify their consideration. Both arise, in part, from waste disposal and treatment. Both are subject to long-range transport through the air. For both, revolatilization complicates the atmospheric and terrestrial/aquatic pathways.

A large volume of peer-reviewed information is now available about mercury (see Volume II, Mercury Case Study). Elemental mercury (Hg^0) is a highly volatile metal, and the methylated form (CH_3-Hg) is a potent neurotoxin which bioaccumulates through the biotic food chain to levels that are thousands of times greater than those found in water.

For mercury, transport through the atmospheric and terrestrial environments is complicated by its interaction with organic matter. The form of mercury of most concern is methyl mercury. Some of the mercury (about 1%) in wet and dry deposition is methyl mercury but most of it is deposited in an inorganic form. A research priority is to assess the relative availability of atmospherically deposited inorganic mercury to the methylating bacteria that connects mercury to the methyl mercury form. A second research priority is to assess the relative contribution of atmspherically deposited mercury to the overall supply of methly mercury in freshwater ecosystems and its eventual uptake by fish species used as human food.

Much research during the past decade has focused on quantifying the historical record of mercury emissions and eventual atmospheric deposition of mercury to the earth's surface. A widely held, though not unanimous, scientific consensus is that Hg emissions have increased by two to five-fold over the last century. This is attributed to increased industrial activity and increased anthropogenic releases of mercury to the environment and especially to the atmosphere. **Improved understanding of emissions (natural and anthropogenic) as well as the availability of new information derived from monitoring of atmospheric concentrations and atmospheric deposition of mercury will help in refining these estimates and further clarify the significance of anthropogenically released mercury.**

Sources, Pathways, Receptors

On a regional basis anthropogenic sources, the most important of which is the combustion of coal, are a major contributor to the long-range transport of Hg. When the anthropogenic sources are reduced the downwind deposition of mercury is reduced as well as the concentrations of mercury in surface sediments. This relationship has been most recently demonstrated in Sweden where the downwind deposition and surface accumulation of mercury has declined in step with recent reductions in the atmospheric anthropogenic emission of mercury from industrial regions in Central Europe.

The atmosphere is a major vector for the movement and chemical transformations of mercury through the environment. The aquatic ecosystem is the receptor of most concern. The amount and form of mercury reaching lakes from watersheds is dependent on the amount of organic matter transferred from the watershed. Other processes and factors are also involved in the accumulation of Hg in lake sediments.

Generic Characteristics

Methyl mercury is a potent toxin that causes impairment of the central nervous system (CNS) and developmental toxicity in humans and wildlife.

On a regional basis (e.g., Eastern North America) mercury is elevated in the environment (as measured by higher concentrations of mercury in precipitation and in surface sediments of the lakes) downwind of atmospheric anthropogenic sources.

B4.5: Ozone

Problem Statement

Historically, ozone and photochemical oxidants have been regarded as local or regional air pollution problems. Experience in several locations in North America have illustrated the difficulties of dealing with surface ozone. Although impressive advances have been made in control strategies, ozone is still the main reason many cities are not in compliance with the US National Ambient Air Quality Standards. Some local ozone control actions have been counterproductive at regional levels. Since ozone is formed in the atmosphere from the interaction of sunlight, nitrogen oxides and hydrocarbons, control strategies often conflict at local and regional levels as a result of the travel time. In Canada, a concern about surface ozone has increased despite the fact that Canada's northern latitudes restrict the ozone problem to a summer months' phenomenon. In contrast, Mexican cities (particularly Mexico City) generally experience an annual prevalence of high surface ozone.

In North America there is some evidence of a potential increase in background concentrations of ozone. In rural areas, the concentration of ozone is generally limited by the availability of nitrogen oxides, due to availability of natural sources of hydrocarbons. In cities where nitrogen oxides are in excess supply, often the limiting factor is sunlight. An increase in the background ozone concentrations for Mexican and Canadian cities could mean that the current control strategies for photochemical smog are not effective. Additionally, forest and crop productivity ahow declines at relatively low ozone concentrations (exacerbated by the presence of other stressors). Recently, the North American Research Strategy for Tropospheric Ozone (NARSTO) was created to provide, among other things, information on the ozone distribution and trends in North America. NARSTO is planning to complete a comprehensive assessment of the continental ozone problem during 1998.

Sources, Pathways, Receptors

Ozone is not emitted directly, but is the result of chemical reactions between precursors, volatile organic compounds and nitrogen oxides in the presence of sunlight whose intensity varies with latitude. Ozone and photochemical oxidants have been regarded as local or regional problems. There is evidence that rural ozone is increasing due to the presence of nitrogen oxides transported from remote polluted areas. Ozone has an average residence time in the lower atmosphere of 3-5 days and can be transported regionally. It affects human health by direct exposure as well as by damaging crops and materials (such as rubber and plastics).

Ozone is of concern to humans because it has effects on vegetation, like commercial forests and crops, as well as directly on human health. Ozone is the only regionally dispersed air pollutant that has been clearly shown to injure and kill forest trees over a wide geographic range (see volume 2, case study on impact of air pollutants on forest ecosystems). The effects of ozone and other photochemical oxidants on human health are not well understood yet. It certainly produces eye irritation and influences the respiratory functions; especially in the asthmatic and sensitive population.

Generic Characteristics

Some ozone in surface air originates from higher levels in the atmosphere (stratosphere/ troposphere exchange), but most is generated locally from chemicals emitted by societal activities. The key ozone precursors are various oxides of nitrogen (generically referred to as NO_x) and a wide variety of volatile organic compounds (VOCs). Ozone is generated as a by-product of atmospheric chemical reactions involving these chemicals in the presence of sunlight. All of these chemicals, and ozone itself, are susceptible to atmospheric transport, but some of the NO_x and VOC precursors can be carried great distances. In general, we are no longer worried about each area of concern as a separate issue, but need to understand how local upwind emissions combine with the pollution brought in by long range transport to aggravate local ozone exposures.

B4.6: <u>Particulate Matter</u>

Problem Statement

The release of fine particulates to the atmosphere or their creation during reactions in air have been a long-standing concern for atmospheric scientists, often because of their visibility effects but also because of their health consequences. Recent awareness that small particles have severe pulmonary consequences has elevated the issue of respirable particles to a new level. Epidemiological studies have linked respirable particles with absenteeism, hospital admissions, morbidity and mortality. These impacts have been associated with both pulmonary and cardiac impacts of the fine particles.

Respirable particles can be produced by many local, area-wide low-level sources (e.g. backyard burning, fireplaces, cars) and by large point sources. Once produced, they are comparatively slowly deposited from the atmosphere. Their comparatively longer residence time means that they are available for longer range transport than are many other pollutants. Local sources can produce significant background levels elsewhere.

The deposition process is not always unidirectional; at times these particles can be resuspended into the air. Fine particles can serve as "carriers" of other substances, which can also be re-injected into the atmosphere as a result of the resuspension process.

<u>Sources, Pathways, Receptors</u>

Primary Particles

Particulate matter is classified as "primary" if it is directly released into the atmosphere and "secondary" if it is the result of post-emission chemical transformations or reactions in the atmosphere. Primary particles may range in size from less than 1 μm diameter to over 30 μm in diameter and are predominantly produced by the combustion of fuel, biomass and refuse, industrial processes, as well as by natural processes such as wind blown dust, sea spray, volcanic ash and forest fires.

Source apportionment studies of regional PM_{10} ambient air quality levels in the United States have typically identified area sources such as fugitive dust from roads, construction and agricultural activity, smoke from residential wood combustion or prescribed burning, and directly emitted motor vehicle exhaust as the primary contributors to high PM_{10} loadings. Similarly, studies of visibility impairment due to PM_{10} have tended to identify non-point combustion sources that produce primary fine particles in the $PM_{2.5}$ size range as more significant than point sources. Industries which use grinding or pulverizing systems in their operations (e.g. feed mills, cement manufacturing) produce primary particulate emissions in this size range. However, the smallest particles (i.e. less than 1 to 10 μm) tend to be produced in high energy systems such as fuel combustion. Natural processes such as wind blown dust, sea spray, volcanic ash and forest fires also contribute to the formation primary particulate matter.

The chemical composition of primary particles may include inorganic trace elements, heavy metals, and numerous organic compounds. Analyses of organics in $PM_{2.5}$ have identified over 100 organic compounds in emissions from sources such as noncatalyst- and catalyst-equipped automobiles, heavy-duty diesel trucks, the tire-derived portion of road dust, brake linings and resuspended particles, natural gas combustion and from charbroiling and meat cooking operations. The organics which have been identified can be grouped into the following categories: aliphatics, alcohols, amines, aromatics, carboxylic acids, esters, ethers, halogenated compounds, ketones, phenols, natural resins, sulfur compounds (e.g., diazinon) and nitrogen compounds (including nitriles).

Secondary Particles/Aerosols

Secondary particles are formed in the atmosphere by gas-to-particle conversion processes of originally emitted gaseous compounds. Secondary particles are found in both urban and rural areas, and consist of sulfates, nitrates and innumerable organic compounds. The highest concentrations of secondary particles are found in the size range from less than 0.1 to 1.0 μm diameter, and are a major component of urban haze.

Secondary particles less than 0.1 μm are constantly being produced during the daylight hours, as well as at night under certain conditions. Such particles have a lifetime in the atmosphere of about 12 hours before they coagulate or condense to form larger particles. The overall lifetime of the large secondary particles can range from days to several weeks before they are removed from the atmosphere through rainout or dry deposition.

The major portion of aerosol sulfates and nitrates is of secondary origin, resulting from emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x) and ammonia (NH_3). An unknown fraction of organic aerosols is also of secondary origin, resulting from the transformation of volatile organic compound (VOC) emissions in the atmosphere.

Most of the mass of the secondary aerosols appears to reside in the fine fraction of PM_{10} (i.e. less than 2.5 μm). Particles of diameter less than 2.5 μm, but especially particles in the size range 0.1 to 1 μm, efficiently scatter light and are thus of prime importance to visibility reduction. Furthermore, inhaled particles in the size range 1 to 5 μm are most likely to be deposited in the pulmonary region of the human respiratory system. Consequently, secondary aerosols are also relevant to potential impacts on human health.

Sulfates

In parts of eastern North America where SO_2 emissions are high, approximately 40-70% of the $PM_{2.5}$ is composed of secondary sulfates.

Some trace metals can play a role in the liquid phase transformation of ambient SO_2 on particles to produce secondary sulphate compounds. Liquid phase transformation of sulfates and trace elements can have significant consequences for the toxicity of sulfates to respiratory illness. For example, it has been reported that zinc ammonium sulphate may be a more potent respiratory irritant than either zinc sulphate or ammonium sulphate alone.

Nitrates

Inorganic aerosol nitrates (NO_3) are one of the end-products of photochemical reactions of NO_x in the atmosphere. Concentrations of fine particulate nitrate are generally reported to be higher during the day than at night, consistent with the higher contribution of motor vehicle NO_x

emissions during daytime hours and the photochemical origin of most of the fine nitrate aerosol in the atmosphere .

Organic Aerosol

Chemical reactions between NO_x, NH_3 and organic gases are also capable of forming secondary fine organic aerosols. Organic aerosols represent the second major constituent of secondary fine airborne particulate matter in the atmosphere after sulfates. It is reported that organic compounds (primary plus secondary particles) make up from 26% to 47% of the total fine particulate fraction of PM_{10} in parts of the United States (van Houdt 1990). The organic fraction of fine aerosols contains hundreds, probably thousands, of chemical species of which only a fraction have been identified in ambient monitoring programs. These constituents include polycyclic aromatic hydrocarbons (PAH) and nitrated aromatics that have been identified as known or probable carcinogens.

Receptors

While there is no consensus on the degree of transient respiratory function change which warrants health concern, there is evidence that in some areas of North America current levels of urban air pollutants are producing measurable effects on respiratory disease and death. These studies have indicated a statistically significant correlation between levels of particulate matter and adverse health effects in the general population. A recent review of the epidemiological studies used to develop the association between particulate matter and mortality generally agreed with the finding that daily mortality increases with increased levels of particulate air pollution, but that there may be an inter-relationship between the effects of particulate matter and SO_2.

Sources

Regional source emission inventories of directly emitted primary particulate matter are generally dominated by fugitive emissions from paved and unpaved roads, and from construction or agricultural activities (in rural areas). This is true whether the inventories are focussed on TSP, PM_{10} or $PM_{2.5}$. The inclusion of factors that account for secondary aerosol formation due to SO_2, NO_x and VOC emissions reduce the significance of primary fugitive emissions in the inventories, especially in the $PM_{2.5}$ size fraction. Nevertheless, fugitive sources of primary particulate matter remain the dominant sources of particulate emissions as tabulated in emission inventory databases in the United States, accounting for approximately 90% PM_{10} emissions on a national basis.

Sources of fugitive dust are the primary contributors to ambient particulate matter greater than 2.5 µm, while combustion of fossil fuels or wood, as well as the atmospheric transformation of gaseous emissions of SO_2 , NO_x , NH_3 and VOC from natural and biogenic sources, are the primary contributors to $PM_{2.5}$ concentrations. Most of the sulfates, nitrates and ammonium, as well as all of the secondary organic aerosols, are associated with $PM_{2.5}$. Elemental carbon and trace metals such as lead, cadmium, vanadium, nickel, copper and zinc are also largely associated with the $PM_{2.5}$ size fraction. Potentially carcinogenic organic compounds such as PAH, PCDD and PCDF are formed during combustion, and are therefore mainly associated with primary $PM_{2.5}$ emissions. Similarly, most of the CO and CO_2 emissions, as well as a small proportion of total N_2O emissions results from combustion sources. Therefore, the linkage between particulate matter and other air quality issues such as ground level ozone and visibility degradation, acid deposition, hazardous air pollutants and global warming exists with $PM_{2.5}$, but is only minimally associated with emissions of coarse particulate matter (i.e. greater than $PM_{2.5}$).

Generic Characteristics

Suspended particulate matter (SPM or TSP) in ambient atmospheres is generally composed of particles with aerodynamic size diameters less than or equal to 30 μm. Although particles greater than 10 μm diameter make up approximately half of the mass of particulate matter in the atmosphere near the surface, particles of this size are relatively dense and settle out fairly quickly. Smaller particles, those with aerodynamic diameters less than or equal to 10 μm (referred to as PM_{10}), remain suspended in the air for longer periods of time and are capable of being inhaled into the respiratory system. Consequently, the PM_{10} fraction of atmospheric particles is often referred to as inhalable particulate matter.

Mitigation measures that focus on reductions in the amount of fossil-fuel and wood combustion, or control measures that reduce the emissions from fossil-fuel and wood combustion, are likely to yield the largest benefits in reduced $PM_{2.5}$ concentrations.

Particulate matter is produced by both direct emissions from human activity and entirely natural processes, as well as being formed in the atmosphere from chemical transformations of anthropogenic and biogenic emissions of trace gases. In one form or another, particulate matter plays a significant role in radiative transfers of solar and terrestrial radiation in the atmosphere, affects tropospheric and stratospheric chemistry, and ultimately influences the large scale dynamics of the atmospheric circulation.

There is no comprehensive emission inventory of all sources of direct and indirect emissions of particulate matter and particulate precursors important to $PM_{2.5}$. Emission inventories of directly emitted particles prepared for Environment Canada have generally focussed on total suspended particulate matter. A preliminary inventory of $PM_{2.5}$ emissions was prepared for the Lower Fraser Valley, but is incomplete and needs revision.

Because of the importance of particulates to both local and continental pollutant pathways the Panel suggests that the countries of North America plan and implement a comprehensive joint program aimed at developing a much better understanding of emissions, ambient concentrations, pathways, and impacts of particulates.

B4.7: POPs

Problem Statement

Persistent organic pollutants (POPs) are contaminants which are degraded in the environment only very slowly or not at all. Many have a tendency to accumulate in biota and are potentially toxic to biota and human populations. Although the use of most of these chemicals as manufactured products has been banned in developed countries, many are still used in developing countries. Polychlorinated biphenyls (PCBs) are still used in electrical transformers and large amounts remain in storage and in the environment.

Some are released as combustion products (e.g. dioxins) which are subject to emissions restrictions. Another important source of POPs to the atmosphere is the evaporation from widely dispersed chemical reservoirs in the environment, deriving from material deposited to, then re-emitted from soils, vegetation and water bodies. Many POPs have been found to have the potential to be transported at the regional, continental and even hemispheric level. The large scale atmospheric transport of POPs has been compared to the distillation process, in which pollutants are volatalized in the warmer lower latitudes and transferred to higher latitudes where the cold condenses and deposits them back into the environment. They migrate at different rates and thus emerge at different times in remote regions. For some POPs this can result in a reverse concentration gradient with the highest levels being farthest from the release point. Not all POPs will show this pattern, their mobility being dependent on volatility and the affinity to sorb to soil and dissolve in water.

Sources, Pathways, Receptors

POPs are a very diverse group of chemicals, in which individual chemicals have very specific source characteristics. Organochlorine pesticides have been released in large amounts in the past and are now widely dispersed in the environment, being stored in soils, vegetation and aquatic systems. Volatilization from these reservoirs may often be the most significant source to the atmosphere. Many of these pesticides, however, are still used in many developing countries. PCBs are similarly out-gassing from soils and lakes to which they have been deposited over many years. They are also reaching the atmosphere by leaking and volatilizing from electrical installations, open dumps and landfills. Other POPs such as the polycyclic aromatic hydrocarbons (PAHs) are formed during various combustion processes, particularly involving fossil fuels and the transportation sector.

POPs are transported in the atmosphere over long distances, as is evident from the occurrence of many of these chemicals in very remote regions without significant local sources. One of their defining features is that many of them are 'reversibly' deposited and are thus able to cycle repeatedly between the atmosphere and surface (the "grasshopper" effect), which is enhanced by seasonal cycles of temperature. Many POPs, particularly the more water soluble compounds (e.g. γ-HCH), are also potentially subject to continental scale transport in ocean currents and rivers. The majority of POPs are prone to accumulation in phases rich in organic carbon (soils, sediments) and lipids (marine, fresh water and agricultural food chains). This puts wildlife, especially the higher trophic levels in aquatic ecosystems at risk, as well as humans who are exposed to POPs by eating contaminated food or exposed through inhalation and dermal contact.

Generic characteristics

The rates of volatilization and deposition of POPs are a direct function of ambient temperature and scavenging by rain and snow. Temperature and other climatic factors also strongly influence the rates of environmental degradation of POPs. Temperature and precipitation are thus characteristics that influence the pathways and distances that these pollutants are transported. We may hypothesize that regions with hot temperatures and high rainfall such as Southern Mexico will likely experience rapid volatilization, rapid deposition, relatively rapid degradation and short-range transport. The hot and dry areas of southwestern USA will be characterized by very low deposition, rapid volatilization and efficient removal of pollutants by long range transport. Temperate regions of the Northeastern USA and Southern Canada will experience a seasonal cycling of POPs between the atmosphere and the surface, whereas POPs will mostly be deposited in the cold and dry regions of the North American Arctic where they are likely to persist for a very long time (see volume 2, case sutdies on POPs and on Arctic). Important characteristics of POPs are:

Persistence: POPs are degraded in the environment very slowly or not at all. Persistence is often media-specific. Whereas degradation in the atmosphere can occur in the range of weeks or even shorter, degradation of some POPs in soil or sediments may occur on the time scale of decades or not at all.

Hydrophobicity: POPs tend to be non-polar compounds with low water solubility and high affinity to lipids. They thus have a tendency to partition into soils, sediments and accumulate in biological systems.

Semi-volatility: POPs have an intermediate volatility which sets them apart from both volatile organic compounds (VOCs) and non-volatile organic chemicals such as polymers. They can be present in the atmosphere both in gaseous form and associated particles. The POPs on particles can be re-evaporated after being deposited to the Earth's surface.

Toxicity: The majority of POPs are toxic substances. A wide range of effects are seen after exposure to POPs. These include effects on reproduction, development, cytochrome P450-dependent enzymes, porphyrins, the immune system, the adrenals, the thyroid gland and thyroid hormone levels and vitamin A levels. Many POPs also cause visible changes in the liver, including hypertrophy, lesions and, in some cases, tumours.

B4.8: Assessing the Whole as Well as the Parts

Many issues have common sources. If we deal with these sources effectively, the environmental impact of many of the individual issues we face today – acid rain, climate change, global warming, hazardous air pollutants, ground level ozone and smog, fine particulates – will be reduced. The concept of addressing the whole, not just the parts, is well illustrated by particulates and ozone. Such an approach, termed the ecosystem approach in the Great Lakes Water Quality Agreement and elsewhere, leads to a systems rather than a fragmented medium by medium approach.

Particulates and their relationships to other environmental issues of concern

Although the major portion of the mass of suspended particulate matter resides in the largest particles, chemical processes in the atmosphere which lead to the formation of secondary particulate matter contribute a significant proportion of fine particulate matter to ambient concentrations. Consequently, the important links between atmospheric gases and particulate matter are largely associated with the fine particles, those in the size range less than 2.5 µm. Most of the particulate matter formed from the transformation of gaseous compounds is found in this size range, and some, such as sulfates (SO_4), are suspected of having direct health effects. Particulates, especially small size fractions, are also major conveyers of other attached pollutants.

Secondary particles are also largely responsible for the reduction in visibility associated with urban smog. Particles in this size range are more effectively retained in the lungs, and thus pose a greater threat to human health. Many of the heavy metals that are classified as hazardous air pollutants and trace organic compounds considered potential or known carcinogens are more heavily concentrated in fine particles. Deposition of acidic aerosols such as sulfates and nitrates (NO_3) has direct adverse effects on terrestrial ecology. On a global scale, increased concentrations of sulfates may play a major role in the projected effects of greenhouse gases (GhG) on climate change by increasing cloud condensation nuclei (CCN) and altering the planetary albedo through increasing cloud cover. Heterogeneous chemical reactions on the surface of sulphate and nitrate aerosols in the stratosphere are also thought to be accelerating the depletion of the stratospheric ozone layer.

Ozone and its relationship to other environmental issues of concern.

The issue of ozone pollution in surface air is one of the most perplexing to face today's air pollution regulators. First, the issue involves consideration of many chemicals, both natural and man-made, that react to form ozone as an end product. Second, the issue is politically charged, since many of these contributing chemicals derive from traditional activities that are mistakenly identified with maintaining our standard of living (the power industry, automobiles, etc.). Third, the ozone question is confusing to the public, since in the upper atmosphere man-made chemicals are destroying the ozone layer, which is bad, and in the lower atmosphere different man made chemicals are generating ozone, which is also bad. Fourth, the issue is intimately intertwined with that of nitrogen oxides and their influence on ecosystems through excessive deposition of nutrients, contributing to eutrophication and fifth, the same precursors contribute to raising the levels of the fine respirable particulates, arguably the biggest health threat we face today.

The spate of control measures of the 1960s and 1970s focused attention on the need to reduce local VOC emissions, primarily from private automobiles, to start reducing ozone exposures in areas where population centred. These strategies appear to have worked in the near field in major cities such as Los Angeles, but did little to relieve ozone pollution in the far field. Now, we are faced with steadily growing NO_x levels, on a continental scale that are the main contributors to continental scale ozone levels. Monitored levels of nitrogen in the Great Lakes and in other freshwater bodies are continuing to increase. NO_x emissions, as well as other factors such as the widespread application of amonia based fertilizers, have been suggested as contributing causes.

Experience has taught well that the concept of uniform, continental-wide application of standardized control strategies is a reflection of political fairness and legal simplification that fails to recognize the site-specific differences in the environments that contribute to surface ozone pollution. Clearly, solar radiation intensity varies with latitude, and all chemical reactions that are promoted by ultraviolet radiation will be affected accordingly. Among these reactions are many of those that lead to ozone generation from its precursors. Moreover, the composition of natural chemical soup that contributes to ozone production varies greatly from place to place, with striking differences with longitude. Thus, ozone control strategies are likely to need recognition that what works well in one location may not necessarily work as well in others. The range of situations encountered across this continent is so wide that control strategies should be based on only the very best understanding, or else the ozone reduction targets will not be met and the consequences of any regulatory errors will be propagated downwind to affect other areas, in another jurisdiction if not in another country.

> *The idea of having a basic standard to protect continent-wide receptors and a tighter standard for site-specific issues may be necessary and would also provide the level playing field so necessary for industry.*
>
> *or:*
>
> *[It is probably in the best interests of all three countries to agree on basic emission standards for mobile sources of pollutants while encouraging local, state, provincial and national jurisdictions to develop and implement more stringent standards when warranted.]*

There is a newly emerging complexity that might well modify the way in which regulators are thinking about ozone in surface air. The same nitrogen oxides that enter into the ozone generation process are themselves deposited to ecosystems, where they frequently serve as unwelcome nutrients as well as being transformed into nitrate particulate, severely affecting health and visibility. Coastal ecosystems downwind of densely populated areas are especially vulnerable. This coastal region of this continent is already showing the unmistakable effects of excessive nitrogen nutrients, some of which arrive via the atmospheric pathway from air pollution sources far upwind.

Regulating for ozone must take into account the fact that the decisions made will have consequences on the coastal eutrophication issue, as well. Likewise, regulators considering strategies to improve coastal aquatic habitats must be cognisant of the benefits to be accrued as NO_x emissions into the atmosphere are reduced. This is prime example of how different atmospheric issues overlap, and why the focus for regulatory decision-making must be based on the source rather than the atmospheric issue. For example, transportation fuels and their use in the internal combustion engine contribute to many of the atmospheric problems we face, so that their replacement (pollution prevention rule #1) can have a wide ranging positive impact.

Consider for a moment the advantage to North America, if it further developed and was the first to produce transportation and power systems that could be used world wide, in different scales, and with local resources and capabilities, yet didn't create problems of pollution in the environment! This is probably a much more achievable goal in 1997 than standing on the moon was in 1960!

B5: An Example Of Significant Impact

Traditionally, the North American Arctic has been regarded as a pristine environment without the pollution problems associated with heavily populated and industrialized temperate latitudes. It is now recognized that there are major contamination problems in the Arctic due to long range transport of pollutants via the atmosphere. The ocean currents represent a significant storage reservoir. Indigenous peoples depending upon "traditional food" for most of their diet may be adversely affected by chronic exposure to these pollutants, primarily through biomagnification.

Primary food sources and top predators such as ringed seals, beluga whales and polar bears are found throughout the Arctic marine environment. Toxaphene is the most prominent organochloride in the Arctic whales (beluga and narwhal) while PCBs and chlordane-related compounds predominate in ringed seals and polar bears. Mercury levels in ringed seals and particularly beluga whales, are higher than the Health Canada guideline for mercury in fish muscle.

Given the widespread presence of persistent organochlorides and mercury in fish and marine mammals, the presence of contaminants in traditional diets poses a serious dilemma for regulators and for indigenous peoples. Average daily and weekly intakes of several organochlorine contaminants, particularly toxaphene and chlordane, exceed tolerable daily intake (TDI) levels established by Health Canada. Thus, the problem of persistent contaminants in the traditional foods of Arctic peoples will not disappear quickly . Little is definitively known about the long term biological consequences for these human populations. Continued monitoring efforts are needed to evaluate temporal trends and identify the effects on indigenous peoples and the wildlife populations upon which they depend for traditional food.

B6: Conclusion

It is important to realize that the atmosphere is no longer completely external to the human decision-making process – it is now affected by human activities. We are in the situation where "emitters and those impacted" are often the same. This, for better or worse, politicizes atmospheric issues and will require new kinds of defences for what used to be pure scientific research into natural processes.

We do not want to cure one problem only to create two or three more. We do want to take a truly integrated approach to solving atmospheric issues.

"The whole is better than the sum of the parts."

The law of conservation of mass can be simply stated as "*what goes up must come down*" or in the form of Commoners Axiom "*everything has to go somewhere*". In 1997, we need a "Commoners Axiom Revised"...

> "*every pollutant ends up somewhere and[unless we can prevent its formation] it is best for us to decide in advance where we want it to go*".

Linus (Schultz) once remarked "*no problem is so big that we can't run away from it*". We can't run away from this one because we are part of it. We can't go back to our historical ecosystem ... we have to face tomorrow today.

A SYNOPSIS OF THE POLICY, PROGRAM AND LEGISLATIVE FRAMEWORK FOR ADDRESSING CONTINENTAL POLLUTANT PATHWAYS

{**Note:** Section C, and especially subsections C2 and onwards, is written in a much more detailed style and includes many more specific references than is the case in the other sections in Volume I. The expectation is that this section will be shortened considerably in the final report and that some parts of the section may be used as a basis for one or more new annexes in Volume II.)

C1: International and Multilateral agreements and their Relevance to Continental Pollutant Pathways

In the international context, policy is driven by the agreements reached by countries and the role that individual organizations play in their definition.

C1.1: Bilateral Agreements

The Boundary Waters Treaty (BWT) of 1909, the Great Lakes Water Quality Agreements (GLWQA) of 1972 and 1978, and the 1978 Agreement as amendment by protocol in 1987 between the USA and Canada

The BWT was entered into in order to prevent disputes regarding the use of boundary and transboundary waters and to provide for the adjustment and settlement of questions arising between the two countries along their common frontier. It has provided the framework for cooperation on questions relating to air and water pollution and the regulation of water levels and flows. It established the International Joint Commission IJC (cf.. Volume II IJC study case) , requires Commission approval for certain uses, obstructions or diversions of waters along the boundary between the United States of America and Canada if such uses affect the natural levels or flows on the other side of the border. Under the Treaty, the Commission also investigates and monitors specific transboundary issues when requested to do so by the Governments.

The IJC serves as a binational body with three members appointed by each country. The IJC acts as a single body seeking common solutions rather than as separate national delegations representing the positions of their Governments. The IJC issues Orders of Approval in response to Applications for the use, obstruction or diversion of waters. The IJC also undertakes investigations of specific issues, or monitors situations when requested to do so by Governments. Implementation of IJC recommendations made under such Reference is at the discretion of the two Governments.

IJC recommendations concerning pollution in the Great Lakes served as the basis for the Governments to negotiate the Great Lakes Water Agreement in 1972. The GLWQA expresses the commitment of both countries to resolve and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin Ecosystem. Under the Agreement, the Commission monitors and assesses progress toward achieving the general and specific Agreement objectives, and reports at least every two years on the effectiveness of the programs and other measures undertaken pursuant to the Agreement along with advice and

The Canada-United States Air Quality Agreement

This Agreement was signed March 31, 1991 and with an initial focus on reducing the transboundary flow and deposition of acid rain and its precursors. It followed more than a decade of work to develop an agreement to address the acid rain issue. An intergovernmental group , the Air Quality Committee, reports on progress every two years. The Air Quality Committee has in its recent reports also been commenting on other air quality issues such as ozone and persistent toxic substances. The International Joint Commission invites comments on these reports and provides a synthesis of comments to the governments.

C1.2: Trilateral Commitments

The North American Agreement for Environmental Cooperation

Generated at the same time as the North American Free Trade Agreement, the NAAEC built upon previous binational and multinational agreements and expertise, and previous commitments to global environmental protection. The NAAEC builds upon, complements and supports the environmental provisions established in NAFTA. It creates a North American framework whereby trade and environment-related goals can be pursued in an open and cooperative way. The agreement is also intended to help prevent the creation of trade distortions or new trade barriers between the NAFTA partners.

The signing countries agreed to a core set of actions and principles including:

- reporting on the state of the environment;
- effective enforcement of environmental law;
- improved access to environmental information:
- striving for improvement of environmental laws and regulations; and
- promotion of the use of economic instruments to achieve environmental goals.

Under the NAAEC, a Commission for Environmental Cooperation (CEC) was established as a forum to develop strategies for mutual priorities, including:

- identifying appropriate limits for specific pollutants;
- protecting endangered and threatened species;
- protecting and conserving wild flora and fauna and their habitat;
- developing new approaches to environmental compliance and enforcement;
- addressing transboundary and border environmental issues;
- supporting human resource training in the environmental field; and
- promoting greater public awareness of North American environmental issues.

In fact the Commission serves as the implementing body for the NAAEC, as it is governed by the Council of Ministers, managed by a Secretariat, and supported by a Joint Public Advisory Committee. It currently has five major program areas:

- environmental conservation;
- protection of human health and the environment
- environment, trade and the economy
- enforcement cooperation and the law
- information and public outreach.

The CEC also helps to solve disputes arising from citizen's concerns related to perceived failure to enforce environmental laws. Also a country-to-country dispute resolution process operates in cases where a NAFTA partner alleges that another NAFTA partner has persistently failed to enforce and existing environmental law. The NAFTA partners agree to implement the recommendations of the process or confront the suspension of free trade benefits. Article 13 of the Agreement provides for the Secretariat of the CEC to prepare reports to the Council on matters falling within the scope of the annual work program and within the scope of the Agreement. This "continental pollutant pathways" initiative arises from the Article 13 mandate.

Related to the CPP there are at least, two relevant trilateral resolutions from the Council - constituted by the three ministers of the environment - of the Commission for Environmental Cooperation (CEC):

Resolution 95-5 "Sound Management of Chemicals"

Recognizing :

- A common ecosystem,
- That transport of toxic substances across national boundaries is a major and shared concern because of living organisms immune system dysfunction, reproductive deficits, developmental abnormalities, neurobehavioral impairment and cancer, some of them irreversible effects;
- Identifying that their remediation can often place considerable strain on the economies as well as the important contribution that producers and/or users can make to the sound management of chemicals;
- Reaffirming the Rio Principles on discouragement of transfer to other states of harmful substances as well as the precautionary approach, as well as he commitments of the Great Lakes Water Quality Agreement of 1978;
- Cognizant of the unique circumstances of NAFTA;
- Prevention of pollution and reduction of risk is desirable they commit to:

establishing a working group to work with the CEC to implement the decisions and commitments in the Resolution, cooperation for the sound management, through their life cycles, of the full range of chemicals..., to begin the development of a regional action plan for PCBs as well as additional substances, considering national timetables.., to develop recommendations for improving capacity, to exchange information, to promote technical cooperation, to incorporate pollution prevention principles, to encourage public participation, and to assess progress.

Resolution 96-05 "Ensuring Data Compatibility on Air Quality and Emissions".

Recognizing the need for compatible methodologies and data for :

- an accurate representation,
- a basis for determination of compliance,
- public perceptions,
- modeling and transboundary impact assessment
- equivalency of programs and laboratories
- consistent environmental monitoring
- quality assurance of North American air quality and emissions,

The Council agreed to promote regional cooperation among the Parties for the development of air quality monitoring, modeling and assessment programs in North America through the promotion, collection and exchange of appropriate data, and the development and application of appropriate models for the range of chemical substances of mutual concern... work toward adopting compatible methodologies for compiling and reporting emissions inventories... maintain programs and / or laboratories that provide reference materials and develop reference methods to ensure compatible data ... joint placement and joint calibration, when each are appropriate, of monitoring equipment at mutually-agreed upon sites,.., with mutually agreed upon protocols and schedules, in order to ascertain data compatibility with respect to monitoring and modeling of mutually-agreed upon substances.

C1.3: Multilateral Agreements

Global legally binding action on persistent organic pollutants (POPs) following decisions of the Governing Council to UNEP.

In 1995 the 18th session of the Governing Council to UNEP considered the long-range transboundary movement of POPs . Consequently, decision 18/32 of Governing Council identified 12 specific POPs and invited the Intergovernmental Forum on Chemical Safety (IFCS) to develop "recommendations and information on international action, including such information as would be needed for a possible decision regarding an appropriate international legal mechanism" on POPs.

The resulting IFCS report was completed in Manila in June 1996. It concluded that there is sufficient information on the twelve specified POPs to proceed with the expeditious development of a global legally binding instrument. The report further proposed that UNEP Governing Council invite UNEP to prepare for and convene, together with other relevant international organizations, an intergovernmental negotiating Committee (INC) with a mandate to prepare an internationally binding instrument for implementing international action initially beginning with the 12 specified POPs. The IFCS report indicated a number of the challenges to be faced in the development of a global agreement. They include the availability of "affordable" substitutes in the developing world, and the fact that many substitutes which quickly degrade and therefore possess less chronic toxicity are acutely toxic, thus raising occupational exposure problems.

On January 22, 1997, the Executive Board of the World Health Organization (WHO) considered the IFCS report on persistent organic pollutants and recommended to the World Health Assembly that the IFCS report be supported as well as endorsed a number of steps:

- to ensure that health and environment-based scientifically sound risk assessment is the basis for the management of chemical risk...
- to support research on integrated approaches to vector-borne disease control, including environmental management
- to continue efforts to enhance technical cooperation with Member States for the determination of their capacity building needs..
- to participate actively in the intergovernmental negotiating committees on persistent organic pollutants, in the legally binding instrument for the Prior Informed Consent Procedure, and in other intergovernmental meetings on issues requiring health expertise, in particular those relating to the use of pesticides for vector control, to ensure that international commitments on hazardous chemicals are realistic and effective and that they protect human health and the environment.

UNEP Governing Council considered the IFCS report at their nineteenth session 27 January - 7 February 1997, and adopted four decisions concerning chemicals that could be relevant to the CPP process.

- Development of an internationally legally binding instrument for the application of the prior informed consent procedure for certain hazardous chemicals and pesticides in international trade.
- Enhanced coherence and efficiency among international activities related to chemicals.
- Further measures to reduce the risks from a limited number of hazardous chemicals
- International action to protect human health and the environment through measures which will reduce and / or eliminate emissions and discharges of persistent organic pollutants, including the development of an international legally binding instrument.

The Governing Council requested the Executive Director of UNEP "*...to prepare for and convene together with the World Health Organization and the other relevant international organizations an intergovernmental negotiating committee, with a mandate to prepare and internationally legally binding instrument for implementing international action initially beginning with the twelve specified persistent organic pollutants and to take into account the conclusions and recommendations of the Intern governmental Forum on Chemical Safety...*" and that "... the Intergovernmental Coordinating Committee shall commence its work by early 1998". Governing Council also recommended "*...that during the development of a global legally binding instrument due consideration be given to the work currently underway within the United Nations Economic Commission for Europe to develop a regional protocol on persistent organic pollutants under the Convention on Long Range Transboundary Air Pollution...*"

Preliminary estimates suggest that negotiations will require approximately three years in order to reach completion.

The Convention on Long-range Transboundary Air Pollution (LRTAP).

The 1979 LRTAP Convention under the United Nations Economic Commission for Europe (UN ECE) is an umbrella convention which provides a mechanism for the development of individual protocols addressing specific families of pollutants. The geographic scope of the Convention includes the United States, Canada, Europe (north of the Mediterranean), Russia, and other states derived from the former Soviet Union. It does not include Mexico. Details are provided here because Canada and the United States are parties to the Convention and their commitments to several of its protocols are relevant to the topic of "continental pollutant pathways".

Five Protocols have so far been concluded; two on the control of sulfur emissions, one on nitrogen oxides, one on volatile organic compounds, and one on international cost sharing for monitoring and modeling. In addition three further protocols are under preparation, on heavy metals, on POPs and a second protocol on nitrogen.

The first of these new protocols likely to be completed is that on POPs (the Executive Body to the Convention has targeted as soon as possible in 1998). The text currently under negotiation spans the full scope and format of the anticipated protocol, (including basic obligations, procedures for modifying the list of substances, and technical annexes). It proposes that the basic obligations should be applied to an initial list of 15 to 18 substances which have already been identified according to certain criteria and the availability of information on risk (all of which are included in the list identified in UNEP GC 18/32). The structure of the basic obligations permits the use of a wide scope of control and management actions ranging from substance bans and phase-outs to restricted use and emission controls. For many articles and clauses alternative options have been provided. Finally, the draft protocol has been designed "to stand the test of time" by incorporating the ability to modify the list of substances and the actions taken without making it necessary to re negotiate the entire protocol.

The Global Action Plan (GPA) for the Protection of the Marine Environment from Land Based Activities.

This global non-binding agreement was formulated in November 1995 in Washington and embraces a very comprehensive range of actions concerning such topics as eutrophication, hydrocarbon, heavy metal and POP pollution. The emphasis is on domestic and regional action following general guidance criteria. However, in some cases, the plan calls for international legally binding action under the auspices of appropriate substantive bodies. For example, the Global Action Plan adopted in Washington was accompanied by a Declaration which included in Paragraph 17 the following:

> *"Acting to develop, in accordance with the provisions of the Global Program of Action, a global legally binding instrument for the reduction and/or elimination of the emissions, discharges and where appropriate, the elimination of the manufacture and use of the persistent organic pollutants identified in decision 18/32 of the Governing Council to UNEP. The nature of the obligations undertaken must be developed recognizing the special circumstances of countries in need of assistance. Particular attention should be devoted to the potential need for the continued use of certain persistent organic pollutants to safeguard human health, sustain food production, and to alleviate poverty in the absence of alternatives and the difficulty of acquiring substitutes and transferring of technology for the development and/or production of those substitutes."*

The paragraph is quoted at length partly because it provides a concise precise of the complexity of POPs management in the international context, but also because of the potential it may offer in terms of possible access to GEF resources (see below) due to the linkage of POPs and the GPA.

The Arctic Environmental Protection Strategy and the Arctic Council:

In 1991, Ministerial level representatives of the Governments of Canada, Denmark, Finland, Iceland, Norway, Sweden, the then Union of Soviet Socialist Republics, and the United States agreed upon the Rovaniemi Declaration on the Protection of the Arctic Environment and the accompanying Arctic Environmental Protection Strategy (AEPS). Ministers have met twice since that time to review progress and to adjust the Strategy (Nuuk Greenland in 1993 and Inuvik, Canada in 1996). Since September 1996, the AEPS has been subsumed by the Arctic Council. It committed the eight circumpolar governments to support a number of other multinational initiatives such as actions on POPs under both LRTAP and UNEP. It also established several "program areas", including a comprehensive Arctic Monitoring and Assessment Program (AMAP) with a mandate to monitor the levels of, and assess the effects of, anthropogenic pollutants in all components of the Arctic environment. It was envisaged that AMAP should as far as possible be built upon existing national and international programs, which were to be developed into a circumpolar framework. An initial priority was given to persistent organic pollutants, selected heavy metals, and radionuclides (on a circumpolar basis) and to acid precipitation (in Fennoscandinavia). An International Working Group is responsible for implementing AMAP. The output from AMAP will take the form of comprehensive "State of the Arctic Environment" reports for Ministers, the first of which will be available in June 1997.

The experience of the AEPS is instructive since it has demonstrated how a relatively informal agreement with very little dedicated funding can be most effective in stimulating international action in the relevant domestic and international affairs. For example, in the case of POPs, not only did the Ministerial statements catalyze action, but the monitoring data emerging from the work of AMAP contributors played a major role in gathering global support for action. Therefore the value has in part been scientific (in increasing accessibility and comprehensive assessment of circumpolar information), but also political. **Thus the increasing circumpolar awareness of the Arctic POPs situation has facilitated joint declarations of resolve to establish agreements both under LRTAP and at the global level and mutual coöperation.**

Again, this may point to an opportunity for the CEC. A similar concept to AMAP could be established in a North American context.

Other related multilateral agreements

Important examples include the Montreal Protocol to prevent the depletion of the ozone layer; the Basel Convention to control transboundary movement of toxic wastes; and the London Directives. The latter are intended to help governments increase safety in relation to chemical products through an active exchange of scientific, technical, economical and legal information, including establishing the Previous Informed Consent Procedure (PIC) which regulate commerce of banned or restricted chemical products. The United Nations Environment Program (UNEP), through the International Registry of Potentially Toxic Chemicals (IRPTC) promotes the implementation of the PIC procedure.

Synergistic interactions between international initiatives of relevance to the CEC "Continental Pollutant Pathways" initiative.

The preparatory work for a protocol on persistent organic pollutants conducted under the LRTAP Convention has demonstrated how several international initiatives dealing with multinational controls on persistent organic pollutants under a variety of different geographical and political boundaries, may be mutually enhanced through the generation of cooperation and cross fertilization. This experience is instructive in terms of the stimulatory and complementary role that could be occupied through the CEC "Continental pollutant pathways" initiative. In the case of the LRTAP Convention, the most notable example has been with the Paris and Helsinki Commissions for the North Sea/North East Atlantic and Baltic Sea. Considerable time and resources have been saved in the global discussions by building upon and modifying work initially conducted under the LRTAP Convention.

C2: NATIONAL LEGISLATIVE FRAMEWORK TO BE CONSIDERED IN RELATION TO CONTINENTAL POLLUTANT PATHWAYS

C2.1: General framework

Some of the major pieces of legislation related to Continental Pollutant Pathways in North America together with their respective responsible authority are summarized below in Table C1:

Table C1

Major legislation relating to Continental Pollutant Pathways.

COUNTRY	LEGISLATIVE BASE	RESPONSIBLE AUTHORITIES
Canada	-The environment is the jurisdiction of federal and provincial governments. -They have more of a parallel division of authority, not a subservient one. -While the federal government sets guidelines, the provinces establish under their own independent legislation, the standards that are enforceable within each province. -The federal legislation that applies to federal works and undertakings and federally regulated actions related to CPP include: • Canadian Environmental Protection Act (emphasis on toxic substances) • Canadian Air Act • Canadian Water Act • Fisheries Act. • Waters Pollution Prevention Act • Canadian Shipping Act. • Pesticide Management Regulatory Act. -None of these are binding on the provinces unless adopted by them. --The provinces establish the legally enforceable standards under their own independent legislation, seeking , at times federal guidelines. -These standards may be set for the ambient environment, for emission sources, for consumer products, or for rates of reductions. -Provinces have similar legislations applying to actions within their borders.	-Ministry of the Environment -Ministry of Health -Jurisdiction over air and water quality is divided between federal and provinces governments. The federal government has the constitutional authority to control air pollution, primarily through its power to protect public health and safety and to regulate transboundary effects. -The federal government produces guidelines and scientific information for use by the provinces, and coordinate country wide action when asked to by the provinces. -The provinces take the guidelines and information and under their own specific legislation, develop standards and regulatory tools to deal with those contaminants that they consider high priority. -Generally the provinces regulate air pollution from fixed sources and also have power to regulate mobile sources of air pollution. -Provinces are the primary regulators of fresh water resources in Canada.- They have authority over water use and quality because of the legislative powers regarding local works and undertakings. property and civil rights, municipal institutions, and all matters of local and private nature. -Underground water is federal jurisdiction. -Fisheries is a federal responsibility but administration of most sections of the Fisheries Act has been delegated to the provinces sections dealing with pollution. Marine and anadromous species continue to be administered by the federal government.
Mexico	• Constitutional articles: 25,27, 73,115. • LGEEPA (1996) (General Law of Ecological Balance and Environmental Protection). • Fishery law, • Forestry law, • Secondary Regulations : • Regulation to the LGEEPA in matters relative	-SEMARNAP (Environment, natural resources and fishery ministry) with auxiliaries bodies as PROFEPA (Environmental Attorney) for non mobile pollution sources, dangerous wastes and environmental auditing. -Secretariat on Communications and

	to the Prevention and Control of Contamination in the Atmosphere • Environmental Impact (1988) • Hazardous Wastes (1988) • Prevention and control of Pollution generated by mobile sources in the Metropolitan Area of Mexico City (1988) • Prevention and control of Atmospheric Pollution (1988) • Federal Law on Methodology Normalization • Prevention and Control of Water Pollution (1973) • Prevention and Control of Sea Pollution by discharges of wastes and other materials (1979) -Chemical substances and products are governed by a number of overlapping laws. <u>The main pieces are:</u> • The General Health Law and the Sanitary Control, • The Ecology Law (LGEEPA) • Federal Animal Sanitary Law • Federal Vegetable Sanitary Law • The Federal Consumer Protection Law.	Transport (is related also to air regulation) -Environmental responsibilities are distributed between federal and estate authorities. -SEMARNAP is responsible for establishing air and water quality standards, although the states may implement more stringiest standards at the local level -All the water bodies are regulated by federal authority -Chemicals fall under the jurisdiction of six different regulatory agencies: .The Health Secretariat (SS) .The Secretariat of Agriculture, Livestock and Rural Development (SAGADER) .SEMARNAP Secretariat of Commerce and Industrial development (SECOFI) The Secretariat of Communications and Transport (SCT) The Labor Secretariat (STP
USA	Constitution. • Clean Air Act CAA • Clean Water Act CWA • Federal Insecticide, Fungicide and Rodenticide act. FIFRA (related to POPs) • Toxic Substances Control Act TSCA • Comprehensive Environmental Response, • Compensations and Liability Act • Endangered Species Act, • Migratory Bird Treaty Act, • National Environmental Policy Act, • Resource Conservation and Recovery Act, • Toxic Substances Control Act. • The Federal Wild and Scenic Rivers Act. -Non-point sources of water pollution (e.g., agricultural or urban runoff) may be regulated under: • the CWA, the Coastal Zone Management Act (CZMA), or state programs. • The federal Safe Drinking Water Act (SDWA), enacted in 1974 and amended in 1986 • Food, Agriculture, Conservation and Trade Act of 1990, is related to drinking water	-Environmental Protection Agency (EPA) is in charge to enforce, establish standards and inspection related to air and water emissions. -Under CCA, EPA is authorized to set both primary and secondary National Ambient Air Quality Standards for "criteria" pollutants that endangered public health and welfare -Federal regulations are base for states regulations -State Governments may administer the rivers. -State law typically governs most water quantity and usage issues.

Sources: 1995 Informe CCA. Informe sobre la aplicacion de la legislación ambiental en América del Norte. .Information Center CEC. Internet.

C2.2: Basis for norms and standards

The process to establish norms and standards do differ from country to country. In the USA this has represented a lengthy process, based primarily around the development of substance based risk assessment, that, until having had gathered enough strong information, will move into the risk management decision that is to be translated into standards and procedures to meet them. Risk Assessment is built through the following risk assessment paradigm of hazard identification, exposure assessment and risk characterization. Criteria documents are generated along the way, and funds are targeted to reduce the knowledge gaps in order to build the RA. When it is considered that there is enough evidence to act on the substance, then a proposal to rule on the matter is publicly announced and hearings are held in order to gather the societal input. From here several iterations of RA could be done until finding the appropriate balance in order to propose a final rule tat has to be approved by the administration.

For Mexico, standard development has been overhauled; since 1992 the new Federal Law on Methodology Normalization has promoted the development of Mexican Official Norms that have to go through a rapid process of information gathering, public announcement and invitation to participate in the ruling, publication of the ruling for opinions, and a final rule. No formal Risk Assessment is required, or at least it's risk characterization that considers population individual differences or exposure patterns; the Law mentions that the best available scientific information has to be gathered. This has helped to produce a renewal over the last three years of the rulings that is providing Mexico's society with a basic framework for auto regulation as well as for governmental regulatory compliance efforts. By 1996, a specific norm was created that considered the use of Risk Assessment methodologies.

The Canadian Environmental Protection Act authorizes the government to issue environmental Quality objectives, environmental quality guidelines, release guidelines, and environmental codes of practice. In addition to a number of process specific codes of practice, in 1989 Environment Canada issued the National Ambient Air Quality Objectives for Air contaminants. The different jurisdictions rely on essentially three different approaches in establishing these standards: Provincial air quality guidelines or objectives; Fixed emissions limits and modeling to predict the air quality change at the point of maximum effect. Other Canadian Federal legislation allows for federal leadership on transboundary and international issues, migratory species, fish and fish habitat, registration of pesticides, and human health.

C2.3: Basis for economic and other incentives

"Any Policy decision has within it certain inherent environmental costs and tradeoffs. Whether or not we take the time to understand these tradeoffs will determine the ultimate fate of our environment and our economy" (J Young 1991). The regulatory enforcement process should be complemented by other types of instruments in order to achieve environmental objectives. A sustainable development policy requires a pricing system that should have explicit environmental information about the impact of production and its uses on the environment. All three countries are active in the development and use of economic instruments and market incentives to complement regulatory actions. Economic instruments have the potential to make private decisions compatible with collective interests. They are generally based on two key principles:

- whoever pollutes, use excessively the resources or alters the ecosystems, has to assume the costs of their behavior,
- who conserves and reconstitutes the environmental capital of the region should be stimulated or compensated.

They can, at least in theory, open opportunities, promote social equity and intergenerational equity. These instruments should be used WITH other policy actions as:

- emission costs
- product costs
- marketable permits
- deposit-reimbursement systems
- property rights definitions
- transferable development rights
- civil liability insurance for third party damage

(Sedesol 1994)

Other taxation or financial normative and administrative mechanisms through which people incorporate the environmental benefits and costs that their economic activities generate.

These instruments are currently included in the recent reforms to the General Law of Ecology Equilibrium and Environmental Protection (LGEEPA) of Mexico of December 1996, and some are also included in different policy instruments in USA and Canada.

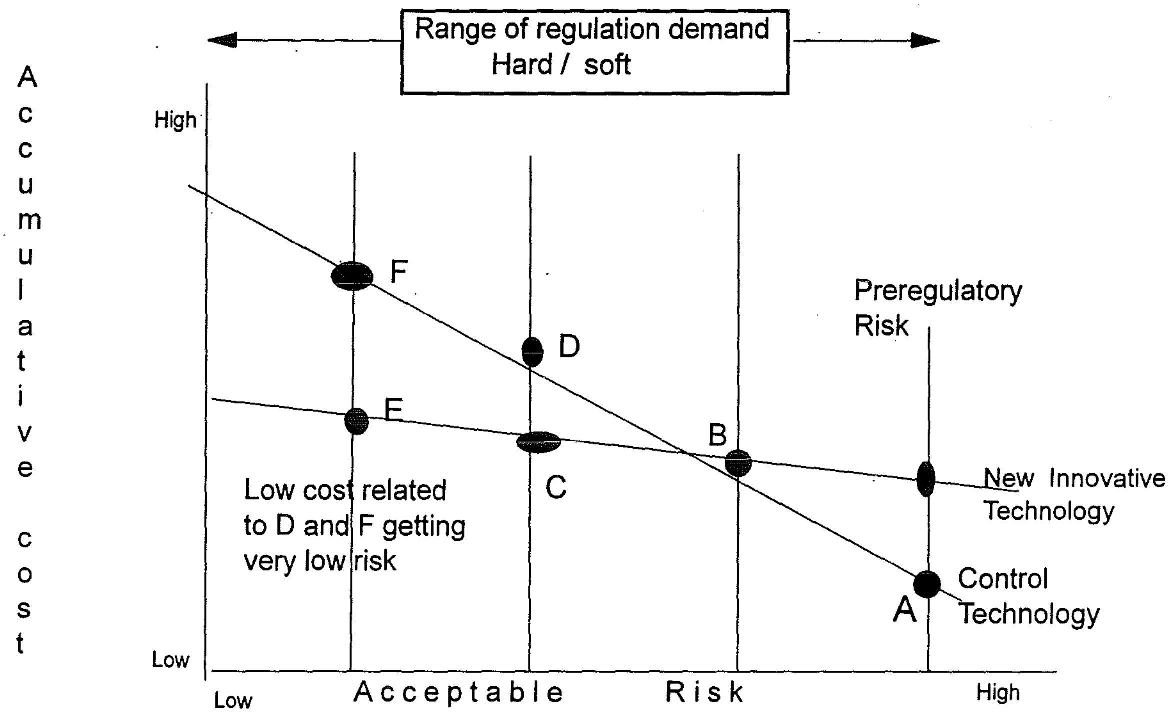
The Mexican Law promotes fiscal incentives for activities related to Research on technologies and
equipment that prevents pollution through:

- energy efficiency
- water pollution prevention
- moving of factories to environmentally appropriate areas
- surveillance of natural protected areas

A major component is the use of innovative approaches to increase competitiveness and environmental protection through pollution prevention. (cf.. case study on innovation Vol.. II). A conventional view has been that emission control requires incremental costs, including costs of new equipment that does not add value to the product, and that requires continuous maintenance and constant compliance surveillance by regulatory agencies. An alternate view is that emission controls usually pay rather than cost and lead to the production of new products, while preventing pollution and generating a more competitive industry. It will also allow for a more complete assessment of population projections and environmental risk.(as shown in the graph, from case study). The letter of agreement signed in 1996 by the USA, Canada and Mexican Councils for Business and the Environment, and the Industrial Chamber of Mexico which was developed under the aegis of the CEC, is consistent with this effort.

Figure C.1.

Acceptable Risk Levels for technologic alternatives



A: High accepted risk don't promote management; **B:** Risk with equal cost of control vs new technology
C: Lower risk achievable with lower costs of innovated technology versus **D** control technology
E: Lowest risk achieved at much lower costs of new technology versus **F** the highest cost of controls

This approach is suited for less capital intensive industries (Erosa, 1995) and an approach consistent with this idea has been pursued by Canada, through the Canadian Environmental Advancement Centers. (CCA, 1996a). Furthermore, for 1995 the US Environmental Protection Agency started the Environmental Technology Initiative , (EPA 1994). The purpose is reflected in the title: "Technology for America's Economic Growth: A New Direction to Build Economic Strength". An objective is to "strengthen the capacity of developers and users to succeed in environmental innovation". Mexico has announced first steps by stating its policy in this area within its National 1995-2000 government environmental program. These first steps are reflected it in recent reforms to the law.

C3: ORGANIZATIONS AND RESOURCES WITH A ROLE TO PLAY ON THE MANAGEMENT OF CONTINENTAL POLLUTION PATHWAYS

C3.1: Organizations

Federal Organizations

Federal organizations and agencies that are likely to have the most direct involvement in "Continental Pollutant Pathways" include:

CANADA:
Environment Canada administers the Canadian Environmental Protection Act as well as environmental protection provisions of other legislation including that related to fisheries and migratory species and endangered species. Other federal authorities related to environmental issues include Health Ministry, Agriculture, Justice, Treasure Board and External Affairs.

MEXICO:
SEMARNAP is the agency that integrates all the issues related to natural resources management apart from the non renewables such as petroleum and mining. It integrates as an administrative unit the PROFEPA , the environmental attorney [authority?] in charge of fixed sources of federal jurisdiction such as atmospheric emissions, dangerous wastes, environmental impact and risk activities.

USA:
The United States Environmental Protection Agency is a regulatory body with executive power on matters related to environmental pollution. The National Oceanic and Atmospheric Administration (NOAA), an arm of the Department of the Interior, is responsible for fisheries and atmospheric science and weather forecasting. Other elements within the Department of the Interior also have responsibility for assessing the effects of pollutants on flora, fauna and ecosystems. (CCA Annex 1 Environmental legislation application in North America Report 1996)

Municipal Organizations

In the Case of Mexico City, by early 1996 a joint effort of the City Government (DDF), with the Secretariat of the Environment (Semarnap), the Secretariat of Health (SSA) and others, launched a major strategic program to reduce emissions targeted to eliminate critical air pollution days. The "Clean Air" program aimed at the reduction of intensity of concentrations. Therefore from 65 critical days in 1991, by 1995 Mexico City had only 5. The experience of Mexico City is being used to target other major critical cities in Mexico such as Guadalajara, Monterrey, Tijuana and Toluca, each one of them with their own critical condition, and pertinent response program.

Other organizations

There are other organizations that actively are involved in environmental promotion, and constitute a resource to address CPP. In the case of USA there are a large amount of organizations to be considered include industrial organizations such as:

- American Coal Foundation
- American Forest foundation
- American Petroleum Institute
- Chemical Manufacturers Association (CMA)

An important industry initiative is the Chemical Manufacturer's Association's Responsible Care Initiative. The initiative, which began previously in Canada, was introduced in 1988 to improve the chemical industry's safety and environmental performance and to respond to public concerns about chemicals. It is an obligation of membership in CMA, whose member companies represent 90% of the productive capacity for basic chemicals in the US. The chemical industry supports the public's right to know about industry wastes and emissions, CMA backed the Community Right-to- Know Act in 1986 that created the Toxics Release Inventory, and was an early supporter of the Pollution Prevention Act of 1990 which expands the information on waste management available to the public.

There are private research and resource centers, such as:

- Center for renewable energy and sustainable
- Conservation Districts Foundation
- Environmental Hazards Management Institute
- Global Issues Resource Center
- National Energy Foundation
- Electric Power Research Institute, Automotive industry, Petroleum industry, Chemical manufacturers associations and Mining associations.
- NGOs, professional and social organizations such as:
  - Border Ecology Project
  - Physicians for Social Responsibility

C3.2: <u>Resources</u>

Major monitoring requirements are emissions, transport of pollutants and of effects on biota and humans.

<u>Emission Resources and Inventories</u>

The registry of emission and transfers of pollutants provide detailed data about the type, location and amount of pollutants emitted and their destiny either to the environment or to their potential recycling. They promote the industry to prevent the pollution, reduce the generation of emissions, and assigns responsibilities. And they are a good source for investigative work in order to develop governmental priorities (CCA, 1996b). In the North American Region there are the following registry systems available:

The Toxic Release Inventory (TRI) has been available since 1987 for non federal industry, and since 1994 has included federal industrial facilities. It is based on the right to know principle Originally it had 309 substances in 20 categories. Most currently it has 346 products in 22 categories. Three further expansions are to happen. The first one is a final rule as of Nov. 1994 to expand to 286 substances (for a total of 632 substances; the second stage - yet to be approved - is to increase non manufacturing industries such as energy and residue material extraction and distribution. The third is to include detailed material accounting.

The National Pollutant Release Inventory (NPRI), started as of 1993 as a public data base of emissions produced by the manufacturing and transport industries. It included 178 products in 14 chemical categories. However many of these substances were emitted in such small quantities that the list is under revision, and is going through a simpler reporting procedure. It is also expected to include the reporting of industry's efforts for pollution reduction.

The Emission and Transfer of Pollutant Registry (RETC) of Mexico, is a new initiative started in mid 1995, and scheduled to become operational by late 1996. The RETC seeks to provide information on chemical substances and support the assessment of the efforts. As for the other partner systems, it is to generate an information system that would be publicly accessible for identification of research and action priorities. An initial list of 132 chemical substances within 17 chemical categories has been obtained. A first and successful test was done with 46 industries in the state of Querétaro.

For the region, all the related resources:

- Identify the installations and chemical substances
- Have a limited report
- Description of emission
- Description of transfers
- Chemical residues
- Other elements, such as pollution reduction and prevention efforts.

Information of the TRI and NPRI are available in multiple formats. Access to the information contained in Mexico's RETC has not, as yet, been defined.

C3.3: Environmental Monitoring

"a bad observation, or an observation whose results are given without verification, is worse than no observation at all"
Herschel JWF, 1849

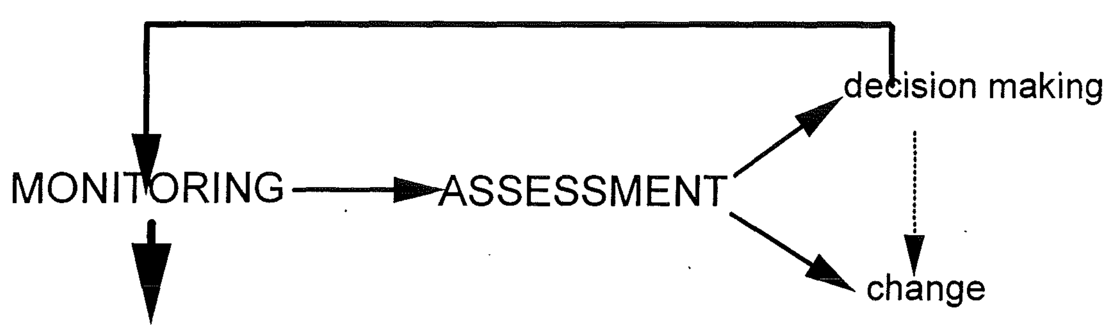
The purpose of monitoring is to collect and document information about environmental characteristics, and the changes in these characteristics in time or from place to place, in as reliable way as possible in order to show to the public and the politician in as convincing way as possible what is happening or what may be happening to our environment; and then to state what may be or are some main causes of what is happening. (Roots 1997).

A monitoring effort should be able to carry a convincing message between those who know perfectly well that their understanding is incomplete and that the more they learn, the more problems they raise, and those who need convincing assurance that the information they receive on ecological changes is reliable enough and important enough to cause them to make some really significant changes in policy, economic expectation, or life style. It "needs grease to make our scientific engine work, and glue to stick the science into policy".

Data provided by monitoring networks is to be used, not only for just building data sets, but for a coordinated ASSESSMENT to be used for decision making and for change.

Figure C.2

ENVIRONMENTAL MONITORING AND ASSESSMENT



Environmental monitoring is a process by itself (vertical arrows); however it should be followed by its assessment in order to either promote change or generate a decision to act; decision itself might relate to modify monitoring itself for better assessment and decision making.

Understanding how pollutants migrate through the global environment has become the focus of international concern (Wania, 1996). Not only pollutants can be transported through different media pathways (water, air, soil), but the pathways may inter-transfer pollutants, while the pollutants themselves may change because of their own geophysical characteristics, generating global fractionation processes. Pollutants, especially POP's appear to migrate to higher latitudes in a series of relatively short jumps, termed as "grasshopper effect". Their migration might be modeled through steady state or dynamic models, but models are as good as the data that we feed them. Therefore the need of good data gathering.

C3.4: Air Pollution Monitoring Resources at the Northern Border of Mexico

Good information on the air monitoring facilities at the northern border of Mexico is available primarily because of the Air Pollution Training Institute of US EPA working with the Universidad Autonoma Metropolitana - Azcapotzalco in Mexico. A survey in five cities located at Mexico's northern border, to identify human and infrastructure resources, found the following:

- Sonora — 24 monitoring resources, of which 14 where PM samplers, 11 PM10.
- Coahuila — 21 monitoring resources, of which 14 where PM samplers, 6 PM10
- Tamaulipas — 14 monitoring resources for PM10
- Chihuahua — 19 monitoring resources, of which 15 were PM10 samplers
- Baja California — 6 monitoring resources, of which 4 where PM10 samplers (Espitia, 4-2-97)

C3.5: Monitoring Capabilities for Air and Water within the Region.

In 1995, a trinational workshop gathered technical experts on Ecological Monitoring from Canada, USA and Mexico. It provides an excellent introduction to the ecological monitoring facilities and data availability in the region.

Figure C.3

CONCEPTUALIZATION OF CONTINENTAL POLLUTANT PATHWAY MONITORING

Arrows illustrate continental pathways

United States of America:

CASTNet: The US Clean Air Status and Trends Network

Clean Air Status and Trends Network, CASTNet, developed by the EPA in coordination with NOAA. For EPA, this involved folding existing air monitoring efforts begun in 1986 under the National Dry Deposition Program (NDDN) into CASTNet. CASTNet goals were to establish an effective monitoring and assessment network to determine the status and trends of air pollution levels and their environmental effects and to develop a scientific database to improve understanding of causality for policy considerations. Over the years within the CASTNet framework, new monitoring sites have come "on line," while others have been discontinued. The current CASTNet sites are identified in the map. Currently, CASTNet is comprised of some 51 sites located mainly in the eastern US. Of these, a relatively complete data record exists for the period 1989 through the third quarter of 1995 for 38 sites, 35 in the East. Monitoring activities at the CASTNet sites focus mainly on air quality measurements and supporting meteorological measurements. Wet deposition is monitored at approximately 20 CASTNet sites where National Acid Deposition Program (NADP) sites are outside a 50 km radius. In addition, visibility monitoring began in late 1993 at 9 eastern sites, and cloud monitoring during the growing season began in 1994 at three high altitude (mountain) eastern sites.

(Needs map Current CASTNet sampling sites)

EMAP: Environmental Monitoring and Assessment Program (EMAP)

The Environmental Monitoring and Assessment Program (EMAP) was established in 1989 and restructured in 1995. The program retains its goals to: Monitor the condition of the Nation's ecological resources to evaluate the cumulative success of current policies and programs and to identify emerging problems before they become widespread or irreversible. The strategy for EMAP is centered on three principals. First, all tiers in the monitoring framework must be pursued (i.e., Index Sites, Geographic Surveys and Landscape Monitoring). Second, focus the next three years on the research and demonstration necessary to provide the scientific credibility for the monitoring network. Third, based on the knowledge of the science necessary for success, build the national network from the bottom up starting with those existing networks and add where gaps exist. The later means that EMAP itself will not be the entire national monitoring network but will contribute components to it.

EMAP has established a national network of index sites with the National Park Service to serve as Outdoor Laboratories. This was part of the original EMAP vision and has now been added back to the programs efforts.
EMAP builds upon the strengths that it developed in monitoring ecological resources such as estuaries, streams, and terrestrial systems. These efforts will be focused on specific geographic regions of the country rather than occurring independently in different regions of the country. If the budget does not permit all regions to be done at once, a rotation approach will be adopted

EMAP continues its interagency efforts to complete a national land cover database.

EMAP places a high priority on research to ensure that monitoring which continues is based on strong science. The high priority research areas are:

- ecological indicators
- monitoring design
- integration and synthesis of environmental data

By addressing these scientific uncertainties in a credible manner, EMAP will make important contributions toward the goal of providing information necessary for protecting our national heritage.

The approach also considers the spatial pattern of other biophysical attributes, including geology, climate, topography, hydrology, and soils, as they often influence (determine) landscape composition and pattern, and the sensitivity of ecological resources to stressors within any given area. For example, the extent and spatial distribution of acid-neutralizing soils dramatically influences the vulnerability of lakes to acidification from atmospheric deposition.

Changes in landscape composition and pattern can significantly influence fundamental ecological processes of water, nutrient and materials, energy, and biotic flows and fluxes at a variety of scales, which in turn affect the risk to and sustainability of desired conditions in valued ecological goods (e.g., high quality and abundant water, productive forests, and abundant and diverse wildlife), and services (watershed resistance to flooding).

EPA Aerometric Information:

EPA has an Aerometric Information Retrieval System (AIRS), collecting data from state and local governments as well as federal agencies. It has about 500 million air measurements in AIRS, representing most of them the most heavily populated urban areas of the nation (US EPA, 1991). This includes about 5,120 monitoring sites, of which 1279 are for O3 the largest numbers, and the smallest number of 313 for NOx. Long term good quality data is available for 2,862 sites. The 1990 Clear Air Act amendments request further expansion of monitoring into air toxics, yet to be incorporated in the networks. The largest network is in Los Angeles (it has 13 O3 monitoring sites), and its data is available on-line through Internet.

LTER: *Long Term Ecological Research*

The National Science Foundation has been providing long term funding for a number of reference ecosystems in the United States. These sites which combine both research and monitoring functions and are likely to become increasingly important as reference sites for monitoring and assessing the status and long-term trends in representative US ecosystems.

<u>Canada</u>

EMAN: *Ecological Monitoring and Assessment Network*

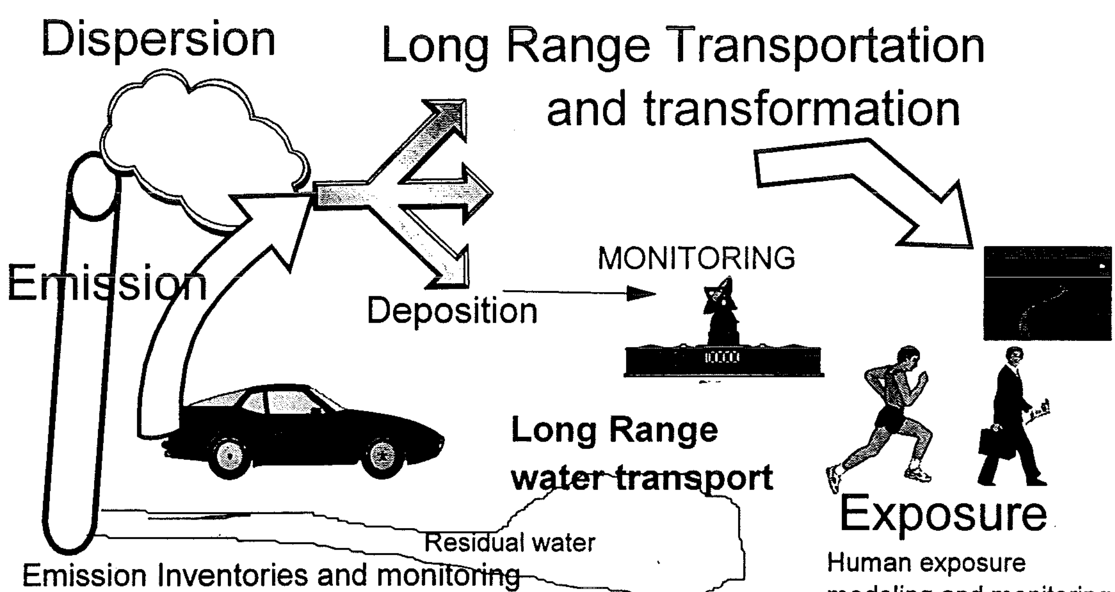
Canada has developed (Bridges T, 1996) the "Ecological Monitoring and Assessment Network", recently established to define what is changing in the environment and why. The major indicators (Shear, 1996) that are now used are:

- Status of aquatic communities
  - native species loss
  - ecosystem imbalance
  - reproductive impairment
- Human health and environmental contaminant risks
  - Air/water/sediment contamination
  - Fish consumption advisories
  - Human contaminant body burdens
  - Measurements of health status/health effects (including reproductive and developmental)
- State of aquatic habitat and wetlands
  - Loss in habitat/wetlands quality and quantity
  - Encroachment / development basin wide
  - Gains in habitat / wetlands quality and quantity
- Nutrient stresses

  - Total phosphorous loads
  - chlorophyll
- Contaminant stresses
  - loading
  - residue in fish
  - residue in birds
  - body burdens
- Economic stresses

This country currently counts with different environmental monitoring networks like the Canadian Air and Precipitation Monitoring Network, their related Provinces Programs, and British Columbia Precipitation Chemistry Sampling Network. It has also two networks on acidic precipitation, the Environmental Protection Service Network and the Great Lakes Precipitation Network (Lawrence, 1996). (cf.. Volume II case study)

Figure C.4
KEY CONCERNS IN UNDERSTANDING POLLUTANT PATHWAYS



What is the dimension of the link between a Continental Pathway of a Pollutant - air or water or soil - and biota / human exposure ?

Other federal initiatives

Several federal agencies including Federal Departments of Energy and Natural Resources (including the Canadian Geological Survey and Atomic Energy of Canada Limited), Fisheries and Oceans, Agriculture, Health and Welfare and Indian and Northern Affairs have carried out a variety of monitoring, survey and research activities that are relevant to the "continental Pollutant Pathways" initiative.

Mexico

The evolution of national monitoring programs has not progressed as rapidly as in Canada and the United States but important steps have been taken. The first steps have been primarily organizational (González Vicente C, 1996). However there are resources (Ruiz Corral, 1996) for monitoring available that could be incorporated into an integrated effort. The INIDFAP computerized cartographic data base (Instituto Nacional de Investigaciones Forestales y Agropecuarias) including summary climate and soil use data includes the data from 1500 network meteorology stations operated by the Mexican National Meteorology Service. There is also cartographic material assembled and managed by the National Institute of Geography and Statistics (INEGI)

Furthermore for Air Pollution monitoring seventeen of Mexico's cities with a manual networks, with a total of 230 monitoring stations.[for PST?]. Continuous air monitoring stations are available in 9 metropolitan areas, with a total of 68 stations (plus five mobile units) having primarily SO2, most of them NOx CO, PM10 and O3 (SEDESOL, 1994). Mexico City and Monterrey data, as is the case for Los Angeles, are the only Mexican data available continuously on-line through Internet. The Mexico City Network is a remarkable accomplishment, developing over the last 10 years into a state-of-the-art air monitoring and analysis system directly linked important, real-time decisions which are communicated directly to the public. These decisions often affect millions of people, as well as the industries provides up to 40% of the GNP.

The National Water Quality Monitoring Network was established in 1974 to provide continuous and systematic measurement of water bodies (SEDESOL, 1994). Currently it includes 793 sites in all the Mexican States, including 29 hydrologic regions. It collects 4012 samples to obtain 23 basic water quality parameters plus 24 special parameters (metals). Mexico City has its own laboratory that takes samples within the water distribution network as well as home water samples.

Model for cooperation.

North American collaboration has been started in the monitoring of forests (Hall J, 1996). The Model Forest Network currently consists five model forests in Canada, three in the United States and three in Mexico. The network is to help refine the concept of a sustainable development and use of forests and forest resources.

C3.6: North American Integrated Information System

A special mention in the trilateral effort as generated by the NAIIS. The Commission for Environmental Cooperation (CEC) began the development of the North American Integrated Information System (NAIIS) in late 1995. This important trinational effort began as a result of a recognizing the importance of information to foster environmental cooperation coupled with a concern as to the limited sources of information on environmental issues covering the North American region. The project is intended to provide public on-line access to environmental and selected social variables in North America. The NAIIS provides the user limited capabilities to overlay variables in order to expand the use of the available variables in the system (Sanchez, 1997).

The project has three levels.

Level I creates a North American perspective of environmental issues for educational and demonstration purposes, using data at the country and state scales in the three countries. It gives ability to overlay ecological data based on the results of the ecoregional maps and other physical variables (topography, hydrology, geology, etc.), with socioeconomic data from the national census and other sources.

Level II provides the user a more analytical level of detail, presenting the same variables as level I at the municipal / county level.

Level III creates a WWW interface, an Integrated Environmental Information Gateway, enabling users access to other existing regional systems with a higher level of detail and resolution on particular areas of North America or particular topics.

C3.7: International Monitoring Programs

International monitoring resources available to complement this initiative include the following, several of which are supported by the scientific programs of UNESCO:

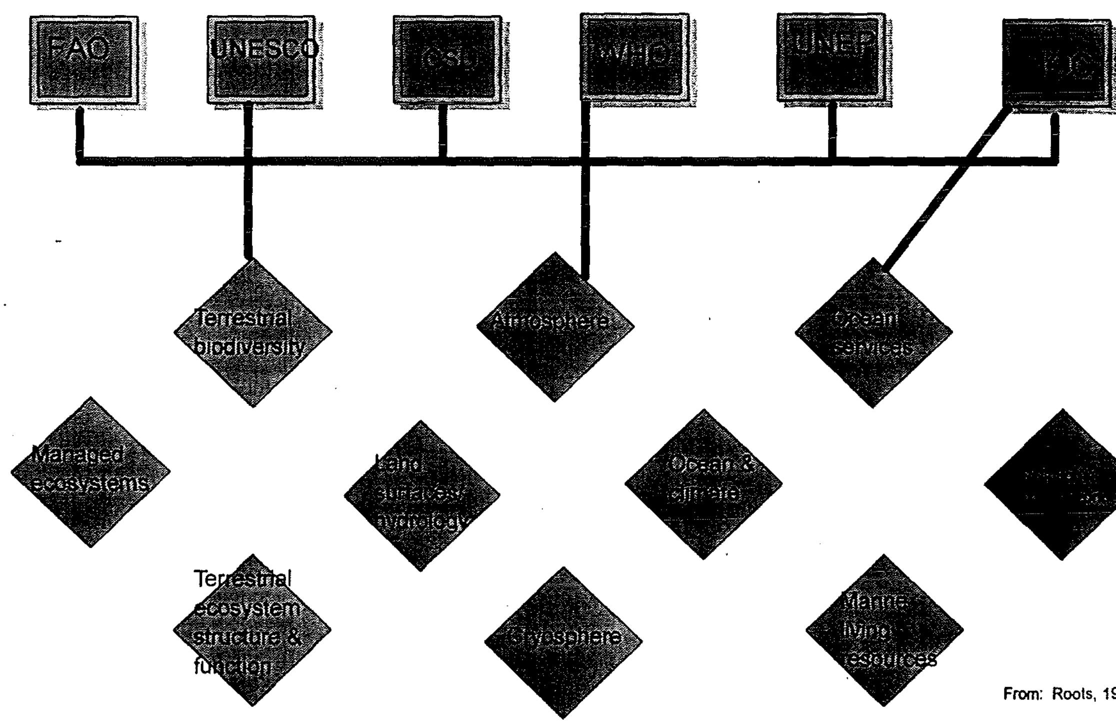
- Man and Biosphere Program (MAB)
- International Hydrological Program (IHP), with activities related to Northern Research Basin, Regional and Global Pollution, and sustainable development
- Intergovernmental Oceanographic Commission (IOC) with information on environmental change in the oceans, ocean data, coastal issues, and the 1998 Year of the Ocean.
- International Geological Correlation Program (IGCP) with information and studies on landscape change, the process and effects of environmental change in the geological past are pertinent to ecological change and assessment.
- Management of Social Transformation (MOST), with information and studies on social and community response to change.

Others are:

- The Canadian Global Change program
- The Global Observing System, consisting of coordinating activities in many areas, building from national monitoring efforts.
- The Global Ocean Observing System (GOOS)
- The Global Climate Observing System (GCOS)
- The Global Terrestrial Observing System (GTOS)
- Arctic Monitoring and Assessment Program (AMAP). A circumpolar monitoring Program which includes the study of persistent organic pollutants, heavy metals, radionuclears, acidification, and hydrocarbons.
- The Health and Environmental Analysis for Decision Making (HEADLMAP), a World Health Organization initiative that uses Environmental Health Indicators.

Figure C.5

INTERNATIONAL GLOBAL OBSERVING SYSTEMS



From: Roots, 1997

The Consortium for International Earth Science Information Network (CIESIN), was established in 1989 as a private, nonprofit membership corporation. It is an integrative effort initiated to advance the interdisciplinary study of global environmental change. It specializes in access to, and integration of, physical, natural and socioeconomic information across agency missions and scientific disciplines. It is developing capabilities on Global scale time series and baseline data and information on the human interactions with respect to global environmental change and in this way it has helped to provide a bridge between the socioeconomic and natural science research communities, and between research and policy communities.

Access of information.
An issue that has been raised from previous experience is the public access of information. Recently, increasing numbers of people and governments feel that they can be exploited or disadvantaged if others have information about their environment; there is unfortunately evidence that this is sometimes the case, as when land humidity environmental data has been used to manipulate the corn prices (Roots, 1997). This is an issue that has to be directly addressed

C3.8: <u>Human Exposure Identification.</u>

The migration of pollutants to large distances is a fact that is more and more well documented in humans. In remote arctic areas where industrial development is almost non existent, at least 500 measurable chemicals not present in humans prior to 1920 now exist (Canadian Polar Commission, 1996). PCB levels in mother's milk in some Baffin Island communities were reported to twice as high as in southern Canada samples. The same is happening with systematic samples of PCB in cord blood. The distribution of contaminants in humans and in fish and wildlife have provided strong evidence that Arctic acts as a "global sink" for some substances that have apparently originated very long distances from the Arctic. Surveys have tested arctic populations for heavy metals, radio nuclides and organochlorides. For these communities in the Arctic the key question is "What is the health risk for humans from exposure to pollutants transported long range?. This helps us to understand the challenge of the general question to the North American Continent.

The development of Health Indicators for Environmental Surveillance has been promoted by international agencies (HEADLAMP), but is still in developing phases. The Agency for Toxic Substances and Disease Registry, and the Center for Disease Control have developed certain tools for Health Departments. A pilot study has been developed for the Secretariat of Environment in Mexico, using data from urban, seminar and rural areas (Santos-Burgoa, 1996)

The analysis of human exposure is now considered a National Priority in the United States as it is an important input to cost effective risk management (Daisey, 1995). It allows provides a means of estimating the exposure of individuals and of establishing the relative importance of sources of exposure and thus has obvious linkages to the "Continental Pollutant Pathways" initiative. Analysis of exposure to multiple pollutants (multiagent) through multiple media, during different activities is the purpose of the development of Total Human Exposure Assessment Methodologies (TEAM) as developed in the late 80's in the USA. (Pellizari, 1987). This has been further expanded to Canadian and Mexican examples (mainly to particulates, lead, and most recently to some VOCs).
For the USA, a review by Sexton (1994) identified a total of 67 Exposure-Related Data Bases supported by Federal Agencies. A comparison of their scope follows:

Table C2

Comparison of the Scope of 67 Exposure-Related USA Data Bases

	Sample types						
Geographic Scope	Water	Soil	Air	Food	Human Tissue	Bulk Chemicals	Other
National	23	16	20	14	6	9	11
Regional	5	0	3	0	5	0	1
State	0	0	1	0	0	0	0
Region of state	1	0	1	0	0	0	0
County	0	0	0	0	0	0	0
City	2	0	4	0	2	0	1
Other	2	1	2	1	0	1	0

The linkage of ecological and air monitoring data with human exposure data can make an integrated system of UNIQUE characteristics that gives a comprehensive view of the reality.

C3.9: Laboratory Resources

Monitoring facilities in the USA and Canada have attached laboratories for the analysis and samples obtained. This is different in Mexico, where standardized and quality analysis of samples is starting, and the widespread use of laboratories are still lacking. In Mexico the air pollution network has laboratory or in site analysis facilities for criteria pollutants, not so for air toxics. information on air toxics is much less limited. The current Mexico City air pollution network built its state of the art facilities over the last ten years. The water quality network has facilities for the basic physicochemical and bacteriologic monitoring, but is not well equipped for wide scale monitoring of most other parameters. This represents a challenge for the integration of data from the monitoring networks within the three countries. The lessons learned in criteria air pollutants monitoring clearly points to the need to expand the laboratory capabilities in Mexico.

C3.10: Human Resources

In the APTI/EPA-UAM-A border survey (Espitia, 1997), the survey showed that the distribution of human resources for monitoring and assessment in the border states by level where:

Table C3

CITY / STATE	MUNICIPAL	ESTATE	FEDERAL
Matamoros	4		
Ciudad Acunia	3		
Nogales	3		
Cd. Juarez			
Tijuana			
Tamaulipas		5	9
Coahulia		6	3
Sonora		3	8
Chihuaha		3	11

Most of these who were interviewed had an environment related degree, with an average seniority of more than 24 months in their current position.

A national plan for environmental and occupational health human resources. A WHO-UNEP sponsored project in Mexico.

In Mexico the pilot project served to understand the characteristics of personnel actually working in private and public institutions in the environmental field. The study was a first attempt at a national level to diagnose the situation and define strategies for development.

The major findings of this study was that the country and the companies were assigning enough positions for personnel but that there was a severe scarcity of well trained personnel with adequate background in the relevant scientific disciplines. That training institutions were heterogeneous in their response but all were trying to respond to the severe need detected. The study reported the lack of coordination of investment in human resources. Risk Assessment expertise was a key capability required for the area of sound management of the problem. Those who conducted risk assessment typically had epidemiological experience or experience in toxicology and the control of toxic substances. They are more likely to work in government and are more likely to work in the central and northern states. Although many of the interviewed people were actively developing risk assessments it was found that 69% of this group required additional training in this field. Environmental monitoring was the major activity developed by most personnel actively involved in risk assessment

Table C4

General characteristics of Personnel in the Environment and Health Public and Private Sector practice. Mexico, Report MoH, WHO, UNEP, 1996	
age less than 38 years	47%
females	53%
duration in his employment less than 12 months	31%
Practice within government	67%
Location Northern / Central / Southern states	24 / 51 / 25 %
With short training courses	55%
Specialty, masters or doctorate	31%
Develops environmental evaluation	90%
Develops environmental planning	80%
Deals with more than 3 major problem areas	67%
Has minimal institutional infrastructure	46%
Has more than 30 days / year for training	51%

Examples of the most efficient strategies recommended by the report were:

- To coordinate the national training and research programs
- To develop a strong recruitment program of leadership professionals
- To integrate universities and industry
- To promote a fund training programs
- To develop economic incentives for training and further employment
- To adequate legislation
- To establish an aggressive international cooperation program
- To develop a central intersectorial group to establish training guidelines for accreditation
- To establish a Collegiate Body to develop and evaluate Human Resources training

-Currently a coordinating effort lead by the Secretariat of Health is being built to implement such strategy.

In the Case of Mexico, the federal government has responded to the international commitments and initiatives, and to its own reformed law, and has launched a major effort in upgrading its capabilities for emission inventories. For example, in 1994, the State of the Environment report of Mexico (Sedesol, 1994) was able to report only on annual total emissions estimated by fixed sources for 17 cities in Mexico, and of 10 cities for mobile sources as estimated for 1993. Now for 1995, Mexico has been able to develop a detailed emission inventory from the three major metropolitan areas (Mexico City, Guadalajara and Monterrey), being able to divide the emission sectors (Industrial, Services, Transport, Soil and Vegetation) and sub sectors that contribute to the total load. The exercise started in Mexico City (1994), followed by Guadalajara (1995) and then Monterrey (1996).

To this date, the initiative has been extended to Ciudad Juarez, Torreón and Tula, and the goal is to extend it nationwide. An effort to expand these capabilities is being built by training personnel at every state, and major city and industrial complex (Espitia, 1997). However, the budgetary constraints make the burden to develop this inventory an strenuous load. The human resources available to develop and maintain it is very small.

In Canada, environmental Canada is spending about one million Canadian dollars each year to develop a national Ecological Monitoring & Assessment Network. The Network includes more that 80 sites where long term multidisciplinary monitoring & research is carried out. The operating objective is to define what is changing and why. In addition to defining the ecological responses to the stress on the environment, the information can be used to develop pollution control on management programs, evaluate the effectiveness of these programs and to identify new problems.

The network involves over 100 agencies, including governments, universities, industries and non governmental organizations, that collectively spend many million of dollars on monitoring and research. Approximately from 600 to 1500 people are professionally involved in this activity. The network is one service of information used to prepare issues and areas based assessments of the state of the environment (Bridges, 1997). A set of environmental indicators is being developed to provide ongoing information to the public, on the issues that will be the subject of periodic assessments.

C3.11: Financial Resources

For many of the developments needed to address continental pollutant pathways new policy and legislative impetus is needed, as well as a stronger infrastructure and increased capacity in both human and technological terms. This is particularly the case with Mexico. An immediate need is to identify and mobilize financial resources that might be specially targeted for addressing these actions. There are resources in Canada (CIDA, IDRC), in the United States (AID, CDC, other federal agencies), public and private (Foundations, etc...) that could be useful for furthering the "Continental Pollutant Pathways" initiative. There are examples of actions that if expanded, could lead to better improvement the capabilities to confront the many challenges associated with continental pollutant pathways. Examples of potential international sources include:

The Global Environment Fund (GEF).

This was established in 1992, at the Rio de Janeiro Conference on Environment and Development (UNCED), to provide funds to accomplish Rio Agreements including the Framework Convention on Climate Change, the Convention on Biological Diversity and as well for other agreements related to Depletion of the Ozone Layer; and International Waters. Activities are further clustered into operational programs, one of which, within the International Waters area, is called the "Operational Program on Contaminants. It is intended to develop and implement projects that include demonstrating how to overcome barriers, such as barriers to best practices, ineffective polices, lack of awareness of alternative environmentally sound technologies, and ineffective cooperation between countries. GEF is intended to play a catalytic role by helping leverage other funds. Therefore not only can GEF be potentially available for POP work in some geographic areas within the area of the CEC, but it appears to be a legitimate use of GEF to provide seed funding.

US-Mexico Science Foundation

Science has developed over the years usually without regards to borders. Corporations have known this as they go global and internationalize their activities. However, besides the larger corporate life, resources are difficult to find that can provide for activities that scientists from different countries can use to act on specific issues of common interest. An effort specially targeted to provide resources for scientists in both sides of the Mexico-US border was initiated in 1994 through the Mexico-US Science Foundation. It is chartered in Mexico and was created by US Congress initiative which, with the Government of Mexico, creating a private fund. This provided initial resources (up to 100,000 USD for two years for each project awarded) for scientists on both countries to work together on projects of common interest. The resources provided for this fund where equally given by both countries. The first year's experience, after calling for proposals is that in a two month period more than 170 proposals where submitted. Fourteen were assigned support (three of them on the environmental field). The magnitude and speed of the response clearly signaled a potential to build on existing liaisons between scientists, which with adequate financial resources could dramatically increase the level of collaboration. Unfortunately the US congressional budgetary cuts (not even the Mexican economic crisis) limited the follow up on this program. However, it has not been canceled and could, if revitalized, play a significant role in addressing the scientific gaps identified in this report.

Fogarty International

The US National Institutes of Health have assembled all their international resources into this single program. Starting in 1995 Forgarty International has generated a specific program targeted towards environmental health research and human resources development outside of US borders. A competitive grant is awarded to a US University or Department that shows experience in international collaboration targeted towards institutional strengthening, and then used for the expansion of their international support. This is open to all the world, and for US and Mexico collaboration, we know of two universities (UCLA and Mount Sinai at NY) that are including Mexico as their counterparts. This has proven an effective way of orienting the resources towards collaboration.

BECC--NAD Bank:

The Border Environmental Cooperation Commission (BECC) and the North American Development Bank (NAD Bank) were established as a result of the NAFTA to assist in providing financial assistance to improve environmental conditions in the border region. In addition, NAD Bank manages a small amount of funds to address social displacement within the United States or Mexico as a result of NAFTA.

C4. POLICY NEEDS AND OPPORTUNITIES FOR COOPERATION

The following are needs and opportunities that arise from the policy and resources gaps as learned from the experiences described in this section.

C4.1: Ecologic and Population Health risks and chronic environmental exposure

Legislative action at the National level, and the support of international agreements frequently are based on the knowledge of Human and Ecological Risks. There is a growing body of evidence indicating that standard risk assessment methodologies, including those used in preparing criteria documents for air quality risk determinations, are of limited use for evaluating the risks to human health and the environment associated with long term chronic exposure to many of the pollutants being considered in the context of CPP. In addition, they are not useful with respect to segments of the general population who for a variety of reasons may be subject to increased risk. For example, these methodologies are not sensitive to the type of information being generated by long-term cohort studies, such as those which have linked intellectual impairment in children (to at least age eleven) within uteri exposure to PCBs (derived from chronic maternal exposure associated with a fish diet). This case illustrates an increased sensitivity for the fetus, leading to implications which may extend well into later life.

In addition, there is no consistency in the manner in which these methodologies are used in the air and water pollution programs of the different governments in North America. This leads to different levels of protection for the human populations and the ecosystems in different regions.

There is no quick solution to this difficulty. However, a comprehensive program of work must be initiated to address this missing segment in our ability to effectively manage certain chemicals in the environment. The three CEC countries encompass an extremely wide range of environmental, geographical, biodiversity, demographic and socioeconomic variables and therefore the CEC offers the prospect of providing an excellent platform for a coordinated approach. A possible title for the proposed program would be: "Ecological and Human Population Health risks and chronic environmental exposure". The initial goal would be the development of criteria (including their justification) upon which the risks could be evaluated from long term chronic environmental exposure to certain contaminants associated with CPP.

A second task could be the development of methodologies for the inclusion of these criteria in chemical regulatory and management regimes. Finally, the CEC countries could consider the extent to which they may be able to utilize the developed methodologies. Given the complexity of the task, a stepwise strategy could be designed in which a given goal would be reached before resources would be committed to the next step.

C4.2: A North American monitoring program on Continental Pollutant Pathways

[Note: In the monitoring graph that has assessments for decision making.... make an arrow line between decision making and monitoring so it will draw a feedback line into it.]

In August 1996, the Council to NAAEC agreed to promote regional cooperation among the Parties for the development of air quality monitoring, modeling and assessment programs in North America. The resolution recommends and encourages a range of activities including joint collaboration, collection and exchange of data, the development of models applicable to a range of substances, and the use of interlaboratory comparisons, compatible methodologies and common reference materials to facilitate integrated assessments throughout the continent.

There is a need to not only implement this resolution but to also to expand it or develop another more inclusive resolution addressing the full scope of multi media monitoring, including for example, ecological and human health parameters. A basic set of indicators that would be common to all countries should be agreed upon and serviced by standardized data collection and management. Periodic assessments should be assembled in order to provide feedback to the CEC environmental ministers. This would therefore provide the ministers with substantive evidence upon which proposals for remedial action can be based. The activity could be coordinated by a tri-national working group supported by the CEC Secretariat (although the resources and actual monitoring would be from the countries and states/provinces themselves). The toxics monitoring activities conducted under the Great Lakes Water Quality Agreement and the circumpolar Arctic Monitoring and Assessment Program are useful precedents to consider in the development of this type of collaboration.

There are resources for monitoring throughout the region. However there are difficulties with geographic variability in the availability of data, inter comparison of data derived from different methodologies, and under representation of monitoring of particular components. These seriously limit the ability to integrate results between media and frustrate attempts to link sources through vectors to human health. Implementation of an integrated North American monitoring program would require support to enhance Mexico's human and laboratory capacity in this area, particularly with respect to toxics monitoring in air, water and soil. Success with this type of technological enhancement involving international cooperative assistance has been demonstrated in the case of Mexico City which in 1986 integrated an initial network for air pollution monitoring. By December 1996 it had evolved into a network of 23 state of the art automatic monitoring stations of high reliability. The Network has served as a model that has led to the development of other networks in several cities throughout the country. Together these networks have had a very positive impact on national air quality management.

C4.3: <u>Components for action on the needs</u>

The three countries need a formal commitment and an "action plan", with phased mileposts, to address the continental pollutant pathways of concern.

The action plan will need to:

- establish common norms (that will not be harmonized as a regulatory "ceiling" or limit) to protect human health and the environment for each pollutant pathway of concern.

- Deadlines will be needed for each country to implement the norms through their national regulatory systems in coordination with the other two countries
- phased plans of prevention and control for each pollutant to meet these norms will be needed that are specific to the differing environments and sources.
- commitments and a timelines to establish steps within each country, that will be needed related to pollutant pathways within each country's respective regulatory system;
- once the process described above is agreed upon by the three countries a report on the success of implementing the proposed action plan including recommendations for the future should be developed on a regular basis by the CEC secretariat.
- taking into account the complexity of establishing norms, controls and prevention strategies, an emphasis on innovative technologies should be made where appropriate.

Needless to say, the needs herein outlined will require "new and additional" resources if the are to be addressed in an effective manner.

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REGIONAL ENVIRONMENTAL COOPERATION:ON THE NEED TO FACILITATE EFFECTIVE COOPERATION FOR THE CONSERVATION, PROTECTION AND ENHANCEMENT OF THE NORTH AMERICAN ENVIRONMENT

D1: MANDATE FOR COOPERATION

"The Government of Canada, the Government of the United Mexican States and the Government of the United States of America:

CONVINCED of the importance of the conservation, protection and enhancement of the environment of their territories and the essential role of cooperation in these areas in achieving sustainable development for the well-being of present and future generations;

REAFFIRMING the sovereign right of States to exploit their own resources pursuant to their own environment and development policies and their responsibilities to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction;......

CONVINCED of the benefits to be derived from a framework, including a Commission, to facilitate effective cooperation on the conservation, protection and enhancement of the environment in their territories;

HAVE AGREED AS FOLLOWS:"

The above quotation is from the opening and concluding lines in the preamble to the North American Agreement on Environmental Cooperation (NAAEC). It provides a clear statement of an official recognition of the need for environmental cooperation. The Commission for Environmental Cooperation (CEC), established under that Agreement, is uniquely positioned to facilitate and catalyze effective cooperative initiatives.

The "Continental Pollutant Pathways" initiative that the Secretariat of the CEC has launched under Article 13 of the NAAEC is in the Panel's view, an excellent example of a collective international challenge that by its very nature almost compels the three countries to work cooperatively together to address matters of common concern. While the NAAEC is a formal agreement between federal governments, the potential for cooperation extends to many other areas. State, provincial and local governments as well as professional, labor, and industrial associations and non governmental organizations are all developing new models of environmental cooperation - stimulated in part because of the transjurisdictional and transdisciplinary nature of many emerging environmental issues.

D2: Sound environmental Information as a Basis for Consensus and Collaborative Action

The Panel believes that sound environmental science and information is a prerequisite for sound environmental policy. It further believes that, under the right set of circumstances, engineers, scientists, public health researchers and other experts can be called upon to seek general consensus (or at a minimum clarify the points of difference) on the scientific aspects of important environmental policy issues. The International Joint Commission (case study volume 2) has, for almost a century shown that its "Boards" of experts, working in a "personal and professional capacity" and not as representatives of their agencies or jurisdictions, have been able to play very important roles in resolving conflict and, probably more importantly, in preventing disputes involving water and air issues along the Canada/United States boundary. A starting point for the work of these Boards is almost always the core data sets that are collected under agreed-upon arrangements and protocols.

The Panel sees the "continental pollutant pathways" initiative as providing Mexico, Canada and the United States with an opportunity to take joint action to develop a environmental information system that is both comprehensive and integrated. Such a system encompassing the full range of disciplines and activities involved in measuring, monitoring, modeling, research, assessing and communicating environmental information would be a cornerstone of their collective efforts to conserve, protect and enhance the environment within their territories. Ideally the information and collective understanding of the environmental dimensions of important public policy issues would be available to all and would promote collaborative initiatives within and between the three countries and would help to position them to collectively play a global leadership role in addressing continental and global environment and sustainable development challenges.

The Panel assumes that the Governments, if they do decide to commit to developing such an environmental information system, would work through, and with, the Commission for Environmental Cooperation. Indeed important initiatives that could be consistent with such an undertaking are already in place. Council Resolutions #95-5 on the Sound Management of Chemicals (Annex 1) and Council Resolution #96-5 on Ensuring Data Compatibility on Air Quality and Emissions (Annex 2) each address a part of the challenge. In this regard the Panel notes that while Council Resolution #95-5 addresses atmospheric emissions and air quality parameters of such an environmental information system it does not provide for equivalent information on receptor ecosystems, land, water, biota or human health.

Throughout this report the Panel has emphasized that, while its terms of reference led it to focus on atmospheric pollutant pathways and on pollutants released to, formed within or transported by the atmosphere, "Continental Pollutant Pathways" is a cross-media issue and an integrated approach is required if it is to be understood and effectively addressed.

D3: THE ENVIRONMENT ECONOMY CONNECTION

Technology and communication have greatly enhanced our capacity to transfer ideas, people, goods and services, and pollution across national boundaries. These transfers create a growing interdependence among different and sovereign nations. The NAFTA has been described as a comprehensive free trade pact negotiated between regional trading partners, and the first reciprocal free trade pact between a developing country and industrial countries. Unlike the United States - Canada Free Trade Agreement and the GATT, the environment played a very prominent role in the NAFTA negotiations. Trade and environment issues were very controversial and much attention was paid to the actual and potential conflicts between trade and environmental policies. This public concern as to the potential negative effects of increased free trade between the three countries influenced the negotiation of environmental goals and objectives included in the trade agreement. More importantly from an environmental perspective, these concerns also led to the negotiation of a parallel side agreement, the North American Agreement on Environmental Cooperation and to the establishment of a Commission for Environmental Cooperation. It also prompted a number of US - Mexico border environmental clean-up initiatives.

D4: BUILDING ON PREVIOUS SUCCESSFUL COOPERATIVE VENTURES

The following examples of cooperative initiatives are illustrative of the range of actors - governmental and non governmental - involved in cooperative environmental international issues. It is intended to provide a sense of the potential for cooperation. Some of the examples were first raised in other sections, especially in section C, however here our focus is more on the factors that led to the cooperative actions and some of the lessons learned. Our examples include international cooperative initiatives at the national and subnational level. They include examples of international cooperation by the scientific community and by non governmental groups. While we have not detailed examples of international industrial cooperation we fully expect that such examples will become more common as the links between environment, economy and sustainable development become increasingly more apparent.

We can learn a lot from previous cooperative initiatives. Within North America we are learning to cooperate with one another despite difference in culture and interests. We have found that we can agree mutually to gather data, monitor conditions, develop measurements, and generate action plans as well as implement intervention programs. Most of the mentioned experiences relate either to efforts to address a local issue, or border and regional problems. Now the challenge is to build a shared understanding of "Continental Pollutant Pathways" and to use this shared understanding as a basis for cooperative action.

D4.1: <u>The North American Agreement on Environmental Cooperation</u>

The North American Agreement on Environmental Cooperation (NAAEC) and its related Commission for Environmental Cooperation (CEC) provide a unique mandate. The CEC role is to facilitate cooperation and public participation to foster conservation, protection and enhancement of the North American environment for the benefit of present and future generations, in the context of increasing economic trade and social links between Canada, Mexico and the United States. It clearly states the principles of cooperation and equity not only between nations but also between generations. Such a spirit should be fostered. A useful precedent for the work of our Panel is the CEC's Article 13 report on the waterfowl die-off at the Presa de Silva in Mexico's Turbio River Basin. That report, while addressing an event that took place in Mexico, had continental implications and, clearly showed the benefits of joining forces to better understand a critical issue for later recommending actions of benefit for the region.

D4.2: <u>The Washington-British Columbia Environmental Cooperation Agreement</u>

In 1992, The Governor of the State of Washington and the Premier of British Columbia jointly signed the Environmental Cooperation Agreement between their two jurisdictions. This Agreement was put in place "... to promote and coordinate mutual efforts to ensure the protection, preservation and enhancement of our shared environment for the benefit of current and future generations." The Agreement established a program, lead by the senior bureaucrats in the environmental organizations of the two jurisdictions. This program was started with major initiatives dealing with surface and ground water quality, surface water quantity/flooding, solid, hazardous & biomedical waste disposal, wetlands protection and regional air quality management.

Under this authority, the regional air quality management program has developed rapidly. Both groups quickly learnt how to 'communicate' with each other by learning the nuances of the language each used. Information on public and industry concerns were shared, and educational material exchanged so that neither side needed to spend resources on material already produced by the other. (This included sharing video and text material in such a fashion that they could be reused with different logos if necessary.) Joint programs were developed to establish real-time computer linkages for the sharing of information, emergency alerts, and archived and real-time data. Standards-were developed to ensure data quality was comparable between the two regions. Each side made use of information developed in the partner jurisdiction in presenting arguments for air quality improvements to political decision-makers. Public and industry groups were met with jointly so as to ensure neither jurisdiction could be fooled by different arguments made at different times. Joint or complimentary bargaining positions were developed for dealing with industry, with the understanding that while industrial bases and thus forces were different across the border, the air quality problems were common. Representatives for the other jurisdiction were routinely invited to private of public meetings and asked for input on press releases involving any air quality issue that might have an impact on anyone within 100 miles of the border. Air quality alerts in shared valleys were jointly negotiated so that the press on both sides of the border would be receiving the same message, even though the standards in the two jurisdictions are different. Finally, a formal four party agreement was signed between the State, the Province, the Greater Vancouver Regional District and the Northwest Air Pollution Authority (the latter two being the regional controllers across a significant section of the common border), dealing with "prior consultation on air permits which are deemed to have significant potential for cross-border air quality impacts."

D4.3: Paso del Norte Air Quality Problem

For years, serious health-threatening air pollution problems have plagued the sister cities of El Paso, Texas/Ciudad Juarez, Chihuahua/Sunland Park New Mexico (the "Paso del Norte" region) along the US-Mexico border. Here, efforts to clean up the common air shed have been complicated by the presence of an international border. While each country has a comprehensive governance mechanism for air pollution control within its boundaries, no one is in charge of air pollution at the border. It is acknowledged that the solution of the problem will be possible only if both countries work together in joint air pollution control strategies. The impact in rural areas around the Paso del Norte is actually unknown, but may be a serious problem.

The Paso del Norte region receives high amounts of solar radiation, specially during the summer, starting a series of chemical reactions involving nitrogen oxides, hydrocarbons and water that produces ozone and particulates. Monitoring stations show that levels of ozone are well above the standard and may increase as a result of new industrial, commercial and traffic activities in the region. The region also presents high levels of particulate matter in the atmosphere that represents a hazard to human health. Air pollution control strategies have been proposed and are oriented to control stationary, surface and mobile sources. However, the cost associated to different strategies need to be evaluated in terms of their effectiveness to reduce air pollution in the region.

On early 1993, the Paso del Norte Air Quality Task Force—a binational group of business leaders, regulators scientists, environmentalists and elected officials –was organized to work for cleaner air. But local cooperation could not achieve its potential so long as national air quality officials continued to define air quality goals and programs strictly on a national basis, ending at the international border. On May, 7th 1996 the United States and Mexican Government signed Appendix 1 to Annex V of the La Paz Agreement, designating the metropolitan area of the "Paso del Norte" region, an International Air Quality Management Basin and creating a Joint Advisory Committee for the Improvement of Air Quality (JACIAQ), empowering Paso del Norteans to develop cooperative transboundary strategies to improve air quality throughout the air basin and committing to implement those strategies through national law.

D4.4: Air Quality at the Big Bend National Park-Maderas del Carmen/Cañon Santa Elena.

On December 19th, 1996, after 18 months of public hearings (domestic and binational) the United States and Mexico published and signed the final document for the Border XXI Program, which seeks to promote the transition to sustainable development in the border region. It is a binational effort directed at conserving natural resources and protecting the environment and the environmental health of border area communities taking into account the present and future needs of the region. The Border XXI Program is an unprecedented example of bilateral cooperation along the United States/Mexico border region to address serious transboundary environmental problems, with the participation of border communities and local and state authorities in priority-setting and environmental decision-making in their own geographic areas.

Within the framework of the Border XXI, the United States and Mexico will continue baseline air quality monitoring. Both countries will be able to assess air quality, and develop a strategy to prevent these areas from deteriorating into non- attainment areas. If baseline air quality measurements indicate violations of health standards, this will likely lead to an expansion of the emissions inventories and of the monitoring network, increased equipment, operation and maintenance of the Automatic Air Quality Monitoring Network, and increased attention sample analysis and quality assurance of the data.

Particulate matter below 10 microns in size, PM10, is of great concern due to the hazard that it represents to human health and to the environment. Recent studies show that PM2.5 represents the highest hazard to human health since it deposits in the lungs. Particulate matter in the atmosphere has its origin in natural and anthropogenic sources, and may be emitted directly or be formed by oxidation of gaseous contaminants, like sulfur dioxide and nitrogen oxides. Visibility is also another form of air pollution and the impact in National Parks has become of great interest. Examples of this problem are the studies to assess the impact of emissions of the United States and Mexico in the Grand Canyon and in the Big Bend National Parks.

The case of visibility degradation in the Big Bend-Maderas del Carmen/Cañon Santa Elena National Parks is of great interest. The park is a natural ecosystem divided by the Rio Grande (Rio Bravo) which serves to mark the political boundary. The Big Bend is located in Texas, USA, while Maderas del Carmen/Cañon Santa Elena is located in Chihuahua, Mexico. The ecosystem is affected by emissions of both countries. A primary concern is the impact that sulfur dioxide emissions of a Mexican power plant may have in the park. This plant is located about 600 kms from the park and studies in the United States show that these emissions are affecting the park. Similar studies in Mexico show that other sources in the eastern United States and in New Mexico and Arizona may also play a significant role in the degradation of visibility in the park.

In a recent meeting to study the problem, the participants of the two countries recognized that the solution may depend of the combined enforcement of emission control strategies in the United States and Mexico. To solve the problem, the participants suggested to integrate monitoring and modeling efforts, increase meteorology measurements in the region and beyond to study long range transport of pollutants. Improved emission inventories using appropriate emission factors (this is especially important for Mexico), a common integrated data base for dispersion studies, and an assessment the relative role of different sources of air pollutants on park visibility will also result.

D4.5: International Cooperation for Emission Inventories

In an effort to better understand the visibility problems of the Colorado Canyon plateau, the Western Governors Association (WGA), invited the Mexican Government to participate, in a joint initiative. It was assumed that emissions originating the in and Sonora states contributed to their visibility problems. Mexico's National Institute of Ecology (INE), through a grant coming from the WGA, is working on the development of appropriate methodologies to elaborate its emissions inventories.

In this context, the consulting firm that was awarded with the project of the Grand Canyon, is participating with INE to develop XI Manuals to cover all sources of emission, as well as to start a training program to train instructors in this topic. The program includes elements such as: program plan, emission estimate, database management, emission validation, quality control and quality assurance. Initially, the XI manuals were presented in an English version and INE is working on the translation for a Spanish version. The consulting firm contracted by the WGA and the Autonomous Metropolitan University (UAM) in Azcapotsalco, Mexico, under INE's supervision have developed a training course directed to federal, state and municipal urban development and ecology personnel, but will also include participation of industry and staff of private consulting companies.

D4.6: <u>Cooperation in reducing the negative environmental effects of copper smelting</u>

The La Paz agreement prompted action to effectively cut potential copper smelter SO_2 in the border region by about 1.2 million short tons per year from anticipated emissions for 1990; it actually reduced – through Mexican pollution control and through United States closure and control – border emissions by 700,000 tons annually by late 1988. All non - ferrous (copper, lead, zinc) smelters within the border region with the exception of the Cananea copper smelter – were required to meet United States New Source Performance Standards for stack emissions. The 106 year old Cananea smelter was prevented from expanding its smelting capacity unless it met the same standard.

The Nacozari copper smelter invested US $60, million in construction of a double - contact sulfuric plant and started operations in August 1988, to meet these requirements. Mexicana de Cobre invested another $54 million and completed an expansion of the smelter in January 1997 that increased capacity by 70% and concurrently reduced, hopefully, SO_2 emissions. The company believes that it will (profitably) meet emissions requirements. In fact with the installation of a new refinery in 1997 they expect to get their investment returned in pollution control in less than 2 years. This is a clear example on how environmental management can help industries to progress. An ambient air emission monitoring network was established to confirm that 24 hour SO_2 standards equivalent to those of the United States were being met.

The Phelps Dodge Douglas copper smelter was shut down for failure to meet US pollution control requirements under the Clean Air Act and to prevent endangerment to human health. This application of the strongest environmental standard of either country to protect the environment set a standard for cooperation on environment between the two countries and is an concrete example of successful effort to address pollution. A combination of US and Mexican grassroots politics, economic analysis, enforcement mechanisms, and detailed examination of long range sulfate deposition (western acid rain) all played a role in making transboundary smelter air pollution a high priority for the United States under the La Paz agreement and under Arizona and US environmental regulatory priorities. Other smelters in New Mexico, El Paso, TX and San Manuel, Arizona have been required to submit monitoring reports equivalent to those submitted by the Nacozari smelter.

Annex IV became a coordinated regional effort on both sides of the border that resulted in a feasible program of pollution control. Canada used it in 1987 in negotiations leading to the Canada - United States Air Quality Agreement of 1991. Officially, the social justifications for the US actions to control SO_2 were to protect health of the population while for Mexico it was to reduce damage to crops.

D4.7: Surface Air Ozone Pollution

The issue of ozone pollution perplexes today's air pollution regulators. First, because it involves consideration of many chemicals, both natural and anthropogenic. Second, it is politically charged, since many of the precursor chemicals leading to the formation of ozone derive from activities fundamentally identified with maintaining our standard of living. Third ozone by itself is confusing to the public. In the upper atmosphere man-made chemicals are destroying the ozone layer that shields the earth surface from harmful radiation. In contrast, in the lower atmosphere man-made chemicals are generating ozone, which is also bad because this ozone is destructive of forests and crops and poses a health hazard to humans and air breathing animals. Fourth, the issue is intertwined with that of nitrogen oxides and their influence on ecosystems. The issue is fraught with danger of imposing inadequate or cost inefficient controls, because effects are complex and so many chemicals are involved.

Regulating any one of the causative chemicals alone may not be effective in reducing ozone. Furthermore, not all of the chemicals involved are amiable to local control. The precursors can be transported and ozone itself may not go as far, but is formed as the precursors move along. The key ozone precursors are various oxides of nitrogen (NOx), and a wide variety of volatile organic compounds (VOCs). Ozone is generated as a by - product of atmospheric chemical reactions involving these chemicals. Sunlight is the driving force, and it is most often the limiting variable regardless of the actual concentrations of NOx and VOCs.

Experience has taught that the concept of uniform, continental - wide application of standardized control strategies fails to recognize the differences in the environments that contribute to surface ozone pollution. Thus, what works well in one location will not necessarily work as well in others. The range of situations across this continent is so wide that control strategies should be based on the very best understanding, or else the ozone reduction targets will not be met and the consequences of any regulatory errors will be propagated downwind to affect other areas, in other jurisdiction if not in another country.

Coastal ecosystems downwind of densely populated areas, such as the mid- Atlantic seaboard of the United States, is already showing the unmistakable effects of excessive nitrogen nutrients, some of which arrive via the atmospheric pathway from air pollution sources far upwind.

Regulating for ozone must take into account the fact that the decisions made will have consequences on the coastal eutrophication issue as well. Likewise, strategies to improve coastal aquatic habitats must be cognizant of the benefits to be accrued as NOx emissions into the atmosphere are reduced. Considering the spread conditions in North America, and the long - range aspects of air pollution, NAFTA / CEC focuses on the coupled / eutrophication issue as a prime example of how the member states must work together to achieve the continental environmental standards that are desired, while maintaining economic growth and prosperity.

D4.8: Water Perspective in the US - Mexico Border

Colorado River water quality.

The Colorado River represents a case study where the problem involves a river crossing an important region within the United States, which after passing by two states in Mexico, it discharges to the Gulf of California. It is relevant from the point of view of conserving natural resources, as well as fishing and recreation area, even more, because of the dry conditions of the area, where water is a fundamental resource for the survival and development of the agricultural region.

The Mexican - Imperial Valley

The Mexican - Imperial Valley is an important binational agricultural region. It lies primarily on the western side of the Colorado River, which drains 242,000 square miles of southwestern United States and 2,000 square miles of northwestern Mexico, flowing to the Gulf of California. Several conflicts exists which have grown initially from a water quantity focus to include water quality problems. The most obvious change in water quality has been increases in salinity. Although some information of heavy metals exists, there is a lack of systematic and updated data regarding environmental problems, such as level of increases in pesticide and other organic compounds. A pesticide assessment for the Colorado River has been done since the sixties, as part of the National Pesticide Monitoring Program in the United States.

New River, Baja California / California.

The New River originates from agricultural runoff south of Mexicali, Mexico, it passes through Mexicali acquiring sewage and industry waste waters, crosses the Mexico - US border, then flows through the Imperial Valley in California, to a final destination at the Salton Sea, a saline lake in Imperial County. The New River flows into the southern most region of the Salton Sea where there is a National Wildlife Refuge.

Rio Grande Valley, Ciudad Juarez / El Paso.

Rapidly increasing population and industrialization along the US - Mexico border has resulted in large numbers of people on both sides of the border living in poor conditions. The CD. Juarez - El Paso region is one of the most heavily populated areas on the US - Mexico border, with a combined population of nearly 2 million people. Urban growth along the border has been primarily due to the development of manufacturing plants known as Maquiladoras.

Many border residents live in underdevelopment communities, referred as colonias in the United States, lacking protected drinking water or wastewater treatment facilities. Of the several hundred houses in the colonias in El Paso, Texas, less than 20% have any form of sewer systems or waste water treatment facilities. A study was carried out in the Rio Grande Valley in El Paso County, an agricultural and industrial zone located in a region with a water table depth of only 2 to 3 meters below soil surface during most of the year. There is concern that the shallow transboundary groundwater reservoir are being contaminated by agricultural runoff, raw sewage, and possibly industrial waste.

At present there is no comprehensive database of safe and unsafe drinking water sources at El Paso - Ciudad Juarez border region. More significantly, NAFTA will promote increasing industrialization and the concomitant urbanization and population growth, which in turn, will have a direct impact on environmental quality at the United States - Mexico border. There is an ongoing project to asses the extent of microbial contamination of groundwater in the Upper Rio Grande in El Paso County, Texas.

D4.9: Mexico City Air Quality Research Initiative

Among the most serious problems facing our modern world is air pollution. In the Mexico City Metropolitan Area (MCMA), addressing this problem has become a high priority affecting both the environment and health of its more than 15 million inhabitants. US and Mexican officials recognized that the issue of urban air quality was a common priority. Subsequently, Mexico designated the Instituto Mexicano del Petroleo (IMP), and the United States designated the Los Alamos National Laboratory, to jointly lead a bilateral technical team, with essential participation of other public and private institutions from both nations.

While the focus was Mexico City, any breakthroughs made in solving air pollution problems of this metropolitan area would have application to other cities in their respective countries, and have relevance to the global air quality community as well as implications for future international cooperation. The Mexico City Air Quality Research Initiative (MARI) resulted in major advances for decision makers in understanding and directing technical applications of air pollution control measures. The evaluation tools developed through MARI are expected to become increasingly important as decisions pertaining to less obvious measures will be necessary to achieve incremental pollution reductions. Emission inventories for the MCMA have been significantly improved. Measurement and modeling showed that the Hydrocarbon component of the City's emission inventory was severely underestimated. This insight saved time and potentially funds as well. MARI has generated broad support from high-level officials in both the United States and Mexico. Not only is MARI viewed as a new standard for scientific collaboration, but the project broke new ground in meeting its goals and deadlines.

D4.10: The International Joint Commission

The International Joint Commission is a binational organization established by the Boundary Waters Treaty of 1909. The Commission in response to specific requests from Governments, has addressed matters related to transboundary air pollution since 1928. The Commission is requested to take note of air pollution problems in boundary areas. The International Air Quality Advisory Board was established to assist the Commission in this alerting role, and this Board, has been active in bringing air quality issues to the attention of the Commission. The Board currently includes five members from Canada and five from the United States who have expertise in various aspects of air pollution sources, effects and control.

A principle source of the Commission's authority with respect to air quality matters is derived from a 1966 reference from governments. The focus of the reference was on air pollution in the Detroit-Windsor and Port Huron-Sarnia areas, but the reference also contained a paragraph which reads as follows:

> *"The Commission is also requested to take note of air pollution problems in boundary areas other than those referred to in Question 1 which may come to its attention from any source. If at any time the Commission considers it appropriate to do so, the Commission is invited to draw such problems to the attention of both Governments."*

This paragraph has been used as the basis of a continuing advisory role on transboundary air quality even though the initial investigation of the Detroit-Windsor and Port Huron-Sarnia areas was completed and reported on in 1972. It has generally been considered that the Commission's continuing responsibility under this reference is limited to alerting Governments to transboundary issues or concerns, as opposed to undertaking investigations or studies.

D4.11: The Arctic Council

The Arctic Council and its programs have provided an instructive example of the broad scope of issues which can be addressed under a relatively informal international agreement. This experience may be reviewed by the CEC ministers should they decide to develop mechanisms to address the issues associated with continental pollutant pathways.

In response to concerns regarding the Arctic environment, the governments of eight Arctic countries (including Canada and the United States) agreed in 1991 that collective action was needed to safeguard the Arctic ecosystem. In 1996, the ministers further elaborated their commitments by establishing the Arctic Council with the aim to promote cooperation and coordination of action on a broad range of common Arctic issues. The programs undertaken include activities to operate a circumpolar Arctic Monitoring and Assessment Program, to review marine environmental protection legislation and its effectiveness, to cooperate on emergency preparedness and response, to cooperate on the conservation of flora and fauna, and to develop activities related to the sustainable utilization of resources. The ministers meet at bi-annual intervals to review progress to agree upon appropriate actions, and to provide the program areas with new work plans. Therefore the Council structure enables mutual responsiveness between the political level and the various program areas.

D4.12: Air Quality over the Gulf of Mexico

A research cruise was conducted in the summer of 1986 by a team of scientists from the US (NOAA, ERL, and ARL) and Mexico (UNAM) to investigate air chemistry over the Gulf of Mexico. Chemical, physical, meteorological and oceanographic measurements were carried out to survey temporal and spatial variations, with emphasis placed on air - sea - land exchange of gases and aerosols, natural air quality, transport of man-made air pollution, and acid rain to the Gulf. The investigation was the first cooperative project between the United States and Mexico to survey air pollution and acid rain problems over a Gulf that the two nations share. The research began in Galveston TX and ended in Veracruz, Mexico.

The study yield information to conclude that the Gulf air is highly polluted with continental and man-made aerosols. Dry deposition of aerosols is a continuous process for air-to-Gulf fluxes of air pollutants. Rain samples were found to be very acidic, calculation showed that for soluble particles, wet deposition is even more important than dry deposition in the Gulf. The ecological and environmental impact of the air pollution and acid rain on the Gulf need further study.

D4.13: Cooperation in the Monitoring of the Atmosperic Deposition of Mercury

To narrow the knowledge gaps on mercury cycling, international compatible networks are needed between Canada, the United States and Mexico. In 1996, a hemispheric mercury deposition network (headed by Steven Lindberg of ORN) was proposed for wet mercury deposition within the America (AMT, 1996). An independent group from Mexico, Canada the United States and Brazil worked together with the CEC and EMAN Canada to plan the project.

Representatives from 14 agencies in conjunction with EMAN Canada and the US National Atmospheric Deposition Program/Mercury Deposition Network proposed the initial foundation stages of an "Americas Mercury Deposition Network" (AMDN), (Pilgrim, et al., 1997). The objectives of the network are: a) Training - the AMDN will provide training and technology transfer thorough the development and sharing of expertise and equipment for high quality measurements of mercury (Hg) in wet deposition; b) Measurements - the AMDN will provide measurement of the wet deposition of mercury for the purpose of quantifying inputs and describing seasonality in loading for representative ecosystems in the regions of each site; c) Integration - the AMDN will integrate measurements of mercury in wet deposition into ongoing research programs to add value to related biogeochemical and atmospheric research; d) Collaboration - the AMDN will establish a foundation for future expansion of collaborative research on the fate, transport, and effects of air toxics throughout the hemisphere; and e) Data - the AMDN will develop a fully quality assured and reliable data base for sites in the Americas which will be widely available to anyone interested. These data will establish a baseline of Hg wet deposition loading in each region prior to the establishment of any possible Hg emission controls.

D4.14: Great Lakes United

Great Lakes United (GLU) is an international coalition of grassroots community, environmental, labor, and First Nations/Tribes created in 1982. Great Lakes United has led in generating a robust, international dialogue in the Great Lakes Region and has become a pioneer in developing ecosystem management policies, particularly in regards to persistent toxic substances. It has become a powerful constituency for the Great Lakes, the Great Lakes Region, and for the Great Lakes Water Quality Agreement. It has formed effective working arrangements with the Great Lakes Research community and plays a major role at international meetings convened by the International Joint Commission. Among its many roles it has carried out research on important issues related to the Great Lakes water Quality Agreement, has held and reported on public hearings in the Great Lakes Basin and has participated in the negotiation of the 1987 protocol amending the Great Lakes Water Quality Agreement of 1978.

D4.15: Cooperation on Technology Innovation for Environmental Protection

Although still at an early stage, there are two examples of technological innovation that, within the region, could be particularly pertinent to the "Continental Pollutant Pathways" initiative. In January of 1996, under the promotion of the Commission for Environmental Cooperation, a letter of agreement was signed between the Mexican Chamber of Industry, the SEMARNAP (Environment, natural resources and fishery ministry) in Mexico, and the Councils for Business and the Environment of Canada and Mexico. Among the several aspects included in this agreement was one on cooperation to transfer and facilitate the joining of forces between industrial users and providers of technology for more efficient and environmentally protective equipment. This is consistent with the approach to link technology providers with the growing and newer industries being developed in the region.

A second example has been the research effort that, since 1990, has been underway to help understand the role of lead in human intoxication in Mexico. A major source for urban and rural lead pollution is the lead in pottery. A network of Mexican and US researchers have provided valuable information on the presence of low levels of lead in different age and sex groups. The knowledge acquired increased the governmental and social awareness, and has provided an impetus for the Fondo Nacional de las Artesanias (FONART) to lead a technology innovation effort. It is now being implemented to help the ailing art and craft industry to reinvent the way they produce their pottery, and reopen their markets, while protecting the health of workers and the consumers.

D5: IN SUMMARY

Cooperation in the North American region is not new and as the above examples illustrate there are many examples of governments at various levels coming together to cooperate when circumstances warranted. The many models for cooperation between and amongst non governmental groups and associations present a rich source of experience to be drawn upon. The proliferation of non-binding, but important, initiatives to cooperate in addressing environmental issues that transcend jurisdictional boundaries is in the Panel's view a very healthy sign of a recognition of the benefits - and indeed the necessity - of learning to cooperate in the interests of protecting shared environments.

The International Joint Commission (IJC) experience would seem to be particularly relevant to the "Continental Pollutant Pathways" initiative. After almost a century of existence there are many examples of how the IJC has adapted "tried and true" methods for fostering cooperation and consensus in response to current realities and current demands. Many of those lessons were built into the approach employed by our Panel as it has attempted to contemplate a continental challenge that cries for continental cooperation.

ON IMPROVING OUR UNDERSTANDING

E1: INTRODUCTION

There is little doubt that existing understanding is enough to convince even the most ardent critics that action to prevent further deterioration of the continental environment is warranted. In addition to that, there is now a recognition that improving the state of the environment is good business, and adopting pollution prevention is even better.

The old dichotomy between the environment and the economy is a thing of the past. Every dollar spent on dealing with problems traditionally viewed as environmental generates jobs and flow of money in the economy, addresses past wasteful practices or improves efficiency and effectiveness in the use of resources, and, in many cases, reduces short and long term health costs. Such investments also assist in revealing wastage in a system, thereby giving those alert to opportunities the chance to change designs, processes, technologies or procedures. With these new approaches, often generated through research, alert organizations find they can create new business and trade opportunities leading to greater corporate diversity and consequent robustness.

In the environmental situations outlined in the previous sections and covered in more detail in Volume II, the major sources of the problems are clear. There is no need to wait, in fact there are sound financial reasons to begin to take action on reducing discharges from those major sources through either policy or regulatory action on a continent-wide basis. There is, however, a need to quickly put in place the monitoring and agreed-upon goals, objectives milestones and, perhaps in some instances, standards to be able to evaluate the overall effectiveness of programs. Such monitoring is essential now so that background information is available when program reductions begin to take effect. There is also a need to improve overall communications between the various scientific and policy teams in the three countries to ensure that the information available to policy-makers in the future is consistent, uniform and all-encompassing. These two issues are addressed in this section.

While not included here, it should be noted that, once the first levels of source discharge reductions are underway, more detailed information will be needed to ensure that the remaining problem sources are dealt with optimally. This will entail further research on source-receptor relationships, particularly on health impacts and the role of confounding factors.

E2: PROGRAM EVALUATION NEEDS

E2.1: Meteorological Monitoring

The atmosphere is the main medium for continental-scale movement of pollutants. Atmospheric transport of material is difficult to precisely assess under any circumstances, largely because of the very nature of the variability of its motion; however, the situation is made worse than it needs to be by the great variations in coverage of meteorological reporting stations. The lack of adequate data in some areas limits the accuracy of meteorological models for the entire continent. The matter is especially important in the case of atmospheric pollutant transport, since small errors in wind direction can have large effects on predictions of pollutant movement. Thus, basic meteorological measurements need to be taken in an expanded grid, particularly in Mexico.

Once better data is available, improved transport and dispersion models will be needed so as to enable a tighter focus on areas that are most vulnerable to high pollution episodes, even after the first levels of reductions have occurred.

E2.2: Monitoring pollutant transport, deposition, fate and the resulting exposure of humans and the environment

There are three aspects critical to pollutant monitoring: (1) the location of the site; (2) the method/type of sample used; and (3) the adaptability of resulting information. Each aspect must be addressed now within the context of the continental nature of the pollutants and their pathways, as elucidated elsewhere in this paper.

As far as location is concerned, existing monitoring sites tend to be concentrated in urban areas. For regional applications, more regionally representative data are desired. A redistribution of some monitoring sites appears to be called for. In considering how one should relocate sites, it is important to remember that it is not just the concentration that causes an effect, but the exposure. The concentrations to which receptors (a group of people or a sensitive ecosystem) are exposed are the critical measurements. In addition, a key consideration is that many of the chemicals that are currently of concern are not yet monitored in any routine manner, except perhaps in a few intensive research programs. (An excellent example of this is the great need to improve the collection of deposition and effects information on acid rain in Mexico.) This is not a reflection of a lack of interest by the national bureaucracies so much as an indication of the complexities and technological challenges of the issues that are now being confronted, and a lack of reasonably priced, reliable, durable sensors with sufficient sensitivity and range to meet the needs.

Modern environmental scientists are concerned not only about the problems of the past and present, but also about those of the unknown future. The world is slowly adopting a new approach to monitoring, in which the historic emphasis on routine and standardized monitoring is replaced at a subset of stations with procedures that emphasize flexibility and scientific understanding. The old paradigm of having monitoring separate from research has been broken by the new need to understand more about why changes are occurring, so that regulatory responses can be optimized. We see a need to work towards a continental coverage of monitoring stations, with a subset of special sites where research and monitoring combine to attack specific environmental problems in a cross-disciplinary and multimedia way. This new approach to monitoring must also include efforts to evaluate the distribution and effects of pollutants throughout the environment, including all media: many examples in this report demonstrate how air pollutants may pose risks to humans and ecosystems through their routes of exposure involving soil, water, or food. In addition, the monitoring effort should focus on human or ecological "effects." New methods, including immunoassay or other biologically-based methods, need to be encouraged and developed which focus on indicators of effects, rather than to continue the expensive and difficult approach of measuring every chemical in the complex mixture.

The data derived by measurement programs in each of the nations may be internally consistent, but may not necessarily be easily combined into a single data base of uniform quality. An existing agreement calls for collocation of key sensing systems at selected locations. The agreement needs to be implemented, with initial emphasis directed at issues of immediate transboundary and international importance.

As far as adaptability is concerned, the arrival of new information is a continual generator of pressure to adjust monitoring activities - both for the location of the sampling stations and for what is being measured. As we step into the new century, it is appropriate to remember that new problems will certainly arise, and that our monitoring activities will consequently be far from stagnant.

Scientists from all walks of life, from government and industry as well as from academia, must share in this new way of watching over our continental environment. The new approach is only now starting to be implemented. At this early stage, it is appropriate to ensure that the first steps are taken in as collaborative a manner as is possible, so that the development of the concepts will be paralleled in our three signatory nations.

E2.3: Emission Monitoring

Accurate and current emissions data are needed. To this end, a common set of models/algorithms for emissions estimation, of requirements for industrial emissions monitoring, of pollutants to be monitored, and of frequencies for monitoring. A comprehensive quality assurance program is required, to permit the development of an integrated multi-national emissions database. Electronic mechanisms to rapidly exchange this new data, and to expand, extend, and share access to existing national data archives are also needed.

E2.4: Shared Common Goals and Objectives

Government regulations are based on estimates of what is acceptable as a "safe exposure." At present, the different countries differ not only in their standards but also in how these standards are set. In addition, in some cases (e.g. trace metals) current estimates of "safe levels" are vague, in part due to the complexity of the substance's behavior in the natural environment.

In the past, regulatory bodies attempting to develop quantitative criteria have paid little attention to natural or anthropogenic variability. This may be partly due to the scarcity of relevant data, and partly to the common misconception that the background level or "baseline" is constant for each element across large geographic regions. New statistical approaches to taking variability into account are currently being explored. Examination of these new approaches and the eventual acceptance of them on a continental scale would best require multi-national attention.

There are lessons to be learned from the Great Lakes Water Quality Agreements. Canada and the United States agreed to a shared purpose, common objectives and committed to the development of joint programs. They also agree to use their best efforts to develop legislation, regulations and standards that were consistent with the achievement of these objectives. This approach enabled each country to agree on a common direction while at the same time being sensitive to sovereignty considerations

E2.5: Water as a transboundary pollutant pathway and the need to recognize the cross-media dimensions of continental pollutant pathways

Mexico still faces basic sanitation problems in some rural and urban areas, resulting in gastrointestinal diseases and other problems caused by the degradation of drinking water. Thus, in the consideration of regional transboundary pollution issues, it is important to include surface water and groundwater pathways. For example, in the Colorado River Basin, which includes seven American states, two Mexican states and the Gulf of California, water quantity has been a problem since the 1940s and now water quality degradation caused by pesticides and salinity is of increasing concern. Emerging issues in Mexico are organic compounds directly released as contaminants to the environment (soil, air and water) as well as organic compounds formed as byproducts during the chlorination process. Bioaccumulative compounds can in turn accumulate in terrestrial and aquatic ecosystems.

The Gulf of Mexico is proposed as an area that is especially vulnerable to impacts of pollution from both the USA and Mexico. At this time it is known that pollutants delivered to coastal waters via the air pathway can provide a large proportion of the nutrients and other pollutants that are causing anoxia (or hypoxia) in sensitive areas. It is not known whether US emissions are affecting Mexican coastal waters, or vice versa. However, it is recognized that the Gulf coastal waters are starting to show the symptoms of NO_x over-enrichment. A targeted, multinational program is required to protect Gulf waters from further encroachment by man-made pollution delivered by the atmosphere.

E3: SHARING INFORMATION

E3.1: A Continental Data Exchange Program

There is little doubt that the Internet will serve as the mechanism for rapid exchange of recent information across national boundaries. The use of such data on a continental scale is at the mercy of the slowest data delivery. There is a need not so much for a mechanism by which data can be exchanged, as for agreements about when data will be made available. The relevant data are those that relate to the whole pollution cycle - including emissions, ambient air concentrations, deposition, pathways and fate within terrestrial and aquatic ecosystems, and exposure to humans and the environment.

E3.2: Database design and management

Once data are available and easily accessible by all parties, data management and data standardization issues will need to be addressed. Standardization issues include consistency in the definition of sources (point, mobile and area sources) and receptors, documentation of data quality and other attributes, methods of data collection and methods of statistical reduction.

E3.3: Assessment methodologies

Each nation will continue to rely on its independent assessments but will need to share these assessments in a timely fashion. It is necessary that the knowledge of the scientists of each nation be made available to those conducting assessments in the other nations, so that avoidable errors can be anticipated and by-passed. Moreover, the knowledge resident in each nation is based on a different set of environmental conditions. To obtain a mutually-agreed upon continental picture, it is necessary to bring this special knowledge together in a comprehensive manner, and to jointly work on identifying exposures, risks, and useful control technologies. An example of this type of collaboration is the North America Research Strategy for Tropospheric Ozone (NARSTO), which is a partnership of universities, government institutions, industries, contractors and environmental organizations from the three countries.

E3.4: Evaluation

All assessments of atmospheric pathways will necessarily rely on computer models of some kind. These models need to be tested before their outputs and predictions can be accepted. A continental approach is required, or else we risk taking future action on the basis of models applied where later data might show these same models are not adequate.

E3.5: Human Health

The main routes by which pollutants affect human health are inhalation and ingestion. In most cases, the dose of importance is influenced by both long-range transport and regional (and especially local) emissions. The current movement towards an emphasis on fine particles of 2.5 µm in diameter in place of earlier standards relating to 10 µm particles is elevating the long-range transport issue to a new level of importance. The smaller particles reside in the atmosphere for a much longer period, and are therefore transported continent-wide through the air.

Research has indicated the need to consider all routes for human exposure. This is most important, since there is an undisputed need to understand the different ways that long range transport of pollutants can be related to human and biota health effects. In some cases, daily and even hourly concentration variations are significant factors influencing health (e.g. respirable particulates), whereas in other cases, chronic effects dominate (e.g. persistent organic pollutants).

Traditional health issues have tended to concentrate on the short-term episodic exposures. Thus, standard risk assessment methodologies are of limited utility for evaluating the risks to human health associated with long term chronic exposure to many of the pollutants being considered in the context of continental pollutant pathways. A comprehensive "Health risks and chronic environmental exposure" program is proposed to develop criteria to evaluate these risks for utilization in regulatory decisions in all three jurisdictions.

E3.6: Identification of sensitive receptors

A continental-wide recognition of susceptible ecosystems and sensitive receptors, and how they have changed and will change with time and with variations in global climate, is needed. Multinational acceptance of the importance of receptors that lie outside individual jurisdictions is a requisite step in the path towards continental-scale consideration of environmental protection and remediation. Steps are needed to review and order vulnerable systems.

E3.7: A Continental-Scale Intensive Experiment

It is recognized that knowledge, absent from the scientific community among the scientists of one signatory nation, may not be absent form the others. A mechanism is therefore needed to promote exchange of knowledge relating to the North American continental environment. The requirement is more than what is provided by meetings or professional journals. A rapport is needed, so that regulators and policy makers in each country can draw upon the experience and understanding elsewhere to help solve internal problems, and to assist in minimizing transboundary repercussions. Processes to promote the growth of this cooperation and assistance are sorely needed. Continental scale joint experiments may provide an answer, preceded by tri-national modeling studies to point out conditions contributing to the long-range transport of emissions into the atmosphere. At some time, studies using atmospheric tracers released from several locations across the continent may well prove necessary to resolve a simple question of great contemporary uncertainty -- How much data is necessary to drive atmospheric transport and dispersion models with enough accuracy for assessment purposes?

E3.8: Risk Communication and Public Education

Risk communication is not a one way communication process whereby information is given to a passive public. In some cases the public may be aware of a specific risk and demand understandable information; in other cases the public may not be aware of the risks associated with their daily practices. Thus, risk communication must include an environmental education strategy, through which the different players may achieve the knowledge needed to understand their exposure to risks and the environmental impact of their practices and decisions. This knowledge may promote change, but one must be ever cognizant of the different way that the public views risk - in particular the distinctions it makes between voluntary and involuntary risks.

Non-governmental organizations can be important agents for monitoring sustainable development and for forming effective communication channels between decision-makers and the public at large. Increasingly, United Nations bodies and other intergovernmental organizations are recognizing the value of including NGOs in the risk assessment process.

E4: CONCLUSION

The August, 1996, agreement of the Council of the Commission for Environmental Cooperation (Council Resolution #96-5), to promote regional cooperation among the Parties for the development of coordinated compatible air quality monitoring, modeling and assessment programs in North America, should be implemented and expanded to embrace the full scope of multimedia monitoring, including for example, ecological and human health parameters. Periodic assessments should be assembled in order to provide feedback to the CEC environmental ministers, thus providing them with substantive evidence upon which proposals for remedial action can be based.

Joint actions to fulfill needs identified to address continental pollutant pathways should have (1) common norms; (2) phased plans of prevention and reduction, commitments and timelines to establish steps, that while unique to each country, are consistent with the achievement of agreed upon goals and objectives; and (4) there should be emphasis on innovative technologies.

There is a need for the three countries to report on a regular basis on their progress in implementing joint regional action plans. The first opportunities for such reviews could well be for the North American Regional Action Plans (NARAPs) on DDT, chlordane, mercury and PCBs. These action plans, while developed under a different program in accordance with Council resolution #95-5 on the Sound Management of Chemicals will, it is assumed, soon be approved. All are relevant to the "Continental Pollutant Pathways" initiative.

Multi-national collaborative programs should be encouraged, to address issues such as those discussed above in a manner that ensures acceptance of the results by the scientific communities of each of the countries. This mutual acceptance is a necessary prerequisite to a continental-wide uniformity in regulatory philosophy.

There is an overlying requirement for information transfer and training in all areas. In practice, the construction of a continental infrastructure for rapid sharing of data and understanding may well prove to be among the most important components of this activity.

CONCLUSIONS AND RECOMMENDATIONS

F1: GENERAL CONCLUSIONS

The Panel's primary task was to prepare a report, to be transmitted to the Secretariat of the CEC, on the nature, extent and significance of Continental Pollutant Pathways in North America. Our primary focus has been on atmospheric pathways and on chemical pollutants released to, formed within or transported by the atmosphere. We also need to appreciate how pollutants are transferred to and from other environmental media. The reader should also be aware that biological pollutant pathways are also significant and that they also warrant attention.

Pollutant pathways - between and within the air, water, land and living components of the ecosphere - combine to create a very dynamic, constantly changing, interconnected web of interactions operating at very different spatial and temporal scales. One cannot appreciate the significance of pollution in one medium without an understanding of what is happening in other media. An understanding of the terrestrial, aquatic and food chain pathways followed by these pollutants is important in assessing their relevance and the risks they pose to human health and the environment. Anthropogenic point and mobile emissions as well as diffuse sources arising from land use activities are all important to understanding the scope of the problem. In some instances natural sources can also be important. The prevention and reduction of anthropogenic releases of pollutants to the atmosphere may, to a significant degree, be addressed by altering the economic incentives and social motivations influencing the human and corporate behavior that leads to these releases to the atmosphere.

Atmospheric pollutants are of obvious transboundary relevance and atmospheric pathways are frequently the primary pathway for delivering pollutants to terrestrial and freshwater ecosystems. Marine pollutant pathways, at every scale up to global, are also important and for some pollutants the marine ecosystem is the largest reservoir of global pollutants. Freshwater ecosystems can also transport pollutants over long distances. In addition they often flow across or form political boundaries and all too frequently are a direct and immediate means of transporting pollutants from one country to another. Finally, birds and insects (and people) that migrate carry chemical and biological pollutants from one region to another. Once these pollutants leave their bodies, they can begin again the complex processes of transport mentioned above.

Lakes, reservoirs and rivers and their watersheds exchange pollutants with the air above and with the groundwater below. Pollutants once volatilized or revolatilized to the atmosphere can be carried long distances before being deposited or redeposited, as wet or dry deposition, in another watershed. Atmospheric deposition is for many such ecosystems, especially those that are remote from major industrial activity, the primary route of entry for many persistent and toxic pollutants. In some instances, such as in the case of some persistent organic pollutants (POPs), there is clear evidence of atmospheric transport from the tropics and mid latitudes to high latitudes. Once deposited these pollutants can enter other pathways - including terrestrial and especially aquatic food webs - where in many instances they have bioaccumulated in fish and wildlife to levels that are toxic to the organism or which exceed levels established for human food. Three of the specific case studies on mercury, persistent organic pollutants and dioxin deal with pollutants that bioaccumulate in the food chain and which are pollutants where the primary route of exposure to humans and biota is through the food chain.

The ozone, acid rain and respirable particulates case studies are each interrelated examples of how atmospheric chemistry plays a role in transforming substances released from point, mobile and diffuse sources into the pollutants that pose a risk to humans and the environment. Here, direct inhalation (in the case of humans) or direct surface exposure (in the case of plants) is our primary cause for concern. While some respirable particles are produced directly, the majority are produced as a result of reactions involving trace gases in the air and have both health and visibility effects. Automobiles, backyard burning and fireplaces are important anthropogenic sources of the emissions leading to the presence of high levels of respirable particles in the atmosphere.

One of the more challenging aspects of Continental Pollutant Pathways is our limited ability to predict unplanned and unexpected accidents and natural disasters. Volcano eruptions, earth quakes and a major industrial accident cannot be predicted in advance, but they can result in the release and rapid dispersal of pollutants over long distances . The example we have used is the Chernobyl accident where - within a matter of two weeks - radioactive material was distributed over the globe. There is a growing recognition that natural disasters including floods droughts, hurricanes, tornadoes and tsunamis as well as major industrial accidents can lead to major unanticipated environmental impacts. The release and subsequent long-distance transport of pollutants, as a result of such occurrences, is a matter of concern.. Joint contingency plans for coping with major natural hazards and accidents are warranted.

F2: Overview of Recommendations

The Panel's recommendations are grouped under four themes or categories: a) Purpose and Principles, 2) Improving and Communicating Understanding, 3) Policy and Management Opportunities, and 4) "Institution Building".

The **"Purpose and Principles"** grouping reflects the "direction" that we see as being appropriate for addressing the many challenges involved in influencing/managing human activity so as to prevent or reduce the risks of exposure of humans and the environment to pollutants released to, formed within, or transported by, the atmosphere. The Panel believes that a clear and unambiguous signal from governments would help to stimulate the development and application of practices and technologies to reduce these risks. Formal trinational recognition of the importance of this issue as well as a clear resolve to collaborate in actively addressing it would be an appropriate signal. The Panel suggests that a trinational statement, perhaps building on, and similar to, Resolution #95-5 on "Sound Management of Chemicals" or as an amendment to that resolution would be an appropriate means of setting the stage for effective collaborative continental action in this important area.

The second category on **"Improving and Communicating Understanding"** is a broad group encompassing the gathering, managing and interpretation of data, the communication of information and understanding with others, and building and maintaining the expertise and National Capacity needed to effectively understand and manage the many issues pertinent to the "Continental Pollutant Pathways Initiative". The Panel recognizes that scientific uncertainty will always exist but that the weight of scientific evidence clearly points to the need to prevent and reduce the exposure of humans and the environment to pollutants released to, formed within or transported by the atmosphere. **Enough is already known on most fronts for us to say, unequivocally, that significant emission reductions from present levels are needed now!** All three jurisdictions need to assign much hugger priority to that task, with a clear focus on emissions from the power sector and from the transportation sector, particularly the automobile.

There are clearly instances where carefully planned monitoring and targeted research are needed to develop more precise predictions of the benefits of emission reductions and to provide status and trends information as a basis for assessing the effectiveness of control programs. There remains a clear need to develop better emission inventories for pollutants of concern and for the integrated monitoring of atmospheric deposition on as well as additional targeted research on the effects of atmospherically transported pollutants on receiving ecosystems.

Mercury is a good example. First, and perhaps most importantly, recent developments (in the last decade) in the analytical measurement of mercury in the environment now make it possible for researchers to reliably measure minute quantities of mercury in all environmental media. The group preparing the mercury case study found that mercury does increase in sediments downwind of atmospheric sources, that reduction in atmospheric sources results in reduction in the downwind deposition of mercury, and that reduction of point source discharges to aquatic ecosystems results in reduced mercury concentrations in biota. While agreeing that the link between atmospherically deposited mercury and the concentrations of mercury in biota in the receiving ecosystem is less well defined the mercury group would nevertheless expect that reduction of atmospherically deposited mercury would lead to reductions in mercury concentrations in biota and that therefore emissions should be reduced.

The need for more information on the spatial distribution of atmospherically deposited mercury on the North American continent is clear and as more information becomes available it will provide an important quantitative baseline for comparison with emission sources and lead to important new insights as to the geographic scope of the problem. Also such a baseline would be invaluable in assessing and predicting the trends in mercury deposition that one would expect under different emission and deposition scenarios. Such a baseline, when considered together with emission data, provides a better basis for assessing the extent and significance of current anthropogenic emissions relative to other sources. Targeted research to refine estimates of the relative contribution of atmospherically deposited mercury to receiving ecosystems, the availability of this atmospherically transported fraction to methylating bacteria and the subsequent uptake of methyl mercury through the food chain would also lead to better predictions of the effects of emission reductions on the eventual exposure to humans as a result of the consumption of fish. The group also saw a need for additional targeted research to assess the long-term health effects of consuming fish that contain elevated levels of mercury.

In the third category, on **"policy and management opportunities,"** The Panel saw the need for an ecosystem approach for addressing Continental Pollutant Pathways and recognized the importance of pollution prevention. It also saw a continuing need to incorporate the most up-to-date scientific understanding into relevant policy and management decision-making. The case example on "Pollution prevention and increased regional competitiveness through technological innovation" provides a strong argument linking these aspects to governmental resolve. Pollution prevention could receive much higher priority - now. Action that can begin now. The Panel is convinced that there is ample evidence that collaborative binational and multinational institutions and actions will be increasingly needed to address large scale environmental issues such as that of "Continental Pollutant Pathways". The Panel is also firmly convinced of the need for the three countries to work together in addressing Continental Pollutant Pathways and encourages additional joint planning and programs. The North American Agreement on Environmental Cooperation and the CEC provide one important means of furthering cooperative initiatives among the three countries.

The last category on **"Institution Building"** is, in the opinion of the Panel extremely important and that continuing trinational institutions and fora are needed to bring the issue to the attention of governments and the public. It suggests a number of continuing or new initiatives that the three countries might jointly create or undertake to provide a continuing focus for collective action on both continental and global pollution matters. In particular it suggests that a North American Working Group made up of research managers and other experts involved in the measurement, monitoring, modeling, research and assessment of pollutants in the environment is needed and urges that such a body be established. Such a group would be invaluable as an advisor on environmental priorities, could play a lead role in promoting and establishing a continental environmental information system, and could serve as a focal point for the development and coordination of joint monitoring and research projects

F3: RECOMMENDATIONS

F3.1: Purpose and Principles

The North American Expert Advisory Panel on Continental Pollutant Pathways recommends to the Secretariat of the Commission for Environmental Cooperation that the Secretariat suggest to the Council of the Commission that:

1. the Parties to the North American Agreement on Environmental Cooperation formally recognize that there are major health and environmental problems already being caused by the continental transfer of pollutants from one location to another and that additional action by each Party to reduce emissions should be pursued vigorously and without delay;

2. the Parties to the North American Agreement on Environmental Cooperation formally recognize the importance of working together to prevent and reduce the exposure of humans and the environment to pollutants released to, formed within or transported by the atmosphere;

3. the Parties to the North American Agreement on Environmental Cooperation formally recognize the complex systemic nature of Continental Pollutant Pathways and that they intend to adopt a comprehensive ecosystem approach in planning and implementing programs, practices and technologies to prevent and reduce the exposure of humans and the environment to pollutants released to, formed within or transported by the atmosphere.

4. the Parties to the North American Agreement on Environmental Cooperation formally undertake to make a major collaborative effort to develop and implement programs, practices and technology to enhance understanding of continental pollutant pathways and to prevent and reduce the exposure of humans and the environment to pollutants released to, formed within, or transported by the atmosphere;

5. the Parties to the North American Agreement on Environmental Cooperation formally agree to work together towards the adoption of coordinated ambient air quality objectives, agreed-upon maximum loadings of pollutants to target ecosystems, and to develop and implement joint programs and other measures to prevent, control or reduce the exposure of humans and the environment to pollutants released to, formed within or transported by the atmosphere;

6. the Parties to the North American Agreement on Environmental Cooperation formally agree that when developing national air quality standards and other regulatory requirements that these will, to the extent reasonably possible, be consistent with the achievement of coordinated air quality objectives that are adopted by the Parties;

7. the Parties to the North American Agreement on Environmental Cooperation adopt a "no regrets" approach when choosing between alternate policy and management actions for limiting the exposure of humans and the Environment to pollutants. Furthermore it is suggested that the Parties to above Agreement build upon Principle 15 of the *"1992 Rio Declaration"* which states that: *"In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific evidence shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation";*

8. the Parties to the North American Agreement on Environmental Cooperation develop a framework agreement, perhaps in the form of a resolution of the Council of the Commission for Environmental Cooperation, to prevent and reduce the exposure to humans and the environment to pollutants released to, formed within or transported by the Atmosphere which builds on *Council Resolutions 95-5 Sound Management of Chemicals, Council Resolution 96-5 Ensuring Data Quality on Air Quality and Emissions* as well as upon other existing bilateral and multilateral commitments related to the sound management of chemicals or the long range transport of atmospheric pollutants to which at least two of the *North American Agreement on Environmental Cooperation* are Party.

Council Resolution #95-5 provides a trinational framework for addressing the many issues associated with the Sound Management of Chemicals, and establishes a Working Group to work with the CEC in implementing the resolution including the development of regional action plans for specific chemicals. The four North American Regional Action Plans (NARAPs) now developed or under development are for PCBs, DDT, chlordane and mercury which are all substances that are relevant from a continental pollutant pathways perspective.

F3.2: Improving and Communicating Understanding

The North American Expert Advisory Panel on Continental Pollutant Pathways recommends to the Secretariat of the Commission for Environmental Cooperation that the Secretariat suggest to the Council of the Commission that:

9. the Parties to the North American Agreement, through their respective agencies responsible for the funding and conduct of activities addressing the measurement, monitoring, modeling, research and assessment of continental pollutant pathways, use their best efforts to:

a. develop and recommend, with respect to priority pollutants subject to long range transport through the atmosphere, coordinated ambient air quality objectives, maximum agreed-upon loadings of certain pollutants to target ecosystems, agreed upon parameters to be selected as indicators of the status of target ecosystems and their components (including as appropriate samples of fluxes and concentrations within and between air, water, biota and humans) as well as sampling protocols and procedures for assuring the quality of data;

b. develop and recommend, with respect to priority pollutants subject to long range transport through environmental media, coordinated environmental quality objectives for water, and for wild flora and fauna used for human food;

c. develop and recommend, with respect to priority pollutants subject to long range transport through environmental media, maximum acceptable concentrations in human tissue, and maximum acceptable exposure levels for humans;

d. establish integrated reference monitoring sites combining measurement, monitoring, modeling, research and assessment functions building upon existing sites and national, binational and international networks already in place for monitoring the pathways and concentrations of pollutants released to, formed within or transported by the atmosphere in order to i) provide a basis for establishing the status and trends in the deposition of pollutants and the accumulation in ecosystem components, ii) provide a basis for assessing the success of programs, practices and technologies for preventing and releasing the exposure of humans and the environment to these pollutants and iii) provide a basis for predicting the impacts of alternate policy and management measures on the exposure of humans and the environment to continental pollutant pathways;

e. with respect to the integrated reference monitoring sites that every reasonable effort be taken to address the integrative cross-media aspects of pollutant pathways and that indictors of human health and well-being be incorporated in the design of such integrative reference monitoring sites;

f. develop and implement joint targeted research programs to address key uncertainties concerning the natural and anthropogenic sources, transport, deposition, receptors and effects of pollutants released to, formed within, or transported by the atmosphere and in so doing consider ways and means of promoting integrated, interdisciplinary 'ecoresearch' encompassing the social, natural and medical sciences. for example the national granting bodies that fund academic research in the social, natural and medical social sciences may be able to work together to find ways and means of encouraging such interdisciplinary ecoresearch;

g. actively promote and facilitate the transfer of pollution prevention and pollution control technologies;

h. actively promote and foster scientific and technical exchange programs so as to increase the scientific and technical capacity to assess continental pollutant pathways;

i. actively encourage the development of programs to communicate and interpret the results of research, monitoring and assessment programs in ways that meet the needs of particular users of this information.

F3.3: Policy and Management Opportunities

The North American Expert Panel on Continental Pollutant Pathways recommends to the Secretariat of the Commission for Environmental Cooperation that the Secretariat suggest to the Council that:

10. the Parties to the North American Agreement on Environmental Cooperation, through their respective agencies that are responsible for preventing and reducing the exposure of humans and the environment to pollutants released to, formed within or transported by the atmosphere, be encouraged to increase their national and joint efforts to prevent and reduce the exposure of humans and the environment to such pollutants and that in so doing they:

a. adopt a holistic ecosystem approach in planning pollution prevention and pollution reduction programs and practices to address the many cross-media, cross-disciplinary dimensions of the continental pollutant pathways issue;

b. plan and design such programs and practices to include mechanisms for review and revision in response to new circumstances and new understanding;

c. plan and design such programs and with due regard to sustainable development and inter-regional and inter-generational equity considerations;

d. consider vulnerable populations, including vulnerable life stages, in the planning and development of programs and practices;

e. develop programs to encourage technological innovation to reduce the exposure of humans and the environment to pollutants emitted to, formed within, transported by environmental media;

f. use existing national, binational and international mechanisms and, if necessary, new joint mechanisms to build national capacity to address continental pollutants, and where new and additional funds are required to work collaboratively to obtain the necessary funds;

g. agree that joint trinational initiatives will not, under any circumstances, relax commitments that the Parties have made in other multinational or binational agreements;

h. actively develop joint or collaborative initiatives concerning continental pollutant pathways including the development of joint contingency plans to address unplanned developments including those that could arise a result of unplanned releases of pollutants to the environment arising because of accidents or natural disasters.

F3.4: <u>Institution Building</u>

A Framework Agreement or Council Resolution, hereinafter referred to as the Resolution, along the lines of that proposed in Recommendation #8 is needed to provide a continuing overall framework for addressing the many interwoven facets associate with pollutants that are released to, formed within or transported by the atmosphere. This Resolution should:

11. establish a trinational Working Group of research managers and other experts familiar with the measurement, monitoring, modeling, research and assessment of pollutants in the environment to work with the CEC to implement the decisions and commitments agreed to in the Resolution with specific responsibility for:

a. planning and implementing an overall trinational strategy for the integrated monitoring and assessment of continental pollutant pathways with respect to pollutants released to, formed within or transported by the atmosphere. In developing the strategy as well as specific projects the Working Group shall collaborate with existing initiatives such as the initiatives resulting from Council Resolution 95-5 (Sound Management of Chemicals), Council resolution #96-5 (Ensuring Data Quality on Air Quality and Emissions), the Arctic Environmental Monitoring and Assessment Program of the Arctic Environmental Protection Strategy, the Integrated atmospheric Deposition Network of the Great Lakes and other appropriate international, binational and national monitoring and assessment programs;

b. recommend, within one year, the selection of an initial set of trinational integrated reference monitoring sites in North America together with a set of core parameters and sampling protocols to be followed at integrated monitoring sites. At a minimum the pollutants monitored should include all chemicals for which North American Regional Action Plans (NARAPs) have been, or are being developed under Council Resolution #95-5 as well as all pollutants selected as case examples in this report of the North American Expert Panel on Continental Pollutant Pathways;

c. commit to an annual trinational forum of experts, to review and assess the status, trends and current understanding of continental pollutant pathways and to consider progress being made with respect to preventing and/or reducing the exposure of humans and the environment to pollutants released to, formed within or transported by the environment;

d. address and report on specific matters, as requested by the Council of the Commission for environmental Cooperation concerning any or all matters contained within the scope of the Resolution referred to under Recommendation #8.

e. submit a written report, no less frequently than biennially, to the Council of the Commission for Environmental Cooperation on pollutants released to, formed within or transported by the atmosphere.

ANNEXES

ANNEX 1: RESOLUTION #95-5

Oaxaca, October 13, 1995

<u>COUNCIL RESOLUTION # 95-5</u>

Sound Management of Chemicals

THE COUNCIL:

RECOGNIZING that the territories of the Parties comprise shared regional ecosystems in which the land, air, water, flora and fauna are linked and interdependent;

RECOGNIZING that transport of toxic substances across national boundaries is a major and shared concern;

NOTING WITH CONCERN that certain persistent toxic substances bioaccumulate in living organisms and have been associated with immune system dysfunction, reproductive deficits, developmental abnormalities, neurobehaviorial impairment and cancer, as well as acutely toxic and other harmful effects on human, plant, and animal health and the environment;

NOTING FURTHER that some of these harmful effects are irreversible and that remedial measures to improve degraded environments and treat pollution-associated diseases even when feasible can often place considerable strain on local, regional and national economies;

RECOGNIZING the need to assess and develop strategies for addressing new and existing chemicals in North America, throughout their life cycles, to reduce and prevent adverse effects to human health and the environment;

RECOGNIZING the important contributions that producers and/or users can make to the sound management of chemicals;

REAFFIRMING the Parties' commitment to the sound management of chemicals, as stated in *Agenda 21* and adopted at the *1992 United Nations Conference on Environment and Development*;

REAFFIRMING the Principles of the *1992 Rio Declaration*, noting in particular those Principles that have special importance for the promotion of chemical safety, including:

Principle 14, *States should effectively cooperate to discourage or prevent the relocation and transfer to other States of any activities and substances that cause severe degradation or are* *found to be harmful to human health*; and

Principle 15, *In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific evidence shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation;*

RECOGNIZING that the Intergovernmental Forum on Chemical Safety has recommended that regional cooperation and information exchange networks should be established in all regions as soon as possible;

FURTHER RECOGNIZING that this resolution should build upon existing bilateral and multilateral commitments related to the sound management of chemicals, to which at least two of the *North American Agreement on Environmental Cooperation* (NAAEC) countries are Party, including, for example, the commitments made in Article II (a) of *the Great Lakes Water Quality Agreement of 1978* (Canada-United States of America) that, *"The discharge of toxic substances in toxic amounts be prohibited and the discharge of any or all persistent toxic substances be virtually eliminated"*;

ACKNOWLEDGING the responsibility of the Council, under Article 10(5)(b) of the NAAEC to promote and, as appropriate, develop recommendations regarding appropriate limits for specific pollutants, taking into account differences in ecosystems and other responsibilities for the sound management of chemicals included under other relevant provisions of the NAAEC;

FURTHER ACKNOWLEDGING Article 10(3) of the NAAEC, which calls upon the Council to strengthen cooperation on the development and continuing improvement of environmental laws and regulations, including by: *"(a) promoting the exchange of information on criteria and methodologies used in establishing domestic environmental standards; and (b) without reducing levels of environmental protection, establishing a process for developing recommendations on greater compatibility of environmental technical regulations, standards and conformity assessment procedures in a manner consistent with the NAFTA";*

COGNIZANT of the need to consider the unique circumstances of NAFTA Partner economies and ecosystems and to develop regional approaches for the sound management of chemicals, particularly to reduce the risks posed by persistent, toxic substances of mutual concern;

CONCLUDING that prevention of pollution and reduction of risk through cooperative actions for the sound management of chemicals, particularly of persistent, toxic substances, is both desirable and imperative in order to protect and improve the environment of North America;

COMMITS to regional cooperation for the sound management, throughout their life cycles, of the full range of chemical substances of mutual concern including by pollution prevention, source reduction and pollution control;

DECIDES to give priority to the management and control of substances of mutual concern that are persistent and toxic beginning with the development of a regional action plan for the management and control of polychlorinated biphenyls (PCBs). Regional action plans will also be developed for a short list of three additional substances selected from among a group of substances, including the 12 persistent bioaccumulative organic chemicals identified in the recent United Nations Environment Programme Governing Council Decision 18/32 of May 1995 (see Annex I to this resolution) and certain heavy metals;

FURTHER DECIDES that regional action plans for such substances of mutual concern be developed as specified below, taking into consideration different national approaches and timetables for the sound management of chemicals in a manner that respects the different economic, political and regulatory circumstances of the Parties.

HEREBY ESTABLISHES a working group comprised of two senior officials selected by each Party whose duties pertain to the regulation or management of toxic substances, and who shall work with the Commission for Environmental Cooperation (CEC) to implement the decisions and commitments set out in this Resolution, including development of:

1. a regional action plan for the management and control of PCBs;
2. criteria for identifying additional persistent and toxic substances for regional action by November 15, 1995;
3. a regional seminar to be held in December 1995 in Mexico for discussion of ongoing actions and experiences on the matter;
4. a short list of three priority persistent and toxic substances in addition to PCBs to be developed by January 15, 1996, for which regional action plans will be prepared;
5. regional action plans covering each of the persistent and toxic substances on this short list to be submitted to the Council for approval by December 15, 1996; and
6. refined criteria for identifying persistent and toxic substances for regional action, an updated short list, and recommendations on other persistent and toxic substances to be the subject of action plans on an annual basis, beginning in 1996.

DIRECTS the working group, in addressing the above-mentioned decisions and commitments, to:

a) develop recommendations for improving the capacity for monitoring, research and information sharing with respect to the sound management of chemicals;

Annex 1 to the Council Resolution #95-5 on Sound Management of Chemicals

List of 12 persistent organic pollutants identified in the United Nations Environment Programme Governing Council Decision 18/32 of May 1995:

1. PCBs
2. dioxins
3. furans
4. aldrin
5. dieldrin
6. DDT
7. endrin
8. chlordane
9. hexachlorobenzene
10. mirex
11. toxaphene
12. heptachlor

ANNEX 2: RESOLUTION #96-5

Toronto, August 2nd, 1996

COUNCIL RESOLUTION: #96-05

Ensuring Data Compatibility on Air Quality and Emissions

THE COUNCIL:

REAFFIRMING the importance of the objectives of the North American Agreement on Environmental Cooperation (NAAEC);

DETERMINED to take action pursuant to Article 10(2)(a) of the NAAEC which provides that the Council may consider and develop recommendations regarding: "comparability of techniques and methodologies for data gathering and analysis, data management and electronic data communications on matters covered by this Agreement";

TAKING INTO ACCOUNT Article 7 of the *Agreement Between the Government of Canada and the Government of the United States of America on Air Quality,* which provides that the Parties agree to exchange information on monitoring, emissions, technologies, measures and mechanisms for controlling emissions, atmospheric processes and effects of air pollutants;

ALSO TAKING INTO ACCOUNT the *Agreement Between the Government of the United States of America and the Government of the United Mexican States on Cooperation for the Protection and Improvement of the Environment in the Border Area*, and other subsequent bilateral activities pursuant to this Agreement;

BUILDING UPON activities under existing agreements by focusing on the compatibility of methodologies for data collection and analysis;

CONVINCED of the importance of reliable and relevant environmental data to assist the Parties and others in taking informed and responsible actions pursuant to the NAAEC and other bilateral or multilateral agreements;

AFFIRMING that compatible methodologies and data are necessary for an accurate representation of North American air quality and emissions;

ACKNOWLEDGING that equivalent air quality data provide a consistent basis for determination of compliance with applicable standards and objectives;

CONSCIOUS that different air quality standards and objectives lead to different public perceptions of air quality;

ACKNOWLEDGING that compatible methodologies and data assist in more accurate modeling and transboundary impact assessment;

STRESSING the importance that Parties retain equivalent reference programs and/or laboratories for standards and measurements, which are necessary to assure data comparability;

RECOGNIZING that consistent environmental monitoring site specifications and documentation are essential to ensure compatibility;

CONSCIOUS that relative data biases between sampling networks are readily identified by implementing a joint comprehensive quality assurance and quality control program;

SUPPORTING the commitment of the Parties in their bilateral agreements to assure comparable and compatible methodologies and data quality control for air emissions and meteorological information;

HEREBY:

AGREES to promote regional cooperation among the Parties for the development of air quality monitoring, modeling and assessment programs in North America through the promotion, collection, and exchange of appropriate data, and the development and application of appropriate models for the range of chemical substances of mutual concern as defined by the Commission for Environmental Cooperation; and

RECOMMENDS that the Parties work toward adopting compatible methodologies for compiling and reporting emissions inventories;

ENCOURAGES the Parties to maintain programs and/or laboratories that provide reference materials and develop reference methods to ensure compatible data;

RECOMMENDS the joint placement and joint calibration, when each are appropriate, of monitoring equipment at mutually-agreed upon sites, as resources become available, with mutually-agreed upon protocols and schedules, in order to ascertain data compatibility with respect to monitoring and modeling of mutually-agreed upon substances.

APPROVED BY THE COUNCIL:

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Government of the United States of America

(S) Julia Carabias

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(S) Sergio Marchi

____

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ANNEX 3: TERMS OF REFERENCE

November 14, 1996

Terms of Reference

North American Expert Advisory Panel on Continental Pollutant Pathways

(1) The North American Expert Advisory Panel on Continental Pollutant Pathways, hereinafter referred to as the Expert Advisory Panel or as the Panel, was established by the Secretariat of the Commission for Environmental Cooperation to provide the Secretariat of the CEC with an overall assessment of the general nature, extent and significance of pollutant pathways to, from and within North American. The Expert Advisory Panel shall in developing this assessment take into account other international, regional and national initiatives that are pertinent to this initiative. The Expert Advisory Panel shall:

a) Provide a general overview of the major health and environmental issues associated with Continental Pollutant Pathways.

b) Provide a general overview of the pathways by which different "classes" of airborne pollutants are moved to, from and within North America, together with an assessment of relative significance of different pathways.

c) Provide a general overview of the major pathways or "regions of influence" for source and receptor regions of airborne pollutants in North America;

d) Provide a general overview of the pathways, including food chain pathways, followed by different "classes" of airborne pollutants after these pollutants are deposited on terrestrial and/or aquatic ecosystems;

e) Provide an overview of the major international, regional, and national initiatives pertinent to the work of the Panel;

f) Provide an overview of the primary technological and analytical methodologies currently used in studying continental pollutant pathways and provide an indication of whether emerging methodologies are likely to lead to significant advances in our understanding of continental pollutant pathways;

g) Provide a sense of the level of confidence that members of the Expert Advisory Panel have in the general overviews developed in response to items 1a, 1b, 1c, and 1d above;

h) Provide an assessment of the major gaps in understanding of continental pollutant pathways and advise the CEC Secretariat as to whether existing monitoring, modeling, and research initiatives are likely to contribute significantly to addressing these gaps;

i) Identify opportunities for targeted coordinated monitoring, modeling and research initiatives to address major gaps in understanding of continental pollutant pathways;

j) Provide, in accordance with the schedule outlined in paragraph 8, reports to the Secretariat of the Commission for Environmental Cooperation covering the items outlined in this paragraph and such other items as the Expert Advisory Panel considers appropriate.

(2) The Expert Advisory Panel shall convene on or before December 20, 1996 to consider the tasks assigned to it and shall develop a draft work plan outlining the approach, timing and associated costs of work to be carried out by, or under the direction of, the Expert Advisory Panel.

(3) The Secretariat of the Commission for Environmental Cooperation, shall within the limits of its capabilities, endeavor to provide technical, administrative, translation and financial support to the work of the Expert Advisory Panel, including work carried out by consultants and others working under its general direction. In the event that the Panel identifies resource requirements in excess of those anticipated by the Secretariat, the Secretariat shall make every effort to obtain the resources required to meet these unanticipated needs so identified.

(4) The membership of the Expert Advisory Panel shall consist of approximately 12 persons made up of scientists and other experts from Mexico, the United States and Canada with expertise relevant to the tasks assigned to the Panel. In selecting members to serve on this Panel every effort will be made to balance the disciplinary expertise and experience of the Panel members while at the same time seeking a "nationally balanced" membership from the three countries. The Panel shall have three co-chairs, one from Mexico, one from the United states and one from Canada.

(5) The Panel may in the course of its work establish subgroups made up of its members and, in consultation with the Secretariat, other experts as required to assist in its work. Members are encouraged to draw on expertise, information and support from within their respective agencies and institutions, however, in carrying out the work of the Panel, the members are requested to serve in a personal and professional capacity and not as representatives of their governments, agencies or institutions.

(6) The Expert Advisory Panel shall strive for consensus in the decisions that it makes during the course of its work and if consensus cannot be reached on substantive matters then the Panel shall make provision for minority views to be communicated to the Secretariat including, if the Panel considers it appropriate, the inclusion of minority statement(s) in the reports that it provides to the Secretariat of the Commission for Environmental Cooperation.

(7) The Expert Advisory Panel, or its co-chairs, shall meet with the Secretariat by mid February 1997 to discuss progress and preliminary findings;

(8) The Expert Advisory Panel shall forward an interim draft report to the Secretariat on or before March 3, 1997 and it shall forward its final report to the Secretariat on or before May 1, 1997. The Panel report shall, subsequently, be forwarded by the Secretariat to the Council of the Commission for Environmental Cooperation, probably in conjunction with, or as part of, the Secretariat's Article 13 report to the Council. Each report and all drafts of the report are to include page headers that clearly indicate the status of the report.

(9) The Expert Advisory Panel, or its spokespersons, may be asked by the Secretariat to brief the Secretariat on its report and it may be called upon to assist the Secretariat in preparing the Secretariat's Article 13 Report to the Council of the Commission for Environmental Cooperation.

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