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Office of Water
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Water Quality



EPA Technical Information Packages

This brochure is part of a series of information packages prepared by the United States Environmental Protection Agency (EPA). Aimed at the international community, the packages focus on key environmental and public health issues being investigated by EPA. The products highlighted within these packages provide a sound technical basis for decisions regarding the development of environmental policy, abatement activities, and pollution prevention. By pooling expertise in the areas of environmental science and technology, significant progress can be anticipated to ensure a habitable environment for all nations.

Water Quality discusses the establishment of water quality goals, monitoring and assessment methods, and techniques for pollution control. Brochures and associated support material are available on the following topics:

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| • Ensuring Safe Drinking Water EPA/600/M-91/012 | • Water Quality EPA/600/M-91/033 |
| • Mining Waste Management EPA/600/M-91/027 | • Risk Assessment EPA/600/M-91/034 |
| • Pesticide Waste Disposal EPA/600/M-91/028 | • Pesticide Usage Guidelines EPA/600/M-91/035 |
| • Air Quality Management EPA/600/M-91/029 | • Pollution Prevention EPA/600/M-91/036 |
| • Solid Waste Disposal EPA/600/M-91/030 | • Environmental Impact Assessments EPA/600/M-91/037 |
| • Hazardous Waste Management .. EPA/600/M-91/031 | • EPA Information Sources EPA/600/M-91/038 |
| • Small Community Wastewater Systems EPA/600/M-91/032 | • Environmental Management ... EPA/600/M-91/039 |

Each complete Technical Information Package (TIP) consists of a cover brochure as well as all of the documents highlighted within the body of the brochure. Generally, the cover brochures contain a section discussing the environmental issue, associated health and environmental effects, guidelines, sampling and analytical methods, as well as treatment and disposal technologies. Following this section, a bibliography is provided to identify other important sources and documents in the field. An attempt has been made to provide references that are readily available in technical libraries. Finally, a number of Office of Research and Development (ORD) technical experts followed by some additional EPA resources are listed to facilitate consultation and technical assistance. Document ordering information is provided on page 12.

Water Quality Protection

The area of water quality protection is continually being influenced by advances in science and engineering and by changing social and economic factors. The term **water quality** refers to the overall health of surface water bodies including the interrelationships between the water and underlying sediments. In general, water quality protection involves water quality monitoring and assessment, establishing achievable water quality goals and controlling pollutant loadings to reach and maintain desired water quality levels.

Water quality monitoring and assessment begins with collecting and analyzing samples to measure various physical, chemical and biological parameters. The resultant data are then evaluated and compared with accepted criteria to develop an understanding of the health of the water body. These data can also be used as inputs to verify or calibrate water quality simulation models. Once proven to produce reliable results, these models can be used to predict and evaluate the water quality benefits of varying levels of pollution control.

In establishing water quality goals, the desired use of the water body is determined. Specific water quality levels, often referred to as **water quality standards**, are established to sustain such uses as providing safe drinking water, shellfish harvesting, safeguarding swimmers and bathers, and protecting aquatic life.

Pollution loads that cause the degradation of water quality originate from both discrete

and diffuse sources. Discrete sources, also known as point sources, include sewage treatment plants and wastewater discharges from industrial and mining facilities. Diffuse sources, often referred to as nonpoint sources, include contaminated runoff from agricultural, forestry, and urban areas. For the most part, discrete sources are easily identified and regulated. On the other hand, diffuse sources are difficult to isolate and control.

Technologies for the treatment of domestic and industrial wastewater are well established and documented. However, as treatment needs are increased to address water quality problems such as effluent toxicity, bioaccumulation, and sediment contamination, additional technologies must be developed. Controlling diffuse sources of water pollution is a more complex and challenging task. The use of conventional treatment techniques is limited due to the intermittent and widespread nature of these sources. Pollution prevention measures that reduce the amount of pollutants generated and best management practices that attempt to alter land use to reduce pollution loads appear to be the most practical means to control diffuse sources.

Water Quality Monitoring and Assessment

The foundation of sound water quality management is reliable monitoring and assessment. Monitoring data result from **physical, chemical and biological measurements** of ambient waters, pollution sources, sediments, and biota.

Each type of data plays an important role in conducting a complete assessment of the health of the water body.

- EPA/600/6-85/002a & b *Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water - Part I & Part II* — These documents present a simplified methodology that can be used to perform preliminary assessments of toxic and conventional pollutants in surface and ground waters. Conventional pollutants include suspended solids, nitrogen, phosphorus, coliform bacteria, and biochemical oxygen demand. The 126 U.S. EPA Priority Pollutants are included in the sections dealing with toxic pollutants. The documents include six major chapters dealing with the environmental chemistry of toxic organic chemicals; methods to estimate pollutant loads from discrete and diffuse pollution sources; effects of discrete and diffuse pollution sources on rivers; methods for assessing water quality in impoundments; methods for assessing water quality in estuaries; and a methodology to predict the transport and fate of ground water contamination.

- EPA/600/4-82/029 *Handbook for Sampling and Sample Preservation of Water and Wastewater* — This document provides guidance for selecting appropriate sampling and monitoring techniques for surface waters; ground waters; and municipal, industrial, and agricultural wastewaters. The handbook ad-



dresses general sampling procedures; the selection of automatic samplers and flow monitoring devices; a statistical approach to sampling; and the proper preservation of samples to be analyzed for physical, chemical and radiological parameters.

- EPA/600/4-79/020 *Methods for Chemical Analysis of Water and Wastes (Revised 1983)* — This document contains analytical procedures for the examination of surface waters, ground waters, domestic sewage and industrial wastewaters. This manual provides sample preservation and test procedures for the measurement of physical, inorganic and selected organic constituents and parameters.

- EPA/625/6-86/013 *Handbook-Stream Sampling for Waste Load Allocation Applications* — This handbook discusses sampling requirements in support of waste load allocation studies in rivers and streams. The document presents sampling and monitoring requirements for the two approaches to waste load allocation: the chemical-specific approach and the whole effluent approach.

- EPA/600/4-90/027 *Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms* — This manual describes methods for measuring the acute toxicity of effluents to freshwater and marine macroinvertebrates and fish. The methods include a preliminary range-finding test, a screening test, and multi-concentration static and flow-through toxicity tests.

- EPA/600/4-85/014 *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* — This manual describes short-term methods for estimating the chronic toxicity of effluents and receiving waters to a freshwater fish (*Pimephales promelas*), an invertebrate (*Ceriodaphnia dubia*), and an alga (*Selenastrum capricornutum*).

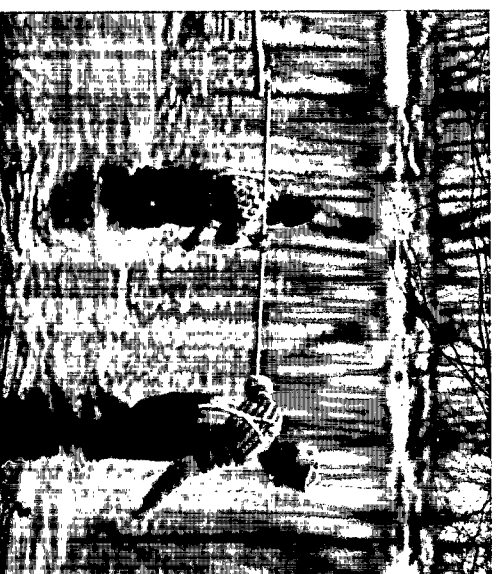
- EPA/600/4-87/028 *Short-Term Marine Tests for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms* — This manual presents short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine fish (*Cyprinodon variegatus* and *Menidia beryllina*), an invertebrate (*Arbacia punctulata*) and an alga (*Champia parvula*).

- EPA/440/4-89/001 *Rapid Bioassessment Protocols for Use in Streams and Rivers-Benthic Macroinvertebrates and Fish* — This document presents protocols for conducting rapid biological assessment techniques. These protocols include cost-effective screening procedures, procedures for establishing priorities for more intensive evaluations, and more rigorous procedures for obtaining confirmational data.

- EPA/600/4-90/030 *Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters* — This manual describes guidelines and stan-

dardized procedures for the use of macroinvertebrates in evaluating the biological integrity of surface waters. The document presents methods for measuring the status and trends of environmental pollution on freshwater, estuarine, and marine macroinvertebrates in field and laboratory studies.

- EPA/600/S4-90/002 *Multispectral Identification and Confirmation of Organic Compounds in Wastewater Extracts* — This summary describes the application of multispectral identification to identify organic compounds other than priority pollutants that are found in wastewaters. It provides insight into the problem of identifying such compounds reliably and demonstrates how multispectral identification techniques can provide identifications for a wide range of chemicals that are comparable in reliability to those made for the priority pollutants.



Sampling for an aquatic toxicology study.

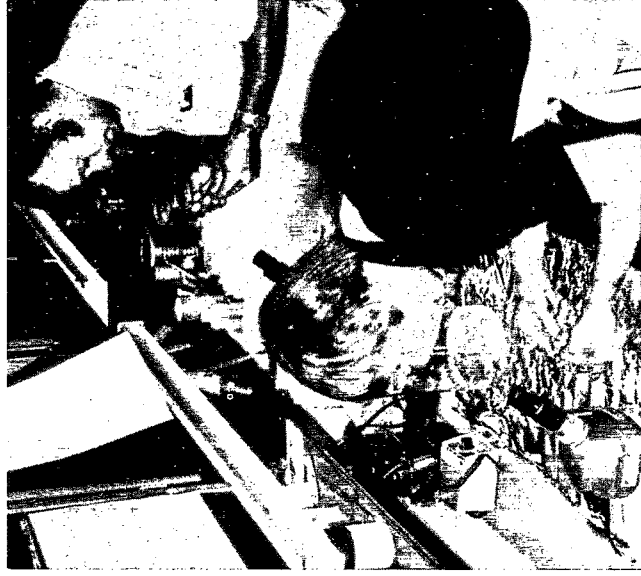
Establishing Water Quality Goals

Once a reliable assessment of the health of a water body is made, realistic water quality goals can be developed. Based upon established levels of water quality needed to achieve and protect a desired use, it is possible to determine the total maximum daily load (TMDL) of pollutants that the water body can receive. These pollutant loads are established and specific pollutant reduction goals set for each source through a process known as **waste load allocation**. Once these waste loads are allocated, both discrete and diffuse control measures must be identified. Two integral aspects of the TMDL process, in addition to monitoring and assessment, are selecting appropriate **water quality criteria** and using **water quality models** that simulate water quality responses to various pollutant loads.

- EPA/440/5-86/001 *Quality Criteria for Water 1986* — This document presents ambient water quality criteria that reflect the latest EPA recommendations on acceptable limits for the protection of aquatic life and human health. These criteria present scientific data and guidance on the environmental effect of pollutants that can be useful in establishing water pollution control requirements. These criteria reflect the latest scientific knowledge on the kind and extent of all identifiable effects expected from the presence of pollutants in any body of water (including ground water); on the fate of pollut-

ants or their by-products, through biological, physical and chemical processes; and on the effects of pollutants on the diversity, productivity, and stability of biological communities.

- EPA/600/1-80/031 *Health Effects Criteria for Marine Recreational Waters* — This document presents health effects quality criteria for marine recreational waters and a recommendation for a specific criterion among those developed. The criterion is established based upon the mathematical relationship of the swimming-associated rate of gastrointestinal symptoms among bathers to the quality of the water as determined by the density of a fecal indicator, enterococci.



Artificial insemination of fish eggs for use in toxicity research.

- EPA/600/1-84/004 *Health Effects Criteria for Fresh Recreational Waters* — This document presents a recommended criterion for the quality of bathing water based upon swimming-associated gastrointestinal illness and developed from data obtained during a multi-year freshwater epidemiological-microbiological research program. Three bacterial indicators of fecal pollution (*E. coli*, enterococci and fecal coliforms) were used to measure water quality.
- EPA/600/8-87/042 *Selection Criteria for Mathematical Models Used in Exposure Assessments: Surface Water Models* — This document presents criteria that provide a means for selecting the most appropriate mathematical model(s) for conducting an exposure assessment related to surface water contamination. The report provides general background information regarding surface water flow and contaminant transport and characterizes the important assumptions and limitations of existing models.
- EPA/600/3-87/039 *WASP4, A Hydrodynamic and Water Quality Model - Model Theory, User's Manual and Programmer's Guide* — The Water Quality Analysis Simulation Program Version 4 (WASP4) is a dynamic compartment modeling system that can be used to analyze a variety of water quality problems in a diverse set of water bodies. WASP4 simulates the transport and transformation of conventional and toxic pollutants in the water col-

umn and benthos of ponds, streams, lakes, reservoirs, rivers, estuaries and coastal waters.



Obtaining sediment samples.

- EPA/600/3-87/007 *The Enhanced Stream Water Quality Models QUAL2E and QUAL2E-UNCAS: Documentation and User Model* — QUAL2E is a comprehensive and versatile stream water quality model. QUAL2E, which can be operated either as a steady-state or as a dynamic model, is intended for use as a water quality planning tool. QUAL2E can be used to study the effect of waste loads on instream water quality or to identify the magnitude and quality characteristics of diffuse waste loads as part of a sampling program. QUAL2E-UNCAS is an enhancement to QUAL2E that allows the user to perform uncertainty analysis.

- EPA/600/3-91/039 *Modeling of Nonpoint Source Water Quality in Urban and Non-Urban Areas* — This document presents a review and discussion of diffuse (nonpoint) source assessment procedures and modeling techniques for both urban and non-urban areas.

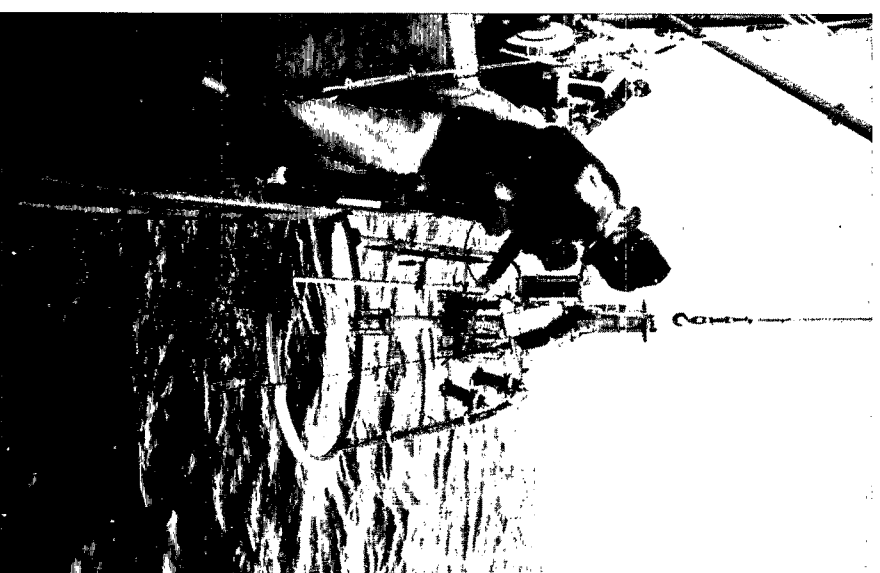
Detailed reviews of specific methodologies and models are presented, along with overview discussions focussing on urban and non-urban (primarily agricultural) methods and models.

- EPA/505/2-90/001 *Technical Support Document for Water Quality-Based Toxics Control* — This document presents technical guidance for assessing and controlling the discharge of toxic pollutants to water bodies. The document provides guidance for each step in the water quality-based control process from standards development to follow-up monitoring. Both human health and aquatic toxicity issues are incorporated into the discussions throughout the document.

- EPA/600/3-89/060 *Regionalization as a Tool for Managing Environmental Resources* — This document presents an explanation of the utility of an ecological-based regional framework for resource management. A review of some of the more popular regional frameworks is presented, as is the process for selecting regionally representative reference sites and examples of applications of ecoregions and reference sites for setting water quality criteria.

Pollutant Identification and Control

While technologies available for the treatment of specific pollutants in domestic and industrial wastewaters are well documented, it is often difficult to identify which pollutants cause whole effluent toxicity and therefore,



Measurement of abiotic factors affecting aquatic fauna.

need to be treated. Before control measures or treatment schemes can be implemented, pollutants causing toxicity in discrete wastewater discharges need to be identified. Once identified, these toxic pollutants can be reduced in the wastewater or at the source.

Addressing the control of diffuse water pollution sources is a complex undertaking. Potential solutions vary with site-specific differences in land use activities, climatic condi-

tions, topography, and geology. In most instances, a combination of **best management practices** are used to control these types of sources.

- EPA/600/6-91/003, EPA/600/3-88/035, and EPA/600/3-88/036 *Methods for Aquatic Toxicity Identification Evaluations, Phase I Toxicity Characterization Procedures, Phase II Toxicity Identification Procedures, & Phase III Toxicity Confirmation Procedures* — These documents present guidance on conducting aquatic organism toxicity identification evaluations for acutely toxic effluents. Phase I contains methods to identify the physical/chemical nature of the constituents causing toxicity. Phase II describes methods to specifically identify the toxic constituents if they are non-polar organics, ammonia, chlorine, or metals. Phase III describes methods to confirm the suspected toxic constituents.

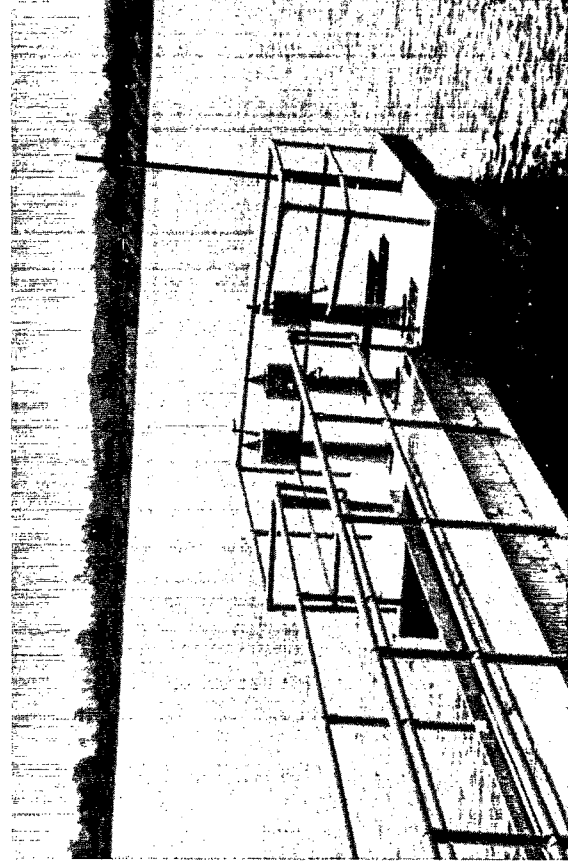
- EPA/600/2-88/062 *Toxicity Reduction Evaluation Protocol for Municipal Wastewater Treatment Plants* — This document presents a generalized protocol for conducting toxicity reduction evaluations at municipal wastewater treatment plants. The protocol involves an evaluation of the treatment plant performance; an identification of the specific toxic pollutants; a review of procedures used in controlling industrial discharges to the treatment plant; a characterization of the nature, variability and sources of toxicity; and the evaluation, selection and implementation of control options.

- EPA/600/2-88/070 *Generalized Methodology for Conducting Industrial Toxicity Reduction Evaluations* — This document presents a methodology for conducting toxicity reduction evaluations at industrial facilities. The methodology involves a six-step approach consisting of: information and data collection; an evaluation of actions to optimize the industrial operation to reduce whole effluent toxicity; characterization and identification of the pollutants causing toxicity; identification of the sources of toxicity in the industrial facility; identification and evaluation of methods to reduce toxicity in the final effluent; and confirmation that the toxicity has been eliminated.

- EPA/600/9-91/012 *Storm and Combined Sewer Pollution Control - A Compilation of Significant References* — This report presents selected abstracts from reports documenting research performed over the past 20 years. These reports will aid in addressing the chal-

lenges of controlling urban wet-weather pollution sources. The reports cover monitoring and assessment, management and control planning and engineering design.

- ES-NWQEP-84/02 *Best Management Practices for Agricultural Nonpoint Source Control: Pesticides* — This document, developed in cooperation with the U.S. Environmental Protection Agency and the U.S. Department of Agriculture, identifies and discusses best management practices (BMPs) for the control of diffuse loads from pesticides. The document addresses the occurrence and effects of pesticides in aquatic systems. Also discussed are models of pesticide transport and BMPs for reducing pesticide delivery to aquatic systems; integrated pest management; and pesticide BMP systems by crop and region. Basic conclusions regarding pesticide management for nonpoint source control are drawn.



Water supply intake.

Photo by Joe Bender

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Photo by Walt Feige

Water Quality Expertise List

<u>Technical Area</u>	<u>Contact</u>	<u>FAX No.</u>
Aquatic Biology	James Lazorchak	513-533-8181
Aquatic Toxicology	Teresa Norbert-King	218-720-5539
Domestic Wastewater Toxics Control	Dolloff (Fred) Bishop	513-569-7680
Domestic Wastewater Treatment	Carl Brunner	513-569-7680
Fate and Treatability of Toxics	Richard Dobbs	513-569-7680
Ground Water Monitoring	M. Richard Scalf	405-332-2256
Health and Environmental Effects	Judith Olsen	513-569-7475
Industrial Wastewater	Glenn Shaul	513-569-7787
Limnology	Spencer Peterson	503-757-4600
Marine Ecology	William Davis	904-934-9201
Monitoring, Freshwater	Steve Hedke	218-720-5539
Monitoring, Marine	Richard Latimer	401-782-6030
Rapid Bioassessment Protocols	Chris Faulkner	202-260-7044
Sediment Toxicity	Gerald Ankley	218-720-5539
Stream Ecology	David Larson	503-757-4338
Water Quality Criteria, Ecoregionalization	James Omernick	503-757-4338
Water Quality Criteria, Freshwater	Charles Stephan	218-720-5539
Water Quality Criteria, Marine	D. Hansen	401-782-6030
Water Quality Modeling	Thomas Barnwell	404-546-2018
Water Quality Monitoring and Assessment	Hiranmay Biswas	202-260-9830
Wetland Ecology	Mary Kentula	503-757-4600

Additional Opportunities for Obtaining Technical Information

ORD TECHNOLOGY TRANSFER NEWSLETTER

An Office of Research and Development newsletter providing a current listing of scheduled workshops, conferences and seminars. It also announces the availability of new publications, reports, databases, and expert systems. A publication order sheet is included. To be added to the Technology Transfer Newsletter mailing list, write to: CERL, Technology Transfer, U.S. Environmental Protection Agency, P.O. Box 19963, Cincinnati, OH 45219-0963.

ORD ELECTRONIC BULLETIN BOARD SYSTEM

The ORD Electronic Bulletin Board System (BBS), in addition to fostering communication among officials, researchers and the private sector, facilitates the exchange of technical information and ORD products in the form of electronic messages, brief bulletins about ORD products and activities, files for downloading, participation in confer-

ences, and on-line databases for identifying ORD publications. For additional information and assistance in using the BBS, call 513-569-7272 or write to: CERL, U.S. Environmental Protection Agency, ORD BBS, G-76, Cincinnati, OH 45268.

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The Nonpoint Source Information Exchange Computer Bulletin Board System (NPS BBS) is designed to provide interested individuals with timely and relevant nonpoint source information, a forum for open discussion and special interests, and the ability to exchange computer text and program files. For assistance in accessing the NPS BBS, call 202-260-3666 or write to: NPS BBS, Nonpoint Source Information Exchange, Office of Water (WH-553), U.S. Environmental Protection Agency, 401 M Street SW, Washington, DC 20460.



Ordering Technical Documents

The EPA documents mentioned in the Technical Information Package brochures can be ordered at no charge (while supplies are available) from the Center for Environmental Research Information (CERI). Once the CERI inventory is exhausted, clients will be directed to the National Technical Information Service (NTIS) where documents may be purchased. Orders can be placed by mail, phone, or FAX. To order documents, have the document number or the EXACT title ready. The journal articles listed in the *Additional References* section may be ordered from the U.S. National Focal Point of INFOTERRA.

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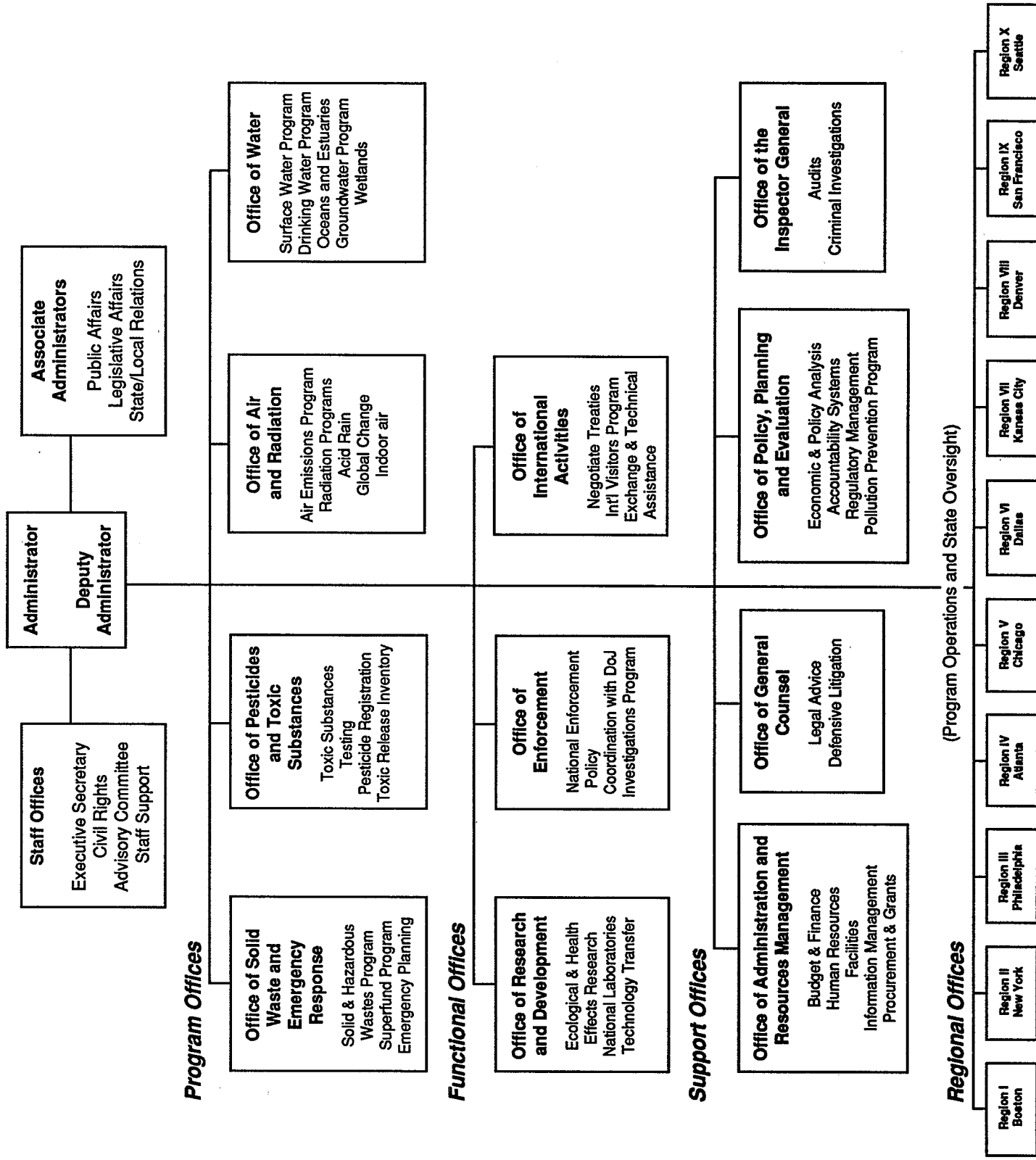
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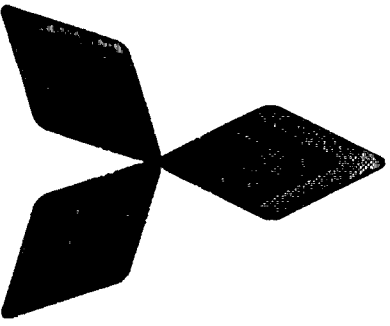
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