

# 1. Introduction and Inventory Objective

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This 2001 inventory update, a product of the Great Lakes Regional Air Toxic Emissions Inventory Project, presents a multijurisdictional inventory of point, area and mobile sources of toxic air emissions that have the potential to impact environmental quality in the Great Lakes region. This initiative was undertaken through an intergovernmental partnership involving the eight Great Lakes states, the province of Ontario, and the U.S. Environmental Protection Agency (U.S. EPA). The objective of this ongoing initiative is to present researchers and policy makers with detailed, region wide data on the source and emission levels of air toxic contaminants.

The development and release of the inventory is an important step in meeting the goals of the 1986 Great Lakes Toxic Substances Control Agreement (signed by the Great Lakes governors and Premier of Ontario), and sections 112(c)(6), 112(k) and 112(m) of the 1990 U.S. Clean Air Act Amendments (see <http://www.cglg.org/pub/toxics/index.html> and <http://earth1.epa.gov/oar/caa.html> for further details).

The inventory project presents a compilation of the best available data for calendar year 2001 emissions. Great Lakes jurisdictions believe this work will provide a strong foundation upon which to build national and binational strategies to reduce toxic air emissions affecting the Great Lakes.

This inventory effort focused on the identification of point, area and mobile source categories that contribute to the total emissions of toxic contaminants listed in Table 1-1. This list of 213 contaminants was compiled using the Great Lakes Water Quality Agreement, International Joint Commission's list of Great Lakes critical pollutants, U.S. EPA's list of targeted toxic chemicals and compounds defined in the U.S. Clean Air Act Amendments of 1990, section 112 (c)(6), and those pollutants suggested by the Great Lakes states and Province of Ontario.

The inventory project is strengthening decision making capabilities in the region by promoting interjurisdictional consistency in data collection and analysis, establishing standard procedures and protocols, developing and testing an automated emission estimation and inventory system, and demonstrating the value of client/server technology via the Internet to transmit and exchange environmental data among the Great Lakes jurisdictions and inform the larger Great Lakes community.

## Inventory Scope

The Great Lakes Toxic Air Emissions Inventory effort began in 1989 with primary funding provided by the U.S. EPA. Development of a *Regional Air Pollutant Inventory Development System* (RAPIDS), a regional protocol for calculating emissions and an inventory for Southwest Lakes Michigan launched this regional effort. To date we have released full inventories for the years 1993, 1996, 1997, 1998, 1999, and 2001. The 1993 inventory consisted of point and area sources for 49 pollutants of concern. The 1996, 1997 and 1998 inventories include emissions information from point, area, and mobile sources for 82 toxic air pollutants. For the 1999 and 2001 inventory, the list of target compounds was increased to 213. Emissions estimates are not

available for all 213 compounds on the target list. Reasons for lack of estimates for targeted compounds include lack of activity data, lack of appropriate emission factors, and possibly high reporting thresholds for some jurisdictions.

## Inventory Methodology

The 2001 update of the Regional Toxic Air Emissions Inventory effort focuses on significant sources of air emissions of 213 toxic air pollutants in the jurisdictions bordering the Great Lakes. Working cooperatively through the Great Lakes Commission, inventory work is undertaken by the air quality departments of the state and provincial governments in the region. Staff at each agency followed the *Regional Toxic Air Emissions Inventory Protocol* (online at [www.glc.org/air/protocol/protocol.html](http://www.glc.org/air/protocol/protocol.html)). The protocol provides guidelines to accomplish the regional inventory development effort so the inventory is complete, accurate, and consistent from one jurisdiction to the next. The protocol includes:

- Assigns responsibilities and procedures to the states, Great Lakes Commission, U.S. EPA Great Lakes National Program Office (GLNPO);
- Outlines procedures to identify and locate emission sources of target compounds;
- Guides selection of specific emission estimation techniques;
- Instructs states on compiling and updating the regional repository at GLNPO;
- Outlines quality assurance/quality control procedures for emission data and estimates; and
- Identifies and explains the full suite of automated tools available for developing the regional inventory.

Two important issues for the inventory development effort are the appropriate level of detail and the use of facility versus area approach for calculating emissions. For the inventory, the protocol defines the following level of detail as being appropriate for meeting the goals of the project:

- **Emitants included:** Include all target compounds listed in Table 1-1;
- **Spatial resolution:** By county for area and mobile sources, and to the nearest 100 meters for facility sources and associated devices;
- **Temporal resolution:** Annual emissions estimates and annual activity data; and
- **Source/device/process categorization:** By the most detailed source/device/process as identified in U.S. EPA's Source Classification Codes (SCC) and Area and Mobile Source (AMS) coding systems of process codes plus a further breakdown by North American Industrial Classification System (NAICS) or Standard Industrial Classification (SIC), as appropriate, to better categorize a given source (required to prevent the problem of inconsistent aggregation of sources/devices/processes among the participating states).

The protocol describes the two emission calculation approaches as follows:

- **Facility source approach:** Separately identify each device/process at each facility source and calculate its emissions (often referred to as a facility/point source approach); and
- **Area source approach:** Aggregate all similar or identical device/processes within a defined area and calculate their total emissions directly using the appropriate surrogate activity data

(the source in this case is the area in which all of the devices are found, usually an entire county).

The area source approach is generally used for sources that are small and numerous, such as gasoline stations and dry cleaning establishments. They are not included as facility sources because the effort required to gather and estimate emissions for each individual facility is beyond the resources available for inventory development efforts. Some area sources, such as consumer products, have no analog as a facility source.

The protocol refers to certain software tools (e.g. the Regional Air Pollutant Inventory Development System (RAPIDS), discussed below) that can be used to prepare a state or province's portion of the regional inventory. However, the protocol procedures, if followed, will result in emissions data and estimates that are compatible and consistent, whether or not these software tools are used.

## **RAPIDS Development**

The RAPIDS Steering Committee is composed of representatives from each of the air management programs from the eight Great Lakes states and province of Ontario and observers from U.S. EPA. A complete list of members with contact information can be found in Appendix M. For further information on Steering Committee functions see <http://www.glc.org/air/>.

The Steering Committee worked closely with the project software development contractor, Ennovations Technologies Inc., to enhance emissions estimation and reporting capabilities in RAPIDS. RAPIDS is a client/server system developed in PowerBuilder® with an ORACLE® back-end database. The software takes full advantage of Internet/Great Lakes Information Network (GLIN) connections between the states, the Great Lakes Commission and the U.S. EPA GLNPO office in Chicago.

## **Quality Assurance/Quality Control**

Finally, Quality Assurance/Quality Control (QA/QC) of the inventory was performed. The RAPIDS software provides feedback on missing data during emission calculation and “out of range” errors when importing or entering data via the input screens. Regional checks included items such as:

- Comparing emissions of the states to each other
  - state emissions by pollutant;
  - state emissions by pollutant and source category (point, area, etc.);
- Comparing emissions of a state to its emissions from previous inventories, and other sources of data;
- Ranking emissions by county for each pollutant and looking for outliers;
- Identifying the individual source types for area, mobile and non-road sources that were not inventoried by a state;
- For each SCC, identified which pollutants each state inventoried and indicated which pollutants were missing or extra.

These checks, and other minor ones, ensured that this report provided an accurate and useful summary of toxic air emissions at the regional level.

## **Next steps**

The regional inventory project will be focusing on the completion of a comprehensive inventory for the year 2002, and on improving the RAPIDS. We will continue to improve emission estimates PBTs, with particular focus on mercury and benzo(a)pyrene, and to improve the level of detail of the inventory information to better satisfy policy, modeling, and research needs. RAPIDS will be modified to handle inventories for multiple years and to improve its reporting capabilities for pollutant groups. Moreover, we will continue to work on improving the states capacity to compile inventories, and in coordinating our project with other regional and national initiatives dealing with emission inventories and the assessment of toxic air emissions.

The Steering Committee is currently working with Pangaea Technologies, Ltd. on the development of a spatial, online interface to the regional inventory data, the Centralized Air emissions Repository On-Line (CAROL). CAROL will represent a vast improvement in the communication and outreach capacity of the regional inventory program. This tool will allow users to view and download emissions inventory data in a user-specific format, including online mapping applications. This will be a powerful tool in promoting the broader use of the emissions inventory data in modeling and impact assessment activities throughout the basin. The expected benefits include better-informed decision making and identification of additional inventory needs, among others.

**Table 1-1: List of 213 targeted toxic air pollutants.**

Pollutant Name	CAS Number	RAPIDS Code
1,1,1-Trichloroethane	71-55-6	TCE,111
1,1,2,2-Tetrachloroethane	79-34-5	TETCLET,1122
1,1,2-Trichloroethane	79-00-5	TRICLETH,112
1,1-Dichloroethane	75-34-3	DICLETH,11-
1,1-Dimethyl hydrazine	57-14-7	DIMETH HY,11
1,2,3,4,5,5-Hexachloro-1,3-cyclopentadiene	77-47-4	HEXACL-1,3-C
1,2,4-Trichlorobenzene	120-82-1	TRICLBZ,124
1,2-Dibromo-3-chloropropane	96-12-8	DIBROMO3,12
1,2-Dibromoethane	106-93-4	DIBROMOET,12
1,2-Dichloroethane	107-06-2	DICHLORETH12
1,2-Diphenylhydrazine	122-66-7	DIPHENHYD,12
1,2-Epoxybutane	106-88-7	EPOXYBUT,12
1,2-Propylenimine	75-55-8	PROP IM, 12
1,3-Butadiene	106-99-0	BUTADIENE,13
1,3-Dichloropropene	542-75-6	DICLPROPE,13
1,3-Propane sultone	1120-71-4	PROPANESU,13
1,4-Dichlorobenzene	106-46-7	DICLBENZ,14
1,4-Dioxane	123-91-1	DIOXANE
2,2,4-Trimethylpentane	540-84-1	TRIME-PENTAN
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6	TCDD,2378
2,3,7,8-Tetrachlorodibenzofuran	51207-31-9	TCDF,2378
2,4,5-Trichlorophenol	95-95-4	TRICLPHN,245
2,4,6-Trichlorophenol	88-06-2	TRICLPHN,246
2,4-D, Salts And Esters	94-75-7	D,2,4
2,4-Diaminotoluene	95-80-7	TOL DIAMIN24
2,4-Dinitrophenol	51-28-5	DINITROPH,24
2,4-Dinitrotoluene	121-14-2	DINITRTOL,24
2-Acetylaminofluorene	53-96-3	ACETYLAMIN,2
2-Chloroacetophenone	532-27-4	CLACETOPHE,2
2-Nitropropane	79-46-9	NITROPROPA,2
3,3-Dichlorobenzidine	91-94-1	DICLBENZD,33
3,3-Dimethoxybenzidine	119-90-4	DIMETHOXY,33
3,3-Dimethylbenzidine	119-93-7	DIMETHBNZ,33
4,4-Methylene bis(2-chloroaniline)	101-14-4	METEN BIS,44
4,4-Methylenediphenyl diisocyanate	101-68-8	METHENE(B)4-
4,4-Methylene dianiline	101-77-9	METHENE DIAN
4,6-Dinitro-o-cresol (including Salts)	534-52-1	DINITRO-O-CR
4-Aminobiphenyl	92-67-1	AMINOBIPHE,4
4-Nitrobiphenyl	92-93-3	NITRBIPHEN,4
4-Nitrophenol	100-02-7	NITROPHENL,4
Acenaphthene	83-32-9	ACENAPHTHEN
Acenaphthylene	208-96-8	ACENAPHTHYL

Pollutant Name	CAS Number	RAPIDS Code
Acetaldehyde	75-07-0	ACETALDEHYDE
Acetamide	60-35-5	ACETAMIDE
Acetonitrile	75-05-8	ACETONITRILE
Acetophenone	98-86-2	ACETOPHENONE
Acrolein	107-02-8	ACROLEIN
Acrylamide	79-06-1	ACRYLAMIDE
Acrylic acid	79-10-7	ACRYLIC ACID
Acrylonitrile	107-13-1	ACRYLONITRIL
Alkylated lead		LEAD,ALK
Allyl chloride	107-05-1	ALLYL CHLORI
Aniline	62-53-3	ANILINE
Anthracene	120-12-7	ANTHRACENE
Antimony	7440-36-0	ANTIMONY
Arsenic (and compounds)	7440-38-2	ARSENIC
Asbestos	1332-21-4	ASBESTOS
Atrazine	1912-24-9	ATRAZINE
Benz(a)anthracene	56-55-3	BENZ(A)ANTHR
Benzene	71-43-2	BENZENE
Benzidine	92-87-5	BENZIDINE
Benzo(a)pyrene	50-32-8	BENZO(A)PYRE
Benzo(b)fluoranthene	205-99-2	BENZO(B)FLUO
Benzo(g,h,i)perylene	191-24-2	BENZ(GHI)PE
Benzo(k)fluoranthene	207-08-9	BENZO(K)FLUO
Benzotrichloride	98-07-7	BENZOTRICHLO
Benzyl chloride	100-44-7	BENZYL CHLOR
Beryllium (and compounds)	7440-41-7	BERYLLIUM
Beta-propiolactone	57-57-8	BETA-PROPRIO
Biphenyl	92-52-4	BIPHENYL
Bis (2-chloroethyl) ether	111-44-4	BIS(2-CLETH)
Bis(chloromethyl)ether	542-88-1	BIS(CLMETH)
Bromoform	75-25-2	BROMOFORM
Bromomethane	74-83-9	BROMOMETH
Cadmium (and compounds)	7440-43-9	CADMIUM
Calcium cyanamide	156-62-7	CALCIUM CYAN
Captan	133-06-2	CAPTAN
Carbaryl	63-25-2	CARBARYL
Carbon disulfide	75-15-0	CARBON DISUL
Carbon tetrachloride	56-23-5	CARBON TETRA
Carbonyl sulfide	463-58-1	CARBONYL SUL
Catechol	120-80-9	CATECHOL
Chloramben	133-90-4	CHLORAMBEN
Chlordane	57-74-9	CHLORDANE
Chlorine	7782-50-5	CHLORINE
Chloroacetic acid	79-11-8	CHLOROACETIC

Pollutant Name	CAS Number	RAPIDS Code
Chlorobenzene	108-90-7	CHLOROBENZ
Chlorobenzilate	510-15-6	CLBENZILATE
Chloroethane	75-00-3	CHLOROETHANE
Chloroform	67-66-3	CHLOROFORM
Chloromethyl methyl ether	107-30-2	CLMETH METH
Chloroprene	126-99-8	CHLOROPRENE
Chromium (and compounds)	11115-74-5	CHROMIUM
Chromium VI	18540-29-9	CHROMIUM VI
Chrysene	218-01-9	CHRYSENE
Cobalt (and compounds)	7440-48-4	COBALT
Coke oven emissions		COKE OVEN GS
Copper (and compounds)	7440-50-8	COPPER
Copper cyanide	544-92-3	CU CYANIDE
Cresol (mixed isomers)	1319-77-3	CRESOL MX IS
Cumene	98-82-8	CUMENE
Cyanide	57-12-5	CYANIDE
Diazomethane	334-88-3	DIAZOMETHANE
Dibenzo(a,h)anthracene	53-70-3	DIBENZAHAH
Dibenzofuran	132-64-9	DIBENZOFURAN
Dibutyl phthalate	84-74-2	DIBUTYL PHTH
Dichlorvos	62-73-7	DICHLORVOS
Diethanolamine	111-42-2	DIETHANOLAMI
Diethyl sulfate	64-67-5	DIETH SULFAT
Diethylhexyl phthalate	117-81-7	DIEYLHEX PHT
Dimethyl aminoazobenzene	60-11-7	DIMETH AMINO
Dimethyl phthalate	131-11-3	DIMETH PHTHA
Dimethyl sulfate	77-78-1	DIMETH SULFA
Dimethylaniline (N,N-Dimethylaniline)	121-69-7	DIMETHYLANIL
Dioctyl phthalate	117-84-0	DIOCTYL PHTH
Epichlorohydrin	106-89-8	EPICLHYDRIN
Ethyl acrylate	140-88-5	ETH ACRYLATE
Ethyl carbamate	51-79-6	ETHYL CARBAM
Ethylbenzene	100-41-4	ETHYLBENZENE
Ethylene glycol	107-21-1	ETHYLENE GLY
Ethylene imine	151-56-4	ETHYLENE IMI
Ethylene oxide	75-21-8	ETHYLENE OXI
Ethylene thiourea	96-45-7	ETHYLENE THI
Fine mineral fibers		FINE MNRLFIB
Fluoranthene	206-44-0	FLUORANTHENE
Fluorene	86-73-7	FLUORENE
Formaldehyde	50-00-0	FORMALDEHYDE
Glycol ethers		GLYCOL ETHRS
Heptachlor	76-44-8	HEPTACHLOR
Hexachloro-1,3-butadiene	87-68-3	HEXCL-13-BUT

Pollutant Name	CAS Number	RAPIDS Code
Hexachlorobenzene	118-74-1	HEXCLBENZENE
Hexachloroethane	67-72-1	HEXCHLORETH
Hexamethyl phosphoramidate	680-31-9	HXMETH PHOSP
Hexamethylene-1,6-diisocyanate	822-06-0	HEXAMETHYL16
Hydrazine	302-01-2	HYDRAZINE
Hydrochloric acid	7647-01-0	HCL
Hydrogen cyanide	74-90-8	HYDROGEN CYA
Hydrogen fluoride	7664-39-3	HF
Hydrogen sulfide	7783-06-4	HYDROGEN SUL
Hydroquinone	123-31-9	HYDROQUINONE
Indeno(1,2,3-c,d)pyrene	193-39-5	INDN(123CDPY
Isophorone	78-59-1	ISOPHORONE
Lead (and compounds)	7439-92-1	LEAD
Lindane (all Isomers)	58-89-9	LINDANE ISO
m-Cresol	108-39-4	CRESOL,M
m-Xylene	108-38-3	XYLENE,M
Maleic anhydride	108-31-6	MALEIC ANHYD
Manganese (and compounds)	7439-96-5	MANGANESE
Mercury (and compounds)	7439-97-6	MERCURY
Mercury (organic)	22967-92-6	MERCURY,ORG
Methanol	67-56-1	METHANOL
Methoxychlor	72-43-5	METHOXYCHLOR
Methyl chloride	74-87-3	METHYL CHLOR
Methyl ethyl ketone	78-93-3	METH ETH KET
Methyl hydrazine	60-34-4	METH HYDRAZI
Methyl iodide	74-88-4	METH IODIDE
Methyl isobutyl ketone	108-10-1	METH ISOBUT
Methyl isocyanate	624-83-9	METH ISOCYAN
Methyl methacrylate	80-62-6	METH METHACR
Methyl tert butyl ether	1634-04-4	METH TERT BU
Methylene chloride	75-09-2	METHYLENE CL
N,N-Dimethyl carbamoyl chloride	79-44-7	NDIMETH CARB
N,N-Dimethylformamide	68-12-2	DIMETHFORMAM
n-Hexane	110-54-3	HEXANE
N-Nitroso-n-methylurea	684-93-5	NITROSO-N,N
N-Nitrosodimethylamine	62-75-9	NITROSODIMET
N-Nitrosomorpholine	59-89-2	NITROSOMORPH
Naphthalene	91-20-3	NAPHTHALENE
Nickel (and compounds)	7440-02-0	NICKEL
Nitrobenzene	98-95-3	NITROBENZ
o-Anisidine	90-04-0	ANISIDINE,O-
o-Cresol	95-48-7	CRESOL,O
o-Toluidine	95-53-4	TOLUIDINE,O-
o-Xylene	95-47-6	XYLENE,O

Pollutant Name	CAS Number	RAPIDS Code
p-Cresol	106-44-5	CRESOL,P
p-Phenylenediamine	106-50-3	PHENYLENED,P
p-Xylene	106-42-3	XYLENE,P
Parathion	56-38-2	PARATHION
Pentachloronitrobenzene	82-68-8	PENTCLNITBEN
Pentachlorophenol	87-86-5	PCP
Phenanthrene	85-01-8	PHENANTHRENE
Phenol	108-95-2	PHENOL
Phosgene	75-44-5	PHOSGENE
Phosphine	7803-51-2	PHOSPHINE
Phosphorus	7723-14-0	PHOSPHORUS
Phthalic anhydride	85-44-9	PHTHALIC ANH
Polychlorinated biphenyls (PCBS)	1336-36-3	PCBS
Polychlorinated dibenzodioxins, Total		PCDD
Polychlorinated dibenzofurans, Total		PCDF
Propionaldehyde	123-38-6	PROPIONALDEH
Propoxur	114-26-1	PROPOXUR
Propylene dichloride	78-87-5	PRPLENE DICH
Propylene oxide	75-56-9	PRPLENE OXID
Pyrene	129-00-0	PYRENE
Quinoline	91-22-5	QUINOLINE
Quinone	106-51-4	QUINONE
Radionuclides		RADIONUCLIDE
Selenium (and compounds)	7782-49-2	SELENIUM
Styrene	100-42-5	STYRENE
Styrene oxide	96-09-3	STYRENE OXID
Tetrachloroethylene	127-18-4	PERC
Titanium tetrachloride	7550-45-0	TITAN TETCL
Toluene	108-88-3	TOLUENE
Toluene-2,4-diisocyanate	584-84-9	TOLUENE24DII
Toxaphene	8001-35-2	TOXAPHENE
Trichloroethylene	79-01-6	TRICHLORETHY
Triethylamine	121-44-8	TRIETHAMINE
Trifluralin	1582-09-8	TRIFLURALIN
Vinyl acetate	108-05-4	VINYL ACETAT
Vinyl bromide	593-60-2	VINYL BROMID
Vinyl chloride	75-01-4	VINYL CHLOR
Vinylidene chloride	75-35-4	VINLIDENE CL
Xylene (mixed isomers)	1330-20-7	XYLENES ISO

Data summaries of the 2001 update and all previous inventories are available online at the Great Lakes Information Network (GLIN, <http://www.great-lakes.net>). Additional information, including background documents, the emissions protocol document and list of products for the project are located on the emission inventory project's web site (<http://www.glc.org/air/>).

The air emissions inventory project is funded primarily by the U.S. EPA from the Great Lakes Geographic Initiative air program grant funds designated for regional projects that address air toxics and the Great Lakes.

The eight states and Ontario will continue to work collaboratively to improve and refine the toxics inventory and strengthen its ability to support sound regulatory decisions at all levels of government.