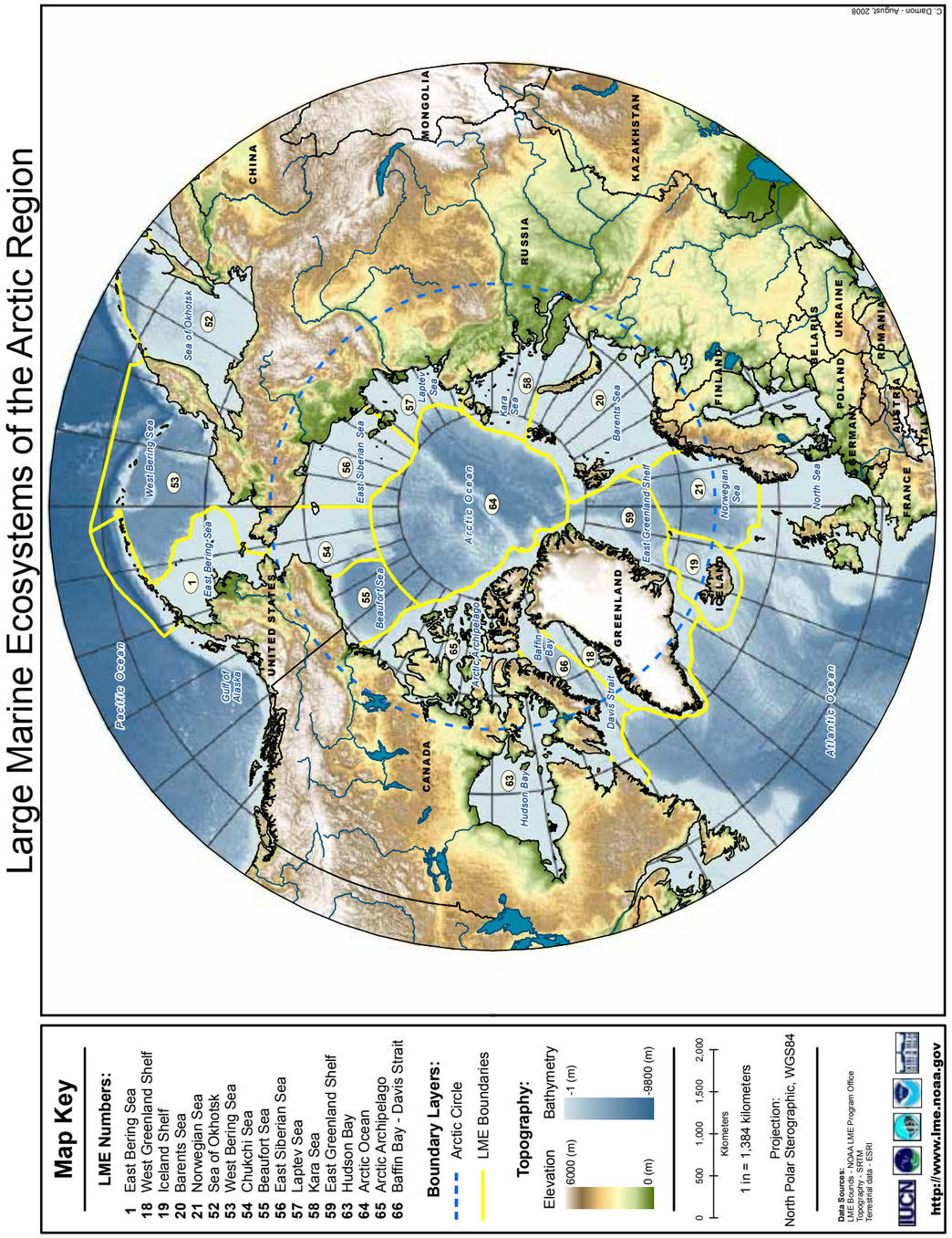
PAME
Protection of the Arctic Marine Environment

ARCTIC COUNCIL

Arctic Council

Regional Programme of Action for the Protection of the Arctic Marine Environment from Land-based Activities



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Front and back Cover: Panorama shot of town with two ships in water, by Martin Fortier (ArcticNet)
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FOREWORD

In the Iqaluit Declaration, dated September 18, 1998, Arctic Council Ministers adopted the *Regional Programme of Action for the Protection of the Arctic Marine Environment from Land-based Activities (RPA)*. The RPA is a dynamic programme of action that uses a step-wise approach for its development and implementation. It is the regional extension of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA). The GPA is designed to be a source of conceptual and practical guidance to be drawn upon by regional and national authorities in devising and implementing sustained action to prevent, reduce, control and eliminate marine degradation from land-based activities. This is to be done within the framework of integrated management of coastal zones and, where appropriate, their associated watersheds.[1]

Since the Iqaluit Declaration, there have been many developments that affect the RPA, several of which have arisen from Arctic Council activities. For example, the Arctic Climate Impact Assessment (ACIA) has led to an awareness of the vulnerability of the northern environment to the effects of climate change. The Arctic Human Development Report (AHDR) stressed the importance of maintaining environmental quality as an element of a more stable and sustainable Arctic economy. The Arctic Monitoring and Assessment Programme (AMAP) Working Group conducted further Arctic environmental assessments in 1998 and 2002 related to heavy metals, radioactivity, hydrocarbons, human health and changing pathways in light of climate change. The Russian National Programme of Action (Russian NPA – Arctic) has also made progress in its work since its approval in 2001. Finally, the Arctic Marine Strategic Plan developed by the Protection of the Arctic Marine Environment (PAME) Working Group was endorsed by the Arctic Council Ministers in 2004. This strategic plan provides a framework for the protection of the Arctic marine environment, in which the RPA is an essential component.

Other important developments that have affected the RPA include intergovernmental actions outside the Arctic Council, such as the United Nations Economic Commission for Europe (UNECE) Long-Range Transboundary Air Pollution (LRTAP) Protocols on Persistent Organic Pollutants (POPs) and Heavy Metals, both of which came into force in late 2003, as well as the Stockholm Convention on Persistent Organic Pollutants (POPs), which came into force in 2004.

In addressing both existing and emerging challenges in a more efficient way, the Arctic Council adopted the Arctic Marine Strategic Plan in 2004, which promotes the application of integrated ecosystem-based approaches. This is consistent with the GPA, which promotes the links between fresh water management and the management of coastal and large marine ecosystems.[2]

In the context of the above and other related changes, Arctic Council Ministers, in their Salekhard Declaration of October 26, 2006:

> *Request PAME to review, update and expand the Regional Program of Action, where necessary, and possibly restructure it to allow for more rapid response to developments and opportunities,*
>
> *Recognize the importance of National Programs of Actions as components of the RPA implementation phase, and note the progress in the implementation of the Russian NPA - Arctic.*

The RPA recognizes the continually evolving situation in the Arctic environment and the need for an integrated approach using the experience and knowledge of all the Arctic Council Working Groups. In particular, AMAP will be invaluable in assessing and monitoring environmental changes. Concern over habitat damage and destruction is a shared responsibility with the Conservation of Arctic Flora and Fauna (CAFF) Working Group. Dealing with the prevention, preparedness and response to environmental emergencies from human activities and natural disasters is a related mandate of the Emergency Prevention, Preparedness and Response (EPPR) Working Group. In addition, the objectives for the RPA complement those of the Sustainable Development Working Group (SDWG) and the Arctic Contaminants Action Programme (ACAP) Working Group.

In collaboration with Arctic Council Working Groups, new developments can be identified on a timely basis and brought forward by PAME to the Arctic Council for its consideration. The RPA will be reviewed and updated as needed to reflect emerging changes in the Arctic and to coincide with the Intergovernmental Review process of the GPA. It is expected that the RPA will remain an important programme for Arctic States to help protect the Arctic marine environment.

1. UNEP (OCA)/LBA/IG.2/7, December 5, 1995.
2. http://www.gpa.unep.org/documents/ecosystem-based_management_english.pdf

1.0 INTRODUCTION

1.1 ***Although the Arctic Ocean has remained relatively clean in relation to other oceans and marginal seas, there is no room for complacency. Combinations of physical and biological mechanisms can focus particular contaminants in certain geographical locations and/or species. Furthermore, geographically localised elevations in contaminant levels in the marine or estuary environment can be attributed to pollution sources within the Arctic basin and coastal zone.***

1.2 Recent information has shown that environmental threats from land-based pollutants within the Arctic have now become apparent:

i. The Polar Regions are extremely sensitive to the global rise in greenhouse gas emissions. Temperature rise affects ice cover, ocean processes, permafrost, and the population and distribution of species. Habitats can be altered or lost, and cultures changed by the disappearance of traditional foods.

ii. Increasing resource industries and shipping activities in the Arctic Region are leading to coastal infrastructure development and demographic changes.

This calls upon Arctic States to work cooperatively, and with industry and communities concerned, to ensure that adequate and compatible national actions are undertaken with increased vigilance.

1.3 Land-based sources of pollution located both within and outside the Arctic, represent the major sources of pollutants to the Arctic marine environment. There is a need for integrated environmental management approaches (e.g. ecosystem-based management and integrated coastal area management) to address land-based sources of pollution at international, regional and national levels, harmonized as appropriate with river basin and offshore management, and land-use planning.

1.4 Indigenous people are closely linked to their environment, particularly through their dependence on traditional foods, which forms the basis of indigenous society, cultures and economies. Because of the consumption of these foods, certain Arctic populations are amongst the most exposed populations in the world to certain environmental contaminants.

1.5 There are also large exports of fisheries products from the Arctic Region to other parts of the world. The economic well-being of many Arctic communities therefore depends on a healthy marine environment. Changes in the ice cover and ocean waters may lead to changes in distribution and availability of fish and the coastal industries they support.

1.6 In the Iqaluit Declaration, dated September 18, 1998, Arctic Council Ministers adopted the Regional Programme of Action for the Protection of the Arctic Marine Environment from Land-based Activities (RPA). They also recognized the important role of the Protection of the Arctic Marine Environment (PAME) Working Group in the implementation and further development of the RPA. The RPA responds to the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA), which recognizes the significance of land-based sources of marine pollution in the circumpolar Arctic.

1.7 Sources and activities that affect the marine and coastal environment necessitate a collaborative approach by the Arctic Council. The RPA builds on existing and planned Arctic Council activities and is intended, in part, to provide a mechanism for improving coordination among them, as well as to identify additional actions needed. The RPA serves as a comprehensive action plan for the Arctic Council's work relating to the protection of the Arctic marine environment from land-based activities. Building on the experience achieved since the 1998 Iqaluit Declaration, this document creates a more responsive and results-oriented programme of action that will further the Arctic Council's objectives and benefit the Arctic environment and its peoples.

1.8 The Arctic States recognize the need to cooperate closely in the implementation of National Programmes of Action (NPA). It is these national efforts that underpin and supply the impetus for regional action.

1.9 The RPA gives due consideration to the suggested GPA assessment and approaches identified at the Second Intergovernmental Review (IGR-2) of the GPA in 2006 and the methodology for preparing programmes of action. Through the GPA, Arctic countries have individually and collectively declared their intention to continue to develop and implement national programmes on the basis of their national priorities and strategies.

1.10 The RPA follows the GPA methodology and includes provisions for:

- identifying and assessing problems;
- establishing of priorities;
- setting management objectives and targets for priority problems;
- identifying, evaluating and selecting strategies and programmes;
- selecting criteria for evaluating the effectiveness of strategies and programmes; and,
- identifying programme support elements and management approaches (e.g. ecosystem-based management).

2.0 GOALS AND OBJECTIVES

2.1 Circumpolar countries have much to gain from coordinated international, regional and national efforts to protect the Arctic marine environment from land-based activities. The RPA makes a significant contribution towards sustainable development and the application of integrated and ecosystem-based management approaches, as demonstrated by its goals, which are set out below.

Figure 1: Goals for RPA Cooperation to Protect the Arctic Marine Environment:

- Protect Human Health;
- Prevent and Reduce Degradation of the Marine Environment and Coastal Areas;
- Remediate Contaminated Areas;
- Support Conservation and Sustainable Use of Marine Resources;
- Maintain Biodiversity;
- Maintain Cultural Diversity;
- Mitigate the Impact of Climate Change;
- Contribute to the Overall Management and Protection of the Arctic Marine Environment;
- Encourage Compatible National Approaches to Activities Related to Land-Based Sources of Marine Pollution;
- Encourage Risk-Management Approaches to Prevent or Mitigate the Impact of Environmental Emergencies; and
- Identify Marine Ecologically Sensitive Areas.

2.2 The objectives of the RPA are to:

- take action individually and jointly, which will lead to the prevention, reduction, control and elimination of pollution in the Arctic marine environment and the protection of its marine habitat;
- respond to the impacts of climate change as they relate to land-based sources of marine pollution in the Arctic;
- identify and assess regional problems from land-based activities;
- establish regional priorities for action as it relates to sources of land-based marine pollution;
- strengthen regional and national capacity building; and
- harmonize, as appropriate, and adjust measures to fit the particular environmental and socio-economic circumstances.

2.3 The RPA recognizes and supports sub-regional and national efforts in the Arctic for the protection of the marine and coastal environment from land-based activities.

3.0 PRINCIPLES AND APPROACHES

3.1 The Arctic Council is committed to sustainable development, which can be facilitated through the use of a number of internationally recognized principles and approaches, including those found in Agenda 21 (1992 Earth Summit), the Rio Declaration, the Convention on Biological Diversity, the World Summit on Sustainable Development Plan of Implementation and the Arctic Council's founding documents. These principles and approaches include, inter alia,:

- adoption of ecosystem-based management;
- application of a precautionary approach as reflected in Principle 15 of the Rio Declaration;
- promotion of the polluter pays principle as reflected in Principle 16 of the Rio Declaration;
- protection of biodiversity;
- use of adaptive management practices;
- use of economic incentives;
- duty not to transfer, directly or indirectly, damage or hazards from one area of the marine environment to another or transform one type of pollution into another;
- duty to co-operate on a regional basis for protection and preservation of the marine environment, taking into account characteristic regional features; including marine ecologically sensitive areas;
- full public consultation and awareness through a transparent process;
- recognition and use of traditional and local knowledge; and,
- other principles and approaches as defined and applied within national contexts.

4.0 IDENTIFICATION AND ASSESSMENT OF PROBLEMS

4.1 The GPA recommends that assessment of land-based activities consider the severity of the problem in relation to:

- food security;
- public health;
- coastal and marine resources;
- ecosystem health; and
- socio-economic benefits, including cultural values.

4.2 In addition, the assessment should consider the affected areas of concern, the sources of degradation, be they point or non-point sources, and, in the case of physical changes, the cause and impacts of those changes.

4.3 Within the last decade, climate change has become a major concern for the Arctic. It deserves special attention as it not only influences the physical, chemical and biological processes occurring in the marine environment that have to be understood, it also creates a dynamic suite of changes that are difficult to predict and understand. Many of these changes to the environment and its ecology have significant social and cultural impacts on northern communities.

Table 1: Qualitative Assessment of Land-based Activities

Activities	Source Within/ Outside Arctic	Persistent Organic Pollutants	Heavy Metals	Physical Alteration and Destruction of Habitats	Radio-nuclides	Petroleum Hydrocarbons	Sewage and Nutrients	Sediment	Litter
Oil and Gas	in out			■		■ ▲ ▲	■	■	■
Mining	in out		■ ■	■	■ ■			■	■
Forestry/ Agriculture	in out	■ ■						■	
Urban Residential	in out	■ ■	■ ■	■		■	■	■	■
Nuclear Activities	in out				■ ■				
Government Facilities	in out	■	▲		■	■	▲		
Industrial and Energy Complexes	in out	■ ■	■ ■			■			■
Ports	in out	■	■	■	▲	■	■	■	■
Recreation and Tourism	in out			■			■		■

LEGEND: ■ existing source of concern to the Arctic marine environment ▲ possible source of concern to the Arctic marine environment
NOTES:
1. Future work of the Arctic Council Working Groups will assist in the future coverage of land-based activities of concern.
2. The Section on Physical Alteration and Destruction of Habitats has been elaborated in collaboration with the Conservation of Arctic Flora and Fauna Working Group.

4.4 An overview of existing and possible sources of concern from land-based activities for the protection of the Arctic marine and coastal environment is presented in Table 1. This table is compiled from a qualitative assessment of the information contained in this chapter.

4.5 There are many sources of information regarding the existing situation and potential threats to the Arctic environment, including, in particular, the assessments produced by the Arctic Monitoring and Assessment Programme (AMAP) Working Group and the Conservation of Arctic Flora and Fauna (CAFF) Working Group.

4.6 The RPA recognizes the need for timely information on inputs, causes, sources and pathways of land-based sources of marine pollution in the Arctic, including persistent organic pollutants (POPs), heavy metals and radionuclides, changes to and destruction of coastal habitat, impacts of climate change, and the risks to the environment from increased northern population and development. The identification of significant sources of pollution from within, and entering from outside of, the Arctic is important and should be continuously monitored and assessed.

4.7 Findings of Arctic Council Working Group reports, taken together with information from other international, regional and national sources, will be used to identify priority areas of concern for the Arctic marine environment from land-based sources of marine pollution. This will ensure that the RPA is kept up-to-date and will assist Arctic States to better understand and predict future risks. The aim is to improve the basis for sustainable development and well-informed decision making on Arctic environmental policies and programmes.

4.8 Arctic States and Permanent Participants of the Arctic Council should work together in the collection and sharing of information and knowledge of benefit to the Arctic environment and its peoples, and encourage other interested governments, non-governmental organizations, industries and institutions to actively participate to the extent possible.

4.9 The sections below summarize the present knowledge with respect to POPs, heavy metals, physical alteration and destruction of habitats, radionuclides, petroleum hydrocarbons, sewage, sediments and litter (including municipal and household solid waste).

4.10 **With respect to POPs and other hazardous substances, the present knowledge indicates that:**

- POPs are of particular concern to human health and the environment as they are toxic, persistent and bioaccumulative, and are subject to long range transport and deposition in remote parts of the world, far from their original sources in more heavily populated regions.
- The consumption of food in which POPs are bioaccumulated is a major factor in contaminant intake. Some indigenous groups are exposed to levels that exceed established tolerable intake levels. Transfer to infants can result in levels in newborns that are significantly higher than in regions further south. Cohort studies have revealed significant correlations between prenatal exposure to polychlorinated biphenyls (PCBs) and subtle, non-clinical effects in Inuit newborns.
- POPs have the potential to interfere with a number of biological systems of wildlife and humans. The effects can include reduced fertility, increased birth abnormalities, metabolic and behavioural abnormalities, and compromised immune systems.
- The majority of POPs found in the Arctic are transported over long distances from sources outside of the region. This includes chemicals such as organochlorine pesticides (e.g. dichloro-diphenyl-trichloroethane [DDT] and hexachlorocyclohexane [HCH]) and their metabolites (e.g. dichloro-diphenyl-dichloroethylene [DDE]), industrial organochlorines (e.g. PCBs) and combustion products (e.g. polychlorinated dibenzo-p-dioxins and dibenzofurans [PCDD/Fs]). Their production and use has been severely curtailed in recent decades through regulations at national and international levels. These POPs are currently regulated under the POPs protocol of the United Nations Economic Commission for Europe (UNECE) Long-Range Transboundary Air Pollution (LRTAP) Convention and the global Stockholm Convention on POPs.
- In the previous AMAP assessment, only limited data were available on toxaphene concentrations in Arctic biota. A great deal more data are now available, showing that toxaphene is widespread throughout the Arctic. In some seal species, toxaphene concentrations are comparable to PCB concentrations. Some whale species, such as beluga and narwhal, also have particularly high toxaphene levels, but only very limited temporal trend data are available.
- While the levels of most POPs in the Arctic appear to be decreasing, the levels of some other hazardous substances have generally been increasing over recent decades. These compounds include brominated and fluorinated fire retardants and surfactants (e.g. polybrominated diphenyl

ether [PBDEs], perfluorooctane sulfonate [PFOS]), chlorinated industrial chemicals (e.g. short-chained chlorinated paraffins [SCCPs], polychlorinated naphtalenes [PCNs]) and current-use pesticides (e.g. endosulfan). Due in large part to the accumulation of Arctic data on levels and trends, most of these compounds are now being considered for addition to the LRTAP and Stockholm Conventions.

- In many Arctic marine mammals and sea birds, concentrations of POPs, particularly PCBs, can still exceed thresholds above which toxic effects are considered to be probable. However, these thresholds were not designed to be predictive of effects in Arctic species and therefore may not be the most accurate predictor of toxic effects. Some studies conducted on Arctic species, such as polar bear and glaucous gulls, have demonstrated a variety of toxic effects related to POPs exposure.

- Climate change has the potential to alter key characteristics of the Arctic environment that influence how POPs are transported and processed in both physical and biological systems. For example, an increase in seasonally ice-free water will increase exchange of POPs between the ocean and the atmosphere, and changes in food web structures will alter energy budgets within the food web and influence biomagnification. Climate related changes in POPs exposure coupled with new environmental stresses have the potential to push marine wildlife to a tipping point beyond which population-level effects might be possible or even expected (e.g. polar bears).

- However, there remains some sources of POPs that are in the Arctic Region, which include active industrial activities and historically contaminated sites. These consist primarily of:

  > Elevated PCB levels in nearshore areas have been detected close to abandoned or existing government installations (e.g., Saglek Bay, Canada; and Thule, Greenland) and around government installations along the Norwegian coast. Similar situations may be expected to occur in other Arctic countries. The majority of these sites have undergone some form of land based remediation (e.g. Saglek), which may have resulted in an improvement in near-shore contamination.

  > High PCB, and aggregate DDT and derivatives in suspended solids in the Ob and Yenisey rivers, as well as HCH levels in water of the Ob and lakes of the Taimyr Peninsula are substantially higher than found in river water of industrialized areas of Europe and North America. The signature of the DDT data indicates recent use. Although both of these observations need further verification, the PCB, DDT and HCH information suggests there are sources in the watersheds and airsheds of these rivers. This general trend is also evident in snow, seawater, coastal sediments, fish, and the few data collected for reindeer, lemming, seabirds, seals and beluga whales.

  > There are industrial complexes using PCBs (e.g. the heavy industry and mining activities on the Kola Peninsula) in the Russian Federation. Elevated PCB levels have been detected in marine sediments close to landfills on Svalbard.

  > Local dioxin/furan contamination has been detected close to a smelter in Kirkenes, Norway.

  > Some of the biggest pulp and paper mills in Europe are situated along the North Dvina, which empties into the White Sea. Little treatment exists on the discharges to air and water, which include quantities of chlorine and mercury. Some of the pulp and paper mills are close to the North Dvina river mouth and are contaminating the river delta and the White Sea (Archangelsk pulp and paper mill in Novodvinsk and Solombola in Archangelsk city), while other mills are further upstream (Kotlas) and are mainly affecting the river. The contamination can be seen clearly in the river sediments and the White Sea.

  - Studies in the Archangelsk area show local contamination with dioxins and furans from pulp mills on the North Dvina and tributaries that extend to the White Sea. However, they are not believed to be major sources to the offshore Arctic Ocean. Drinking water for Archangelsk city is taken one kilometre downstream of the outlet from Archangelsk pulp and paper mill.

4.11 **With respect to heavy metals, the present knowledge indicates that:**

- Attention on heavy metal contamination in the Arctic has historically focused on mercury, cadmium and lead, of which mercury and lead are effectively transported to the Arctic via long-range transport from sources outside of the region, and cadmium to a lesser extent. Concerns related to marine contamination of cadmium and lead have recently diminished, while there is increasing concern over mercury.

- Heavy metals occur in all Arctic marine ecosystems as a result of natural sources and take part in natural geochemical cycling processes. Metal levels in Arctic Ocean water away from local sources are generally similar to background levels. Regional differences in metal burdens in marine mammals for lead and cadmium strongly imply that tissue concentrations depend largely on regional geology and biogeochemistry.

- For the most part, it has been shown that cadmium is derived from natural marine sources and, therefore, is not a widespread pollution issue for the Arctic marine environment. However, monitoring results suggest that cadmium levels in some seabirds are high enough to present a risk of kidney damage and, therefore, further monitoring has been recommended.

- The majority of lead pollution reaching the Arctic was historically derived from the use of leaded gasoline, which in recent decades has been largely phased out. This is reflected in natural contaminant archives, such as glacial ice cores, which demonstrate that levels in the environment have decreased. Lead may still be a pollution issue in areas where lead shot is used for hunting, where it can accumulate in water bodies and wet lands and has toxic effects on fish, birds and wildlife. The use of lead shot also contributes to lead exposure among subsistence hunters. In certain regions of the Arctic where the use of lead shot has been banned, observed levels of lead exposure have decreased (e.g. results of Inuit blood monitoring in Nunavik, in northern Quebec, Canada).

- Mercury is the heavy metal of greatest concern because it accumulates in fish and wildlife and magnifies up the food chain. In the environment, mercury can be transformed to methyl mercury, which is efficiently taken up following consumption and retained very effectively in biological tissues; therefore, posing the main risk. Methyl mercury is a potent neurotoxin that can adversely affect neurological development and function in wildlife and humans at relatively low levels. Concentrations in commonly consumed wild food species can regularly exceed established guidelines for human consumption. Levels of dietary exposure, particularly among Inuit, can exceed levels that concern health authorities (e.g. WHO tolerable daily intake). Cohort studies have revealed significant correlations between pre-natal exposure to mercury and subtle, non-clinical effects in Inuit newborns.

- Widespread contamination of the Arctic marine environment also occurs as a result of anthropogenic activities, in particular from sources in the industrialised regions of Europe, Asia and North America. Emissions from these areas are subject to long-range transport by the atmosphere or ocean currents. This is especially so in the case of mercury, which exhibits characteristics similar to those of POPs. A major source of mercury to the Arctic marine environment will be atmospheric emissions from coal-burning power stations. This source is likely to increase in importance in the future as global energy demand increases. Of the heavy metal contamination in the Arctic, industrial sources outside of the Arctic in Europe and North America account for up to one-third of the deposition, with maximum input in winter.

- A recent assessment of temporal trends in Arctic biota indicated that mercury concentrations in Canada and West Greenland have increased over recent decades, whereas concentrations in East Greenland and the European Arctic have generally decreased over the same period of time.

- Mining and metallurgical industries on the Kola Peninsula and in the Norilsk region are major contributors of metals to the local aquatic environment and elevated metal concentrations in air in these regions. The atmospheric emissions from these sources within the Arctic supplement the atmospheric loading from Eurasian sources further south. Downstream of Norilsk, the lower reaches of the Yenisey River are at global background levels for heavy metals, indicating that Norilsk may not be making a significant contribution to the pollution of the adjacent marine environment.

- Local sources that may impact directly on the marine environment include mines and industrial activities located on or close to the coast. These may have significant local impacts, with heavy metal concentrations exceeding background at distances generally within 30 km of the source.

- River systems can be significant in transporting metals to the marine environment, in particular zinc and, to a lesser extent, cadmium and lead. However, levels away from local sources are generally similar to background levels. The flux of metals to the marine environment depends on the season, characteristics of the river system and distance from the source. Metal-laden sediments transported to the coast by rivers are generally deposited on the shelf seas and only a minor proportion reach the open ocean. Natural sources of metals are important and, in many cases, are found to be the main source to the marine environment.

- Local sources with impacts restricted largely to a local scale also include untreated sewage sludge, which is contaminating the Kola fjord and part of the White Sea from discharges in Murmansk and Archangelsk, respectively.

- Incineration plants, such as those at Murmansk, emit heavy metals (lead, zinc, mercury, cadmium) and other pollutants, largely in particulate form, leading to deposition in the nearby coastal environment.

- Climate change has the potential to alter key characteristics of the Arctic environment that influence how mercury is transported and processed in both physical and biological systems. As was previously mentioned for POPs, an increase in seasonally ice-free water will increase exchange of mercury between the ocean and the atmosphere, and changes in food web structures will alter energy budgets within the food web and influence uptake and biomagnification. Furthermore, a warming of the climate may result in increased release of mercury that is currently bound in natural reservoirs like permafrost and coastal sediments; both of which are undergoing increased degradation and erosion. Climate related changes in mercury exposure coupled with new environmental stresses has the potential to push marine wildlife to a tipping-point beyond which population-level effects might be possible or even expected (e.g. polar bears).

4.12 **With respect to physical alteration and destruction of habitats, the present knowledge indicates that:**

- Prevention of habitat destruction and physical alteration has become a much higher priority due to the increasing effects of climate change and its impact on sea ice and permafrost. Shore erosion presents a particular problem since reduced sea ice diminishes the protection of coasts from storm waves. Additional threats are arising from demographic changes and increasing marine and coastal development.

- Resource use, human development and settlement activities result in physical alteration and destruction of habitats.

- Physical alteration and destruction of habitats is considered a major threat to the preservation of biological diversity on a global scale. In the Arctic, this remains mainly a local concern. Not only can coastal habitat be destroyed, but the anthropogenic noise from shoreline construction and port development can have impacts on marine mammals. Further, if the affected habitats support rare and endangered species or species of circumpolar conservation concern, such physical alteration may have regional or global implications.

- Large numbers of species are gathered in small areas, such as marginal ice zones, leads and polynyas.

- Marine ecosystems support economic and socially important species including seals, murres, guillemots, polar bear, arctic char and others.

4.13 **With respect to radionuclides, the present knowledge indicates that:**

- The Arctic marine environment has been historically contaminated by fallout from nuclear weapons testing and releases from European reprocessing plants. The levels of contamination associated with nuclear weapons testing peaked in earlier decades and have since decreased since to a point where current levels of contamination in the Arctic marine environment are considered low and of minimal environmental risk. Unless contaminated sediments are remobilized, this historical contamination will continue to decrease as sediments are buried and radionuclides decay.

- Discharges of technetium-99 to the marine environment from the fuel reprocessing plant at Sellafield have been decreasing since 1995 and since new contaminant recovery technology was installed in 2004 have dropped substantially. This decrease in the source is reflected in results of monitoring from coastal Norway and the Barents Sea.

- Aside from reprocessing plants and fallout from weapons testing, other sources of radionuclides to the Arctic have been associated primarily with inadequate waste management practices (e.g. ocean dumping) and accidents, such as the crash of a U.S. nuclear bomber at Thule, Greenland in 1962, or Chernobyl in 1986. Although detectable in some areas of the Arctic marine environment, e.g. Chernobyl fallout in the European Arctic, contamination from these sources is generally localized. On an Arctic wide basis, these sources are minor in comparison with past nuclear testing fallout and European reprocessing plant releases.

- On May 17, 2005, the Russian Federation accepted the ban on radionuclide dumping at sea as contained in the amendments to the London Convention 1972 under Resolution LC.51(16).

- Radioactivity issues of relevance to the Arctic marine environment are currently of a potential nature rather than representing health and environmental concerns due to current levels. Due to the significance of the potential risks, several programmes are underway to address the problems. Russia provided most of the information relevant to such potential threats. In this context, the following two groups of potential future environmental contamination from radioactive sources may be identified:

(i) Potential for Accidental Releases of Radioactive Material

- Potential large-scale releases associated with accidents at existing nuclear sites in the Arctic, as well as accidental releases in connection with handling of the nuclear waste produced during normal operation of a nuclear reactor and handling of spent nuclear fuel from nuclear reactors, constitute particular topics of concern..

- Northwest Russia, particularly in the Kola region, contains a high concentration of nuclear-powered vessels and nuclear reactors. Spent fuel from nuclear reactors is highly active and needs special treatment, and is often stored temporarily close to the reactors or bases where the vessels are served to allow the decay of short-lived fission products.

- A new potential radioactivity issue for the Arctic is the construction of small- and medium-sized nuclear power plants. In April 2007, the Sevmash plant in Severodvinsk started construction of the first floating nuclear power plant, the "Academician Lomonosov," scheduled for completion in 2010.

(ii) Possible Future Leakages of Contaminated Radioactive Material and Run-off of Deposited Radioactive Material

- Of 198 decommissioned nuclear submarines in Russia, a total of 164 had been dismantled as of March 2008 while progress was being made on an additional 11. According to Russian plans, the majority of the remaining submarines are to be dismantled by 2010. Additional plans will see the dismantling of nuclear ice-breakers and other nuclear facilities such as the Lepse floating maintenance base. During the dismantling process there are potential radioactive waste management risks that have been identified including those associated with the handling and transport of waste and spent fuel in the Murmansk and Archangelsk districts.

- The facilities at Andreeva Bay and Gremikha are used as temporary storage sites for radioactive wastes, spent fuel, and reactors from decommissioned submarines. Progress has been made in improving the physical infrastructure and the legal arrangements to manage these sites. However, much remains to be done, including transport of spent fuel and waste to safer storage sites.

- Leakage from discarded reactor cores and associated waste constitute potential sources of radioactive contamination of the Arctic Ocean, although such leakages only will be of local significance. Joint Norwegian and Russian monitoring activities in the Barents sea and coastal Norway have shown no signs of leaks from ocean disposal sites, such as those in the Kara Sea, however it is acknowledged that these sites require regular localized monitoring.

- At the Mayak reprocessing plant (next to the Tetcha River, a tributary to the Ob River that empties to the Kara Sea), there are considerable amounts of stored radioactive material found in lakes, reservoirs and river beds, especially close to the reprocessing plant. Assessment of transport by the river system to the Kara Sea concluded that the contribution of Mayak to the radioactive contamination of the Kara Sea has been significantly less than from other sources (e.g., fallout from atmospheric nuclear testing and from Sellafield). However, there remains a potential for further transport of larger amounts of radioactive material from Mayak through the river systems to the Arctic Seas should there be a failure in containment facilities.

- Radioisotopic thermal electric generators (RITEGs), which are used in navigation equipment, present a special problem when their service lives have expired. If handled improperly, they can present a lethal threat of irradiation. At present, the inventorying and replacement of most RITEGs in the western part of the Russian Arctic has been completed, but they remain a problem in the Sakha Republic and Chukchi Autonomous Okrug.

- Some risk reduction has been achieved through significant joint Russian-international action. This includes a regulatory framework for handling the clean-up actions. Moreover, a long-term strategic master plan has been developed, which could become an important tool for further management of radiation risks.

(iii) Climate change and radioactivity

- The current AMAP assessment identifies the potential for climate change to mobilize

radionuclides in the Arctic terrestrial environment and in glaciers. This may also affect radon emission from the ground, which is a major contributor to human exposure to radiation.

- Changes in permafrost, erosion, precipitation and extreme weather events may also affect infrastructure related to nuclear activities.

4.14 **With respect to petroleum hydrocarbons, the present knowledge indicates that:**

- The anticipated increase in hydrocarbon exploration and production in the Arctic may have a major impact on the marine environment. The risks of oil pollution from onshore oil and gas operations are associated with the catastrophic release of oil. The effects of such a release would not be of regional significance, but they could become of sub-regional significance if large amounts of oil were to reach the Arctic marine environment. Severe local and sub-regional problems have occurred recently, associated with the development and transportation of oil and gas.

- Oil pollution from urban settlements, government facilities and industrial complexes is primarily of local rather than regional concern with respect to the marine environment.

- Oil pollution at ports is likewise primarily of local rather than regional concern The severity of this problem is likely to vary in accordance with the volume of ship traffic in the Arctic. With the potential increase in ship traffic associated with expanded oil and gas operations, mining and greater use of the Northern Sea Route, and taking into account the precautionary approach, there is a shared regional interest in addressing this issue.

- Accidental releases are an emerging potential source of oil pollution, for which the extreme environmental conditions and isolated localities in much of the Arctic greatly increase the difficulties of detection and taking remedial measures.

- In relation to sub-regional petroleum hydrocarbon contamination of the Arctic marine environment resulting from land-based activities, the threats are essentially potential in nature and related to possible unintentional releases from existing facilities and future development of oil and gas resources (including related oil transportation infrastructure) in the coastal zone or watersheds of north-flowing rivers. A key feature in evaluating potential threats will be the distance from the marine environment and the characteristics of the relevant riverine environment.

- Coastal erosion is endangering community fuel tanks, waste management tanks and storage tanks; making them vulnerable to impact during coastal storms.

4.15 **With respect to sewage and nutrients, the present knowledge indicates that:**

- The increase in coastal infrastructure due to resource developments and the associated pressures from population increases may cause local problems resulting from sewage. These issues will be compounded by climate change, leading to permafrost loss and coastal area erosion, which will lead to increased drainage of lakes and additional nutrient burdens in river outflows that may impact coastal ecosystems.

- Urban residential settlements that could affect marine waters are either small communities with small quantities of human sewage or urban/ industrial complexes with large quantities of human sewage, often including industrial wastes.

- Sewage disposal is a local concern for virtually all coastal communities in terms of public health and environmental effects because conventional sewage treatment systems often do not work well in the Arctic. Further, coastal erosion is threatening to breach sewage lagoons, which could contaminate marine waters.

4.16 **With respect to sediments, the present knowledge indicates that:**

- Natural sedimentation and siltation are important in the development and maintenance of numerous coastal habitats. Reduction in natural rates of sedimentation can compromise habitat integrity, as can excessive sediment load, which may bury benthic communities and threaten sensitive habitats.

- Contaminated sediments may also lead to pollution. There are elevated levels of contaminants (heavy metals, POPs and ***polycyclic aromatic hydrocarbons*** [PAHs]) associated with some major seaports on the Russian Federation's area of the Arctic coast.

4.17 **With respect to litter, including municipal and household solid waste, the present knowledge indicates that:**

- Litter threatens marine life through entanglement, suffocation and ingestion, and is widely recognized to degrade visual amenities.

- Sources of littler include numerous human activities, and poorly managed or illegal waste dumps.

- Demographic changes related to the increase in economic and social developments in the Arctic may lead to an increase in threats to the marine environment arising from infrastructure development and associated increases in human and industrial wastes.

- Municipal and household solid waste threaten marine life through entanglement, suffocation and ingestion, and is widely recognized to degrade visual amenities.

- Sources of municipal and household solid waste include numerous human activities, and poorly managed or illegal waste dumps.

- Disposal of municipal and household solidwaste is a local concern for virtually all coastal communities because solid waste disposal systems often do not work well in the Arctic due to the cold climate and, in some areas, the presence of permafrost.

5.0 PRIORITIES

5.1 The following criteria are used to establish regional priorities for action:

i. severity of risk (e.g. major sources) with respect to an existing high risk to human health, the environment, or economic and social benefits and uses, including cultural values;

ii. shared problems where there is an existing or potential risk of transboundary pollution effects, ecological changes or habitat degradation; and

iii. common issues where there is existing or potential similarity in local and national problems that would benefit from common approaches.

5.2 Combining these criteria with the current identification and assessment of problems produces the current list of recommended priorities, which is summarized below in Table 2. For example, major sources that present an immediate and concrete threat to the Arctic marine environment are given a high priority (e.g. POPs). Sources that present a potential regional threat are given a medium priority (e.g. radionuclides) and sources that present no immediate regional threat are given a low priority (e.g. litter). Sources that are a combination of shared problems and common issues are given a medium to high priority (e.g. physical degradation and heavy metals, respectively).

5.3 In general, there is concurrence between the identification and assessment of problems presented in Section 4.0 and the information on major sources of Arctic marine contamination provided by the Russian Federation (Appendix 2).

Table 2: Priorities for Regional Action

SOURCE CATEGORIES	PRIORITIES FOR ACTION
Persistent Organic Pollutants	High
Heavy Metals	High
Physical Alteration and Destruction of Habitats	Medium-High
Radionuclides	Medium
Petroleum Hydrocarbons	Medium
Sewage	Low
Nutrients	Low
Sediment	Low
Litter	Low

6.0 SETTING MANAGEMENT OBJECTIVES, STRATEGIES AND MEASURES

6.1 The GPA recommends that wherever possible, Arctic States should take immediate preventive and remedial action using existing knowledge, resources, plans and processes. Appendix 1 provides a summary of the possible recommended activities for each GPA source category, along with a wide range of strategies, measures and management approaches that are generally applicable to the RPA.

6.2 The specific regional management strategies and actions for the priority source categories are intended to complement actions at the national and international levels. Horizontal issues such as information exchange, reports on implementation and effectiveness, technical co-operation and assistance, education and training, public information and secretariat support are addressed in Section 7.0.

6.3 Considerable work has been undertaken nationally, bilaterally and multilaterally to identify the significant sources of pollution in the Arctic and to determine the actions and investments needed to reduce or eliminate pollution. The experience and results of this work continue to support RPA objectives.

6.4 Timely information and the ability to understand and predict future risks are essential to improve the basis for sustainable development and well-informed decision making on Arctic environmental policies and programmes. To that end, Arctic Council Working Groups are encouraged to cooperate to ensure that the RPA is kept up-to-date and that the related existing and potential problems are identified.

Persistent Organic Pollutants

6.5 The most appropriate RPA strategies and actions for meeting the objectives related to POPs would be:

At the international level, Arctic States should:

- Sign and ratify the UNECE LRTAP Protocol on POPs and the Stockholm Convention, and encourage other states to do the same.

- Continue to draw the attention of international financial institutions , of which they are a member, to the global aspects of the POPs issue and, as appropriate, promote the participation of these institutions in financing and partnership arrangements aimed at reducing the adverse effects on human health and the environment.

At the regional level, Arctic States should:

- Take expeditious action to implement measures that are needed to meet obligations under the UNECE LRTAP Protocol on POPs and the Stockholm Convention.

- Distribute information to Arctic communities on POPs pollution, including the geographic distribution and impact of POPs on the Arctic marine environment and human health.

- Consider the need to set dates for phasing out and providing substitutions for certain POPs, in addition to what is required under international agreements.

Heavy Metals

6.6 The most appropriate RPA strategies and actions for meeting the objectives related to heavy metals would be:

At the international level, Arctic States should:

- Sign and ratify the UNECE LRTAP Protocol on Heavy Metals (cadmium, lead and mercury) and encourage other states to do the same.

- Explore and, where needed, cooperate on activities at the global level on mercury reduction.

- Continue to draw the attention of international financial institutions, of which they are a member, to the global aspects of the heavy metals issue and, as appropriate, promote participation of these institutions in financing and partnership arrangements aimed at reducing the adverse effects on human health and the environment.

At the regional level, Arctic States should:

- Take expeditious action to implement measures that are needed to meet obligations under the UNECE LRTAP Protocol on Heavy Metals as soon as possible.

- Exchange information as needed, related to best environmental practices, guidelines and national actions for the opening, operating and closing of mines in the Arctic coastal zone. Mining is defined as the extraction of coal and ore from mines.

- Explore and, where necessary, cooperate on activities, arrangements and monitoring to reduce or eliminate cadmium, lead and mercury pollution in the marine and coastal environment.

Other Significant Sources

6.7 The most appropriate RPA strategies and actions for Arctic Council Member States to take in order to meet the objectives related to all significant regional sources would be:

- Maintain a common inventory of significant sources of POPs, heavy metals, radionuclides and petroleum hydrocarbons.

- Encourage and assist, as appropriate, the continuing implementation of the Russian Federation National Programme of Action for the Protection of the Arctic Marine Environment from Land-based Activities.

- Support collaborative activity needed to monitor, identify and evaluate threats to the Arctic marine environment from land-based activities. Encourage Arctic States to incorporate the approaches endorsed by the GPA on risk-based and ecosystem-based management to improve decision making and strategic directions.

- National land-based sources of marine pollution managers should exchange best practices on national priorities, policies and activities as they relate to a regional approach of dealing with all land-based sources of marine pollution.

- Support directions to Arctic Council Working Groups to pay particular attention to the degradation and loss of coastal and marine habitat, which will come under additional pressures from climate change, and increased resource and demographic impacts.

- Encourage the Arctic Council Working Group Chairs to find appropriate opportunities to discuss the status of the RPA in order to maintain collaboration and exchange of information. This will facilitate the continued implementation and elaboration of the RPA, as well as the close coordination of related national and regional activities.

- Assist Arctic Council Working Groups and their national representatives to cooperate and collaborate on projects related to the effects of climate change on the marine environment, and the physical, chemical and biological impacts that arise.

7.0 PROGRAMME SUPPORT ELEMENTS

In support of the implementation of the RPA, the following administrative and management activities should be undertaken by the appropriate organizations at the international, regional and national levels.

7.1 Information Exchange

Actions for information exchange should include:

- Linking to GPA and related Arctic Council information systems.

- Actively promoting the participation of relevant intergovernmental and international sources of information and expertise.

- Defining user needs and identifying potential information providers.

7.2 Monitoring and Assessment

The AMAP and CAFF Working Groups are responsible for the monitoring and assessment programmes in the Arctic marine environment carried out under the auspices of the Arctic Council. PAME, in close cooperation with AMAP and CAFF, will evaluate threats and recommend priorities related to Arctic marine pollution from land-based activities based on knowledge from all relevant sources.

PAME, in collaboration with Arctic Council Working Groups, will continue to ensure that the results of the evaluation and identification of priority issues are recorded, and the priorities for regional action (Table 2) are adjusted as appropriate.

7.3 Reports on Implementation and Effectiveness

Using GPA criteria for evaluating effectiveness, open and transparent reporting is required and should include:

- Reporting on the implementation of the RPA to Arctic Council Ministers, Senior Arctic Officials (SAOs) and interested intergovernmental bodies (e.g. United Nations Environment Programme, UNECE and Commission on Sustainable Development).

- Developing a reporting procedure and format for the assessment of the RPA implementation and effectiveness in collaboration with other working groups.

- Maintaining meaningful and transparent communication with indigenous people and local residents.

7.4 Technical Co-operation and Assistance

Actions for technical co-operation and assistance should include:

- Encouraging and facilitating co-operation between and among regional organizations, conventions and agreements to promote the exchange of information, experience and expertise.

- Assessing co-operative assistance projects to facilitate coordination and avoid duplication.

- Developing and sharing technology, with due regard to Intellectual Property Rights, methods and information on pollution prevention and control, habitat protection and remediation.

- Developing partnerships for environmental protection and management of the Arctic Region among the Arctic countries, as well as among governmental and non-governmental organizaions, research and academic institutions, organizations representing indigenous people and the general public, international financial institutions, United Nations system, etc.

- Promoting the application of risk assessment/cost-benefit analysis to reinvestment strategies for the priority actions identified, such as the work being done through the Barents Region Environment Programme and the Nordic Environment Finance Corporation (NEFCO).

- Exploring innovative approaches to encourage multilateral financing agencies, including regional development banks and national institutions for bilateral development, to co-operate in programming and project implementation, and to further explore innovative approaches to provide continuing and predictable programme funding for the priority actions identified.

- Collaborating on management strategies, which could include the identification of ecologically, biologically and culturally sensitive areas, as well as the establishment of protected areas within the Arctic marine and coastal zone.

- Encouraging the development and wide distribution of appropriate contingency plans for environmental accidents (particularly those involving oil, gas and chemical spills, and nuclear accidents), taking full account of emergency preparedness guidance and assessments within

the Emergency Preparedness Prevention and Response Working Group and the broader international community.

7.5 Education and Training

Actions for education and training should include:

- Promoting information exchange and training programmes to build capacity in skills (particularly among local residents) to prevent and minimize damage from land-based activities.
- Training and building capacity in areas that facilitate the management of risks, conducting environmental assessments, environmental audits and evaluations, application of contingency plans and integrated coastal zone management.
- Training and building capacity in relation to best available techniques and practices, for example, among people employed in land-based industries.
- Developing education materials on human influence on the Arctic marine environment (within and outside of the Arctic).
- Promoting programmes and activities that raise awareness of threats to and the value of the Arctic marine environment within land-based activities of greatest concern (within and outside of the Arctic).
- Improving management training for conducting environmental audits, introducing economic instruments and calculating permit levels.
- Providing training for pollution inspectors in the enforcement of regulations concerning emissions, permitted discharges and waste repositories.
- Providing training for administrators in integrated management and land-use planning, especially vulnerability assessments and adaptation strategies, particularly of coastal areas.

7.6 Public information

Actions for public information should include:

- Promoting regular consultations with indigenous people and local residents.
- Preparing public brochures and using the media for information distribution.
- Promoting best practices through effective communications strategies with decision makers.

7.7 Secretariat Support

PAME Secretariat support for the RPA should include:

- Helping to facilitate and co-ordinate the work to ensure efficiency, arranging meetings as needed and supporting reporting on the progress and implementation of the RPA.
- Supporting and maintaining the exchange of information both within and outside the Arctic Region and the coordination of other PAME activities in support of the RPA.

APPENDIX 1 - GLOBAL PROGRAMME OF ACTION ASSESSMENT, OBJECTIVES AND RECOMMENDED ACTIVITIES BY SOURSE CATEGORY

SOURCE CATEGORY	TECHNICAL AND SCIENTIFIC ASSESSMENT		OBJECTIVES	RECOMMENDED ACTIVITES
	Source Activities	Effects and Targets		
Sewage	Human settlements	Human health / Biological production / Water quality / Fisheries / Tourism	Installation of appropriate and environmentally sound sewage facilities	• Treatment (see Agenda 21) • Proper outlets • Water-recycling • Productive uses
POPs	Industry / Agriculture / Commerce	Human health / Animal health / Fisheries / Water quality / Biodiversity	Reduce and/or eliminate anthropogenic inputs to prevent, reduce and eliminate pollution	• Waste reduction and treatment • Sound disposal • Substitutes and bans • Clean production • Best environmental practices
Radionuclides	Nuclear installations / Nuclear weapons / Industry / Public services (hospitals, universities)	Human health / Animal health / Water quality / Fisheries	Reduce and/or eliminate anthropogenic inputs to prevent, reduce and eliminate pollution	• Limit generation of waste • Safe processing, storage, conditioning, transportation and disposal of radioactive waste • Meet IAEA Basic Safety Standards
Heavy Metals	Industry / Mining / Sewage (combined) / Non-point sources	Human health / Animal health / Water quality / Fisheries	Reduce and/or eliminate anthropogenic inputs to prevent, reduce and eliminate pollution	• Treatment • Waste minimization • Clean technology • Sound disposal • Recycling
Petroleum Hydrocarbons	Oil production facilities / Oil handling facilities / Sewage works / Non-point sources	Human health / Animal health / Water quality / Reduction of amenities / Tourism / Tainted seafood	Reduce and/or eliminate anthropogenic inputs to prevent, reduce and eliminate pollution	• Treatment • Waste minimization • Clean technology • Sound disposal • Recycling • Spill response
Nutrients	Agriculture / Urban horticulture / Sewage / Aquaculture / Certain industries / Non-point sources	Human health / Biological production (eutrophication) / Harmful algal blooms / Water quality / Fisheries / Tourism	Reduce inputs where they are likely to cause pollution	• Sewage treatment • Coastal Zone Management • Best environment practices for agriculture and aquaculture
Sediment	Construction / Forestry / Agriculture / Mining / Dredging	Habitat destruction/ modification / Water quality / Erosion / Flooding / Biodiversity / Tourism	Reduce, control and prevent environmental degradation duet to anthropogenic changes causing coastal erosion and siltation	• Sound land-use • Coastal Zone Management • Sound management for contaminated dredged material
Habitat	Human settlements / Construction / Forestry / Agriculture / Mining / Dredging	Habitat destruction / Wildlife / Fisheries / Water quality / Biodiversity / Tourism	Conserve and protect habitat and biological diversity	• Identify critical habitats • Protected areas • Sustainable resource-use practices • Costal Zone Management

APPENDIX 2 - LOCATION OF POLLUTION HOT SPOTS IDENTIFIED BY THE RUSSIAN FEDERATION

An updated list of hot spots and estuarine and marine impact zones has been prepared within a special study carried out under the framework of the UNEP/GEF project "Support to the National Programme of Action for the Protection of the Arctic Marine Environment". The list was prepared based on revised information obtained at the preparatory stage of the project (1999), analysis of hot spots obtained within AMAP/NEFCO study (2003), state and regional reports on environmental protection for recent years (2000 - 2007) and consultations with regional authorities.

The following parameters were taken into account: proximity to the sea, population at risk, size of affected area, air and water contamination level, hazard categories for mining raw materials, hazards from transportation, degree of degradation of the environment, range of actual and potential effects, and types of primary activities from which the hot spot derived. Overall severity of actual and potential impacts was evaluated using the above parameters.

The list of the hot spots is presented below and illustrated on the map.. Numbers on the map correspond to the number of the hot spot (impact zone) in the list presented. There is also an indication of the primary source/cause of the environment damage or threats in the area (e.g. transport, mining, oil and gas, pulp and paper). The codes denote the primary source/cause of the environmental damage or threats in the area concerned. Additional coded entries in the same column in parentheses indicate important secondary causes as and when appropriate. The following list provides the codes for each source/cause:

- Fisheries: FI
- Marine resource exploitation: MA
- Metallurgy: ME
- Mining sector: MI
- Oil and gas production: OG
- Pulp and paper and forestry: PF
- Heat and Power Sector: PP
- Food industry: FO
- Heavy and light engineering: HL
- Construction materials manufacturing: CM
- Recreation: RE
- Transportation (land, sea and river) and municipal services: TR
- Complex (mixture or combination of sources/causes): CO

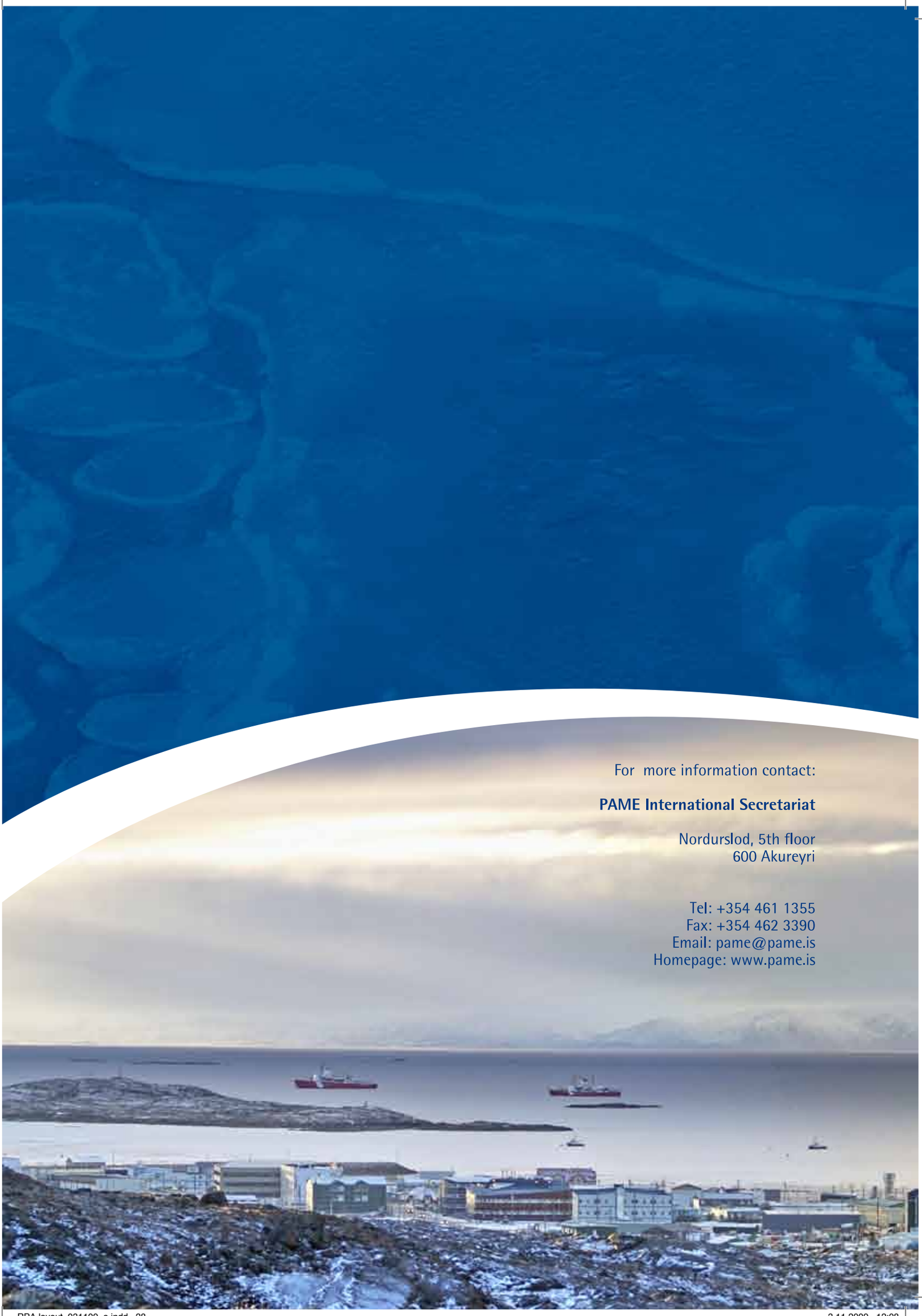
A comparative analysis among the identified hot spots resulted in a list of 30 priority hot spots which are highlighted in red in Table 3 on next page.

Table 3 - Comparative Analysis of Identified Hot Spots in the Russian North (see corresponding map).

#	Title of the hot spot	Primary source/ cause
Republic of Karelia		
1	Belomorsk	TR, PF
2	Kem	PF, TR
3	Nadvoytsy	ME
4	Segezha	PF
Murmansk oblast		
5	Nikel	ME
6	Zapolyarny	ME
7	Pechenga	TR
8	Murmansk	CO
9	Kola	FO (PP)
10	Teriberka	TR
11	Apatity	C
12	Kirovsk	MI
13	Kovdor	MI
14	Ena	MI
15	Polyarnye Zori	PP
16	Kandalaksha	ME, TR
17	White Sea (setlement)	TR
18	Umba	TR, RE
19	Olenegorsk	MI, CO
20	Monchegorsk	MI, ME
Archangelsk oblast		
21	Mezen	TR,C
22	Archangelsk	C
23	Severodvinsk	HL (PP)
24	Novodvinsk	PF
25	Solombala	PF
26	Koryazhma	PF
27	Onega	PF, FO
28	Nizhnyaya Zolotitsa	TR, RE
29	Vasilkovskoe oil field	TR,
Nenetsky AO		
30	Kumzha oil field	G
31	Naryan-Mar	TR, CO
32	Amderma	TR, CO
33	Khar'yaga oil field	OG
34	Toravey oil field	OG
35	Varandey oil field	OG
36	Peschanozersk oil field	OG
Republic of Komi		
37	Vorkuta	MI, PF, CM
38	Inta	MI, PF
39	Verkhnevozesky oil field	OG
40	Vozeusky oil field	OG
41	Usinsk oil field	OG
Yamalo-Nenets AO		
42	Urengoy deposit	OG
43	Yamburg deposit	OG
44	Medvezh'ye, Yubileynoe and Yamsoveyskoe deposits	OG
45	Bovanenkovskoe, Kharasaveyskoye deposits	OG
46	Zapolyarnoye deposit	OG
47	Nakhodkinskoye, Yurkharovskoe deposits	OG
48	Salekhard	TR (FO)
49	Labytnangi	TR (CM)

#	Title of the hot spot	Primary source/ cause
50	Nadym	TR
51	Novy Urengoy	TR (PP)
North of Krasnoyarsk Krai		
52	Norisk	ME (MI)
53	Talnakh	MI (RE)
54	Kayerkan	MI
55	Dudinka	TR
56	Dixon	TR
57	Kayak	MI
58	Khatanga	TR (FO)
Republic of Sakha (Yakutiya)		
59	Tixi	TR
60	Kular	MI
61	Deputatsky	MI
62	Tenkeli	MI
63	Yese-Khaya	MI
64	Nizhneyansk	TR
65	Chokurdach	TR (FO)
66	Chersky	TR (PP)
Chukotsky AO		
67	Iultin	C
68	Bilibino complex	MI
69	Bilibino NPP	C
70	Baranikha	MI
71	Komsomolsky	MI
72	Pevek	TR (PP)
73	Valkumey	MI
74	Krasnoarmeysky	MI
75	Polyarny	MI
76	Schmidt peninsula	TR (FO)
77	Anadyr	MI, TR
Estuarine and marine impact zones		
78	Kola Bay	TR
79	Motovsky Gulf	TR
80	Pechora Bay	TR
81	Varandey zone	TR
82	Prirazlomnoye zone	OG
83	Shtockman zone	OG
84	Dvina Gulf	TR, RE
85	Onega Bay	TR, RE
86	Kandalaksha Bay	TR, RE
87	Mezen Bay	TR,
88	Novaya Zemlya Zone	OG
89	Amderma zone	TR
90	Baidaratskaya Bay	TR
91	Gulf of Ob	TR
92	Yenisey Bay	TR
93	Pyasina Bay	TR
94	Gulf of Taz	TR
95	Khatanga Bay	TR
96	Buor-Khaya	TR
97	Yana Bay	TR
98	Kolyma zone	TR
99	Chaun Bay	TR
100	Shmidt Bay	TR

Figure 2: Hot Spots of the Russian North



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