CHAPTER V
CONCLUSIONS AND FUTURE DIRECTIONS

This report affirms and provides added support for the findings of the First Report to Congress that, for studied Great Waters, atmospheric deposition of toxic pollutants and excessive nitrogen is often an important factor affecting the environmental conditions of these waterbodies and can contribute to adverse ecological and human health effects. Moreover, the contribution of atmospheric deposition can be significant as part of the total loading for many waterbodies. For the freshwaters, such as the Great Lakes and Lake Champlain, metals, organic compounds, and pesticides released into the atmosphere have been measured in significant quantities near these waterbodies, and their deposition has been measured or calculated. For Chesapeake Bay and many other U.S. coastal waters, the impact of atmospheric deposition is not only from toxic pollutant releases, but also from inputs of nitrogen compounds that contribute to eutrophication (an overabundance of nutrients in a waterbody). Significant atmospheric loadings for both nitrogen and toxic pollutants have been determined for certain estuaries.

Since the First Report to Congress, significant progress has been made to increase our knowledge of atmospheric deposition to the Great Waters (see sidebar summary). As highlighted in this report, greater attention has been placed on monitoring and modeling atmospheric deposition at the individual Great Waters, with many of these studies funded or supported by EPA's Great Waters program. Quantitative information has continued to be gathered on the atmospheric levels of pollutants and their deposition to the Great Waters. Monitoring studies have been conducted to provide waterbody-specific data on deposition and the relative contribution of atmospheric deposition to total loadings, as well as to develop and improve measurement and modeling methods. Moreover, the findings from the investigation of one waterbody are expected to lead to a more informed or efficient assessment of atmospheric deposition and its effects for other waterbodies.

Progress Since the First Report to Congress in Cooperation With the Great Waters Program

- Initiation of a comprehensive mass balance model of Lake Michigan, for which results will estimate relative loadings, with the methodology to be adapted and applied to other waterbodies;
- Improved and refined source emission inventories for pollutants of concern;
- Formal policy commitment of the U.S. and Canadian governments to address Virtual Elimination of Persistent Toxic Substances in the Great Lakes;
- Increased monitoring and modeling studies in progress at the specific waterbodies;
- State-of-the-art air quality modeling of nitrogen sources, transport, and deposition to the Chesapeake Bay watershed;
- Increased activities at the coastal waters including development and implementation of monitoring studies, comprehensive pollution prevention plans, and management programs;
- Understanding that atmospheric deposition contributes significantly to excessive nitrogen loads in 13 of the 14 studied estuaries along the East and Gulf coasts; and
- Numerous programs and activities that are funded and supported by the Great Waters program.

Based on the scientific information currently available, EPA continues to support the three broad conclusions presented in the First Report to Congress regarding potential adverse effects, relative atmospheric loadings, and sources of atmospheric deposition.

- Adverse effects (e.g., cancer and developmental effects) that the Great Waters pollutants of concern can cause in humans and wildlife are fairly well understood. However, data are insufficient at this time to establish the linkage between atmospheric deposition of these pollutants and adverse effects.

- Atmospheric deposition can be a significant contributor of toxic chemicals and nitrogen compounds to the Great Waters. The relative importance of atmospheric loading for a particular chemical in a given waterbody depends on many factors, including characteristics of the waterbody, properties of the chemical, and the kind and amount of atmospheric or water discharges (airborne or waterborne).

- Airborne emissions from local as well as distant sources contribute pollutant loadings to waters through atmospheric deposition. Determining the relative roles of particular sources — local, regional, national and possibly global — that contribute significant deposition to specific waterbodies is complex, requiring careful monitoring, atmospheric modeling, and other analytical techniques.

In addition to these conclusions, EPA also reaffirms its support for the three major strategic themes developed in the First Report to Congress, which provide a broad scope for recommendations for action.

(1) EPA will continue ongoing efforts to implement section 112 and other sections of the CAA and use results from this report in the development of policy that will reduce emissions of the Great Waters pollutants of concern.

(2) EPA recognizes the need for an integrated multimedia approach to the problem of atmospheric deposition of pollutants to waterbodies and will continue to pursue implementation of programs available under various federal laws to reduce the human and environmental exposure to pollutants of concern.

(3) EPA is committed to supporting research activities that address the goals of CAA section 112(m).

In this chapter, Section V.A discusses EPA's assessment of the factors listed in CAA sections 112(m)(5)(A) through (E). This assessment is based on the scientific information summarized in this report, as well as the findings in the First Report to Congress. Section V.B discusses future directions and actions that EPA anticipates for the Great Waters program.

Section V.C summarizes EPA's draft determinations under section 112(m)(6), which are being published separately in the *Federal Register*. EPA also must consider under section 112(m)(6) two questions concerning the adequacy of the authority under provisions of section 112 and the possible need for further standards or control measures. Under the terms of a consent decree entered in *Sierra Club v. Browner*, Civ. No. 96-1680, EPA is to issue draft determinations for public notice and comment by June 30, 1997, and final determinations by March 15, 1998.

- EPA is required to determine whether the other provisions of section 112 are adequate to prevent serious adverse effects to public health and serious or widespread environmental

effects associated with atmospheric deposition of hazardous air pollutants (HAPs) to the Great Lakes, the Chesapeake Bay, Lake Champlain, and coastal waters.

♦ Based on the information available in this report and on the determination regarding the adequacy of section 112 authority (which is specific to HAPs), EPA must also determine whether additional emissions standards or control measures under section 112(m)(6), beyond those otherwise authorized or required by section 112, are needed to prevent such effects from atmospheric deposition, including effects due to bioaccumulation and indirect exposure pathways.

V.A Reporting on the Role of Atmospheric Deposition to the Great Waters and Specific Actions Proposed

As stated in the CAA, EPA is required to assess the contribution of atmospheric deposition to the Great Waters on several issues (listed below). While these issues have been discussed at length at various places in the body of this report, this section summarizes EPA's efforts to address these five elements:

- Pollutant loadings — section 112(m)(5)(A);
- Environmental and public health effects — section 112(m)(5)(B);
- Pollutant sources — section 112(m)(5)(C);
- Exceedances of water quality or drinking water standards — section 112(m)(5)(D); and
- Description of any necessary revisions to requirements, standards, and limitations pursuant to the CAA and other federal laws — section 112(m)(5)(E).

Contribution of Atmospheric Deposition to Pollutant Loadings in the Great Waters

A substantial amount of scientific information has demonstrated that atmospheric deposition contributes to pollutant loadings in the Great Waters. In and around the Great Lakes, studies have shown that atmospheric transport and deposition of persistent hazardous chemicals occurs and is significant in the overall inputs to the lakes. The Great Waters program has focused on a set of chemicals that show persistence in the environment, tendency to accumulate in animal tissue, and toxicity to humans and other animals. Data from several studies of the lakes' waters, sediments, fish, and wildlife, show a general decrease in concentrations of persistent toxics during the 1970s and 1980s. These declines have resulted from many efforts taken to reduce discharges to both air and water of potentially harmful chemicals (which included the pollutants of concern). Also, some of these declines may be attributed to significantly reduced use or canceled registrations of persistent pesticides in the United States. In the 1990s, the overall picture of persistent toxics in the Great Lakes basin shows much more gradual decline, if any (though particulars vary from lake to lake and among pollutants). Due to limitations in historical monitoring techniques, considerable uncertainties exist for earlier data

and thus, definitive conclusions about atmospheric pollutant trends are not made in this report. Quantitative monitoring data of atmospheric concentrations and deposition of the pollutants of concern have become available in recent years. It is anticipated that, as more data become available, better interpretations and conclusions can be made about pollutant trends, which in turn will better inform EPA about the extent to which additional actions will need to be taken, with possible focus on individual pollutants. Monitoring of toxics and nitrogen compounds (nitrates and others) has also been performed in Chesapeake Bay and other coastal estuaries and (with a focus on mercury) in Lake Champlain.

The Integrated Atmospheric Deposition Network (IADN) is an ongoing, binational monitoring network that assesses the magnitude and trends of atmospheric deposition to the Great Lakes region for wet and dry deposition and net gas exchange. Results from the past few years indicate that atmospheric deposition of some hazardous pollutants is still a concern for the Great Lakes. In similar work, data have been collected through the Chesapeake Bay Atmospheric Deposition Study (CBADS) on pollutant concentrations in air and precipitation. By incorporating emissions data with these measurements, atmospheric loading rates have been estimated. Certain trace metals appear to be deposited into the Bay as toxic contaminants. However, information on toxic contaminant trends in the Bay is not yet available. At Lake Champlain, researchers have been gathering information on deposition of mercury to the basin to characterize the types of mercury deposition (gaseous, wet, and dry particulate). To date, not enough information is available to assess trends for atmospheric mercury in the Lake Champlain basin.

Recent studies of several coastal waters have investigated the significance of atmospheric deposition to toxic pollutant loadings, and preliminary results show that atmospheric deposition can contribute a significant portion of loadings to coastal waters (e.g., Tampa Bay, Delaware Bay, Massachusetts Bays) for pollutants such as cadmium, lead, mercury, PAHs, and PCBs. For example, atmospheric deposition of cadmium is estimated to contribute 46 percent of the total annual load (direct and indirect) to Tampa Bay and 17 to 31 percent of the total annual load (direct) to Massachusetts Bays. Atmospheric deposition (direct and indirect) has been estimated to be a significant contributor of mercury (80 percent) to Delaware Bay. However, there are several remaining areas of uncertainty to be addressed related to atmospheric deposition of toxic contaminants to the Great Waters, including: the lack of accepted techniques for direct, quantitative measurement of dry particulate deposition and the unknowns associated with indirect loadings of pollutants, as they relate to watershed transmission and retention.

Information on relative loadings from air compared to other inputs of toxic contaminants in the Great Waters is still being assessed, although advances have been made in EPA's ability to address this issue. A comprehensive mass balance model for Lake Michigan has been initiated to gather information on loadings from different pathways, including the atmosphere, sediment, biota, and tributaries, as well as to study the variability in magnitude of atmospheric loadings near more urbanized areas versus rural areas. Preliminary modeling results from this major study are anticipated in 1998, and final results by 1999, which are expected to provide a better understanding of relative loadings and the movements of persistent pollutants in the environment.

Nitrogen deposition has been studied for coastal estuaries. Investigations have gathered information on atmospheric deposition estimates as well as relative loadings to these waters. Computer modeling studies for the Chesapeake Bay indicate that atmospheric deposition

accounts for approximately 27 percent of the total annual loading of nitrogen (376 million pounds), while 23 percent of the load comes from point source water discharges and 50 percent from non-point sources other than air, such as fertilizers and animal wastes. Since the First Report to Congress, additional studies have been initiated to measure nitrogen deposition in coastal estuaries other than Chesapeake Bay (e.g., Tampa Bay, Long Island Sound, Massachusetts Bay). For those studies that evaluated both direct and indirect deposition, the contribution of atmospheric deposition to the nitrogen load ranges from approximately 12 to 44 percent.

To project the ultimate influence of changes in total nitrogen loadings to the Bay (including loadings other than from the air), the Chesapeake Bay Program recently configured the Bay Watershed Model to accept daily atmospheric loadings by land use category (i.e., forest, pasture, cropland, and urban). The Chesapeake Estuary Model is being upgraded to simulate basic ecosystem processes of submerged aquatic vegetation (SAV), benthic microorganisms, and major zooplankton groups. In addition, EPA's Regional Acid Deposition Model (RADM) is being directly linked to the Watershed and Estuary models. This new integrated model, functionally linking the airshed, watershed, estuary, and ecosystem, is expected to be completed in mid-1997. Some of the remaining areas of significant uncertainty in estimating atmospheric loads are: nitrogen retention in watersheds, the relative loadings of ammonia and organic nitrogen (compared to nitrate), and dry particulate deposition directly to water surfaces.

Contribution of Atmospheric Deposition to Adverse Human Health Effects or Adverse Environmental Effects in the Great Waters

Current information on potential exposure to and effects of pollutants of concern to the Great Waters adds greater weight to the scientific data and conclusions reached in the First Report to Congress. Effects on fish and wildlife that are associated with exposures to these persistent chemicals continue to be reported in research literature. At this time, it is not possible to identify which specific individual pollutants, or defined mixtures, cause specific adverse effects observed in the biota of the Great Waters. Even if more direct and definite links between exposure and effect were established, the relative contribution of a pollutant from current air deposition compared to overall loading for the waterbody still needs to be better characterized and quantified to provide a basis for setting appropriate reduction targets. Because many of the pollutants of concern persist for decades, current loading must be considered in light of contamination that has come from many sources and persisted many years. Persistence also means that while emissions and discharges of these chemicals may appear rather small in one year, the loading in the environment builds up over time. While pollutant compounds deposited from the air directly into a waterbody can have different routes of exposure to aquatic biota than the same pollutants brought in by water or in sediments, there are limited quantitative data on such differences in exposure. There is no current evidence that effects on wildlife, and potentially on human health, caused by specific pollutants deposited from the air are different from effects of those same chemicals carried in the water or sediment, once the chemical reaches an organism’s tissues.

Exposure of wildlife or humans to the pollutants of concern can occur directly (e.g., through intake of drinking water, direct contact with water) or as a result of food web contamination. An indicator of potential human exposure to a pollutant is the presence of fish consumption advisories issued by state agencies. These waterbody-specific and fish species-specific advisories caution people against eating fish from a contaminated waterbody and

suggest that consumption of fish with these levels of contamination may result in potential human health effects. According to EPA's 1995 national listing of fish and wildlife consumption advisories, current state advisories for the Great Waters are associated with the same pollutants of concern as in the First Report to Congress (see Appendix B). Fish consumption advisories in the lakes are most commonly issued for PCBs, followed by mercury and dioxins; in coastal waters, advisories are commonly issued for PCBs, followed by dioxins.

Periodic monitoring of pollutant levels in tissues of aquatic organisms, such as game fish, is another indicator of pollutant contamination and exposure and provides information on bioaccumulation in the food web. Most studies are based on measurements of pollutant concentration in fish from the Great Lakes. Studies of several pollutants show that, over many years, pollutant levels in fish are remaining constant or decreasing. In some instances, slight increases of some pollutants have been measured recently in certain fish species. For example, although significant declines in PCB and DDT concentrations in lake trout, walleye, and coho salmon in the Great Lakes were observed during the 1980s, more recently (i.e., in the last eight to ten years) the residues of PCBs and DDT in these fish have leveled off or even increased slightly. Chemical residues in fish tissue are probably the result of many factors in addition to deposition from the air. For example, the apparent increase in pollutants in fish tissue may be a result of resuspension of pollutants from sediment or from changes in the food web structure in the lake.

Adverse effects in wildlife and aquatic organisms in the Great Waters continue to be reported in the scientific literature. The correlations of tissue burdens of persistent pollutants with observed effects in the animals suggest that exposure levels for some pollutants continue to be high enough to produce adverse effects. Health problems persist for fish and other wildlife in certain Great Lakes locations, particularly for predators high in the food web, such as lake trout, mink, and bald eagles. Recent population studies of fish-eating birds in the Great Lakes (e.g., common terns) provide evidence of the developmental problems linked to PCBs during the 1980s.

The occurrence of health effects in humans is less studied in connection with general environmental exposures. Most information is based on laboratory studies in animals, which can provide useful insight on potential adverse effects in humans; however, for most chemicals, the lowest exposure concentration at which these effects would occur in humans is difficult to determine. The pollutants of concern have been investigated individually and are known to cause a variety of health effects, including cancer, and to act on many target organs, including the liver and kidney, and on the endocrine, reproductive, immune, and nervous systems. There are few recent studies of acute human exposures to Great Waters pollutants, although evaluations of people who frequently eat fish from the Great Lakes suggest concerns. The relative role of pollutants deposited from the atmosphere compared with other pathways contributing to exposure has not been quantified in these studies.

Although much information is available on potential exposure to the pollutants of concern and also on the potential effects of these pollutants, uncertainties still exist regarding the association between the actual exposure levels experienced over time and potential effects. Effects that occur in wildlife or humans from long-term exposure to pollutants of concern may differ from those effects caused by acute, high-level exposures because longer exposure to some chemicals can result in metabolism or breakdown of the chemical in the body to another chemical that is more or less toxic and can result in cumulative exposure due to bioaccumulation.

Comparison of the effects reported in laboratory studies to actual observations in the field (i.e., wildlife around the waterbodies) also needs to be addressed. Laboratory studies can provide evidence to support observations of effects in the field and, furthermore, give information on the possible mechanism of action of the effect. However, these studies generally do not duplicate the potential cumulative or combined effects that may occur when pollutants interact in the environment or simulate effects due to exposure in natural food chains.

Atmospheric deposition of nitrogen compounds can contribute significantly to eutrophication in coastal waters where plant productivity is usually limited by nitrogen availability. Eutrophication and its subsequent effects on estuarine ecosystems pose significant problems for Chesapeake Bay and many other coastal waters. Accelerated eutrophication frequently results in severe ecological effects such as nuisance algal blooms and reduced oxygen levels in the water (as unstable algal blooms die back or organisms sink into deeper water). The reduction in oxygen levels may result in altered food webs by reducing or eliminating bottom-feeder populations of fish or shellfish, creating conditions that favor different species, or causing dramatic fish kills. In some cases, overproduction of algae increases the suspended matter in the water, which decreases light penetration to submerged aquatic vegetation (SAV) or coral. In other cases, algae can overgrow directly on submerged living organisms, often with losses of SAV or coral communities. Major areas of uncertainty include the response of living resources, particularly SAV, to reductions in nitrogen loads and the tidal-flow exchanges between coastal estuaries and offshore waters, which also receive atmospheric deposition of nitrogen compounds. Further study is needed on the direct link between atmospheric deposition of nitrogen compounds and ecosystem responses. Oxides of nitrogen are important components in acidic deposition, wet and dry, to fresh waters. In addition, nitrogen compounds and their reaction products in the ambient air can produce direct impacts on human health and terrestrial vegetation. In consideration of these partial impacts, EPA has established programs to evaluate and reduce the threat to human and ecological health from atmospheric nitrogen oxides, ozone, particulates, and acidic aerosols.

Emission Sources that Contribute to Atmospheric Deposition in the Great Waters

For toxic contaminants, information linking specific emission sources to impacts on atmospheric deposition to the Great Waters has been limited. Some work has been done on identification and characterization of specific sources in the Great Lakes, and more is planned. Some of this work does not involve emission inventories, but consists of predicting the origin of an air mass (using meteorology) that passes over a monitoring station and determining emission sources based on observed pollutants and metals ratios in the air samples. For some source categories, there currently are inadequate reliable emissions data and detailed emissions inventories to link pollutant deposition to specific sources. However, for many source categories, substantial progress has been made in recent years to establish source emissions inventories through state and federal efforts. For example, the Great Lakes Emissions Inventory, recently implemented by the eight Great Lakes states and the Canadian Province of Ontario, is compiling a data base on emission sources of 49 toxic air pollutants that will provide information on local and regional sources of pollutants of concern. A pilot project of major urban areas along the southwest shore of Lake Michigan has created an inventory of small point and area source categories in the surrounding region that contribute the most to the total emissions of major pollutants. As a result of this pilot study, a better methodology has been developed for use in the

full regional Great Lakes Emissions Inventory. Research studies on the importance of local "urban plumes" of pollutants have been underway in recent years near Chicago (impacting Lake Michigan) and near Baltimore (impacting Chesapeake Bay). These studies are due to be completed in the next few years. Their results, combined with emission inventories, will assist in defining the relative importance of local emissions upon deposition and in focusing emission reduction efforts. In addition, EPA recently completed a national emissions inventory of known U.S. sources of seven HAPs listed under CAA section 112(c)(6). Identification of the sources for total emissions of these pollutants is necessary to assure that at least 90 percent of emissions from stationary, anthropogenic sources are subject to regulation under CAA section 112(d).

As a result of research funded by the Great Waters program and others, better predictions can be made on the direction and movement of emitted air pollutants over large geographic areas, and more reliable estimates of rates at which pollutants will be deposited on land or water surfaces are possible. For example, some researchers are determining the extent of mercury emissions to air in the United States over an entire year, the deposition to the land and waterbodies, and the contribution by source category to the total amount of mercury emitted and deposited within the United States. In the Great Lakes, a regional network of ten monitoring sites was established in 1993 by EPA and the University of Michigan to measure atmospheric mercury and wet and dry deposition of gases and particulates. One goal is to determine the sources and source areas of mercury deposition to the Basin, using an improved trajectory clustering technique. Such studies will enable EPA and other researchers to better explore source attribution.

What is CAA Section 112(c)(6)?

Under this section, EPA is required to identify and list sources, categories, and subcategories of alkylated lead compounds, hexachlorobenzene, mercury, PCBs, POM, TCDD, and TCDF. This list is intended to assure that not less than 90 percent of the aggregate emissions of each pollutant are subject to standards under section 112(d)(2) or 112(d)(4). To meet these requirements, national inventories of sources and emissions of these pollutants have been developed. Because all seven pollutants are of particular interest to the Great Waters program, these inventories will be useful in protecting the Great Waters and in implementing section 112(m).

Substantial progress also has been made on investigating emission sources of nitrogen compounds in recent years. Due to the impacts that nitrogen overenrichment has in estuaries and coastal waters, sources of airborne and waterborne nitrogen compounds are being evaluated by monitoring and modeling studies. Recent modeling studies have looked at both local and distant sources (generic types) that release atmospheric nitrogen that deposits into the Chesapeake Bay and its watershed. Using RADM, the Chesapeake Bay Program has evaluated sources contributing to the deposition of certain nitrogen compounds and identified electric utilities and mobile sources as major contributors. However, the model runs show that the patterns of nitrate deposition are different for these two broad source categories. Utilities appear to contribute a majority of the nitrate that deposits on the western side of the Bay watershed and exhibit a decreasing trend in deposition from the western towards the eastern portion of the watershed. Mobile source emissions, on the other hand, largely reflect the traffic associated with the Washington, D.C./Boston corridor and contribute the majority of the nitrate that deposits along the Delmarva Peninsula, the Bay itself, and lower portions of the western shore tidal tributaries. Work on addressing a modeling uncertainty in RADM — correct partitioning between particulate nitrate and nitric acid — continues with funding from EPA's High

Performance Computing and Communications Program, the Particulate Program, and the Acid Rain Program.

Contribution of Atmospheric Pollutant Loading to Exceedances of Water Quality Standards and Drinking Water Standards or Exceedances of Objectives of the Great Lakes Water Quality Agreement

While some pollutants remain at levels exceeding applicable criteria in some locations of the Great Waters, no additional pollutants have been found to exceed water quality standards in the Great Waters since the First Report to Congress. Where exceedances occur, it may be reasonable to assume that atmospheric deposition contributes to some (quantity unknown) extent. The contribution of atmospheric deposition is especially likely for open water exceedances, in contrast to localized "hot spots" where other loading mechanisms may dominate. Where data are available, toxic contamination in water does not appear to be increasing significantly for any of the pollutants of concern, but rather appears to be remaining the same or decreasing. However, recent data on water column concentrations are available for only a limited number of the pollutants. Concentrations of DDT/DDE, dieldrin, hexachlorobenzene, and PCBs in the water column of the Great Lakes are reported in both this report and the First Report to Congress. Current levels of dieldrin and PCBs are lower than those presented in the First Report to Congress; however, they continue to exceed the most stringent water quality criteria for the Great Lakes by a substantial margin (tens to hundreds of times). These most stringent criteria incorporate biomagnification up the food chain, and so differ from criteria for direct exposure to water. In addition, the reported concentrations of DDT/DDE may exceed the current water quality criteria under the Great Lakes Initiative; however, the possible exceedance is difficult to establish given analysis limitations. Thus, even though mass emissions of these pollutants have decreased dramatically as a result of actions taken to ban or restrict the manufacture and use of these substances, the long-term persistence of these pollutants in the environment, and apparent cycling among media, cause these compounds to remain pollutants of concern to the Great Lakes. Therefore, these pollutants warrant continued monitoring and tracking until levels no longer exceed relevant criteria or standards.

Among the Great Waters, the only significant sources of drinking water are the Great Lakes and Lake Champlain. The drinking water systems using these sources are not known to have exceedances of drinking water standards for the pollutants of concern, including toxics and nitrates.

Description of Revisions to Requirements, Standards, or Limitations Pursuant to the Clean Air Act and Other Applicable Federal Laws, as Necessary

Section 112(m)(5)(E) requires that EPA describe in this report any revisions to the requirements, standards, and limitations pursuant to the Clean Air Act and other applicable federal laws that are necessary to assure protection of human health and the environment. In reviewing relevant requirements, standards, and limitations established pursuant to applicable statutes, EPA has found that such restrictions are achieving significant reductions in releases of the pollutants of concern. For example, the technology-based standards that have been, and are being, developed and promulgated for stationary air sources require reductions in air emissions

that reflect the maximum that are achievable, in accordance with section 112(d). Section 112(c)(6) specifically lists for special attention seven pollutants: alkylated lead compounds, polycyclic organic matter (POM), hexachlorobenzene, mercury, PCBs, furans (2,3,7,8 TCDF), and dioxins (2,3,7,8 TCDD). These seven pollutants are also Great Waters pollutants of concern. A comprehensive emission inventory has been developed under section 112(c)(6), and further standards are being developed under section 112(d).

As mentioned earlier, section 112 authority is specific to HAPs listed under section 112(b) and, therefore, does not apply to pollutants that are not currently listed, such as nitrogen compounds. However, several major programs have been implemented under other sections of the Clean Air Act to reduce emissions of oxides of nitrogen: sections 108 and 109, pertaining to ambient air standards for stationary sources to protect public health and welfare; section 202, pertaining to air regulations for mobile sources; and section 407, pertaining to acid deposition control.

Nitrogen dioxide is listed under section 108 as a pollutant that causes or contributes to air pollution that may reasonably be anticipated to endanger public health or welfare. Air quality criteria have been issued by EPA for nitrogen dioxide, and ambient air quality standards have been established for nitrogen dioxide under section 109, which directs the EPA Administrator to propose and promulgate primary and secondary National Ambient Air Quality Standards (NAAQS) for pollutants identified under section 108. A primary standard is one that is necessary to protect the public health, allowing an adequate margin of safety. A secondary standard, as defined in section 109, must specify a level of air quality needed to protect the public welfare from any known or anticipated adverse effects associated with the presence of the pollutant in the ambient air. Welfare effects, defined in section 302(h), include, but are not limited to, effects on soils, water, crops, vegetation, materials, animals, wildlife, weather, visibility, and climate. Thus, section 109 provides authority to address a broad range of public health impacts and adverse environmental effects in order to assure protection of human health and the environment.

Several efforts are currently underway to control emissions of nitrogen oxides. The Ozone Transport Assessment Group, a regional body representing 38 eastern and midwestern states, is currently evaluating alternative reduction options for regional control of nitrogen oxides and volatile organic compounds in order to achieve attainment of the current NAAQS for ozone. In addition, EPA is considering revisions to the NAAQS to address the most recent information about health and environmental effects of ozone and fine particulate matter. A subcommittee of the Clean Air Act Advisory Committee chartered under the Federal Advisory Committee Act is evaluating regional approaches to the management of emissions of nitrogen oxides, sulfur dioxide, fine particulate matter, and volatile organic compounds to attain the proposed revisions to the ozone and particulate matter NAAQS and the national goals of the regional haze program. Together these efforts are expected to result in substantial reductions in emissions of the pollutants of concern, with significant additional benefits to geographic areas such as the Chesapeake Bay watershed.

Furthermore, section 202 requires that standards for motor vehicles be established, as needed, to reduce emissions that cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare. Regulations under this section apply to emissions of nitrogen oxides. Section 401 (Acid Deposition Control) identifies the presence of

acidic compounds and their precursors in the atmosphere, and in deposition from the atmosphere, as a threat to natural resources, ecosystems, materials, visibility, and public health. The principal sources of acidic compounds and their precursors in the atmosphere, as identified in section 407, include nitrogen oxides from the combustion of fossil fuels. A program for reducing emissions of nitrogen oxides from coal-fired electric utility power plants has been promulgated under section 407 of the Clean Air Act. In the Acid Rain Phase II NO_x Emission Reduction Rule (*Federal Register*, December 19, 1996), water quality benefits are cited in the preamble justification as a basis for EPA's decision to exercise statutory discretion to lower emission limits for certain coal-fired utility boilers (known as Group 1) and as an environmental impact of establishing emission limits for other boiler types (known as Group 2). Eutrophication is listed with ozone and acid deposition in the summary table of environmental effects.

Pesticides that are included as pollutants of concern have been, and continue to be, effectively addressed by actions taken under relevant statutes. Also, PCB releases have been, and are being, effectively reduced. While concentrations of some of these pollutants of concern in the waterbodies or in animal tissue remain unacceptably high, current releases of these pollutants are being effectively managed. It is important to note that, although current efforts are effective and appropriate, some level of risk to the public health and to the environment may continue for years into the future due to previous releases of the pollutants of concern and their persistence in environmental media for multiple decades.

Various efforts are being taken by EPA that will provide significant concomitant benefits through reduction of pollutants EPA addresses under section 112(m). At this time, no specific revisions to requirements, standards, and limitations pursuant to the Clean Air Act or other relevant federal statutes have been identified as necessary to assure protection of human health and the environment in response to section 112(m) assessments. In the future, as EPA evaluates progress of ongoing efforts and considers new information as it becomes available, new approaches may be pursued.

V.B Future Directions

As described throughout the report, notable progress has been made to further the knowledge of atmospheric deposition of pollutants to the Great Waters. As new information becomes available on atmospheric pollutant deposition to the Great Waters, questions or issues are expected to arise that will require further investigation or action. At this time, EPA has identified areas where information is limited and has identified some specific directions that need to be taken to advance the understanding of issues relevant to the Great Waters program.

Determine Management/Regulatory Actions for Focus Pollutants

EPA plans to continue evaluating the 15 pollutants of concern, focusing on those that are currently being emitted to the air from sources subject to regulations under the CAA. For example, emphasis will be placed on the seven pollutants of concern addressed in section 112(c)(6). Emission inventories have been developed for these pollutants and will provide useful information on sources of atmospheric deposition to the Great Waters. EPA's Air Toxics program has recently prepared some notable studies that may have implications to the Great Waters pollutants of concern, including the Interim Report to Congress on emissions of hazardous air

pollutants from electric utilities. The Interim Report, along with the Great Waters Second Report to Congress and sponsored studies, contribute information focused on persistent pollutants to EPA's ongoing actions establishing emission standards under section 112(d). As these standards continue to become implemented, significant reductions in HAPs are expected, including the persistent chemicals of importance to waterbodies. In addition to these activities, EPA is considering future management and/or regulatory actions for some pollutants of concern, some of which are described below.

Continue Monitoring and Research Efforts to Support Management/Regulatory Actions

EPA plans to continue supporting monitoring and research efforts that provide information for regulatory and management actions for pollutants of concern. Monitoring allows tracking of current and future reductions and evaluation of EPA program effectiveness. In addition, monitoring supports the development and validation of atmospheric transport models that enhance EPA's program implementation and predictive capabilities. Research projects include work that expands current monitoring capabilities, increases knowledge of cycling and transport of contaminants, and evaluates environmental effects.

- ***Exposure and Effects:*** A process to coordinate research strategies on persistent pollutants has begun among several offices within EPA. It is expected that these studies will improve our understanding of the relationship between ambient concentrations in natural media (water, air, and sediments), burdens of pollutants in tissues of living biota, and associated effects. Exposure and effects research will build on methods used to develop the Great Lakes Water Quality Criteria, which incorporate consideration of biomagnification. These types of research are central to increasing our ability to assess the impact of atmospheric deposition to the Great Waters and define efficient approaches to reducing exposures and risks to humans and wildlife.

- ***Mercury and Compounds:*** Mercury is a global pollutant, and is used in industries and released from combustion, manufacturing, and natural processes. Through changes in its ionic and molecular chemistry, mercury can be mobile among the atmosphere, waters, biota, and soil or sediments. EPA is committed to identifying feasible options for reducing or preventing emissions of mercury. Also, following completion of EPA's Mercury Study Report to Congress, the results will be used in the process of identifying sources of mercury emissions and in prioritizing mercury reduction strategies. To date, most routine monitoring for atmospheric mercury does not provide key information needed to evaluate the sources and impacts of mercury loadings. This is due to the relatively recent development of mercury techniques that differentiate between the various molecular states of mercury and have not yet been widely and routinely used. However, these techniques have been used on a research basis concurrent with monitoring for other metals, in order to obtain an atmospheric "fingerprint" that aids in the identification of sources. Monitoring for mercury is expected to continue in biota, atmosphere, and other components of ecosystems, particularly in the Great Lakes region. Monitoring should continue, to track future reductions of mercury, as emissions in the United States are expected to decrease upon implementing recent CAA regulations such as the municipal waste combustor rule, and the proposed standards for medical waste

incinerators and for hazardous waste combustors. The effectiveness of voluntary initiatives also should be evaluated.

- ***Combustion Emissions:*** Combustion emissions (POM/PAHs, dioxins, furans, and PCBs) are part of the EPA's toxics control efforts utilizing regulation, pollution prevention, voluntary measures, and other approaches. Releases that affect the Great Waters include past usage, combustion (including combustion of wastes), and cycling or movements among the components of ecosystems. For example, although PCBs have not been manufactured for a long time, they remain in use within existing electrical equipment. When released into the environment, PCBs have proven to be one of the most persistent of the pollutants of concern. Regulatory action to control these pollutants under the CAA can be complex because current emissions of these toxics from any one source may be a small percent of total loadings. However, their persistence and the tendency of many of the chemical species to biomagnify gives them a particular importance. Research on effects to wildlife associated with environmental exposures, including mixtures of toxics, is expected to continue. Monitoring of fish-eating birds and other wildlife in the Great Lakes should be performed with respect to their geographic relation with the Areas of Concern (AOCs). The compounds grouped under POM, including PAHs, have had less attention in monitoring in the past, but because they are still being emitted, special focus on monitoring and studies of effects are expected. PAH trends are currently tracked in the Great Lakes.

- ***Pesticides:*** Persistent pesticides (chlordane, DDT/DDE, dieldrin, hexachlorobenzene, α-HCH, lindane, and toxaphene) are difficult to control through regulation under the CAA since the most significant potential sources to the Great Waters may not be from current emissions. Releases by several pathways to the Great Waters are due in many cases to past use, often over considerable areas, while cycling or movements among Great Waters' ecosystem components can release earlier contamination. In addition, current human activities, including combustion, can still emit small quantities. Use of all the pesticides of concern are either canceled or severely restricted in the United States, yet they continue to be found in sediments of waterbodies. Research is expected to focus on possible current sources as byproducts or long-range transport of toxaphene and dieldrin due to their continued importance in some of the Great Lakes. These chemicals are retained on the list of Great Waters pollutants of concern, and EPA believes that efforts at preventing and controlling releases of these chemicals are warranted, including continued monitoring until levels no longer warrant fish advisories or exceed water quality criteria and standards.

- ***Nitrogen Compounds:*** EPA is focusing on management strategies to reduce nitrogen oxide (NO_x) emissions. EPA expects that total NO_x emissions will gradually decline about six percent from current levels by the year 2000 due to mandatory CAA programs. After the year 2000, the total national NO_x emissions are expected to gradually increase due to population growth. EPA is developing the Integrated NO_x Strategy, which outlines an integrated approach to controls on mobile and stationary sources through cost-effective mechanisms. The Strategy stresses that consideration of the many environmental effects of NO_x emissions should strongly influence policy decisions regarding the control of NO_x emissions. Accordingly, EPA continues to work in coordination with a wide range of stakeholders to develop and implement new mobile and stationary source control

programs at the federal, state, and local levels to reduce NO_x emissions. Monitoring of future reductions in conjunction with estuarine, watershed, and acid deposition studies is expected to continue. Monitoring should continue to include a comprehensive approach that addresses wet and dry deposition of gases and particulates. Additional research will proceed on improving monitoring methods for dry particles and on quantifying the relative contribution of the chemical species of nitrogen compounds to total loading. Modeling will be important in addressing the multiple questions and benefits that strategies for reducing NO_x are developing in conjunction with programs on ozone and fine particulate matter, as well as impacts on waterbodies.

Expand Modeling Efforts to Estimate Atmospheric Loadings to Great Waters

As data continue to be gathered from studies that were initiated in recent years, the results will lead to better characterization of atmospheric loadings to the Great Waters. One particular study that should provide comprehensive information is the Lake Michigan Mass Balance Model. This model should be adapted and applied to additional waterbodies. EPA also believes that more investigation is needed to assess the contribution of atmospheric deposition to pollutant loadings from urban, stormwater, and agricultural runoff from the watershed. This kind of work is currently being performed for nitrogen compounds in Chesapeake Bay. Results from such projects will provide more comprehensive information to assess the complete picture of atmospheric loadings to the Great Waters.

Increase Focus on Identification of Emission Sources

Significant progress has been made in establishing source emission inventories for some pollutants of concern. However, information is limited on specific sources of atmospheric deposition to the Great Waters, especially sources that are relatively distant from the waterbody. Because this information is critical to developing risk management strategies, EPA believes that more effort should be placed on determining potential sources of these airborne pollutants, with emphasis on identifying significant sources, both local and long range. As described above, source emission inventories have been initiated in the Great Lakes region and nationally, which will be important in identifying source categories of concern. The Chesapeake Bay Program has made important progress in identifying local and distant sources for nitrogen deposition to the basin, but has not determined the specific sources that contribute the most to deposition.

Another future area of study for EPA is atmospheric pollutant deposition from sources other than current air emissions. As discussed earlier, many of the pollutants of concern to the Great Waters are no longer used or manufactured in the United States; however, they cycle in the environment, may be transported considerable distances, and thus can contribute some unknown amount to the waters. Investigations on the relative contribution of deposition from current activities versus past use is an important concern to EPA because several of these pollutants may need to be addressed through approaches that supplement prevention measures and emission controls developed under the CAA.

Continue to Promote Pollution Reduction in the Great Waters

In the past few years, local, regional, and federal agencies, as well as international organizations, have worked together to develop initiatives and agreements that promote activities supporting pollution prevention and reduction efforts in the Great Waters. As such, several of these activities will help to address issues under CAA section 112. Many of these programs, which are described in Chapter IV of this report, were developed recently, and implementation of these initiatives is expected to occur in the near future. EPA is committed to continue its support for, and involvement in, these activities. Some of these broad initiatives are highlighted below:

- ***Strategic pollution prevention plans developed through federal, state, and local partnerships.*** Many waterbodies of the Great Waters currently have specific goals or strategies to characterize and/or reduce water pollution in their respective ecosystems. Most plans promote comprehensive approaches to reduce contamination in a waterbody. Where atmospheric deposition is a significant contributor, EPA is committed to using its section 112 authorities to assist in achieving the emission reductions feasible. As appropriate, other authorities may be considered as well (e.g., provisions of the CAA to reduce emissions of nitrogen compounds).

- ***Use of voluntary efforts to meet pollution reduction goals.*** Pollution reduction goals have been developed for many Great Waters and, in most instances, implementation of these goals involves voluntary initiatives. For example, state agencies and other stakeholders in the Great Lakes region have worked together to propose voluntary, as well as regulatory, measures to prevent or reduce atmospheric mercury contamination in the Great Lakes through increased public awareness, development of alternative technologies, and capturing and recycling of uncontrolled (fugitive) releases. Many activities by industries, individuals, and cities that reduce waste of energy and develop efficient transportation also have the benefit of reducing NO_x emissions.

- ***Binational and international efforts to promote pollution reduction.*** Binational efforts can play a critical role in controlling atmospheric pollution in the Great Lakes. For example, the Great Lakes Water Quality Agreement and the recently signed Binational Strategy for Virtual Elimination between the United States and Canada have set percentage reduction goals as steps towards virtual elimination of persistent, toxic, and bioaccumulative pollutants from the Great Lakes. Through these endeavors, both nations are encouraging and supporting voluntary programs and other actions to reduce generation, use, and release of toxic contaminants to the Great Lakes. In addition, EPA works in cooperation with other agencies and departments to develop and support additional binational and global actions to address atmospheric sources of persistent organic and heavy metal emissions.

- ***Implementation of the Great Lakes Water Quality Initiative.*** The primary purpose of the Great Lakes Water Quality Guidance (GLWQG) is to provide a consistent level of protection to people, aquatic life, and wildlife that may be exposed to toxic pollutants from the Great Lakes. To accomplish this goal, the GLWQG establishes protective levels, or water quality criteria, for toxic pollutants from all sources. Estimates of basin-wide toxic reductions that will result from implementation of the Great Lakes Water Quality Initiative range from 2.6 million to 3.5 million kilograms of toxic pollutants per year.

- ***Continue to take strategic actions.*** Some argue that any continuing releases of persistent bioaccumulative pollutants add to an environmental burden that is already causing effects. EPA believes it is important to balance its present understanding of atmospheric deposition against the implications of inaction in order to define those actions that are justified at this time. EPA is committed to protecting public health and the environment and will promote taking whatever regulatory actions and voluntary initiatives are appropriate in the most cost-effective way possible.

Assess Economic Impact of Pollution to the Great Waters

The economic impacts associated with reductions of pollutants to the Great Waters have not been sufficiently investigated, although a regulatory impact analysis was recently performed on the Great Lakes Water Quality Guidance, which addressed the impacts of the new guidance. For the Great Waters program, EPA plans to identify and quantify, where possible, economic impacts associated with exposure and effects indicators such as fish advisories, habitat decline, diminished species diversity, fish kills, and declining populations of contaminated shellfish and fish.

V.C Draft Determination of Whether CAA Section 112 Authorities are Adequate to Prevent Adverse Effects to Public Health and the Environment from Deposition of HAPs

In accordance with section 112(m)(6) of the CAA, EPA is issuing, at the same time it submits this Report to Congress, a draft determination of the adequacy of the other legal authorities and mandates provided by section 112 of the CAA to prevent specified adverse human health and environmental effects associated with atmospheric deposition to the Great Waters. Based on the information available in this report and in the draft determination regarding the adequacy of section 112 authority, EPA is also issuing a draft determination of whether additional emissions standards or control measures, beyond those authorized or required by section 112, are needed to prevent such effects. These draft determinations are described in a *Federal Register* notice published separately and are briefly summarized below.

Section 112(m)(6) of the CAA requires that EPA determine whether adequate authority exists within the other (i.e., non-Great Waters) provisions of section 112 to prevent serious adverse effects to public health and serious or widespread environmental effects resulting from atmospheric deposition of HAPs to the Great Waters. In making this determination, EPA reviewed the authority granted by the other provisions, as they may apply to deposition of HAPs to the Great Waters. It should be emphasized that this determination pertains to the authority within the CAA to take actions as appropriate to address adverse effects.

In addition, EPA has focused on the authority within section 112 to address those pollutants and sources within the scope of section 112. Therefore, pollutants such as nitrogen compounds that are not on the section 112(b) list of HAPs are not within the scope of this determination. Similarly, sources that are regulated by other sections of the CAA (e.g., mobile sources) or that are addressed by other statutes (e.g., wastewater discharges, which are addressed by the Clean Water Act) are also not within the scope of this adequacy determination.

Section 112 establishes a statutory scheme by which EPA is to identify HAPs that may cause or contribute to adverse effects to public health or the environment, develop standards for the control of emissions from stationary sources of such HAPs, and adjust these control requirements as needed to address any remaining unacceptable risk that may be present after imposition of sources have complied with the emission standards. The types of adverse environmental effects to be prevented are defined in the Act and are broad in scope.

Authorities provided by other provisions of section 112 that may be particularly relevant to the Great Waters pollutants and sources are briefly summarized below and, as stated earlier, are described in more detail in the *Federal Register* notice. Section 112 authorizes EPA to:

- Identify and list additional air pollutants that may cause adverse effects due to atmospheric deposition (section 112(b));

- Identify and list any stationary source category that emits pollutants with the potential to cause adverse effects (section 112(c));

- Establish a lesser quantity (e.g., below ten tons per year for a single pollutant) emission rate for defining major sources based on several factors, including persistence and potential to bioaccumulate (section 112 (a)(1));

- Promulgate performance standards based on best performing technologies for major sources and listed area sources (section 112(d)); and

- Require additional controls, beyond the section 112(d) standards, as necessary to provide an ample margin of safety to protect public health or to prevent an adverse environmental effect (section 112(f)).

Based on its analysis of these and other section 112 provisions, EPA has issued a draft determination that section 112 authority is adequate to prevent serious adverse effects to public health and serious or widespread environmental effects associated with the deposition of HAPs to Great Waters. Consequently, EPA also has issued a draft determination that, at this time, no further emissions standards or control measures beyond those authorized under the other provisions of section 112 are necessary and appropriate for stationary sources of HAPs to prevent such effects. EPA has requested public comment on these draft determinations, which will be finalized in March 1998.