

1. INTRODUCTION

The Great Lakes Areas of Concern (AOCs) are ecologically degraded geographic areas within the Great Lakes Basin. The U.S.-Canada Great Lakes Water Quality Agreement (GLWQA), Annex 2 of the 1987 Protocol, defines AOCs as "a geographic area that fails to meet the General or Specific Objectives of the Agreement where such failure has caused, or is likely to cause impairment of beneficial use or of the area's ability to support aquatic life." Beneficial use impairments (BUIs) means "a change in the chemical, physical, or biological integrity of the Great Lakes" (<http://www.ijc.org/en/activities/consultations/glwqa/agreement.php>) causing, for example, restrictions on fish and wildlife consumption, restrictions on drinking water consumption, and beach closings. Of the 14 indicators named in the GLWQA, the latter three are BUI indicators associated with human health.

The U.S. and Canadian governments have identified a total of 43 AOCs with 28 in U.S. waters, 12 in Canadian waters, and 5 shared between the U.S. and Canada on connecting river systems (binational AOCs) (<http://www.epa.gov/glnpo/aoc/>). All of these AOCs are impacted by chemical contaminants from either local sources and/or remote sources of pollution. This report was developed by the Agency for Toxic Substances and Disease Registry (ATSDR) in response to a request by the International Joint Commission (IJC) regarding the public health implications of hazardous substances found at the U.S. Areas of Concern (AOCs).

The IJC has identified 11 critical pollutants as the focus for efforts to reduce loadings to the Great Lakes. These pollutants are persistent, bioaccumulative, and harmful to the ecosystem and human health. Because of their toxicity, the 11 IJC critical pollutants have been designated by the Great Lakes Binational Toxics Strategy as being Level I substances. These substances have been designated as requiring immediate priority are targeted for virtual elimination, and include banned (e.g., dichlorodiphenyltrichloroethane) and/or highly toxic substances (e.g., dioxins). For this reason, these substances are relevant in the discussion of the Great Lakes AOCs. Substances that are not classified as IJC critical pollutants are also included in the report to demonstrate the number of other toxic substances detected at the AOC sites.

Table 1-1 lists the critical pollutants, along with relevant synonyms or designations used in ATSDR's HazDat data base and in the U.S. Environmental Protection Agency's (EPA) Toxics Release Inventory (TRI). A tracking number has been assigned to each IJC critical pollutant to enable tracking of records that provide information regarding these pollutants in these data bases.

Table 1-1. International Joint Commission (IJC) Great Lakes 11 Critical Pollutants

IJC Tracking Number*	Critical Pollutant, Synonyms, Relevant Contaminants in HazDat and TRI
1	PCBs (polychlorinated biphenyls), Aroclors
2	Dioxins, PCDDs (polychlorinated dibenzo-p-dioxins), TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin), other polychlorinated dioxin congeners
3	Furans, PCDFs (polychlorinated dibenzofurans), TCDF (2,3,7,8-tetrachlorodibenzofuran), other polychlorinated dibenzofuran congeners
2 & 3	Dioxins and dioxin-like compounds
4	B(a)P [benzo(a)pyrene]; carcinogenic PAHs
5	DDT (dichlorodiphenyltrichloroethane) and metabolites, p,p'- and o,p'-DDT, DDE (dichlorodiphenyldichloroethylene), and DDD (dichlorodiphenyldichloroethane)

6	Aldrin/dieldrin
7	Mirex
8	Alkyl-lead, alkylated lead, tetraethyl lead, lead, lead compounds
9	Mercury, methyl mercury, mercury compounds
10	Toxaphene
11	Hexachlorobenzene

*Number assigned to the pollutant(s) by ATSDR to enable tracking of HazDat and TRI records that provide data relevant to that pollutant. The number does not reflect priority.

Maps of the 26 individual U.S. Great Lakes AOCs are provided in the CD accompanying this document. The locations and approximate boundaries of the AOCs, as depicted in the maps and described in the text, are based on information provided by EPA (<http://www.epa.gov/glnpo/aoc/>). The maps show the ATSDR-assessed hazardous waste sites, including the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund Act) sites, TRI release sites, National Pollutant Discharge Elimination System (NPDES) permit sites, schools, hospitals, and population density in the counties that immediately encompass and surround the U.S. AOCs. Children, women of reproductive age, and the elderly have been shown to be vulnerable populations for health effects associated with exposure to contaminants found in contaminated Great Lakes fish. For this reason, these groups were selected as the populations to be shown on the GIS maps. In addition, populations within a one-mile radius of a toxic waste site are considered by ATSDR as potentially vulnerable. This is the reason that the GIS maps characterize this distance.

At the outset of the ATSDR AOC project, EPA was consulted for this report to determine if the Agency had developed GIS maps designating the AOC boundaries. ATSDR was informed by EPA that these maps were being developed and are still in the process of being completed. The decision to include data for entire counties was reached in consultation with the EPA, which provided the list of relevant counties.

The discussion of the Great Lakes AOCs in this document is organized geographically by Lake and from east to west around the lake shoreline. This was done because of the overlap of counties among some AOCs and of AOCs within a county. A map showing the locations of the U.S. (and binational) AOCs is provided in Figure 1-1.

In addition to evaluating information on the ATSDR public health assessments and other assessments for hazardous waste sites within the 26 U.S. AOCs, this document evaluates data on industrial sources of chemical emissions and on county-wide health outcomes, in order to provide a fuller perspective of potential impacts on environmental burdens and public health.

1.1 ATSDR PUBLIC HEALTH ASSESSMENTS FOR THE 26 GREAT LAKES AOCs

In 1980, Congress created ATSDR to implement the health-related sections of laws that protect the public from hazardous wastes and environmental spills of hazardous substances. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) commonly known as the "Superfund" Act, provided the Congressional mandate to remove or clean up abandoned and inactive hazardous waste sites and to provide federal assistance in toxic emergencies (<http://www.atsdr.cdc.gov/congress.html>). As the lead Agency for implementing the health-related provisions of CERCLA, ATSDR is charged under the Superfund Act to assess the presence and nature of health hazards at specific Superfund sites, to help prevent or reduce further exposure and the illnesses that result from such exposures, and to expand the knowledge base about health effects from exposure to hazardous substances.

ATSDR has conducted public health assessments, health consultations, and other assessments at more than 100 hazardous waste sites relevant to the 26 U.S. AOCs. These sites include National Priorities List (NPL) sites, CERCLA sites, and other sites. The NPL sites are areas deemed by the EPA as eligible for long-term cleanups under the Superfund Act. Although a number of factors determine whether a site will be on the NPL, a major determinant is whether the site will result in actual human exposure rather than a potential exposure. The ATSDR assessments contain information that is available from EPA and local governments regarding general information about the site, environmental sampling data, contamination of food sources (e.g., fish and wildlife), and other findings. ATSDR health assessors use comparison values to identify chemicals that need to be further evaluated for their impact on human health under site-specific conditions. Toxic substances detected at U.S. AOC sites exceeding health-based guidance values are displayed in tables for each U.S. AOC site. The ATSDR minimum risk levels (MRLs) and the EPA reference doses (RfDs) are the health-based guidance values used by the ATSDR assessors.

As described in its *Public Health Assessment Guidance Manuals* (2004), "ATSDR has established distinct descriptive [hazard] categories that are assigned to every site to help ensure a consistent approach in drawing conclusions across sites." These categories are shown in Table 1-2.

Table 1-2. Public Health Hazard Conclusion Categories

Category	Definition
1. Urgent Public Health Hazard	Sites where short-term exposures (<1 year) to hazardous substances or conditions could result in adverse health effects requiring rapid intervention.
2. Public Health Hazard	Sites where long-term exposures (>1 year) to hazardous substances or conditions could result in adverse health effects requiring one or more public health interventions.
3. Indeterminate Public Health Hazard	Sites where a professional judgment on the level of health hazard cannot be made due to the lack of critical data about the extent of exposure and/or toxicologic properties at estimated exposure levels.
4. No Apparent Public Health Hazard	Sites where exposure to site-related chemical may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause adverse health effects.
5. No Public Health Hazard	Sites that, because of the absence of exposure, do not pose a public health hazard.

The following analyses of the potential impacts of hazardous wastes sites on the 26 U.S. AOCs is based on data taken from ATSDR health assessments and health consultations obtained from HazDat, ATSDR's Hazardous Substance Release/Health Effects Database, (<http://www.atsdr.cdc.gov/hazdat.html>, HazDat, 2006).

Using HazDat, ATSDR has extracted data for contaminants that exceed human health screening concentrations at hazardous waste sites with public health hazard categories of 1 (Urgent Public Health Hazard), 2 (Public Health Hazard), or 3 (Indeterminant Public Health Hazard). These categories represent 92% of the ATSDR public health assessments conducted at the AOC sites. The remaining 8%, representing approximately 10 sites, were No or No Apparent Public Health Hazard categories. The inclusion of these sites (Categories 4 and 5) would not add to the general purpose of the report which is to determine the public health implications of hazardous substances found at the AOC sites. For the Indeterminant category, a Public Health Hazard may exist, but the missing data prevents the ATSDR assessor from making a definitive judgment about the Hazard category.

For the Urgent Public Health Hazard category, ATSDR expeditiously issues a health advisory that includes strong recommendations to immediately stop or reduce exposure to mitigate the health risks posed by the site. Before ATSDR issues a health advisory, there are discussions with the EPA both at the regional and headquarter levels. If the regulatory agencies act rapidly to mitigate hazards, a health advisory is not issued. The site posing an urgent public health hazard is followed by ATSDR until the implementation of remediation and the removal of the public health hazard.

The data in the U.S. AOC report are used to give a general picture of what chemicals were, at some point in the assessment of the site, present at concentrations that indicated a need for further evaluation. The ATSDR public health assessments, consultations, and related assessments provide a further analysis of the significance to public health of these chemicals, including whether or not completed exposure pathways exist or existed for the chemicals. For NPL sites that may have been remediated subsequent to ATSDR evaluation, information regarding the current status of the site was obtained from the EPA NPL fact sheets (<http://www.epa.gov/epahome/whereyoulive.htm#regiontext>), from written comments from EPA, and from more recent ATSDR follow-up reports, if available. These are incorporated into the report. Although remediation may have occurred at a specific AOC site, the original information regarding contamination at the AOC site remains in the report. This is to demonstrate the extent of EPA's remediation effort given the level of site contamination.

Demographic data for the NPL sites were extracted by ATSDR from the 2000 U.S. Census (<http://www.census.gov/>) and are reported on the AOC maps in the Appendix and also in the text of this document. The GIS maps present the locations and demographic data for all NPL sites, but the data analyses in this document focus on sites with hazard categories of 1-3. For non-NPL sites, demographic data were taken from the health assessment documents.

1.2 TRI DATA FOR THE 26 U.S. GREAT LAKES AOCs

The TRI is a publicly available EPA data base (<http://www.epa.gov/tri/>) of information on toxic chemical releases in the United States for soil, water, and air, as reported by certain covered industries and by federal facilities. The TRI identifies the reporting facilities; chemicals manufactured, processed, and used at the facilities; and estimated annual amounts of these chemicals released. The releases of some IJC critical pollutants are reported through the TRI. These critical pollutants are PCBs, PCDDs, and PCDFs, aldrin, lead and lead compounds, mercury and mercury compounds, toxaphene, and hexachlorobenzene. TRI data are included in this report to provide an indication of the potential impact of chemicals released from industrial sources in proximity to the U.S. Great Lakes AOCs. This document focuses on on-site releases as most relevant to exposures from the U.S. Great Lakes AOCs. Off-site releases are the discharge of chemicals by an industry or facility at sites away from the particular industrial site. The TRI tables, depicting the data on chemical discharges, may contain a zero value. This indicates that a value was not reported.

Discharges in pounds of toxic substances to soil, water, and air, are shown in the TRI data for this report and apply to the counties in which the AOCs are located. No health-based guidance levels are associated with these discharges. However, if the volume, in pounds, of toxic substances is great and the substances that persist in the environment are present, they can quite possibly be transported in media such as air, exposing residents within the AOC and other areas. In addition, the TRI data in this report are for a single year (2001). If the same toxic substances continue to be discharged, they would still have the potential for influencing human health.

Subsequent studies in these areas need to consider the potential of interactive effect of multiple chemicals at a single site where a number of toxic substances have been detected or reported as discharges to the environment.

1.3 NPDES DATA FOR THE 26 U.S. GREAT LAKES AOCs

Following peer review of the April 2004 draft of this document, ATSDR decided to investigate chemical discharges into surface water permitted under the National Pollutant Discharge Elimination System (NPDES) to determine whether these discharges may be contributing to the environmental burden of the IJC critical pollutants and other contaminants. NPDES permits are required by all facilities that discharge directly into surface waters and are authorized under the Clean Water Act (<http://cfpub.epa.gov/npdes/>). These permits cover a broad range of discharges and are used to regulate the discharge of individual chemicals, as well as such general parameters as flow, temperature, and pH. EPA (October 2005) reports that most facilities meet permitted levels of discharge. Some facilities discharge less and some facilities discharge more than their permitted levels.

The Permit Compliance System (PCS) is a database that houses information associated with this program and contains specific information such as average mass of a specific chemical that is allowed in discharges over a specified time. To estimate the contribution permitted facilities make to the chemical loads experienced by the 26 U.S. AOCs, PCS was queried in November 2004 to identify those facilities that, as of that date, were permitted to discharge chemicals into

the counties that encompass and surround these AOCs and that are within the Great Lakes basin. Data regarding permitted discharges (as Quantity Average Limits) are summarized in the text, along with additional explanations of the methodology used to analyze and summarize the data.

Although the report is not a comprehensive review of all U.S. AOC chemical contaminant sources impacting the area, it does use multiple data sources (i.e., TRI and NPDES data and the ATSDR public health assessments of NPL and non-NPL sites), to give a relatively well-rounded picture of contaminant sources for the U.S. AOCs.

1.4 COUNTY HEALTH OUTCOME DATA FOR THE 26 U.S. GREAT LAKES AOCs

Health outcome data for the counties that immediately encompass and surround the 26 U.S. AOCs were obtained from *Community Health Status Reports* (<http://www.plh.org/Data-infra.html>) produced in 2000 by the Health Resources and Services Administration (HRSA) of the U.S. Department of Health and Human Services (DHHS). The county represents the smallest geographic area for which health outcome data are available. The Community Health Status Reports compare measures of birth and death (e.g., morbidity outcomes of low birth weight and mortality rates from infant deaths and from diseases such as cancer), for a county with peer counties and were utilized because of their availability. These statistics are used for research studies and to set health policy based on the observed health outcomes for a given community.

The peer counties are other counties and county-like geographic areas (usually 20 or more) that are similar in population size and density, poverty and age structure, to the counties of interest. The health measures also are compared with the U.S. rates. Both comparisons are intended to identify elevated rates of morbidity and mortality in the AOC counties.

1.5 METHODOLOGY FOR DATA COLLECTION

Since this document is a descriptive report and not a planned epidemiologic study, existing data were used to ascertain the impact of hazardous substances detected within the U.S. AOC counties and their potential health effects, as observed in county-wide health outcome data. This type of study provides information about U.S. AOC areas that will potentially require future in-depth investigation.

For example, ATSDR public health assessments were used to obtain information on exposure and potential health effects for this report. The ATSDR assessor used the data that was available from EPA and state governments for the public health assessment and this information, in turn, was included in the U.S. AOC report. If data on fish consumption advisories or non-point sources of contamination, for example, were available, this information was included in this report.

Chemicals discharged at levels exceeding an accepted standard may contribute to adverse health effects to the population residing in proximity to the contaminated area. Since the report is not an epidemiologic study, no causal inferences are drawn regarding an observed health effect and the presence of a contaminant known to be associated with that health effect.

For the geographic area and the number of U.S. AOC sites, it would be impossible in terms of time and funding to examine in detail all the U.S. AOC sites. For this reason, ATSDR has used pertinent and available information from ATSDR assessments and the EPA TRI and NPDES databases to describe the potential public health hazards from toxic substances found at the U.S. AOC sites.

1.6 BENEFICIAL USE IMPAIRMENTS (BUIs)

The BUIs are an integral part of the AOCs' environmental condition and may be accessed on the EPA web site (<http://www.epa.gov/glnpc/aoc/>). These include three indicators:

- Restrictions on fish and wildlife consumption
- Restrictions on drinking water consumption
- Beach closings

1.7 BIOLOGICAL CONTAMINATION AT THE AOC SITES

This report was not meant to be a comprehensive evaluation of all potentially hazardous substances at the U.S. AOC sites. It deals with a major concern, which is the chemical contamination found in the Great Lakes basin. Biological contaminants found at these sites may pose a serious health threat. The discussion of biological contaminants at Great Lakes beaches is beyond the scope of this report.

1.8 HAZARD CATEGORIES

The U.S. AOC report selected the public health assessments with the categories of Urgent Public Health Hazard (Category 1), Public Health Hazard (Category 2), and Indeterminant Public Health Hazard (Category 3). (See Table 1.2). The Indeterminant Hazard category is used when critical data are missing. For example, data on exposure and/or contaminant levels for different media (e.g., drinking water) may be missing or insufficient. At the various sites where ATSDR has done an assessment, recommendations are made for EPA or the local government to obtain the missing information. If the recommended data become available, then ATSDR will do a follow-up assessment, which will be included in the U.S. AOC report.

1.9 THE COMPLETED EXPOSURE PATHWAY

Exposure pathway evaluations should define the points of exposure, concentrations of environmental contamination at these points, and the populations that are potentially exposed. Five elements must be present to consider the pathway complete. These five elements are:

- Element 1: Contaminant source or release. These may include examples such as drums and landfills;
- Element 2: Environmental fate and transport. This involves the movement of the contaminant through various media (i.e., air, soil, and water) and includes the degradation of the contaminant;

- Element 3: Exposure point or area. The specific location(s) where the population might come into contact with the contaminated media;
- Element 4: Exposure route. This includes the means by which contact is made by the population at the exposure point (e.g., inhalation, ingestion, or dermal contact);
- Element 5: Potentially exposed populations. The identification and characterizing of the population that may have contact with the contaminant.

Although a complete exposure pathway may exist, this does not mean that a public health hazard exists. Rather specific conditions (i.e., route of exposure and the magnitude, frequency, and duration of exposures) need to be examined to evaluate possible health implications of the exposure. A completed exposure pathway exists when direct evidence is available, or in the judgment of the health assessment team, that there is a strong likelihood that people in the past or present are coming in contact with site-related contaminants.

1.10 LIMITATIONS OF THE REPORT

Since this study is not an epidemiologic study, adjusting for confounding factors is not considered a limitation since no causal relationships or associations are inferred. Nevertheless, this report has certain limitations that would tend to underestimate patterns of contamination as well as potential health effects to vulnerable populations. These are:

- Since county-wide data are used to ascertain health outcomes, a dilution or underestimation of effects may result since it includes residents that are not among those most highly exposed;
- The U.S. AOCs may be located across more than one county or be confined within a much localized area in a county. In these instances, the county data may not be totally representative of the population residing in proximity to the site;
- County-wide data would not differentiate between rural or urban industrial area populations or among lower socioeconomic or affluent areas;
- Use of existing health outcome data rather than more sensitive health outcomes that may miss subtle health conditions, such as functional deficits, fertility, cognition or immune function;
- Both the TRI, as required under TSCA and NPDES information rely on self-reporting mechanisms. Neither source of information reflect potential for human exposure.

Future studies investigating the associations between potential exposures to contaminants found within the AOCs and health outcomes should consider examination of smaller, targeted areas near waste sites and/or other sources of contamination. These studies should address sensitive health outcomes (e.g., functional deficits in cognition, immune function, and fertility); confounding factors; critical exposure periods and disease latency, and the effect of mixtures of chemicals. Current insights derived from this evaluation effort regarding the potential for such health effects are summarized in reports based upon peer reviewed literature and an Expert Panel Report (Appendix).