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AQUIRE

AQUatic toxicity Information REtrieval

Database

A Technical Support Document

Prepared for:

U.S. EPA
Office of Research and Development
National Health and Environmental Effects Research Laboratory
Mid-Continent Ecology Division
Duluth, Minnesota

By:

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ABSTRACT

During the last several years, there has been an increased emphasis to improve and enhance the process by which ecological and human health hazard assessments are performed. This has resulted in a range of activity from the hazard evaluation of new and existing chemicals and pesticides to the evaluation of impact assessments associated with effluent, leachate, and environmental monitoring data. Additionally, research programs within the U.S. EPA which are associated with these efforts are expanding to further support the scientific basis of ecological and human health risk assessments for chemical pollutants.

To meet this challenge, a high-quality database, AQUIRE (AQUatic toxicity Information REtrieval), was developed in 1981 through efforts at the U.S. Environmental Protection Agency (U.S. EPA), National Health and Environmental Effects Research Laboratory, Mid-Continent Ecology Division, Duluth, Minnesota (MED). The AQUIRE system is one of the foremost resources for locating aquatic toxicity information and is used to evaluate and prioritize the hazards of industrial chemicals and pesticides for impact assessments of effluent and leachate discharges. The AQUIRE toxicological data summary is designed for use as a stand-alone reference database (Hunter et al. 1990) or as a high-quality data source for risk assessment tools (Russom et al. 1991).

For further information and inquiries regarding access to the AQUIRE database, contact:

Scientific Outreach Program
U.S. EPA
Mid-Continent Ecology Division
6201 Congdon Blvd.
Duluth, MN 55804

(218) 529-5225 (Telephone)
(218) 529-5003 (Fax)
E-Mail: outreach@du4500.dul.epa.gov

I. INTRODUCTION

Scope

Information storage in AQUIRE is organized by individual aquatic toxicity tests or bioassays. Each toxicity test record contains information about the test chemical, species, effect endpoint, concentrations, and conditions under which the toxicity test was conducted. Aquatic toxicity literature has been reviewed and entered into the system for sixteen years, the majority of which encompasses test results reported from 1970 to the present. Current publications are continually and systematically acquired and reviewed. Computerized laboratory data files from the public sector and available unpublished reports are also acquired and critiqued.

Access to the world's aquatic toxicological data is enhanced through international data exchanges with the Organization for Economic Cooperation and Development (OECD) and with the Borok Institute in Russia to promote a centralized source for toxic effects data. AQUIRE is updated regularly, and ongoing maintenance and development are projected to incorporate new publications. Resulting from this effort is a system that presently contains data on more than 3,000 species, 5,900 chemicals, over 10,000 references, and approximately 60 effects from 149,000 toxicity tests. AQUIRE is a summary of available aquatic toxic effects data and is subsequently designed to be used as a reference tool. Researchers or managers using AQUIRE for analyses or summary projects should consult the original scientific paper to ensure an understanding of the context of the data retrieved from AQUIRE.

Input

The toxicity data in AQUIRE is extracted from literature published primarily during the period from 1970 to the present. Current publications are acquired and reviewed regularly. Toxicity papers are acquired through literature searches, abstract journals, U.S. EPA Water Quality Criteria document bibliographies and from existing MED toxicity reprint collections. Literature undergoes a screening process to determine applicability to AQUIRE.

Publications used in AQUIRE must contain unique data. The bibliographic file and the main database files contain quality assurance checks for duplicate publications. If data are published in a dissertation, symposium proceeding, internal report or a book, and also in a peer-reviewed journal, only the journal publication is included in AQUIRE. If portions of the data are published in one source and the rest in a separate publication, both sources are reviewed with care so that each data point is included only once. Data reported in review papers are abstracted from the original publication.

International publications are reviewed by AQUIRE staff if either an English abstract or a translated table of data is included. International cooperative efforts are underway with the Organization for Economic Cooperation and Development (OECD) and Russia (Borok Institute) to enhance the review of the international literature.

Data obtained from independently compiled data files must meet the AQUIRE data parameter and quality assurance guidelines (see Section III). Data files that have been included in AQUIRE are the MED fathead minnow acute toxicity database (Center for Lake Superior Studies; University of Wisconsin-Superior, 1984, 1985, 1986, 1988, and 1990), the U.S. EPA, Office of Pesticide Programs, Ecological Effects Database, and datasets from France, Germany, the Netherlands and Russia (Appendix A).

AQUIRE is catalogued by the toxicant tested using the Chemical Abstracts Service (CAS) registry number. If a CAS registry number is not available through standard sources, the toxicity data cannot be included in AQUIRE. Additional toxicants not included in AQUIRE are water chemistry effects (e.g., pH), complex effluents, sediment studies that do not report a water concentration and chemical mixtures. If a publication contains data for a single chemical besides one of the above categories of toxicants, the paper is retained and only the single chemical data are used in AQUIRE.

Test organisms are limited to those that are exclusively aquatic. Amphibian data for purely aquatic lifestages of the organism are included. Classes of organisms associated with the aquatic environment (e.g., birds, mammals, reptiles) and the microscopic communities (bacteria and virus) are omitted. The test organisms are categorized according to current taxonomy and stored in AQUIRE such that toxicity information can be retrieved at many taxonomic levels (e.g., class, order, family, genus, and species).

The data elements included in AQUIRE reflect standard parameters within a toxicity test (American Society for Testing and Materials (1993), Code of Federal Regulations (1992), and the American Public Health Association et al. (1992)). Each test reviewed for AQUIRE is assigned a documentation code that indicates the amount of methods and results documentation available in the scientific paper.

Exposures must either be aqueous, through the diet or by injection. Toxicity test methods that are not applicable to AQUIRE include publications in which the aqueous exposure concentration or duration of exposure is not reported (e.g., field surveys, sediment toxicity, runoff, or leachate toxicity) and *in vitro* toxicity test results.

Quality assurance procedures begin with literature acquisition and cataloging, and continue through the chemical and species verification, the literature review process,

data entry, and data retrieval. Ten percent of all papers are independently reviewed by two AQUIRE staff members. Any subsequent corrections are also reviewed by two staff members. In addition to manual checks, there are various computerized checks within the database structure.

II. ACCESS

The AQUIRE database is located on a VAX computer at MED and a UNIX workstation at the EPA National Computer Center. The database can be accessed on-line by government offices using a variety of methods including by modem or via the Internet. There are several commercial vendors for access to AQUIRE data by the private sector. See Appendix B for a current listing of AQUIRE sources.

Magnetic tapes of the data may be purchased from the National Technical Information Service (NTIS) as a component of the ECOTOX system. Two versions are available:

* ECOTOX for VMS (PB97-500318) -- This version is specifically for VAX/VMS computers. It contains the data plus an executable copy of the AQUIRE and ECOTOX search and retrieval program that is used for on-line government access.

* ECOTOX for Non-VMS (PB97-500292) -- This version is for all other types of computers. It contains the data files but no executable programs.

Both versions may be purchased in tape densities of 1600 or 6250 or as a 3480 cartridge.

For more information on details of access or for user support, please call the Scientific Outreach Program at (218) 529-5225 for referral to the appropriate database staff person.

III. LITERATURE REVIEW

Data Sources

Pertinent literature is identified through on-line computerized searches of the international literature. The computerized searches were initiated with the 1970 publication year and continue through to the present. A comprehensive search was designed to include the effect of nearly all toxic substances on aquatic organisms within the scope of the AQUIRE guidelines. Commercial literature sources are continually evaluated for relevance to the AQUIRE literature search. The search strategy is evaluated regarding the success ratio of each search. Additional literature sources include abstract journals, U.S. EPA Water Quality Criteria document bibliographies, and the MED library collection.

The abstracts received are screened to identify references applicable to AQUIRE. Those references pertinent to the database are acquired through a variety of literature acquisition procedures such as author reprint requests, inter-library loans, and commercial sources. As the publications are received, a reference number is assigned for storage and retrieval purposes, and a final check for applicability and duplication is made. A bibliographic subfile (RETOX) stores the citations and a reprint of each publication is archived.

Data obtained from independent data files, rather than the published literature, are subjected to a series of quality assurance criteria before acceptance. The key AQUIRE data fields that must be included are: CAS number and chemical name, test organism, effect, exposure duration, and effect concentration. Documentation describing the test methods must be provided. If tests are missing key parameters, the data are rejected. During the incorporation of an electronic data file, a quality assurance check of the CAS number, species Latin name, and reference citation is completed.

The AQUIRE literature is encoded by trained document abstractors. An intensive training period, a well-documented manual (U.S. EPA 1996), and close interaction with the data coordinator help to ensure a high level of accuracy and consistency in the reviewing process. Ten percent of the publications are independently reviewed by two different reviewers. These reviews are compared, differences (if any) are documented, discussed, and resolved by the data coordinator.

IV. DATA ELEMENTS

The data elements for each test contained in AQUIRE are grouped by chemical, organism, exposure conditions, and effect endpoint. The test chemical parameters describe the toxicant, the associated CAS registry number, and the grade, purity and/or composition of the toxicant. The test organism parameters define the type of organism and the lifestage being tested. The test conditions identify the test water, test location, exposure type and duration, control parameters, and basic water chemistry. The effect endpoint parameters consist of a code to define the acute, sublethal, or residue endpoint and the corresponding test chemical concentration. In addition to the preceding categories, AQUIRE incorporates the use of a documentation code which indicates the amount of documentation available for each piece of data in AQUIRE. The following sections describe each of the data elements within these groups. **It is important to stress that the user should refer to the original publication to obtain additional test information which may be important when interpretting results presented in AQUIRE.**

Test Chemical Parameters

A standardized identification number and name for each chemical recorded in the database is used for consistency. Toxicants included in the AQUIRE database are assigned a CAS registry number and are referred to by the Ninth Collective Index (9CI) standard nomenclature. The CAS number and 9CI name are stored in a file accessed by AQUIRE. The CAS number, verified name, synonyms, and verification sources are kept on card file for documentation purposes.

Retrieval is made by using the CAS number or the chemical name. A separate index file (CHEMNAME) is available for screening CAS numbers and chemical names used in AQUIRE.

Relevant chemical information, such as trade names, common names or isomers is recorded in the chemical characteristics field. Percent purity or active ingredient and/or purity code is also recorded.

Test Organism Parameters

The test organism is identified by the current Latin name as verified in the taxonomic literature. Major and minor codes have been assigned to aid the user in obtaining information at various taxonomic levels (Appendix C). For each species entry, the verified name, taxonomic code, nomenclature history, and verification sources are kept

on file for documentation purposes. A species number can be located via two separate index files (SLATIN for Latin names and SCOMMON for common names).

Test organism life stage information includes characteristics such as age, weight, length, developmental stage, and initial cell concentration to describe the organism being tested.

Test Condition Parameters

Test Media

Freshwater (FW) tests include those 1) conducted in freshwater, reconstituted water, distilled water, or tap water, or 2) the organism habitat is exclusively freshwater. Saltwater (SW) tests include those 1) conducted in natural or artificial seawater, brackish water, or estuarine water, or 2) the organism habitat is exclusively saline. If a salinity value of ≤ 4 ppTh is reported and the paper does not specify whether it is fresh or saltwater, it will be coded as a freshwater test. If a determination cannot be made regarding the use of either freshwater or saltwater, an NR (not reported) is recorded.

Test Location (Lab, FieldN, FieldA, FieldU)

A natural (Field N) study is an experiment conducted outdoors in a natural water body or in an artificial water body that has a natural bottom substrate and established aquatic communities (e.g. phytoplankton, zooplankton and fish). Outdoor studies conducted in an artificial water body without a natural bottom substrate are considered artificial studies (Field A). If the water body cannot be determined to be natural or artificial it is coded as field unknown (FieldU). All other studies are considered laboratory (LAB) tests.

Exposure Duration

Exposure duration is coded using the units reported in the literature. For a fluctuating or intermittent dosing experiment, the total exposure time is recorded. The AQUIRE retrieval software uses an automatic conversion to days for consistency in data display.

Exposure Type

The exposure type indicates the type of chemical exposure to the test organisms. The AQUIRE exposure type codes and associated definitions are provided below.

Lab Exposure Types

- **C-** Topical exposure
- **D -** Diet or Oral Exposure - includes simultaneous diet and water exposure.
- **F -** Flow-Through
- **I -** Injection
- **L -** Leaching - used for leachate and sediment exposures, if water concentration reported
- **P -** Pulse (Intermittent or Fluctuating dosing)
- **R -** Renewal
- **S -** Static

Field Exposure Types:

- **B -** Tidal
- **D -** Diet
- **E -** Lentic- Static water system
- **I -** Injection
- **O -** Lotic- Flowing water system

Water Chemistry

The following water chemistry parameters are included in AQUIRE:

- Temperature is expressed in degrees Celsius.
- Hardness and alkalinity are expressed as mg/L as $CaCO_3$. If the author only reports the terms "hard" or "soft", these terms are recorded.
- Dissolved oxygen is reported in mg/L or percent saturation. A "SAT" code denotes 100% saturation.
- pH is reported.
- Salinity is expressed in parts per thousand (ppTh) or as percent seawater.
- Conductivity is reported as μmhos/cm (=μs/cm).
- Organic carbon is expressed in mg/L as C (T = Total, P = Particulate, D = Dissolved)

These measured values pertain either to the test water chemistry (preferred) or the dilution water chemistry values. If it is necessary to report the dilution water chemistry, this is denoted by an asterisk.

Chemical Analysis Method

Quantitative analyses of water in test chambers or field sites are considered a measured (M) concentration. Concentrations that are not analyzed in test chambers or field sites are considered unmeasured or nominal (U). When it is not clear that the values presented are based on measured or nominal concentrations, a code of "NR" (not reported) is assigned.

Control Tests

Control information for the reported effect may be presented in the text, in a graph, or in table format. Previously, AQUIRE reviewers assessed whether the controls were satisfactory (S), insufficient (I), or unsatisfactory (U). Since 1995, AQUIRE reviewers have simply documented the type of control presented by the author(s) using the following codes:

C Use of controls is reported by author; the control was a duplicate of the exposure tank(s) with the exception that test chemical was not present; this includes field studies where the control data are obtained upstream from the exposure data, and controls run in the same system (e.g., lake), but remote from the treatments (e.g., different section of the lake).

V Solvent control reported by author; a duplicate of the exposure tank(s) with the exception that test chemical was not present, but solvent used in stock preparation is present in the control tank.

H Historical control; results are compared to a control, but the control data were collected previously (i.e., not run simultaneously).

O Controls are reported by author, and control was run simultaneously, but not within the same exposure system; (i.e., control data from pond A, exposure conducted in pond B).

B Baseline control; test organism's measurement prior to exposure are used to compare results; mainly used in physiological/biochemical bioassays but includes pretreatment samples in field exposures that were conducted as part of or in preparation of the study.

M Multiple types of controls were reported by author (e.g., control with dilution water and solvent control).

K Control was presented but procedure unknown.

NR Control is not presented by the author.

Effect Parameters

Effect Concentration

The effect concentration is expressed in μg/L. The confidence interval or range is recorded when available. If the concentration is reported in units which cannot be readily converted into μg/L (e.g., mg/kg or μCi/L), the concentration value and its units are recorded. Concentration units used are listed in Appendix D. Concentrations based on the active ingredient or formulation, or as the total, un-ionized or dissolved concentration, are identified. The test compound is reported as the total or formulated chemical unless one of the following identifiers is reported:

A = Active Ingredient
D = Dissolved Metal Ion
U = Unionized Ammonia

In certain cases, the AQUIRE concentration is routinely reported as some form of the test chemical. For metal salts, the concentration is generally expressed as ug ion/L (e.g., Hg^+). When an exponential number is reported (e.g. 1×10^6), it is coded as E+n or E-n (e.g., 1 E+6).

Endpoint

Endpoint information is coded into AQUIRE if it is reported by the author. For the purposes of AQUIRE, an endpoint is defined as the quantification of an observed effect obtained through statistics or other means of calculation for the express purpose of comparing equivalent effects (e.g., LC50). Appendix E identifies the AQUIRE endpoint codes and definitions. The endpoint field will be blank if the author does not report an endpoint.

Effect

The AQUIRE database internally categorizes all observe Effect information must be provided by the author in order for the test to be included in AQUIRE. For AQUIRE database purposes, effect is defined as the observation of a response resulting from the action of a chemical stressor (e.g., mortality). d effects under at least one of eight

major effect group codes (behavior, bioconcentration, ecosystem, growth/development, lethal, physiological/biological, population community, and reproduction). Appendix F identifies the three letter AQUIRE effect codes, major effect group and associated AQUIRE records. Appendix G describes the major groups and associated effect definitions for each three letter code. Major effect group codes allow users to search on broad groups of effects without specifying each individual effect (e.g., growth and development effects are grouped under the GRODEV category).

Effects reported after the organisms are transferred to recovery (toxicant free) test chambers are recorded as delayed effects (~XXX). Delayed effects are reported only if the direct exposure effects are not specified.

Bioconcentration Factor (BCF)

The bioconcentration factor (BCF) is a unitless value describing the degree to which a chemical can be concentrated in the tissues of an organism in the aquatic environment. If in a residue exposure, the authors present a BCF, the value is entered and reported in the BCF field. A bioconcentration endpoint is coded as either wet (or unknown) or as dry weight (BCF and BCFD, respectively). Food chain studies are only coded for the first exposed organism via the diet.

Documentation Code

The AQUIRE documentation code indicates the type and completeness of methods documentation and results presentation accompanying the data. Documentation code assignments range from detailed documentation to summary format. The documentation codes are summarized below. Although a documentation code of C does not signify that these test data are better than test data receiving a documentation code of I, it does give AQUIRE users a means of determining the level of confidence associated with that test record.

Documentation Code = C: Thorough methods and results documentation.

Documentation Code = M: Documentation is generally satisfactory, but one or more of the pieces of information are missing from either the methods or results section such as control information or chemical concentrations are unmeasured.

Documentation Code = I: Insufficient methods and results documentation.

V. REFERENCES

American Society for Testing and Materials. 1993. *Annual Book of ASTM Standards*, Section II Water and Environmental Technology, Pesticides; Resource Recovery; Hazardous Substances and Oil Spill Responses; Waste Disposal; Biological Effects. Vol. 11.04. ASTM, Philadelphia, PA.

American Public Health Association, American Waste Works Association, and Water Pollution Control Federation. 1992. *Standard Methods for the Examination of Water and Waste Water*, Eighteenth Edition, APHA, Washington, DC.

Center for Lake Superior Environmental Studies, University of Wisconsin-Superior; 1984, 1985, 1986, 1988, and 1990. *Acute Toxicities of Organic Chemicals to Fathead Minnows (Pimephales promelas)*, Vol. 1-5. University of Wisconsin-Superior, Superior, WI.

Code of Federal Regulations. 1992. Title 40 - (Protection of Environment), Pt. 792 - "Good Laboratory Practice Standards", U.S. Government Printing Office, Washington, DC.

Hunter, R., G. Niemi, A. Pilli, and G. Veith. 1990. Aquatic Information and Retrieval (AQUIRE) Database System. Pages 42-48 In: Pillman, W. (Ed), *Computer Applications for Environmental Impact Analysis, ENVIROTECH VIENNA 1990*, International Society for Environmental Protection, Vienna, Austria.

Russom, C.L., E.B. Anderson, B.E. Greenwood, and A. Pilli. 1991. ASTER: An Integration of the AQUIRE Data Base and the QSAR System for Use in Ecological Risk Assessments. *The Science of the Total Environment* 109/110:667-670.

U.S. Environmental Protection Agency. 1996. *MED Ecotoxicology Standard Operating Procedures* (prepared by DynTel Corporation, Contract No. GS04K95BFD0169, Task #CCA686461), Mid-Continent Ecology Division, Duluth, MN.

APPENDIX A
INDEPENDENTLY COMPILED DATA FILES

Some data sets have been transferred into AQUIRE from independently compiled data files. The data sets must meet the AQUIRE data parameter and quality assurance guidelines. Data sets available in AQUIRE are:

The U.S. EPA MED data set includes the Acute Toxicity of Organic Chemicals file which contains data for a single test species (30-day fathead minnow). The U.S. EPA Office of Toxic Substances is acknowledged for long-term support in the generation of all acute toxicity data for organic chemicals. All test results, including data not available on-line, have been compiled in five volumes titled: Acute Toxicities of Organic Chemicals to Fathead Minnows (*Pimephales promelas*), available from the Center for Lake Superior Environmental Studies, University of Wisconsin, Superior, WI.

International cooperative efforts are underway with the Organization for Economic Cooperation and Development (OECD) and Russia (Borok Institute) in order to enhance the review of the International literature. Data files from France, Germany, the Netherlands and Russia are received and incorporated into AQUIRE on an ongoing basis.

Office of Pesticide Programs, Ecological Effects Database (OPP) of aquatic and terrestrial effects data are reviewed and categorized as acceptable for fulfillment of pesticide registration and re-registration guideline requirements as explained under FIFRA Subdivision E, Parts 158.145 and 158.150. These data files have been incorporated into the AQUIRE and ECOTOX systems.

These files are searchable from the Reference Number or Data set search screen (Option N) on the AQUIRE main menu. Abbreviated Data set codes will extract all references from a specified data set. Refer to the Retrieval Tips in On-line Help (CTRL X, Option B, Item E) for specific search examples. The available data set codes, descriptions and institution name and address are listed below:

DATA SET CODE	DATA SET DESCRIPTION
MED	MED Acute Toxicity of Organic Chemicals Database: 5 references; 719 records

U.S.EPA, Office of Research and Development
National Health and Environmental Effects
Research Laboratory
Mid-Continent Ecology Division
6201 Congdon Boulevard

Duluth, Minnesota 55804
Contact: Christine Russom

OECDF France: 6 references; 79 records

Ecotoxicology Department
INERIS
Rue Lavoisier, B.P. 1
F-91710 Vert Le Petit
France
Contact: Dr. Roger Cabridenc

OECDG Germany: 9 references; 754 records

Umweltbundesamt
Federal Environmental Agency
Dienstgebaude Berlin-Mitte
Mauerstrabe 45-52

0-1080 Berlin Germany
Contacts: Ms. Cornelia Leuschner
and Dr. Wolfgang Wohlleben

OECDN Netherlands: 17 references; 1989 records

National Institute of Public Health
and Environmental Protection (RIVM/ACT)
PO Box 1
3720 BA Bilthoven
The Netherlands
Contact: Dr. Hans Canton

OPP Office of Pesticide Programs, Ecological Effects Database, 1 reference; 5,926 records

U.S. Environmental Protection Agency
Office of Pesticide Programs
Environmental Fate and Effects Division
Ecological Effects Branch
401 M St., SW
Washington, DC 20460
Contact: Brian Montague

RUSSN

Russia: 18 references; 225 records

Borok Institute
Institute for Biology of Inland Waters
Academy of Sciences
152742 Borok, Nekouz, Yaroslavsky Region
Russian Republic
Contact: Victor Komov

APPENDIX B
GENERAL ACCESS INFORMATION SHEET
November 17, 1997

MED-Duluth is currently aware of the following commercial sources of AQUIRE and/or ECOTOX:

1. On-line access for government agencies is routed through the U.S. EPA National Computer Center. For AQUIRE, ASTER and ECOTOX access information, please contact:

   SCIENTIFIC OUTREACH PROGRAM: Phone: 218-529-5225
   Fax: 218-529-5003
   E-Mail: outreach@du4500.dul.epa.gov

2. AQUIRE on-line access for the private sector is available from the following commercial vendors

   Chemical Information Systems, Inc. Phone: 800-CIS-USER
   Technical Database Services, Inc. Phone: 212-245-0044
   E-Mail: inquiries@tds-tds.com

3. AQUIRE and ECOTOX VAX VMS and non-VMS data tapes are available through the National Technical Information Service (NTIS). For additional information, please contact:

   National Technical Information Service Phone: 703-487-4763
   Web Site http://www.ntis.gov

4. AQUIRE database retrieval service is available from:

   Saturn Systems, Inc. Phone: 218-626-4916

5. AQUIRE database in microcomputer format is available from:

   AScI Corporation Phone: 703-847-0001

6. AQUIRE VAX VMS and UNIX based software for on-site use:

   Daylight Chemical Information Systems Inc. Phone: 714-476-0451

APPENDIX C

MAJOR/MINOR SPECIES CODES

MISCELLANEOUS (MI)

AQCO	Aquatic community (plants and animals)
AQIN	Invertebrates (several phyla)
AQPL	Plankton (planktonic plants and animals)

CYANOBACTERIA (CY)

CYAN	Cyanophycota (blue-green algae)

PROTOZOA (PR)

PROT	Protozoans (unicellular animals)

ALGAE (AL)
By Phylum (See also Cyanobacteria)

ALGU	Algae (more than one taxa)
BACI	Bacillariophyta (diatoms)
CHLO	Chlorophycota (green algae)
CHRO	Charophyta (stoneworts)
CRYP	Cryptophycophyta (cryptomonads)
CRYS	Chrysophyta (golden algae)
EUGL	Euglenophyta (euglenoids)
HAPT	Haptophyta (coccolithids)
PHAE	Phaeophycophyta (brown algae)
PRAS	Prasinophyta (green flagellates)
PYRR	Pyrrophycophyta (dinoflagellates)
RHOD	Rhodophycota (red algae)
XANT	Xanthophyta (yellow-green algae)

BRYOPHYTA (BY)
By Class

HEPA	Hepaticopsida (liverworts)
MUSC	Musci (mosses)
BRYP	Bryopsida

TRACHEOPHYTA (TR)

TRAC	Tracheophyta (vascular plants, macrophytes)

LEPTOSPORANGIOPSIDA (LE)
By Family

AZOL	Azollaceae
MARS	Marsileaceae
SALV	Salviniaceae

LILIOPSIDA (Monocots) (LI)
By Family

ALIS	Alismataceae (arrowhead)
ARAC	Araceae
CYPE	Cyperaceae (sedge)

ERIO	Eriocaulaceae (pipewort)
HYDO	Hydrocharitaceae (frog's bit)
JUNC	Juncaceae (rush)
LEMN	Lemnaceae (duckweed)
LILI	Liliaceae (lily)
LILO	Liliopsida (multiple or unknown families)
NAJA	Najadaceae (water nymph)
POAC	Poaceae (grass)
PONT	Pontederiaceae
POTA	Potamogetonaceae (pond weed)
RUPP	Ruppiaceae (ditch grass)
SPAG	Sparganiaceae
ZANN	Zannichelliaceae (grass wrack)
ZOST	Zosteraceae (ell grass)

MAGNOLIOPSIDA (Dicots) (MA)
By Family

ACAN	Acanthaceae (acanthus)
AMAR	Amaranthaceae (pigweed)
CABO	Cabombaceae (fanwort)
CALL	Callitrichaceae (water starwort)
CAMP	Campanulaceae (harebells)
CERA	Ceratophyllaceae (hornwort)
CONV	Convolvulaceae (morning glory)
GENT	Gentianaceae (gentian)
HALO	Haloragaceae (water milfoil)
LENT	Lentibulariaceae (bladderwort)
MAGO	Magnoliopsida (unknown or multiple taxa)
NELU	Nelumbonaceae (indian lotus)
NYPH	Nymphaeaceae (water lily)
ONAG	Onagraceae (evening primrose)
POLG	Polygonaceae (knotweed)
RANU	Ranunculaceae (buttercup)
SCRO	Scrophulariaceae (figwort)
TYPH	Typhaceae (cattail)
TRAP	Trapaceae (water chestnut)
VALE	Valerianaceae (valarian)

FUNGI (FU)

FUNG	Fungi

PORIFERA (PO)

PORI	Sponges

CNIDARIA (CN)

CNID	Cnidarians (hydroids, sea anemones, jellyfish, corals)

CTENOPHORA (CT)

CTEN	Ctenophores (comb-jellies)

PLATYHELMINTHES (PL)
By Class

CEST	Cestoda (tapeworms)
TREM	Trematoda (flukes)
TURB	Turbellaria (flatworms)

GNATHOSTOMULIDA (GN)

GNAT	Gnathostomulids

NEMERTEA (NE)

NEME	Nemerteans (proboscis worms)

NEMATODA (NM)

NEMA	Nematodes (roundworms)

GASTROTRICHA (GS)

GAST	Gastrotrichs

ROTIFERA (RO)

ROTI	Rotifers

NEMATOMORPHA (NT)

NEMT	Horsehair, gordian worms

PRIAPULIDA (PI)

PRIA	Priapulida (Priapulids)

ANNELIDA (AN)
By class

ANNE	Annelida (more than one group)
HIRU	Hirudinea (leeches)
OLIG	Oligochaeta (earthworms)
POLY	Polychaeta (bristleworms)

BRACHIOPODA (BC)

BRAC	Brachiopods (lamp shells)

MOLLUSCA (ML)
By Class

AMPN	Amphineura [Polyplacophora] (chitons)
CEPH	Cephalopoda (squids, octopuses)
GASR	Gastropoda (snails, limpets, slugs, conch)
BIVA	Bivalvia [Pelecypoda] (bivalves, clams, mussels)
MOLU	Mollusca (unknown or multiple class)

ARACHNIDA (AR)

ARAC	Arachnids (mites, spiders)

MEROSTOMATA (MR)

MERO	Merostomata (horseshoe crabs)

CRUSTACEA (CR)
By Subclass or Order

AMPH	Amphipoda (scuds)
ANOS	Anostraca (fairy shrimp)
BRAN	Branchiura (fish lice subclass)
CALA	Calanoida (calanoid copepod)
CIRR	Cirripedia (barnacle subclass)
CLAD	Cladocera (water fleas)
CONC	Conchostraca (clam shrimp)
COPE	Copepoda (copepod subclass)
CYCL	Cyclopoida (cyclopoids)
CRUS	Crustaceans (several groups)
DECA	Decapoda (lobsters, crayfish, crabs)

EUPA	Euphausiacea (euphasid, krill)
HARP	Harpacticoida (harpacticoids)
ISOP	Isopoda (sowbugs, pillbugs)
MYSI	Mysidacea (opposum shrimp)
NOTO	Notostraca (tadpole shrimp)
OSTR	Ostracoda (seed shrimp, ostracod subclass)

INSECTA (IN)
By Order

COLE	Coleoptera (beetles)
COLL	Collembola (springtail beetles)
DIPT	Diptera (flies, mosquitoes, midges)
EPHE	Ephemeroptera (mayflies)
HEMI	Hemiptera [Heteroptera] (water bugs)
INSC	Insects (several groups)
LEPD	Lepidoptera (aquatic caterpillars)
MEGA	Megaloptera (hellgrammites, alderflies, ishflies)
NEUR	Neuroptera (spongilla fly)
ODON	Odonata (dragonflies)
PLEC	Plecoptera (stoneflies)
TRIO	Trichoptera (caddisflies)

SIPUNCULA (SI)

SIPU	Sipunculid worms (shore worms, peanut worms)

BRYOZOA (BR)

BRYO	Bryozoans (moss animals)

ECHINODERMATA (EC)

ECHI	Echinoderms (starfish, sea urchins)

CHAETOGNATHA (CA)

CHAE	Arrowworms

ASCIDIACEA (AS)

ASCI	Ascidiacea (sea squirts, ascidians)

CEPHALOCHORDATA (CC)

CCHO	Cephalochordates (lancelets)

CHONDRICHTHYES (CH)
By Family

CARC	Carcharhinidae (requiem sharks)
DASY	Dasyatidae (stingrays)
MYLI	Myliobatidae (eagle rays)
OREC	Orectolobidae (carpet sharks, wobbegongs)
RAJI	Rajidae (skates, rays)
SCYL	Scyliorhinidae (cat sharks)

SQUL	Squalidae (dogfish sharks)
TORP	Torpendinidae (electric rays)

AGNATHA (AG)

PETR	Petromyzontidae (lampreys)

OSTEICHTHYES (OS)
By Family

ACIP	Acipenseridae (sturgeons)
AGON	Agonidae (poachers)
AMII	Amiidae (bowfins)
AMMO	Ammodytidae (sand lances)
ANAB	Anabantidae (climbing perches)
ANGU	Anguillidae (freshwater eels)
APHR	Aphredoderidae (pirate perches)
ARII	Ariidae (catfish)
ATHE	Atherinidae (silversides)
BAGR	Bagridae (scaleless catfish)
BALI	Balistidae (leatherjackets, filefishes)
BATR	Batrachoididae (toadfishes)
BELO	Belonidae (needle fish)
BLEN	Blenniidae (blennies)
BOTH	Bothidae (lefteye flounders)
CALL	Callichthyidae (armoured catfish)
CARA	Carangidae (jacks, scads, pompanos)
CATO	Catostomidae (suckers)
CENT	Centrarchidae (sunfishes)
CHAN	Chanidae (milkfish)
CHAR	Characidae (characins)
CHNN	Chnnidae (snakehead catfish)
CICH	Cichlidae (cichlids)
CLAR	Clariidae (airbreathing, labyrinth catfishes)
CLUP	Clupeidae (herrings)
COBI	Cobitidae (loaches)
CONG	Congridae (conger eels)
COTT	Cottidae (sculpins)
CTRO	Centropomidae (snooks)
CURI	Curimatidae (Amazonian fish)
CYLO	Cylopteridae (snailfish)
CYPI	Cyprinidae (minnows, carps)
CYPO	Cyprinodontidae (killifishes)
DENT	Denticidae (silverfish)
ELEC	Electrophoridae (electric eels)
ELEO	Eleotridae (sleepers)
EMBI	Embiotocidae (surfperches)
ENGR	Engraulidae (anchovies)
ESOC	Esocidae (pikes)
FISH	Fish (several groups)
GADI	Gadidae (cods)
GALA	Galaxidae (galaxid fish)
GASE	Gasterosteidae (sticklebacks)
GERR	Gerreidae (mojarras)
GOBI	Gobiidae (gobies)
HAEM	Haemulidae (grunts)
HETE	Heteropneustidae (air-sac catfish)

HIOD	Hiodontidae (mooneyes)
HOLO	Holocentridae (soldierfish, squirrelfish)
ICTA	Ictaluridae (freshwater, bullhead catfishes)
KUHL	Kuhliidae (flagfish, flagtails)
KYPH	Kyphosidae (sea chubs)
LABR	Labridae (wrasses)
LACT	Lactariidae (whitefish)
LEIO	Leiognathidae (ponyfishes, slimys or slipmouths)
LEPS	Lepisosteidae (gars)
LOPH	Lophiidae (goosefishes)
MAST	Mastacembelidae (spiny eels)
MCTO	Myctophidae (lanternfishes)
MELO	Melanotaeniidae (rainbowfish)
MERL	Merlucciidae (cods, true hakes, whitings)
MOCH	Mochokidae (scaleless catfish, squeakers)
MORM	Mormyridae (elephant fishes)
MUGI	Mugilidae (mullets)
NAND	Nandidae (leaffish, nandids)
NOTT	Nototheniidae (cod icefishes)
NOTP	Notopteridae (featherbacks)
OPHI	Ophidiidae (brotulas and cusk-eels)
OPLE	Oplegnathidae (parrot fishes)
OSME	Osmeridae (smelts)
PERC	Percidae (perches)
PERI	Percichthyidae (temperate basses)
PIME	Pimelodidae (S. American freshwater catfish)
PLCO	Plecoglossidae (Ayu)
PLEU	Pleuronectidae (righteye flounders)
PLTS	Plotosidae (eeltail catfishes)
PLYD	Polyodotidae (paddlefishes)
PLYN	Polynemidae (threadfins)
POEC	Poeciliidae (livebearers)
POMA	Pomacentridae (damselfishes)
PRCO	Percopsidae (trout perch)
SALM	Salmonidae (trouts, salmons)
SCHI	Schilibeidae (African and Asian freshwater catfish)
SCIA	Sciaenidae (drums)
SCOM	Scombridae (mackerels, tunas)
SCOR	Scorpaenidae (scorpion fishes)
SERR	Serranidae (sea basses)
SIGA	Siganidae (rabbitfishes, spinefishes)
SILG	Sillaginidae (smelt-whitings)
SILU	Siluridae (Eurasian freshwater catfish)
SOLE	Soleidae (soles)
SPAR	Sparidae (porgies)
SYNB	Synbranchidae (swamp eels)
SYNG	Syngnathidae (seahorses, pipefishes)
TACH	Tachysuridae (catfish)

TETR	Tetraodontidae (puffers)
THER	Theraponidae (tigerfish)
TRIC	Trichomycteridae (parasitic, pencil catfish)
TRIG	Triglidae (gurnards and searobins)
UMBR	Umbridae (mudminnow)

<u>AMPHIBIA (AM)</u>
By Family

AMBY	Ambystomatidae (salamanders)
AMPB	Amphibians (more than one group)
BUFO	Bufonidae (common toads)
HYLI	Hylidae (tree frogs)
HYNO	Hynobiidae (primitive salamanders)
LEPT	Leptodactylidae (froyngs)
MICR	Microhylidae (narrow-mouthed toads)
PELO	Pelobatidae (spadefoot toads)
PIPI	Pipidae (clawed toads)
RANI	Ranidae (common frogs)
SALA	Salamandridae (true salamanders)

APPENDIX D
CONCENTRATION UNITS

Bq	Becquerels
Bq/g	Becquerels per gram
Bq/kg	Becquerels per kilogram
Bq/L	Becquerels per liter
Bq/mg	Becquerels per milligram
Bq/ml	Becquerels per milliliter
cpm	counts per minute
cpm/L	counts per minute per liter
cpm/mg	counts per minute per milligram
Ci/L	Curies per liter
Ci/mol	Curies per mole
dpm	disintegrations per minute
dpm/mg	disintegrations per minute per milligram
dpm/ml	disintegrations per minute per milliliter
gal/acre	gallons per acre
g	grams
g/m3	grams per cubic meter
g/ft2	grams per feet squared
g/fish	grams per fish
g/4m2	grams per four square meters
g/ha	grams per hectare
g/kg	grams per kilogram
g/L	grams per liter
g/μg	grams per microgram
g/m2	grams per square meter
IU	International Units
kBq/dm3	kiloBecquerels per cubic decimeter
kBq/L	kiloBecquerels per liter
kBq/ml	kiloBecquerels per milliliter
kg	kilograms
kg/ha	kilograms per hectare
kg/L	kilograms per liter
L/ha	liters per hectare
μCi	microCuries
μCi/3.6mg	microCuries per 3.6 milligrams
μCi/30mg	microCuries per 30 milligrams
μCi/kg	microCuries per kilogram
μCi/L	microCuries per liter
μCi/μl	microCuries per microliter
μCi/mg	microCuries per milligram
μCi/ml	microCuries per milliliter
μCi/org	microCuries per organism
μeq/g	microequivalents per gram
μeq/L	microequivalents per liter
μg	micrograms
μg/100g	micrograms per 100 grams
μg/100g/d	micrograms per 100 grams per day
μg/50μl	micrograms per 50 microliters
μg/cell	micrograms per cell
μg/cell	micrograms per cell
μg/cm2	micrograms per centimeter squared
μg/d	micrograms per day
μg/egg	micrograms per egg
μg/fish	micrograms per fish
μg/g	micrograms per gram
μg/g/d	micrograms per gram per day
μg/kg	micrograms per kilogram
μg/kg/d	micrograms per kilogram per day
μg/L	micrograms per liter
μg/L/d	micrograms per liter per day
μg/μl	micrograms per microliter
μg/mg	micrograms per milligram
μg/ml	micrograms per milliliter
μg/organism	micrograms per organism
μg/tank/wk	micrograms per tank per week
μl	microliter
μl/100ml	microliters per 100 milliliters
μl/20ml	microliters per 20 milliliters
μl/cm2	microliters per centimeter squared
μl/g	microliters per gram
μl/egg	microliters per egg
μl/kg	microliters per kilogram
μl/L	microliters per liter
μl/ml	microliters per milliliter
μl/organism	microliters per organism
μM	microMolar (micromoles per liter)
μM/L	microMolar/liter
μM/kg	microMolar per kilogram
μM/L	microMolar per liter
μmol	micromoles
μmol/100 g	micromoles per 100 grams
μmol/dm3	micromoles per cubic decimeter
μmol/kg	micromoles per kilogram
μmol/L	micromoles per liter
mBq	milliBecquerels
mBq/ml	milliBecquerels per milliliter
mCi	milliCuries
mCi/ml	milliCuries per milliliter
mCi/mmol	milliCuries per millimole
meq/L	milliequivalents per liter

mg	milligrams
mg/ae/L	milligrams acid equivalent per liter
mg/100g	milligrams per 100 grams
mg/70g	milligrams per 70 grams
mg/dm3	milligrams per cubic decimeter
mg/d	milligrams per day
mg/dose	milligrams per dose
mg/fish	milligrams per fish
mg/g	milligrams per gram
mg/g clay	milligrams per gram clay
mg/kg	milligrams per kilogram
mg/kg/fish	milligrams per kilogram/fish
mg/kg/d	milligrams per kilogram per day
mg/kg/wk	milligrams per kilogram per week
mg/L	milligrams per liter
mg/ml	milligrams per milliliter
mg/organism	milligrams per organism
ml	milliliters
ml/100g	milliliters per 100 grams
ml/body/wt	milliliters per body weight
ml/kg	milliliters per kilogram
ml/L	milliliters per liter
ml/m2	milliliters per square meter
mM	milliMolar (millimoles per liter)
mmol	millimoles
mmol/m3	millimoles per cubic meter
mmol/kg	millimoles per kilogram
mmol/L	millimoles per liter
M	Molar (moles per liter)
mol	moles
mol/m3	moles per cubic meter
mol/L	moles per liter
nCi	nanoCuries
nCi/L	nanoCuries per liter
ng	nanograms
ng/fish	nanograms/fish
ng/organisms	nanograms/organism
ng/g	nanograms per gram
ng/mg	nanograms per milligram
nM	nanoMolar (nanomoles per liter)
nM/g	nanoMolar per gram
nmol	nanomoles
nmol/kg	nanomoles per kilogram
nmol/L	nanomoles per liter
nmol/ml	nanomoles per milliliter
N	Normal (equivalents per liter)
oz/acre	ounces per acre
ppm/organism	parts per million per organism
%	percent
% g	percent grams
% mg	percent milligrams
% sat	percent saturation
% v/v	percent volume per volume
pCi/L	picoCuries per liter
pCi/ml	picoCuries per milliliter
pg/g	picograms per gram
pmol/L	picomoles per liter
pmol/ml	picomoles per milliliter
lb/acre	pounds per acre
lb/cwt sd	pounds per hundred weight seed
T/km^3	tons per cubic kilometer
v/v	volume per volume

APPENDIX E
ENDPOINT CODES

CODE	ENDPOINT NAME:	ENDPOINT DEFINITION
BCF	**Bioconcentration factor:** A unitless value describing the degree to which a chemical can be concentrated in the tissues of an organism in the aquatic environment. At apparent equilibrium during the uptake phase of a bioconcentration test, the BCF is the concentration of a chemical in one or more tissues of the aquatic organism divided by the average concentration in the water.	

$$BCF = \frac{g/kg\ chemical\ in\ organism\ tissue}{g/L\ chemical\ in\ H_2O}$$

or it is calculated from a ratio of rate constants, if at steady state,

$$BCF = \frac{K1\ (uptake)}{K2\ (elimination)}$$

BCFD	**BCF dry-weight:** Bioconcentration factor derived using dry weight.
EC50	**Median Effective Concentration:** Effective concentration for 50% of the organisms tested. Used when an effect other than death is the observed endpoint.
ECxx	**xx% Effective Concentration:** Effective concentration for xx% of tested organisms.
ED50	**Median Effective Dose:** Effective dose for 50% of the organisms tested. Used when an effect other than death is the observed endpoint.
ET50	**Median Effective Time:** Median time to effect or estimated mean survival time.
ICxx	**xx% Inhibition Concentration:** Statistically or graphically estimated concentration of test material, under specified concentrations, is expected to cause xx% inhibition of a biological process for which the data are dichotomous.
IC50	**Median Inhibition Concentration:** Statistical or graphically estimated concentration of test material, under specified concentrations, is expected to cause a 50% inhibition of a biological process for which the data are dichotomous.
LC50	**Median Lethal Concentration:** Statistically estimated concentration that is expected to be lethal to 50% of a group of organisms tested. Death

may be defined by the effect codes MOR, IMM, EQU, HAT. TLms and TL50s with death as the measured endpoint are reported as LC50*.

LCxx	**xx% Lethal Concentration:** Lethal concentration for xx% of the tested organisms.
LD50	**Median Lethal Dose:** A statistically estimated dose that is expected to be lethal to 50% of a group of organisms.
LDxx	**xx% Lethal Dose:** A statistically estimated dose that is expected to be lethal to xx% of a group of organisms.
LETH	**Lethal:** 100% mortality or 0% survival.
LOEC	**Lowest Observed Effect Concentration:** Lowest concentration that has a statistically significant adverse effect on the tested organisms.
LT50	**Mean Survival Time:** Represents time until death of 50% of the tested organisms.
LETC	**Lethal Threshold Concentration:** Toxicity curve asymptotic concentration indicating an incipient LC50 value. Acute lethal action has essentially ceased.
LTxx	**xx% Death Time:** Time until xx% of the test organisms are dead.
MATC	**Maximum Acceptable Toxicant Concentration:** Hypothetical threshold concentration that is the geometric mean between the NOEC and LOEC concentration. The term Chronic Value (ChV) is encoded as MATC.
NOEC	**No Observed Effect Concentration:** Highest concentration that has no statistically significant adverse effect on the tested organisms.
NR-LETH	**Lethal:** 100% mortality or 0% survival including algicidal and herbicidal effects. (No statistically derived endpoint reported).
NR-ZERO	**Zero Mortality:** 0% mortality or 100% survival of organisms. (No statistically derived endpoint reported).
ZERO	**Zero Mortality:** 0% mortality or 100% survival of organisms.