United States
Environmental Protection
Agency

Office of
Research and
Development

EPA/600/M-90-016
October 1990

EPA

Guide to the Office of Modeling, Monitoring Systems and Quality Assurance

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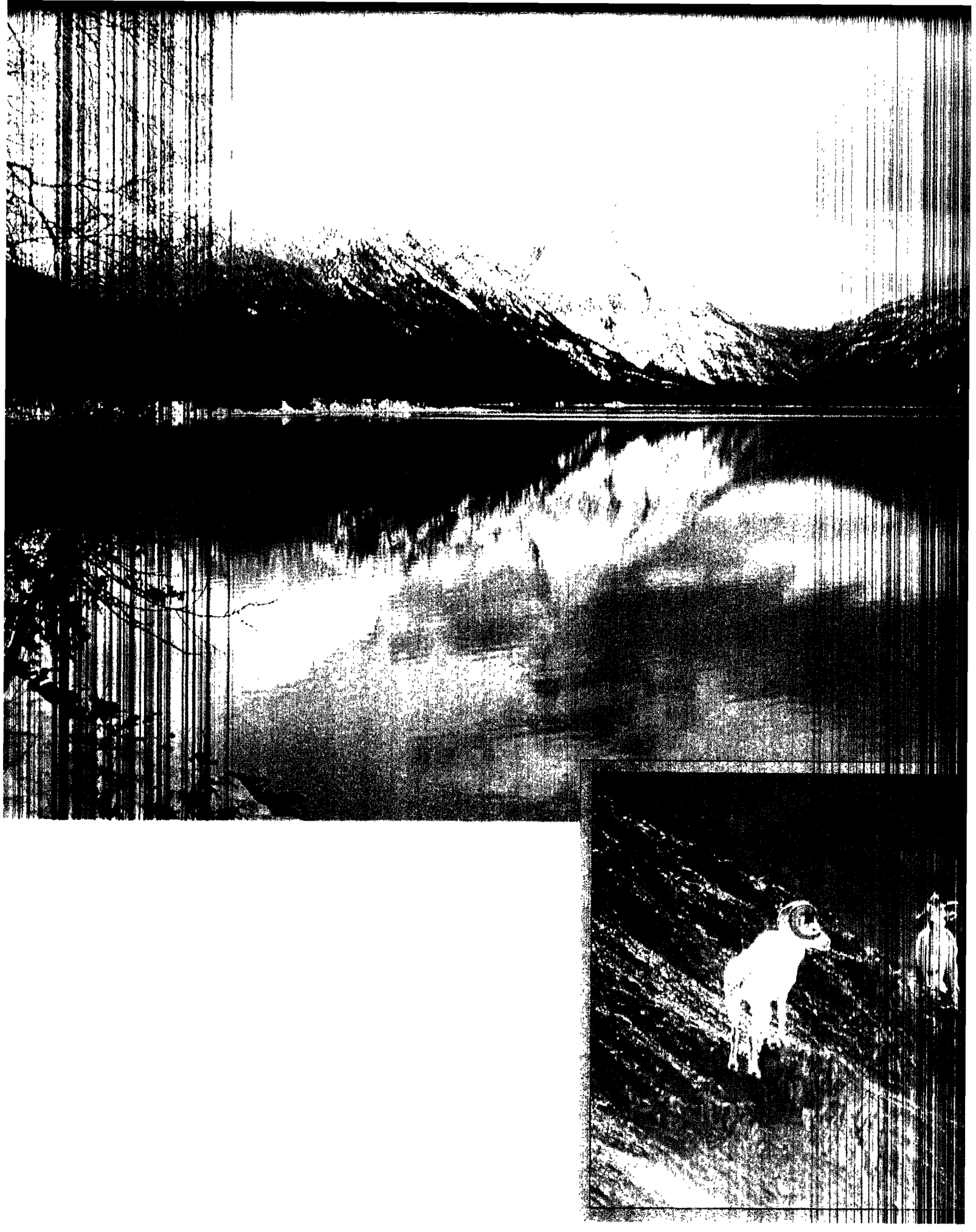
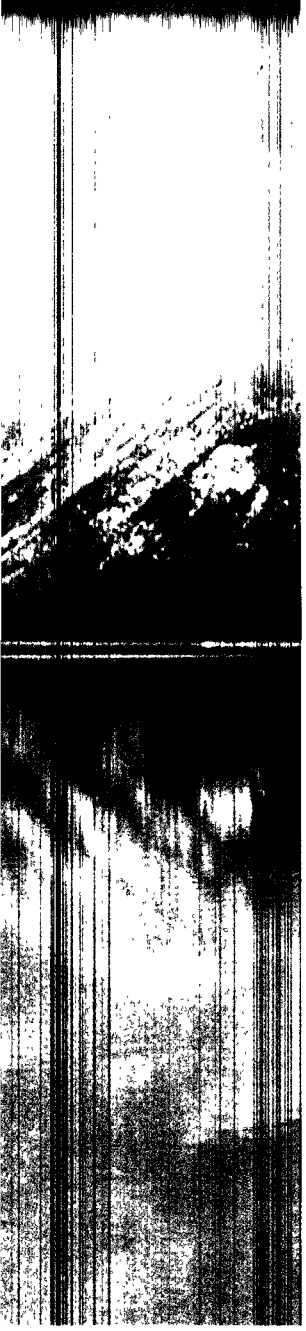




The OMMSQA Vision

The Office of Modeling, Monitoring Systems and Quality Assurance (OMMSQA) has assumed a lead role within the Environmental Protection Agency (EPA) in conducting exposure research. OMMSQA's primary function is to develop methods to measure, characterize, and predict human and ecological exposure to pollutants. Exposure assessments are integral elements in the risk assessment process used to identify populations and ecological resources at risk. The EPA increasingly relies on quantitative risk assessment to regulate chemicals and to appropriate resources. The utility of the risk-based approach, however, depends on accurate exposure information. The mission of OMMSQA is to enhance the Agency's capability for evaluating exposure from a holistic perspective. Specifically, OMMSQA's research program for the next five years is targeted toward achieving the following goals:

- Establish an integrated national scale human exposure database which provides accurate information for predicting and verifying the exposure of humans to pollutants.
- Establish a nationwide integrated chemical and biological monitoring program for representative ecological resources.
- Maintain a national leadership role in atmospheric sciences
- Develop state of the art analytical techniques, instrumentation, and capabilities (i.e., modeling, monitoring systems, quality assurance, and assessment) to quantify the exposure of humans and ecosystems to pollutants.

These goals are the focal point for all of OMMSQA's activities, which balance support of traditional clients, Regional and Program Offices, with basic research. In addition to the pursuit of these goals, it is vital for OMMSQA to enhance the quality of science and to improve the reputation of the Office among its clients and within the international scientific community. One way that OMMSQA will improve its scientific reputation is the periodic distribution of material describing the Office's major research programs and areas of special expertise. The major purpose of this document is to facilitate the exchange of information on OMMSQA's research activities as well as to promote cooperative efforts to foster the science of exposure assessment.

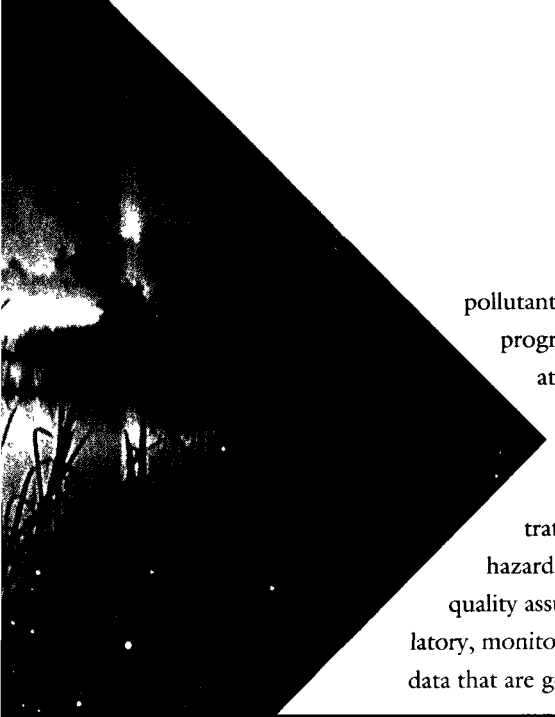
Introduction

The U.S. Environmental Protection Agency (USEPA), created by President Nixon in 1970 under Executive Order No. 3, was established largely as a regulatory agency. Through various legislative mandates, it has sought to regulate air pollution, drinking water, water quality, hazardous waste, pesticides, and toxic substances. EPA is organized into four major regulatory Program Offices, has ten regional offices, and the Office of Research and Development (ORD). The four Program Offices and their areas of responsibility are as follows: Office of Water—drinking water and water quality; Office of Air and Radiation—air and radiation; Office of Pesticides and Toxic Substances—toxic substances and pesticides; and Office of Solid Waste and Emergency Response—hazardous waste, Superfund, and underground storage tanks. In order to regulate, however, it is first necessary to generate the knowledge essential to sound decision making. This is the function of research.

The Office of Research and Development was established within the Agency to provide the scientific and technical information needed to make decisions regarding the development of policy, guidance, standards, regulations, and the tools to implement abatement strategies. The Office of Research and Development is also responsible for providing the scientific and technical information required by the Agency to support its regulatory and enforcement programs. Its overall research effort, which is conducted through 12 environmental research and development laboratories, employs a staff of about 2,000 and has an annual budget of approximately $400-million.

To accomplish its research goals, ORD established the following seven offices: Office of Technology Transfer and Regulatory Support, Office of Health Research, Office of Environmental Engineering and Technology Demonstration, Office of Environmental Processes and Effects Research, Office of Health and Environmental Assessment, Office of Exploratory Research, and the Office of Modeling, Monitoring Systems and Quality Assurance (OMMSQA). Figure 1 provides an overview of the Office of Research and Development.

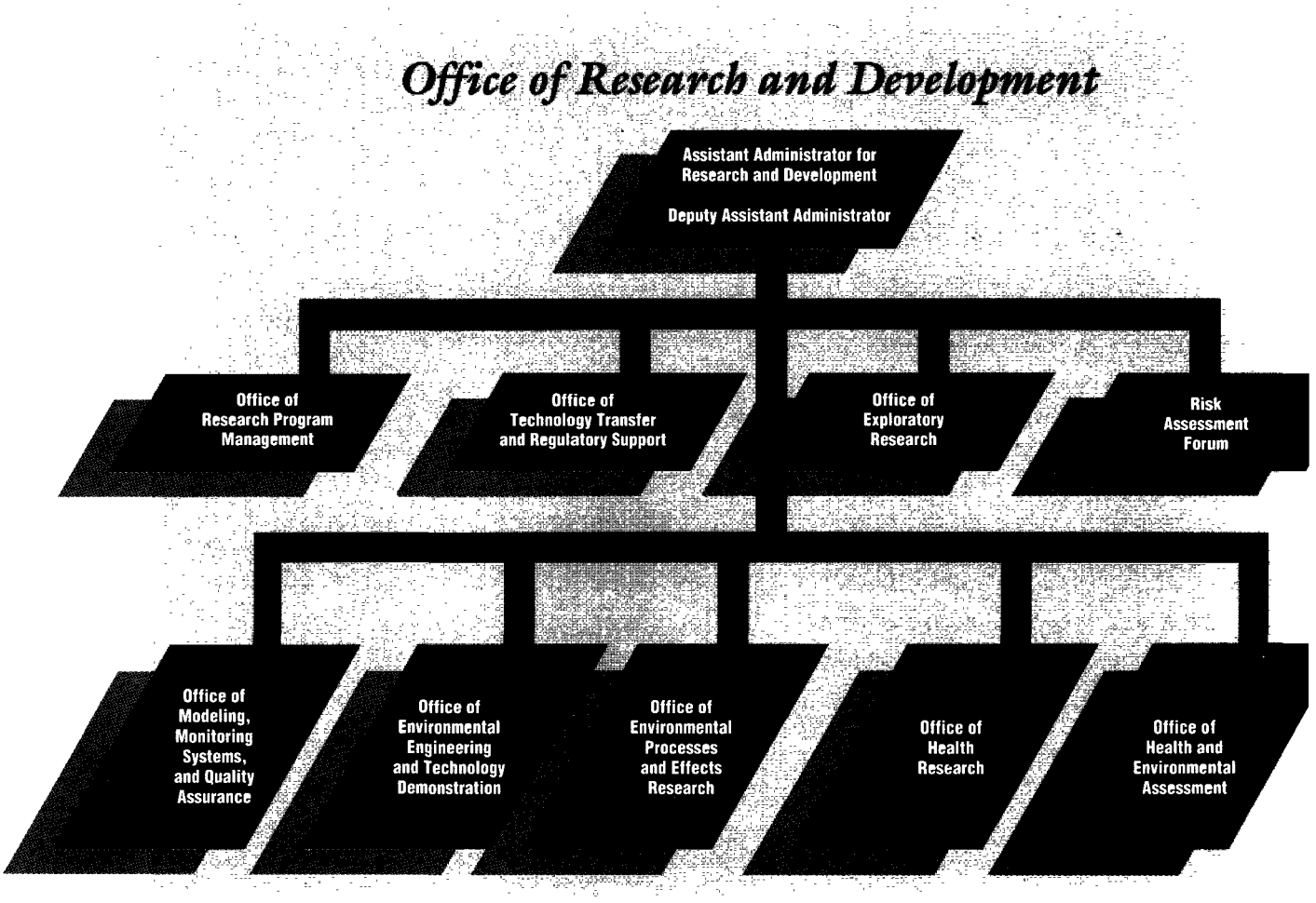
The Office of Modeling, Monitoring Systems and Quality Assurance is responsible for quantifying the exposure of humans and ecological resources to



pollutants and for supporting the Agency's programs. Through research conducted at its three research laboratories, OMMSQA selects/develops sampling and analytical methods to determine the presence and concentrations of chemicals and biological hazards in the environment and provides quality assurance support to the Agency's regulatory, monitoring, and research programs. These data that are generated are integral elements used for the assessment of risk, a tool upon which the Agency increasing relies for making regulatory decisions and appropriating resources. The development of accurate exposure information is essential to fulfilling the Agency's mandates.

In line with the Agency's new long-term strategy for addressing environmental problems in the next decade, OMMSQA is supporting a major new "Core" Research Program that will generate knowledge essential to all areas of environmental decision making, including new initiatives in several critical areas.

This document details the organizational structure of OMMSQA, describes all aspects of its research program, provides a review of its three major research laboratories, discusses its leadership role in the Core Research Program, and cites its support of the 10 EPA Regions and the Agency's regulatory Program Offices. It is intended to acquaint the layman with the functions of this Office, while providing a more substantive picture of its efforts for scientists working in the field.



Organization

OMMSQA's role is to develop the scientific methods, monitoring systems, and quality assurance strategies needed to implement a monitoring and research program that assesses exposure of humans and ecosystems to various pollutants.

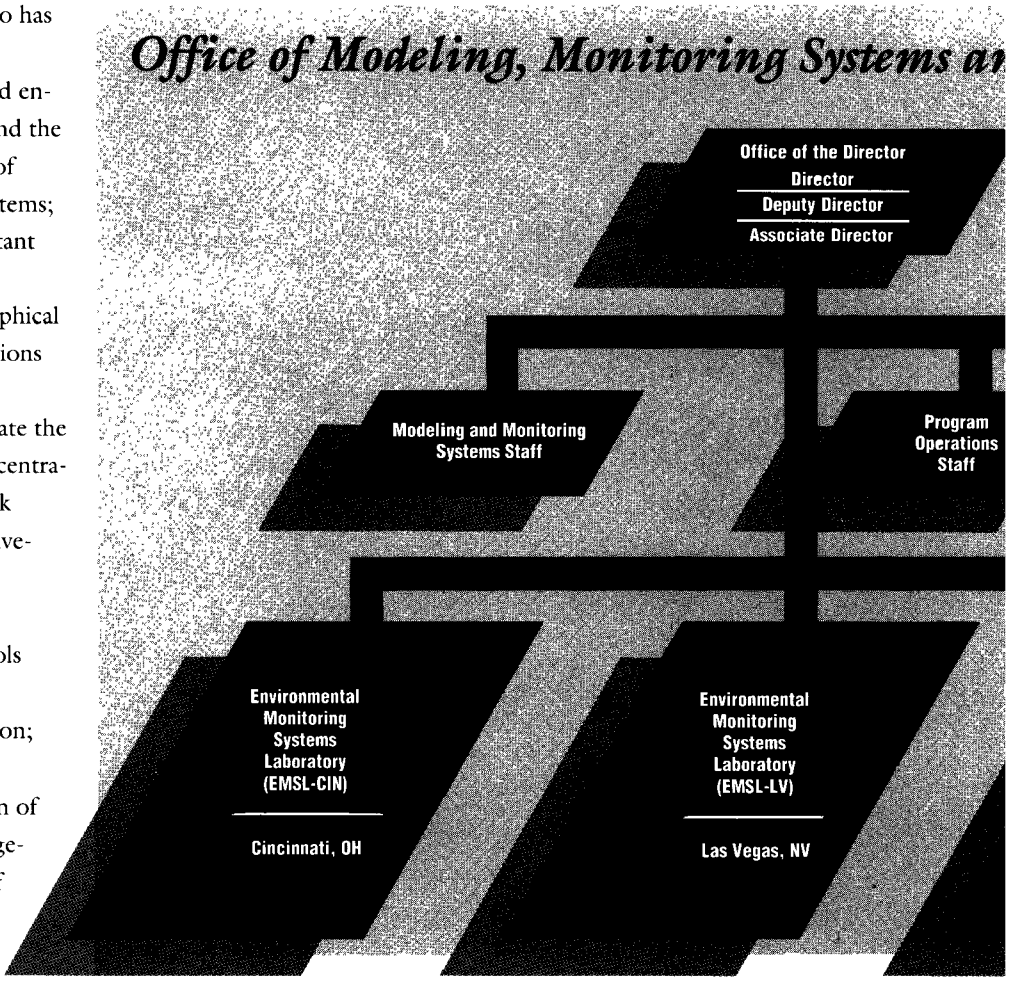
In addition to quantifying exposure, OMMSQA also has the following responsibilities:

- Characterizing the sources, atmospheric and environmental transformations and pathways, and the physical, chemical, and biological properties of pollutants stressing human and ecological systems;
- Determining the status and trends in pollutant concentrations and ecosystem condition;
- Determining the status, trends, and geographical variability of the exposures of human populations to environmental pollutants;
- Developing and validating models to estimate the atmospheric sources, transport, fate, and concentrations of pollutants for use in exposure and risk assessments and in the development of effective-control strategies for risk reduction;
- Developing the measurement techniques, analytical tools, and quality assurance protocols necessary to characterize, monitor, and assess exposure to pollutants and ecosystem condition; and
- Developing and supporting implementation of Agency-wide policies, procedures, and management systems aimed at assuring the quality of data produced by Agency programs.

OMMSQA is composed of a Program Operations Staff, a Quality Assurance Management Staff, a Modeling and Monitoring Systems Staff, and three research laboratories. Figure 2 depicts the overall structure of OMMSQA.

The Program Operations Staff provides administrative support of all staff activities. This includes development of the budget and fiscal administration, staffing and training, and other essential administrative activities.

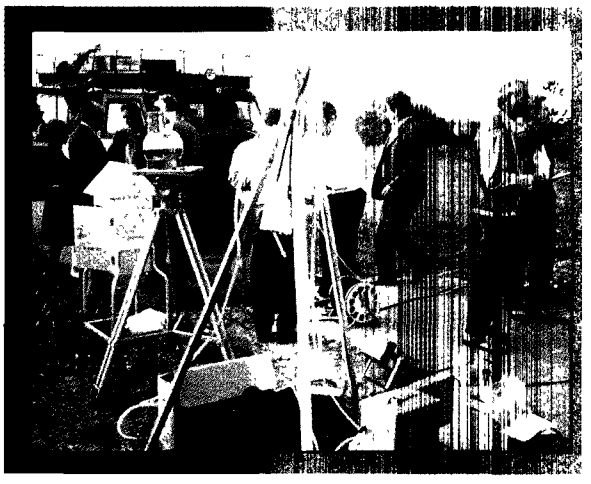
OMMSQA Structure



The responsibility of the Quality Assurance Management Staff (QAMS) is to assess the accuracy and effectiveness of environmental measurements. In fulfillment of this function, QAMS performs the following management-related activities: (1) documents the quality, effectiveness, completeness, and efficiency of major EPA data collection programs; (2) supports and oversees the development of Agency quality assurance (QA) management systems and policies; (3) supports Agency quality assurance efforts; and (4) informs the environmental community on QA. In addition, QAMS provides research support in the design and implementation of exposure studies and monitoring systems to assess exposure trends and improve the process of conducting exposure assessments. The staff conducts research in the areas of data quality objectives, data quality audits, model validation protocols, and improvements in quality control programs.

The Modeling and Monitoring Systems Staff (MMSS) coordinates the scientific planning, program evaluation, budgeting, and management of OMMSQA's research programs. MMSS consists of two teams—a Media Research Team and a Core Research Team. The former coordinates activities among the three laboratories, the regulatory Program and Regional Offices, and the Research Committees, while the latter is involved in the development of the Core Research Program, particularly the Total Human Exposure Research Program and the Environmental Monitoring and Assessment Program (EMAP).

The research laboratories are the Environmental Monitoring Systems Laboratory, Cincinnati (EMSL-CIN), the Environmental Monitoring Systems Laboratory, Las Vegas (EMSL-LV), and the Atmospheric Research and Exposure Assessment Laboratory, Research Triangle Park, North Carolina (AREAL). A laboratory thematic concept is used to delineate the primary responsibilities of each laboratory's work to eliminate overlap. Historically, areas of concentration of each laboratory are as follows: EMSL-CIN—water, EMSL-LV—terrestrial and subsurface environment, and AREAL—air. Each laboratory's areas of concentration are discussed further in a dedicated section of the guide.



Collaborative AREAL and USSR research effort in the USSR to study dispersion patterns of volatile organic compounds.

OMMSQA's quality assurance activities include development and distribution of calibration standards for water quality analyses as well as for the analyses of pesticides and industrial chemicals.

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Quality Assurance Management Staff

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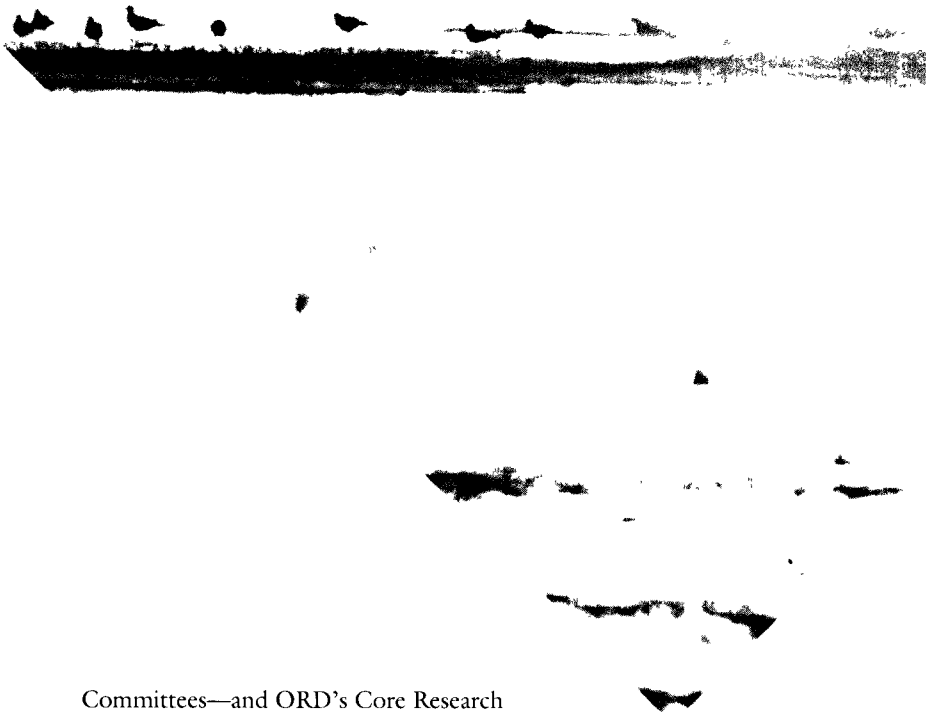
OMMSQA's Research Program

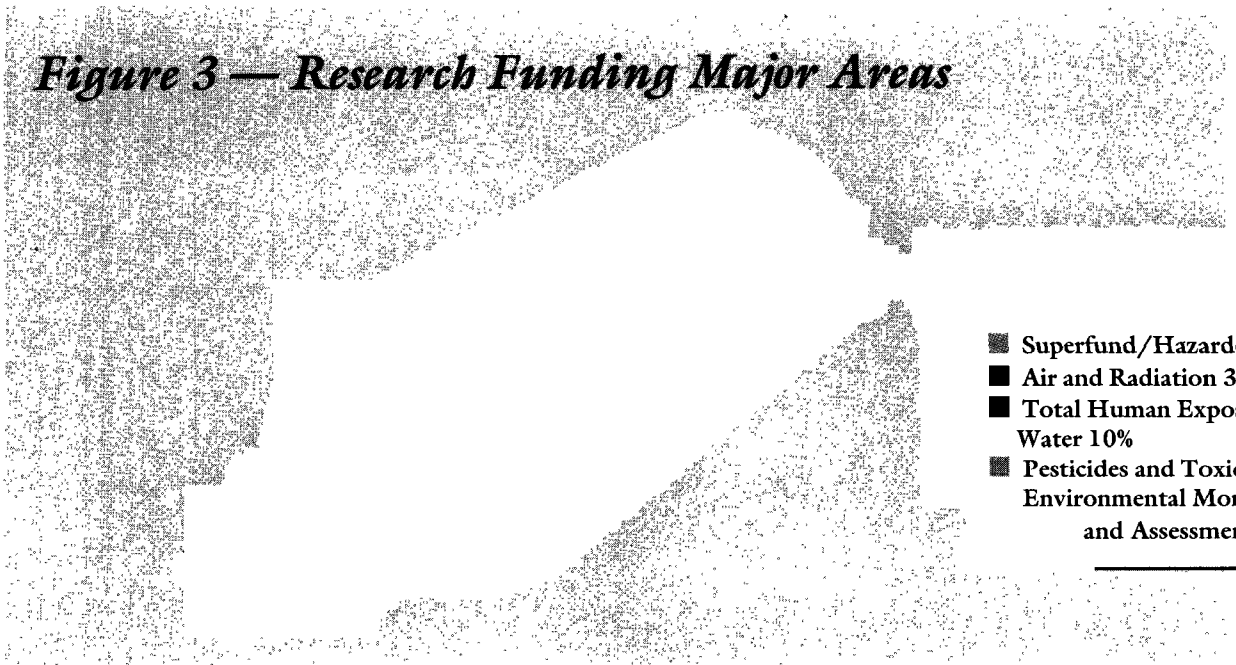


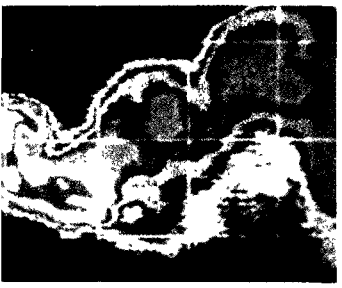
OMMSQA's research is carried out through its three research laboratories and focuses on four major areas: exposure modeling, exposure assessment, exposure classification, and monitoring and environmental characterization. Underlying the Office's entire research and technical support program is its continued development of state-of-the-art modeling, monitoring, method development, and quality assurance capabilities to assure the completion of precise, accurate exposure assessments. The research program supports both its traditional clients—Regional Offices, Regulatory Program Offices, ORD Offices, and Research Committees—and ORD's Core Research Program in the areas of health risk assessment, ecological risk assessment, and risk reduction (pollution prevention). OMMSQA works jointly with the Program Offices and Regions through the Research Committees for planning and coordinating research activities. The Research Committees provide guidance for planning research programs to meet the needs of the regulatory Program Offices, Regions, and the Agency. OMMSQA is represented in the following Research Committees: Air and Radiation, Water, Hazardous Waste and Superfund, Pesticides and Toxic Substances, and Multimedia.

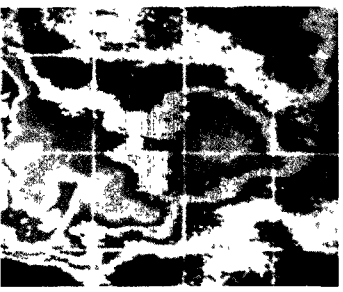
Total research funding in OMMSQA is approximately $120 million per year. Funding for major areas of research is shown in Figure 3. Unlike the research areas described above, the Quality Assurance Management Staff (QAMS) recieves approximately $1.7 million per year to conduct the QA responsibilities.

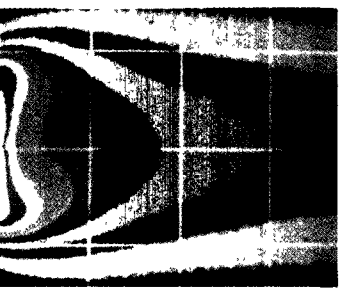
OMMSQA's AREAL laboratory measures dispersion pattern smoke from combustion sou using fluid modeling techniq

Figure 3 — Research Funding Major Areas









National Ambient Air Quality Standards

Under the Clean Air Act Amendments of 1977, EPA was required to reevaluate the standards for ambient air quality for the following "criteria" air pollutants: nitrogen dioxide (NO_2), sulfur dioxide (SO_2), ozone (O_3), carbon monoxide (CO), lead (Pb), and inhalable particulate matter. The standards, known as the National Ambient Air Quality Standards (NAAQS), are intended to protect human health with a reasonable margin of safety (primary standards) and to protect against effects on human welfare such as crop loss, materials damage, and impairment of visibility (secondary standards). Obtaining accurate measurements of these criteria pollutants is essential to air quality control. OMMSQA is responsible for assuring the adequacy of these measurements by developing, evaluating, improving, and standardizing the methodologies and monitoring systems used to gather the data.

OMMSQA provides the support to assure that the NAAQS monitoring methodology remains accurate and appropriate. In line with this objective, OMMSQA developed a methodology both to quantify damage to materials and to determine the extent and causes of visibility loss caused by air pollution. This quantification is necessary to revise the secondary NAAQS, as well as to plan control strategies and prioritize future research. OMMSQA is also initiating an effort to obtain the information that would help the Agency determine whether a fine particle and acid aerosol standard is required to protect human health or welfare. In addition, the Office is developing a methodology to measure aerosol acidity and population exposure in response to needs identified by the Clean Air Science Advisory Committee.

New Source Performance Standards and State Implementation Plans

OMMSQA provides extensive assistance to the Office of Air Quality Performance Standards (OAQPS) to support New Source Performance Standards (NSPS) and State Implementation Plans (SIPs). The NSPS are Federal standards set for new pollutant sources, while SIPs are State strategies for attaining the ambient air quality standards. This support includes monitoring methods and model evaluation and development, data management, quality assurance, technical consultation, and emergency assistance.

In one project, OMMSQA is developing and evaluating state-of-the-art remote monitoring methods to aid air quality regions that are still in nonattainment, that is, those regions that have not attained the ambient air quality standards. OMMSQA is also providing the necessary monitoring support to OAQPS in its efforts to ascertain the need for new standards, assess long-term effects, and determine effects on health and welfare. The Office also devises and evaluates methodologies used to determine compliance with the NSPS and to facilitate the measurement of source emissions as required in the SIPs.

Quality assurance requirements are a vital part of the air monitoring regulations. OMMSQA, therefore, develops the procedures and systems used to assess the quality of source emission data and ambient air data, prepares the guidelines and programs that transfer QA technology to monitoring agencies,

assesses the quality of the data submitted to EPA, and also provides quality assurance to the SIPs.

In other related projects, OMMSQA investigates, develops, and applies air quality simulation models to predict the air quality impacts associated with pollution control strategies (e.g., SIPs). In particular, fluid and theoretical modeling techniques are being used to modify present atmospheric dispersion models as well as to develop new models. The modeling program focuses on both urban scale and regional scale (1,000 km) pollutant transport, with emphasis currently placed on ozone and inhalable particulate matter pollution problems. Models are also being developed by OMMSQA to support the Agency's assessment of primary and secondary air quality standards for fine particles, visibility, and acid aerosols.

Hazardous Air Pollutants

OMMSQA supports several methods development projects for the regulation of hazardous air pollutants. Measurement and characterization of pollutant emissions from municipal and hazardous waste incinerators, chemical manufacturing facilities, and other stationary sources require specialized methods. OMMSQA conducts research to develop these specialized source emission test methods.

There is also a need for more specific, more sensitive, and less expensive methods to measure hazardous/toxic air pollutants at low but significant concentrations in ambient air. Therefore, OMMSQA researchers are developing and evaluating new methods to measure air pollutants and are expanding existing techniques to include additional pollutants. These methods are being developed in the laboratory and tested under field conditions.

In support of risk assessments and regulatory decision making, OMMSQA undertakes laboratory and field studies to provide data on the occurrence,sources, transport, formation, removal, reaction products, and ultimate fate of hazardous air pollutants in the atmosphere.

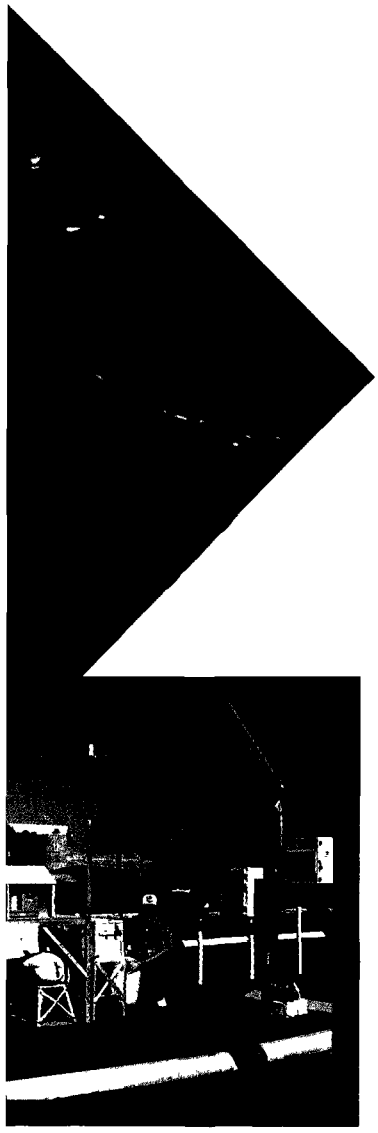
Mobile Source Pollutants

Motor vehicles are important sources of atmospheric pollution. OMMSQA plays a major role in EPA's effort to ensure that no unreasonable risk exists from motor vehicle emissions. Since emphasis is placed on such alternative fuels as methanol, ethanol, and gasoline blends of these alcohols and methyl tert-butyl ether (MTBE), OMMSQA is involved in a project that quantifies emissions from vehicles using these alternative fuels.

This project also includes the modification of standard Agency models and the identification of microenvironments with possible high exposures.

Indoor Air

In recent years there has been an increase in the monitoring of air in indoor locations, termed microenvironments. Microenvironments include residences, offices, and automobiles. The data obtained from such monitoring, when combined with time and activity pattern information, can provide more accurate estimates of human exposure. OMMSQA is conducting extensive exposure monitoring research to develop the tools to estimate human exposure to indoor air pollutants, determine their impact, and to identify their sources and mitigation strategies. Among the tools being scrutinized are portable personal exposure monitors, survey sampling methods, personal activity questionnaires, and fixed outdoor and microenvironment monitoring.



Radiation monitoring in communities near a nuclear test site.

Stratospheric Ozone

Ultraviolet (UV) radiation has a deleterious effect on the earth's biological and chemical systems. Since the stratospheric ozone layer is the earth's primary shield against these rays, more information is needed on stratospheric ozone depletion and the effect of UV radiation on the earth's surface. OMMSQA is conducting air modeling analyses to predict the influence of increasing ultraviolet-B (UV-B) radiation on ambient ozone formation in attainment and nonattainment urban areas. Laboratory studies will be conducted to determine the potential for depletion of O_3 in the stratospheric ozone layer. OMMSQA also is conducting controlled chamber and field studies to determine UV-B effects on selected materials. This work is an integral component of ORD's stratospheric ozone program.

Global Warming

The buildup in the atmosphere of pollutants such as carbon dioxide, methane, solvents, and refrigerants (e.g., Freons) may trap more heat in the atmosphere, producing a greenhouse effect. OMMSQA scientists are involved in an effort to determine what effects the expected change in climate will have on the environment. They are working to develop methods to ascertain the impact of climate on environmental systems and to predict climate on a regional basis, thereby allowing effects-oriented scientists to conduct climate impact assessment studies.

Acid Deposition

OMMSQA's responsibilities in this area involve the construction, documentation, and evaluation of an Eulerian Regional Acid Deposition Model (RADM). RADM describes the atmospheric processes occurring during the transport and reaction of acidic substances from the sources to the receptors, i.e., lakes, streams, and forests. RADM will also be used to simulate and predict the source-receptor relationships over time and space. In addition, OMMSQA has a program to test the scientific accuracy of RADM. To obtain the information needed, OMMSQA researchers are performing field investigations that involve daily measurements of wet deposition and air concentrations of acid compounds.

OMMSQA is also involved in the development of a deposition monitoring data base. Gaseous pollutants and by-products of their interaction that are being emitted into the atmosphere are affecting various ecosystems by returning to the earth's surface through wet (e.g., acid rain) and dry deposition processes. The National Acidic Deposition Program (NADP) seeks to obtain data on the levels of ions in wet deposition throughout the United States. OMMSQA supports the Agency in this effort by sampling rainfall at several sites and analyzing these samples for pH, conductivity, and a variety of chemical concentrations. OMMSQA also provides quality assurance for the Acid Deposition Program and works to improve the methods used to collect relevant data so that uncertainties can be reduced.

In addition, OMMSQA supports the National Dry Deposition Network (NDDN). The NDDN estimates dry deposition rates at a network of monitoring sites to ascertain deposition trends for various pollutants. In conjunction with this effort, OMMSQA develops accurate and reliable field measurement techniques, explores the question of uncertainties, and deploys standard procedures for collecting and analyzing samples.

Radiation

There is a need to provide an independent evaluation of the continuing safety of nuclear testing. EPA, as a separate, unbiased Agency, performs this function for the Department of Energy (DOE). Because of its monitoring expertise, OMMSQA has assumed responsibility for managing the Offsite Radiation Monitoring Program (ORMP) for DOE, which includes both hydrologic and human surveillance monitoring. In addition, the Office maintains a quality assurance support program for measurement of ionizing radiation contaminants in air, water, milk, and food; oversees a radiation data base; and advises DOE on the offsite safety aspects of each test.

Water Quality-Based Approach

To ensure the quality of the Nation's surface waters, EPA has established a water quality-based approach to the permitting of pollutant discharges into aquatic environments. OMMSQA's activities in the area of water quality thus are largely concerned with ensuring that the water quality monitoring data used by EPA for setting regulations and for enforcement and compliance purposes are scientifically valid and legally defensible. In fulfillment of this responsibility, OMMSQA develops the standardized chemical, physical, methods and biological assay procedures used to ensure the collection of accurate data. It also provides the reference materials, calibration standards, and biological test organisms, including fish, microinvertebrates, algae, and microorganisms, needed to support water quality monitoring. In addition, OMMSQA researchers conduct interlaboratory validation studies to obtain precision and accuracy data for each monitoring method and conduct performance evaluation studies of EPA, EPA contractors/grantees, and State and local laboratories.

Marine Waters, Estuaries, and Lakes

The near-coastal areas of the United States are among our richest and most sensitive ecosystems. However, EPA lacks the standardized methods and reference materials to monitor and regulate the chemical constituents and pollutants found in these marine and estuarine waters and sediments. Accordingly, OMMSQA is reviewing available monitoring methods for their applicability to marine and estuarine environments and will modify them as necessary.

Wastewater Treatment Technology

Every industrial facility that discharges wastes into water must have a permit under the National Pollutant Discharge Elimination System (NPDES). Under NPDES, dischargers monitor their own compliance up to the maximum allowable levels and report violations immediately to the Agency. EPA then initiates enforcement actions as needed. Such actions are legally and technically equitable only when the quality of the data generated within the NPDES is assured. OMMSQA is thus involved in evaluating NPDES monitoring and maintaining the credibility of the NPDES data. This is accomplished (1) through the provision of quality control samples to the regulated community as an external QA check, (2) through participation in Performance Evaluation (PE) studies on unknown samples to determine a laboratory's potential analytical capabilities, and (3) through participation in the Discharge Monitoring Report/Quality Assurance (DMRQA) study conducted annually for major NPDES dischargers.

In a related area, OMMSQA is concerned with assuring the adequacy for regulatory purposes of approved analytical methods for measuring pollutants in industrial wastewater. The Office investigates deficiencies in existing analytical methodologies to improve their validity, conducts research on the existing development and standardization of new instrumental techniques for new regulated parameters, and operates an Equivalency Program to evaluate alternative test procedures.

Drinking Water Technology

The Safe Drinking Water Act of 1974 (SDWA) was passed by Congress to ensure that the Nation's drinking water supply is safe from contaminants. With its extensive experience in the area of quality assurance, OMMSQA has the responsibility for designing, preparing, and verifying quality control standards, performance evaluation samples, and calibration standards for drinking water laboratory certification and evaluation. It conducts the National Drinking Water Laboratory Certification

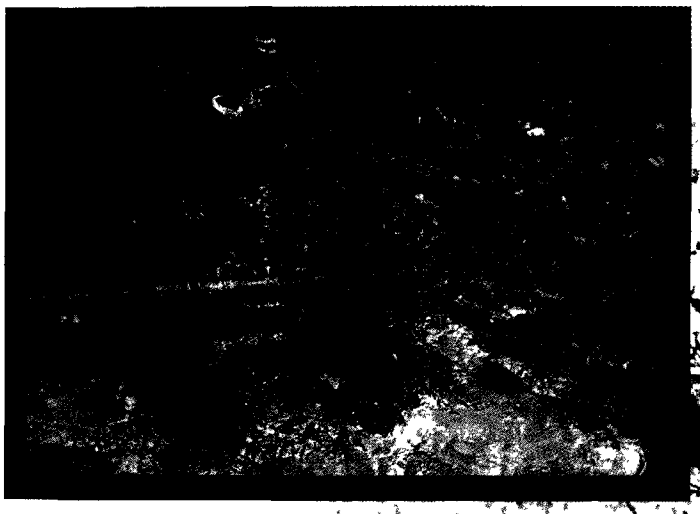
Program. This includes interlaboratory performance evaluation studies of Federal, State, and local laboratories that perform radiochemical, chemical, and microbiological analyses.

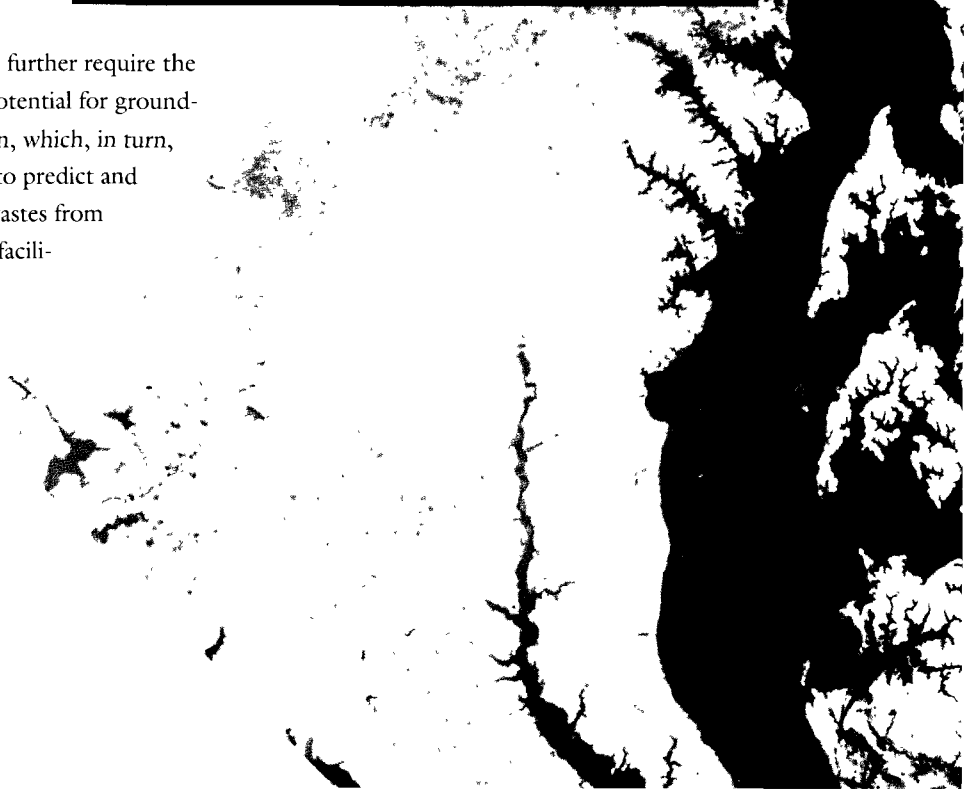
In addition, OMMSQA develops and reviews standardized analytical procedures for onsite monitoring of microbiological contaminants to assure compliance with the maximum contaminant levels set by the SDWA. It also provides support to the Agency's drinking water programs by developing and standardizing technically and economically feasible analytical procedures for determining the presence of contaminants in drinking water. Congress has mandated that 25 new analytes a year are added to the monitoring requirement.

Ground Water

The Safe Drinking Water Act and its amendments also require accurate, cost-effective monitoring of ground-water resources. In particular, monitoring ground-water quality around Wellhead Protection Areas (WHPAs) is necessary to protect drinking water supplies. The Underground Injection Control regulations further require the assessment of the potential for ground-water contamination, which, in turn, requires the ability to predict and map migration of wastes from deep well injection facilities. OMMSQA provides guidance in these areas.

In another ground-water-related effort, OMMSQA is assisting the Office of Ground-Water Protection in developing technical resource documents and other information to aid States and local governments in implementing ground-water protection programs. An assessment of monitoring technologies that can provide inexpensive alternatives to traditional monitoring in a really extensive WHPAs will be performed.





Monitoring of surface water contamination around well head to assess the potential for groundwater contamination.

Infrared satellite imagery of the lower Chesapeake Bay watershed (red depicts vegetation, dark blue is water, light blue is silt-filled water, grey areas are buildings, rocks, houses, etc.).

Waste Identification

The Resource Conservation and Recovery Act of 1976 (RCRA) and the Hazardous and Solid Waste Amendments of 1984 (HSWA) are the vehicles used by EPA to control hazardous waste. Among its provisions, RCRA requires EPA to provide methods that determine the chemical composition of waste, detect trace levels of toxic constituents (both organic and inorganic), and provide for the rapid screening of hazardous constituents in a variety of environmental and waste matrices. Properly validated analytical methods are required to support these regulatory monitoring requirements. OMMSQA is involved in an effort to develop and evaluate more accurate and rapid methods for extracting and analyzing hazardous materials, as well as to improve existing methods.

RCRA also requires that most RCRA waste sites have ground-water monitoring programs. Geophysical, geochemical, and remote sensing methods and hydrologic monitoring approaches are among those used to assess the presence and extent of contamination at these facilities. OMMSQA is currently developing and evaluating a number of subsurface monitoring methods, including soil-gas and vadose-zone monitoring methods, ground-water sampling devices, borehole geophysics, and fiber-optic sensors. OMMSQA is also developing monitoring systems for the Agency's Underground Storage Tank program. In addition, it has the lead for application of external leak detectors and transfer of technology advances to States. The Office is also devising statistically based approaches for sampling network design and data interpretation, and is comparing methods of data analysis currently in use.

Another OMMSQA effort in the hazardous waste area involves releases at hazardous waste sites. If there is a release at a RCRA hazardous waste site, site conditions must be rapidly assessed. Aerial photographs and multispectral scanner data provide the best means of obtaining the necessary information quickly and cost-effectively. Geographic information system (GIS) technology, the computer-based system for referencing all types of spatial data, is being developed. GIS provides a rapid and highly associative and descriptive analytical tool for applying these data to the practical, problem solving needs of the Regional and Program Offices of the Agency. Applications using global positioning system (GPS) technology, a very fast and accurate method of ground surveying that is accomplished from earth-orbiting satellites, are being rapidly assimilated into methodologies where precise geo-referencing is critical. These approaches are also used in the evaluation of permits and of overall compliance status. OMMSQA is involved in the collection and interpretation of data derived from these and similar techniques.

Quality Assurance

In line with its quality assurance objective, OMMSQA documents the quality of the RCRA data generated by the EPA Regions, contractors, and State and local agencies. The Office provides industrial waste and synthetic quality control samples and calibration standards to laboratories conducting RCRA monitoring and analyses. It also

Sampling of contaminated soil from spill using Level B protective equipment.

develops, analyzes, and distributes natural-matrix, liquid, and solid performance evaluation samples for use by these laboratories and reports statistics to the Office of Solid Waste (OSW). In addition, OMMSQA regularly distributes samples to RCRA laboratories for use as quality control samples and conducts referee laboratory analyses on selected RCRA samples. Finally, the Office prepares sampling QA guidance manuals for soils and industrial wastes and provides assistance to Regions and States in QA and in conducting sampling audits.

Releases

Section 311 of the Clean Water Act mandates that Spill Prevention, Control, and Countermeasure (SPCC) plans be prepared for all facilities involved with hazardous materials. OMMSQA provides aerial photography, satellite imagery, Global Positioning Systems (GPS), computer assisted cartographic mapping, and multispectral scanner and Geographic Information Systems (GIS) support to assist Regional Offices in SPCC surveys, planning, and emergency response activities.

In another release-related activity, OMMSQA is evaluating pollution plume models and developing protocols for underground storage tank (UST) modeling. Site characterization procedures are viewed as a high-priority need by the Office of Underground Storage Tanks, therefore OMMSQA is testing relevant monitoring devices and operating procedures, along with various sampling techniques.

Since all releases into the environment must now be reported, there is a need for the proper tools to accurately report releases and predict their paths. OMMSQA is examining such tools, including state-of-the-art dispersion modeling. To validate the accuracy of new models, the Office is developing a methodology for model validation.

Procedures for Site Assessment

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) provides for the cleanup of sites that pose threats to human health or the environment. The Superfund Amendments and Reauthorization Act (SARA), enacted in 1986, provides for the research to support these activities.

OMMSQA provides assistance to the Superfund program by developing the analytical protocols, sampling and preservation techniques, monitoring methods, and data interpretation approaches to be used by on-scene coordinators (OSCs) and regional project managers (RPMs) in assessing the degree of hazard posed by these waste sites. These include air monitoring techniques for ambient and source sampling; ground-water monitoring techniques for hazardous waste and agricultural chemicals; analytical sample preparation methods and automated data transfer techniques; geophysical methods such as high resolution seismic reflection; x-ray fluorescence (XRF) measurements of metal concentrations; remote sensing techniques; soil core preparation procedures; portable GC technology; and PC-based geostatistics computer programs.

Technical Support

Because precise and accurate data are required to properly characterize Superfund sites, OMMSQA provides OSCs and RPMs with site-specific technical assistance, monitoring and characterization support, and quality assurance support. In addition, it evaluates the performance of EPA's Regional Laboratories involved in the Superfund Program.

Advanced Field Methods

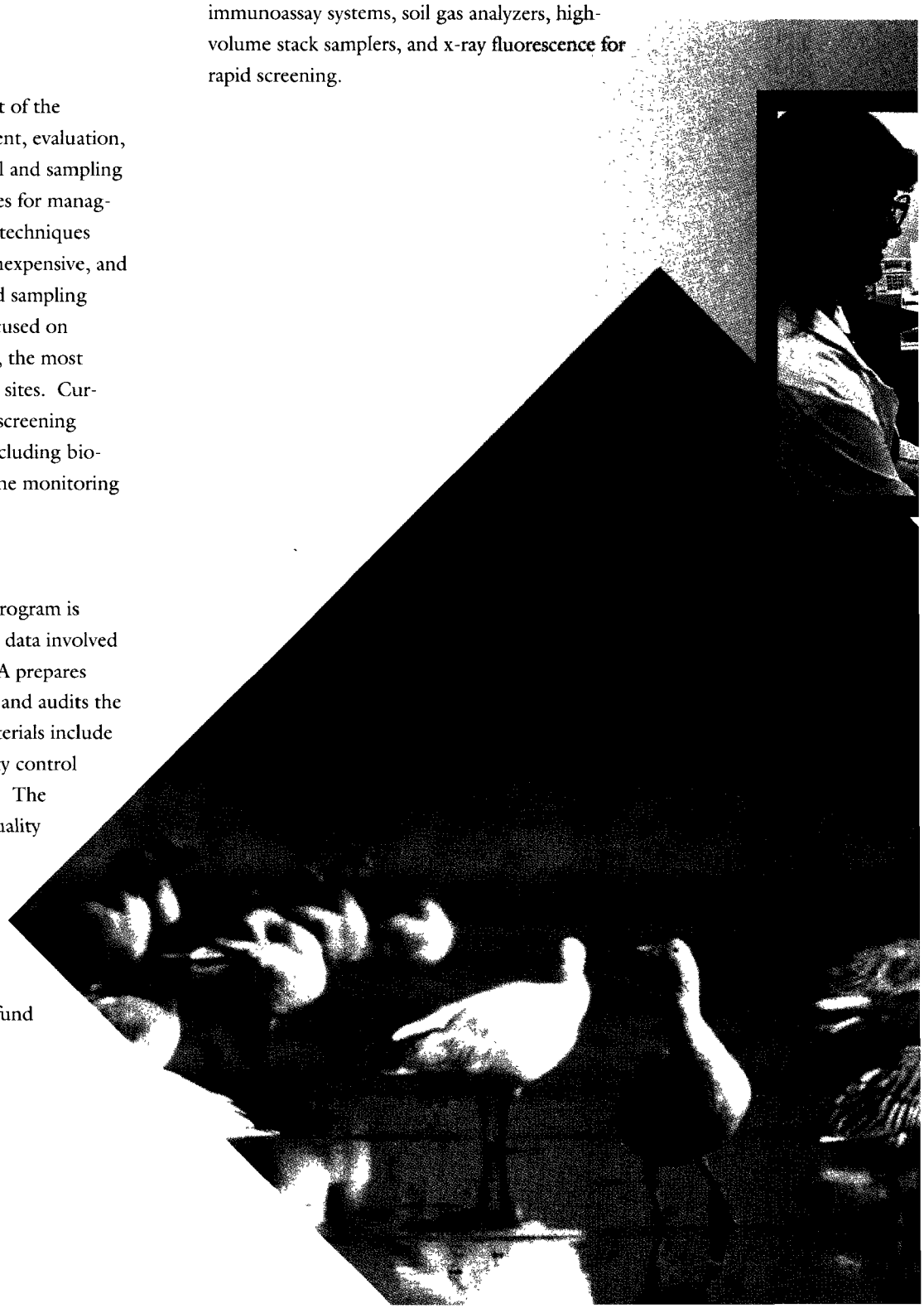
Another OMMSQA effort in support of the Superfund program is the development, evaluation, and standardization of field analytical and sampling methods and the design of techniques for managing and interpreting field data. The techniques under development must be rapid, inexpensive, and sensitive. OMMSQA's analytical and sampling activities in this area have initially focused on volatile organic compounds (VOCs), the most common contaminants at Superfund sites. Currently, the Office is developing new screening methods for exposure assessment, including biomarkers, and is evaluating vadose zone monitoring equipment.

Quality Assurance

Since an effective quality assurance program is essential to ensure that the analytical data involved are of appropriate quality, OMMSQA prepares quality assurance reference materials and audits the data generated. These reference materials include calibration standards as well as quality control and performance evaluation samples. The resulting data are maintained in a Quality Assurance/Quality Control Data Base. These activities are in support of the Contract Laboratory Program (CLP), which is responsible for most of the chemical analyses performed under the Superfund program.

Superfund Innovative Technology Evaluation Program

Section 311b of SARA requires EPA to conduct the Superfund Innovative Technology Evaluation (SITE) Program to promote promising new technologies that can be applied to Superfund contamination problems. OMMSQA is currently evaluating and validating a number of these new technologies, including fiber optics/chemical sensors, immunoassay systems, soil gas analyzers, high-volume stack samplers, and x-ray fluorescence for rapid screening.



IMMSQA's exposure monitoring ınd modeling research utilizes :omputerized methods such as he x-ray spectrometer to meas- ıre exposure of humans and the ɜnvironment to pesticides and oxic substances.

Exposure Monitoring

Direct monitoring of human exposure is a relatively new approach to measuring human exposures to environmental contaminants. It is preferable to inferential or reconstructive exposures, which often result in error, particularly underestimation of total exposure. OMMSQA's exposure research program seeks to measure the exposure of populations to the critical chemicals regulated by the Agency. This exposure information is used by the Office of Pesticides and Toxic Substances (OPTS) in the implementation of the Toxic Substances Control Act (TSCA), the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and related legislative mandates. The results from research are used in evaluating risks associated wıth pesicide use as well as the manufacture, use, and release of new and existing chemicals.

OMMSQA's research is designed to develop models that predict the exposure of the entire target population to these critical chemicals from all sources. Among other things, exposure studies help to identify non-traditional sources that may contribute to exposure. The exposure research also examines dietary, non-dietary, residential, and occupational exposure scenarios to develop models to improve exposure estimation techniques. These exposure estimates can then be extrapolated to larger populations. Emphasis is being placed on estimating pesticide exposures to potentially high-risk populations, such as toddlers and children. Research is designed to detect exposure to pesticide residues, to model exposures and to develop guidelines for registrants.

Test Method Development

The Office of Toxic Substances (OTS) requıres analytical methods for mixtures that are difficult to analyze, as well as for other uncharacterized materials disseminated into the environment. OMMSQA is providing the validated methods to characterize and analyze these materials and mıxtures. Among the technologies being studied are tandem mass spectrometry, inductively coupled plasma mass spectrometry (ICP/MS), immunochemical techniques, liquid and ion chromatography, and supercritical fluid extraction applied to biological samples.

Health Markers, Dosimetry, and Extrapolation

Biomarkers are specific biochemical or physıological changes within an organism. OMMSQA's human biomarker research program involves the investigation of selected biomarkers as indicators of exposure. OMMSQA researchers are seeking to identify, develop, refine, and apply appropriate biomarkers that can be used along with other monitoring data to better measure exposure to individuals and populations. Results will be used to construct pharmacokinetic models. This information will in turn reduce the uncertainty in the estimates of human risk following exposure to toxic chemicals and pesticides.

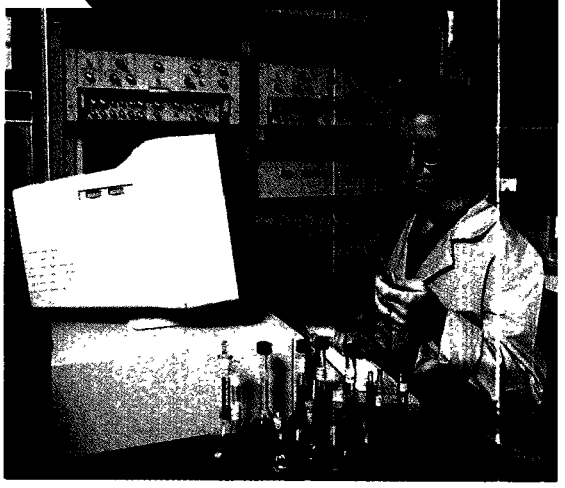
Biotechnology

Since conventional microbiological sampling techniques are inadequate to monitor the dispersion and persistence of microbes in the microenvironment, OMMSQA conducts research to develop and standardize collection and quality assurance procedures to measure these microbes. Emphasis is being placed on development of standard procedures to measure the release of microbes into the environment. The Office will also assist OPTS prepare guidelines and hold demonstrations and workshops to introduce and maintain these monitoring procedures.

Support

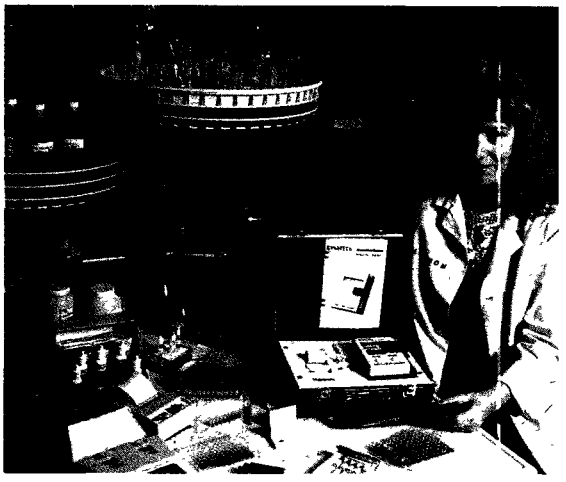
One of the support services that OMMSQA provides in the area of quality assurance is the operation and maintenance of the Pesticides and Industrial Chemical Repository. There is a need to maintain a source of chemical standards in order to establish traceability and maintain comparability between laboratories in chemical analyses of pesticide residues and other analytes. The repository acts as a unique source of chemicals and metabolic degradation products which are no longer available commercially in the U.S., but are needed to implement responsibilities of the Agency.

Providing quality assurance support for the pesticides and toxic substances programs is another function of OMMSQA. Such support includes reviewing current monitoring methodologies used to develop data bases, QA protocols, and guidelines for data management procedures. It also involves providing materials for bioassays, biological measurements, exposure monitoring, and exposure assessments. Advanced computer technology is being used to analyze spatially related monitoring data from existing Agency programs to identify areas of potentially high exposure.



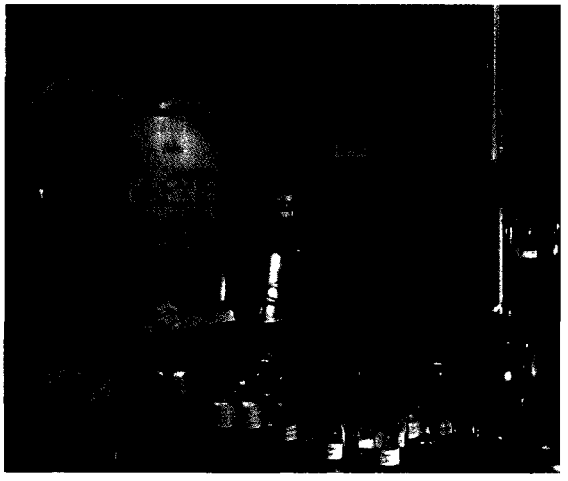
SARA Title III

OMMSQA is concerned with the development and demonstration of an innovative methodology to address the potential for routine or catastrophic chemical releases from industrial sites. The Office investigates process analytical chemistry techniques to monitor chemical production processes and assess potential or actual releases from industrial sites. OMMSQA also develops and evaluates procedures to address environmental and human exposure monitoring at industrial sites.



Asbestos

Since asbestos is present in many public buildings, schools, and residences, human exposure to asbestos is of concern. OMMSQA is developing and evaluating sampling procedures and microscopic procedures to detect asbestos. In addition, monitoring methods to measure human exposure in microenvironments will be studied, with emphasis placed on public building maintenance and abatement practices.



nalytical quality assurance ampling.

ield portable Test Kit for mmunochemical Environmental Monitoring.

dvanced analytical methods to etermine the presence of pesti- ides and toxic substances nclude liquid chromotography nd mass spectrometry.

In recognition of the growing environmental problem resulting from continuing, persistent, and cumulative pollution from a variety of sources, both controlled and uncontrolled, the EPA Science Advisory Board (SAB), in 1988, urged the Agency to reevaluate its approach for dealing with environmental problems in the next decade and beyond and recommended a long-term research program to support this new strategy. Among its recommendations was the establishment of a program to monitor ecological status and trends, as well as to develop innovative methods to detect emerging problems before they reach crisis proportions.

EPA is thus initiating a major new "Core" Research Program, supported by an SAB review of the Office of Research and Development's long-term research program. The Core Research Program is intended to generate knowledge essential to all areas of environmental decision making, not just the immediate regulatory needs of EPA Program Offices. It requires a commitment to long-term research and to maintaining the resources necessary for an effective basic research program. The Core Research Program consists of four parts: ecological risk assessment, health risk assessment, risk reduction, and exploratory grants and research centers. OMMSQA will have a lead role in both the ecological risk and health risk assessment areas. It will also be involved, but to a lesser extent in the risk reduction area.

The Multimedia Planning Group has a lead role in planning the Core Research Program, particularly the Environmental Monitoring and Assessment Program (EMAP) and the Total Human Exposure Research Program.

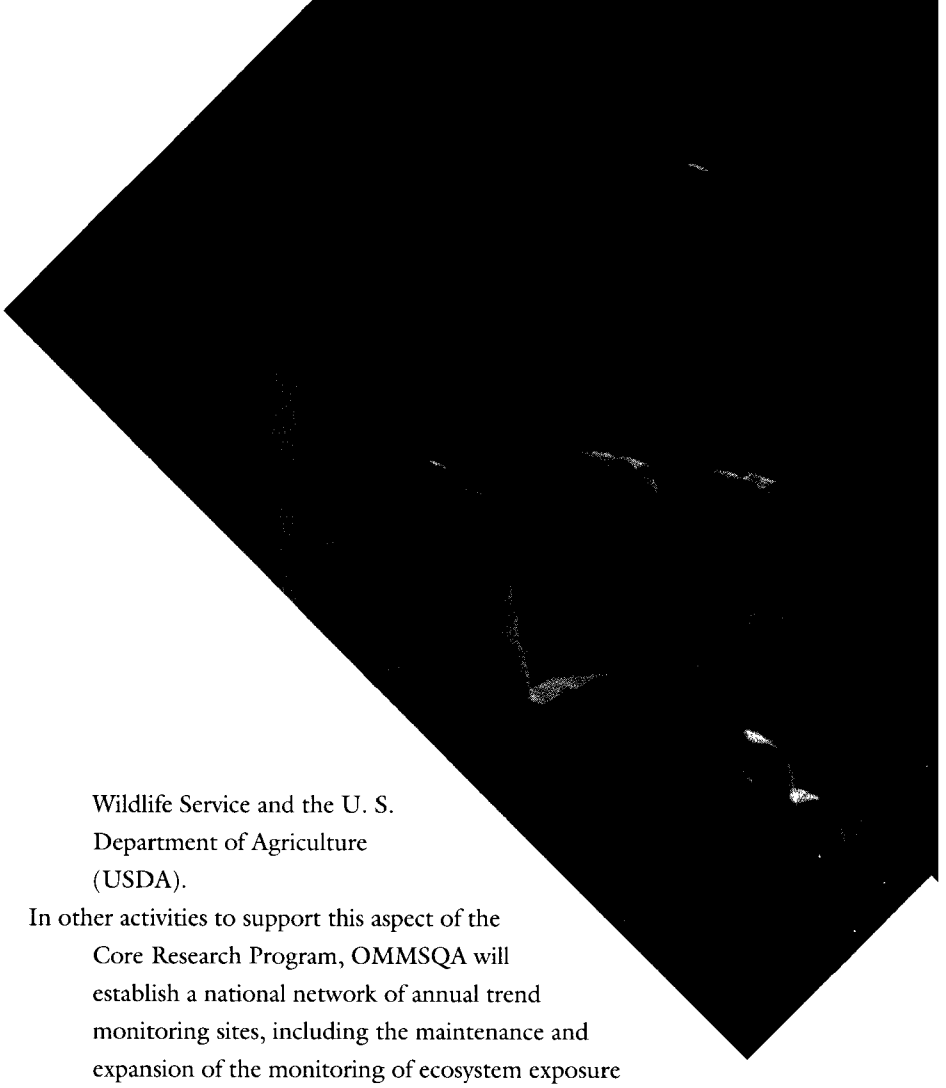
Environmental Monitoring and Assessment Program

Ecological risk assessment is the scientific process of evaluating the risk that pollution poses to our environment. Historically, such risk assessments have focused on evaluating the effects of individual pollutants and discharges on a limited number of species to provide the data for specific regulations. Thus, there is at present a limited information framework from which to assess the cumulative effects of pollution on the ecosystem as a whole. Moreover, the need for such baseline conditions against which future changes can be documented has become more acute as environmental issues have grown in complexity.

To meet this need, the Office of Research and Development has established the Environmental Monitoring and Assessment Program. EMAP is a major effort to assess and document the condition of the Nation's ecological resources. EMAP provides the strategic approach needed to identify and determine the extent, magnitude, and location of deteriorating or improving environmental conditions. It also monitors the status and trends in representative ecological resource systems that are at risk from multiple environmental stresses. The data derived from such monitoring programs will indicate whether serious changes are occurring in these systems and whether single or multiple pollutants are responsible. Because data on large geographic scales and over long time frames are essential to such assessments, EMAP focuses on national- and regional-scale conditions over extended periods of time.

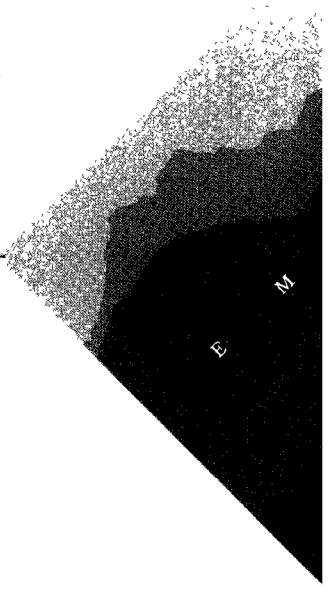
To determine the overall state of the environment, indicators of ecological condition are used. The success of such evaluations depends on the accuracy of these indicators. The EMAP program has identified three categories of indicators: (1) response indicators—biological measures that address the overall condition of ecosystems; (2) exposure indicators—physical, chemical, and biological measurements that can be related to pollutant exposure, habitat degradation, or other causes of poor condition; and (3) stressor indicators—economic, social, and engineering data (e.g., coal production, pesticide applications, pollutant emissions) that can be used to confirm diagnoses. OMMSQA will test and refine these indicators by conducting several pilot studies. The Office will also develop new and improved environmental indicators, along with statistical diagnosis and data analysis techniques.

EMAP monitors conditions in near-coastal systems, wetlands, inland surface waters, and terrestrial ecosystems. It will also monitor acid precipitation and air quality because they are important factors that affect ecosystems. Pollutant exposure and response indicators to be monitored include those related to multiple and cumulative pollutant interactions, regional air pollution and acidic deposition, habitat loss and modification, nonpoint source pollutant impacts to surface water and estuaries, and changes in radiation energy inputs and climate. Early emphasis is being placed on implementing the program in estuaries, near-coastal wetlands, and inland surface waters, as well as on the evaluation and maintenance of the atmospheric deposition network (i.e., the National Trends Network/National Dry Deposition Network). OMMSQA will plan and conduct regional pilot status surveys in near-coastal and forested ecosystems and will modify sampling plans based on these pilot surveys. Estuaries and coastal wetlands were selected as part of the pilot surveys because they are spawning grounds for many organisms, and because estuarine watersheds are primary recipients of pollution. During all phases of the EMAP effort, OMMSQA is working closely with other Agency offices as well as Federal agencies such as the National Oceanic and Atmospheric Administration (NOAA), the U. S. Fish and Wildlife Service and the U. S. Department of Agriculture (USDA).



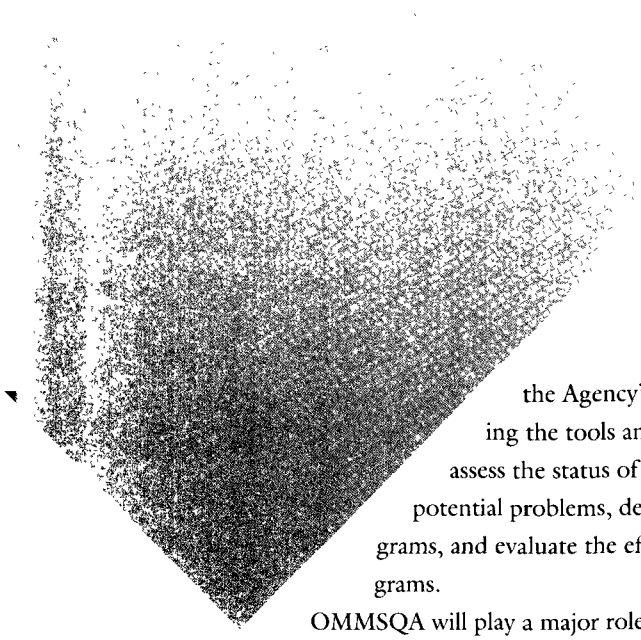
In other activities to support this aspect of the Core Research Program, OMMSQA will establish a national network of annual trend monitoring sites, including the maintenance and expansion of the monitoring of ecosystem exposure to pollutants in air and atmospheric deposition. In addition, the Office will produce annual statistical reports on status and trends for both the scientific community and the public, and will support the Administrator and EPA officials in allocating resources by providing periodic integrated interpretive assessments of environmental data.

To improve coordination of ecological research efforts and to provide a comprehensive view of ecological research to date, the Office of Research and Development is studying the creation of a National Institute of Ecological Research (NIER). The NIER would conduct ecological research, develop field monitoring studies, provide support in the areas of data management and statistical analysis, and disseminate information to policy and decision-makers. OMMSQA is involved in the planning phase of this effort.



Total Human Exposure Research Program

Traditionally, environmental health research at EPA has concentrated on assessing the health risk of single chemicals; therefore, little information is available about how environmental exposures are affecting our health and what can be done about them. The Core Research Program will enhance



the Agency's capabilities by developing the tools and knowledge needed to assess the status of public health, identify potential problems, develop risk reduction programs, and evaluate the effectiveness of these programs.

OMMSQA will play a major role in ORD's Core Research effort in the Total Human Exposure Research Program. Emphasis is being placed on the need for direct measurements of personal exposure through monitoring of media that contact the target and measurements of the biomarkers of exposure, such as body burden. This approach involves the measurement or estimate of total exposure, the measurement of the contribution of each route of exposure, and the apportionment of the exposure among the sources. Estimates of exposure will also be improved because of enhanced abilities to measure human activity patterns.

OMMSQA's efforts will focus on four principal areas of research: (1) characterization and classification of human exposures; (2) design and implementation of human exposure studies and monitoring systems to assess exposure trends; (3) development of the science of predicting exposures to pollutants through models and surrogate systems; and (4) improvement of the process of conducting exposure assessments. These research areas will be incorporated into the major components of The Human Exposure Research Program, that is, methods development, measurement and data collection, modeling, and exposure assessments.

In addition, OMMSQA will coordinate with other Federal agencies, non-Federal groups, and State organizations involved in environmental research to exchange information on the results of their efforts. A data base management system will be devised to efficiently handle the data obtained form these sources.

Risk Reduction

Risk reduction includes any policies, technologies, and activities implemented to lessen the risk to humans or the environment from hazardous contaminants. The risk assessment portions of the Core Research Program will provide the information needed to identify pollutants that pose risks to human health or our ecosystem. They will also determine the magnitude of the risk. If the risk is found to be unacceptable, risk reduction methods, such as pollution prevention, treatment, or minimization of exposure, can be employed to reduce the risk. Pollution prevention, or waste minimization, is the preferred approach. OMMSQA will provide support to this area in the coming years as well.

OMMSQA also conducts atmospheric research on a cooperative basis with various scientific bodies of the People's Republic of China, Poland and others. The topics include transport and dispersion, the influence of aerosols on conversion of sulfur dioxide to sulfate, and the role of pollutants in damaging structures and monuments.

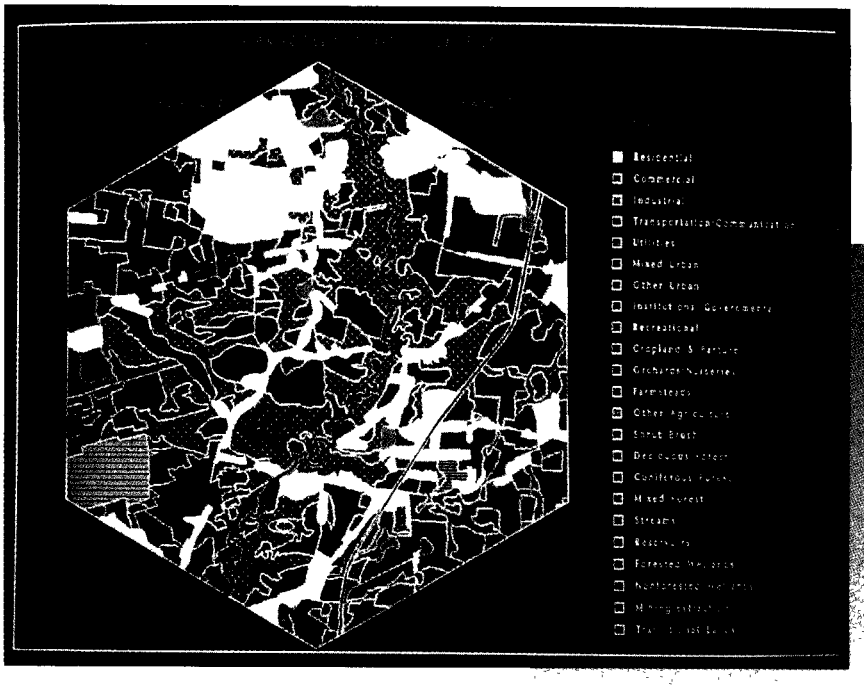
Reducing Uncertainties in Risk Assessment

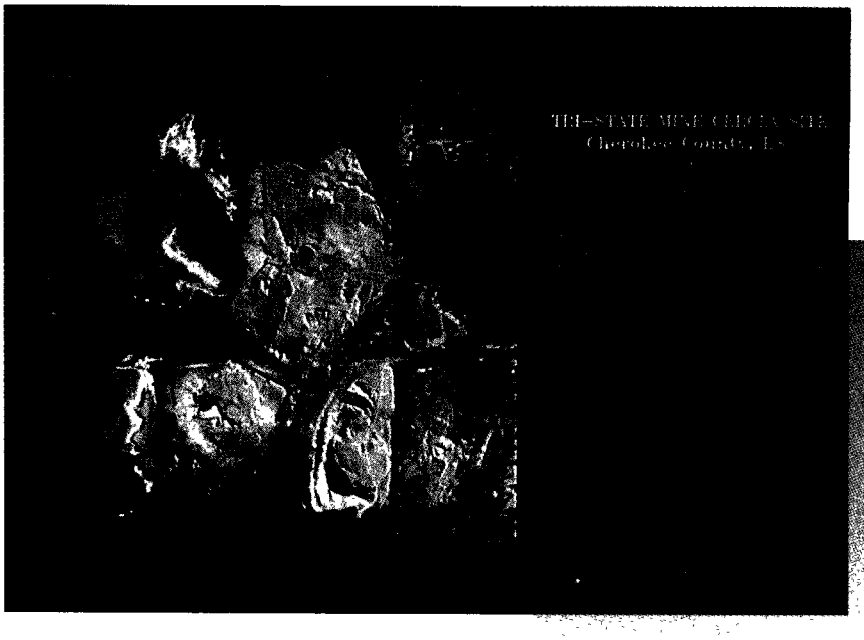
Uncertainty is introduced into risk assessments because chemicals are generally regulated on the basis of the concentration to which an individual is exposed rather than on the dose that actually reaches vulnerable tissue. To reduce these uncertainties, the methodologies for determining human exposure must be improved. One method for assessing human exposure is through exposure modeling. OMMSQA will develop and validate these models as part of its responsibilities under the Core Research Program.

Data Integration and Analysis

EPA's Center of Excellence for Data Integration and Analysis is located within OMMSQA. Their primary function is to promote the use of Geographical Information Systems (GIS), a relational data base to store such themes as land use, soils, populations, or well logs for a particular area. Another computer file contains the earth coordinate data and the relationships between that location and those surrounding it.

More than just a mapping system, GIS functions as a window on existing data bases, allowing the analyst to interact and manage data, models, and maps, develop scenarios and visually showing the results in either permanent paper map form or as temporary presentations on a color screen. The data analyzed are a collection of spatial information (represented by points, lines, and polygons) and their associated attributes (characteristics of the features such as ownership information, chemical characteristics, or economic activities) which the points, lines, and areas represent. The cartographic tools of GIS then allow the analyst to display, overlay, measure, merge, and identify thematic data in support of a particular analysis. By allowing the spatial data maps to be displayed and analyzed on a common scale, GIS provides the linkages necessary for effective decision-making, program prioritizing and the associated implementation of environmental management plans.





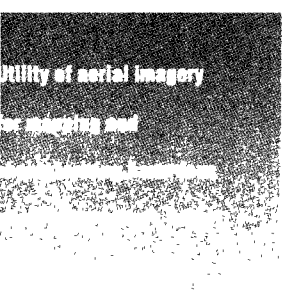
Quality Assurance

In addition to the previous activities, OMMSQA also manages the Agency-wide Quality Assurance Program. In this capacity, OMMSQA provides central management and oversight of the Agency's quality assurance program for environmental data operations. Key program elements include: development of QA Program Plans covering all Agency organizations having environmental data operations; conduct of Management Systems Reviews of selected programs; implementation of the Data Quality Objectives process; and management of an Agency-wide QA training program.

Environmental Monitoring Systems Laboratory-Cincinnati

Cincinnati,
Ohio 45268
(513-569-7301;
FTS 684-7301)

The Environmental Monitoring Systems Laboratory-Cincinnati (EMSL-CIN) develops, evaluates, and standardizes methods and procedures to acquire data used to monitor and assess the status of the environment. Research conducted by the Laboratory involves methods and procedures to detect, identify, and measure both chemical and biological environmental pollutants in various media, including raw and treated wastewater, drinking water, ambient water, soil, sediments, sludge, and biological samples. Once standardized, these methods are used to detect and identify bacteria,viruses, parasites, and aquatic organisms, as well as organic and inorganic pollutants. The Laboratory also develops and tests procedures for sample handling, transport, and preservation. In addition, it operates the EPA's Quality Assurance Program for maintaining the scientific credibility of the Agency's water, wastewater, and solid waste/Superfund/toxics data bases. The quality assurance effort includes method evaluation studies to establish the precision and bias of the Agency's analytical methods and the distribution of quality control samples and calibration standard to Agency, state, and contractor laboratories.



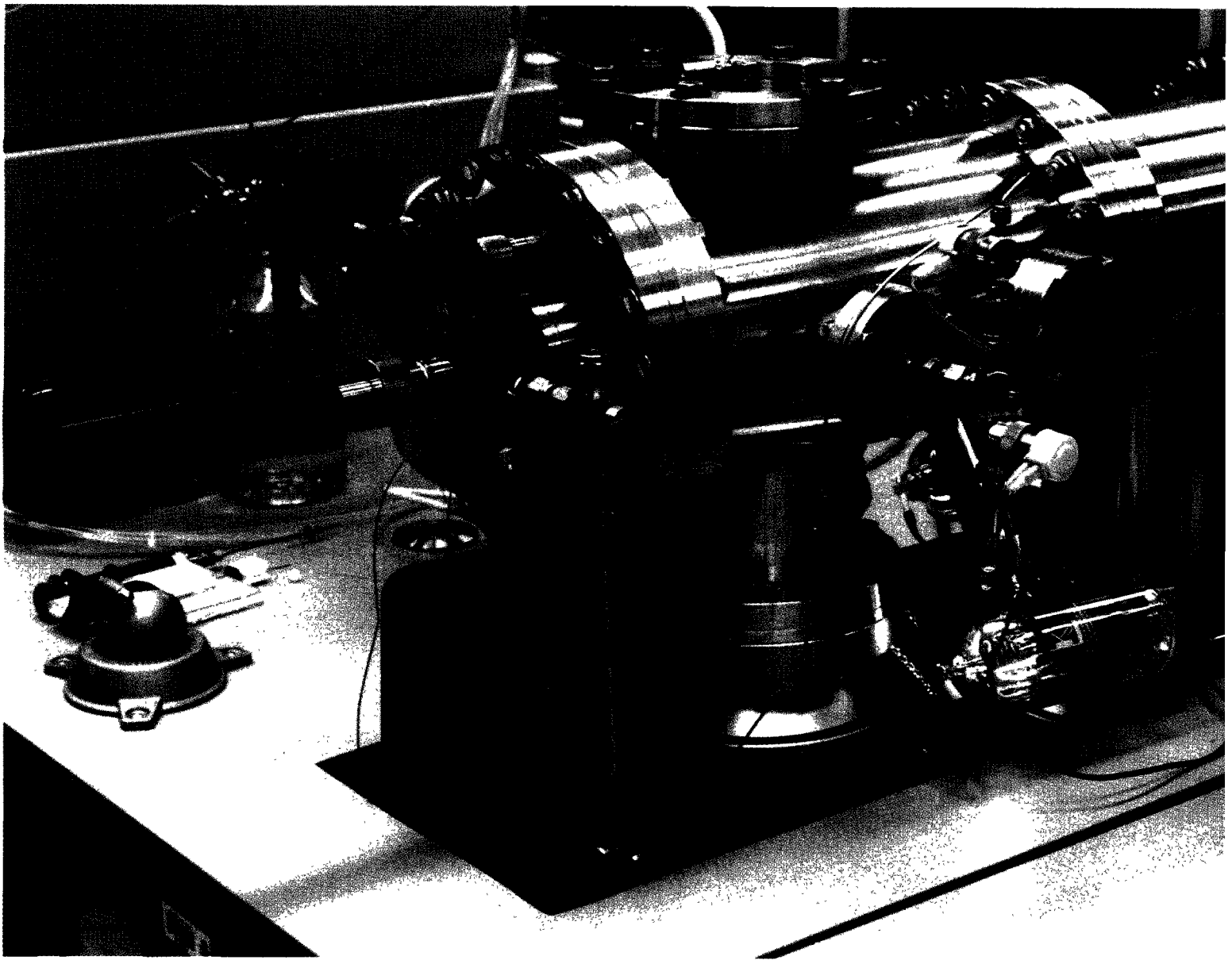
EMSL-CIN employed 98 full-time personnel in FY 89. Its FY 89 budget was $11.7 million, divided between in-house ($5.6 million) and extramural ($6.1 million) research activities.

The Laboratory is organized into three research divisions: Chemistry, Microbiology, and Quality Assurance. A Program Operations Staff coordinates the overall program activities of the Laboratory. Figure 5 depicts the structure of the EMSL-CIN.

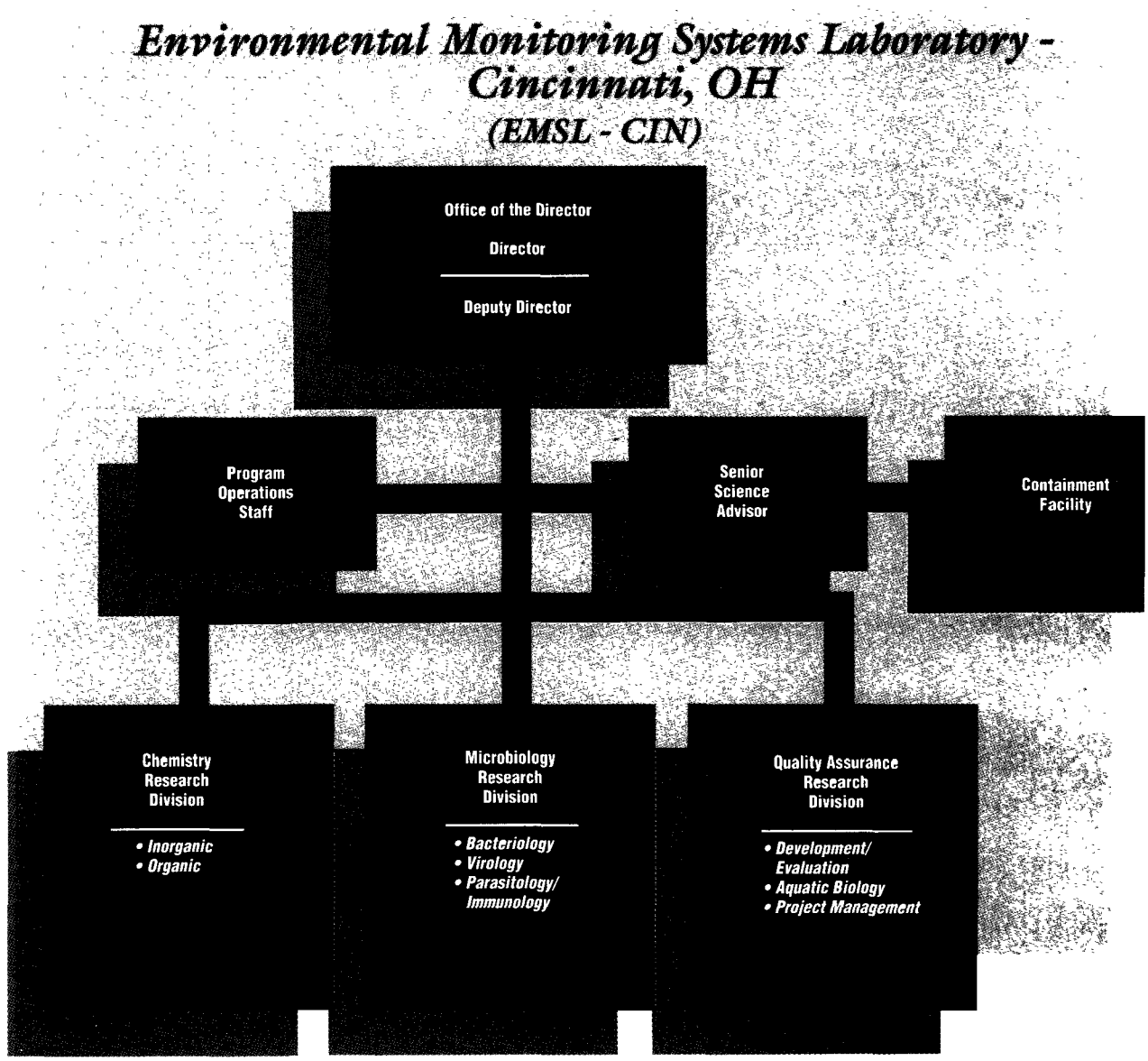
Chemistry Research Division

The Chemistry Research Division (CRD) is responsible for development and standardization of analytical methods for determination of chemical environmental contaminants in various sample types. These methods are used in setting and enforcing Agency standards and regulations for ambient water, drinking water, wastewater, and solid waste.

The CRD is composed of two branches—the Inorganic Chemistry Branch and the Organic Chemistry Branch. Major research areas in the Inorganic Chemistry Branch are determination of metals through application of inductively coupled plasma (ICP) emission spectrometry and ICP/mass spectrometry and determination of inorganic ions, organometallics, and metal speciation with chromatographic procedures. The Organic Chemistry Branch is involved in the development and evaluation of improved data systems; software devices; and techniques employing automated data collection, manipulation, and transfer. This branch uses a variety of computerized systems integrating mass spectrometers with gas and liquid chromatographs, to develop accurate and precise analytical methods.



Liquid chromatograph/mass spectrometer.



Microbiology Research Division

The Microbiology Research Division (MRD) conducts research on methods for detecting, identifying, and quantifying microbial indicators and pathogens found in water, wastes, soil, and air. These methods are used to determine the occurrence, distribution, transport, and fate of microorganisms in the environment. Methods for monitoring microorganisms are also evaluated and standardized. The Division conducts studies to ascertain the health and ecological effects associated with viruses, bacteria, and parasites in the environment. It also develops quality assurance guidelines for inclusion in Agency manuals and produces reference materials. The Division has three branches: Bacteriology, Virology, and Immunology and Parasitology.

The Bacteriology Branch is concerned with detection, enumeration, and identification of indicator and pathogenic bacteria in media such as water, sludge, soil, sediment, air, and leachate. Research is conducted to determine the virulence of infectious agents and the potential for human exposure to them. This Branch also is investigating emerging health and environmental problems caused by bacteria in water and wastes and is evaluating new bacterial indicators of specific health and environmental problems.

The Virology Branch develops methods to identify water quality problems, pollution sources, and control re-

quirements related to human enteric viruses. Emphasis is placed on practical and economical analytical procedures that permit rapid assessment of environmental health problems associated with viral pathogens.

Research on methods to determine the occurence and significance of environmental pathogens is conducted by the Parasitology and Immunology Branch. The Branch also develops and applies immunoassay techniques to ascertain the viability, virulence, speciation, and growth characteristics of bacteria, viruses, and parasites.

Quality Assurance Research Division

The Qualtiy Assurance Research Division provides quality assurance support for various Agency programs, including standardization of methods for aquatic biology, collaborative multilaboratory studies to evaluate the Agency's chemical and biological methods, and large-scale studies to assess analytical laboratory performance. This Division is composed of a Development and Evaluation Branch, an Aquatic Biology Branch, and a Project Management Branch.

The aquatic biology area has activities that include the development and validation of toxicity tests for marine and fresh water and sediments. This division is involved in the biomarker research program. Biomarkers are being developed, standardized and tested in the field for their ability to be used as early indicators of exposure.

The Agency's data collectio and enforcement activities depend upon standards and reference materials supplie OMMSQA for assuring the accuracy of analytical meth

Environmental Monitoring Systems Laboratory-Las Vegas

'.O. Box 93478
.as Vegas, Nevada
'9193-3478
702-798-2100;
TS 545-2100)

The overall mission of the Environmental Monitoring Systems Laboratory-Las Vegas (EMSL-LV) is to develop, evaluate, and apply methods and systems for monitoring the environment in order to assess the exposure of humans and other receptors in the environment to pollution, as well as to characterize the status of and identify trends in environmental quality. To accomplish these objectives, the Laboratory develops and applies field monitoring techniques, analytical methods, and remote sensing systems for monitoring environmental pollutants and then transfers these systems to Agency user organizations. EMSL-LV also develops and operates quality assurance programs for radiation, hazardous wastes, and toxic/pesticide monitoring. It develops and maintains reference standards, prepares performance evaluation materials, and conducts performance audits for the Agency and for other Federal, State, and local laboratories. In addition, the Laboratory provides technical support to EPA's Regional and Program Offices in response to their requests for pollutant monitoring, testing, and surveillance assistance.

The laboratory employs about 250 Federal employees and has 310 contract support employees onsite. Its FY 89 budget was $40.2 million.

EMSL-LV is organized into the following four divisions: Quality Assurance and Methods Development, Advanced Monitoring Systems, Nuclear Radiation Assessment, and Exposure Assessment Research.

Figure 6 shows the organizational structure of EMSL-LV. The divisions and their functions are as follows.

Quality Assurance and Methods Development Division

This division develops and evaluates innovative techniques for sample extraction and analysis of organic and inorganic contaminants in complex environmental matrices. It also develops and implements procedures for assuring and assessing the quality of data from environmental monitoring and distributes standards and reference materials to laboratories around the country. The performance of these laboratories is then evaluated, along with the precision, accuracy, and ruggedness of the analytical protocols. In addition, the Division provides quality assurance support and data audits for the Superfund Contract Laboratory Program and, in cooperation with the University of Nevada-Las Vegas, has established a fully equipped Quality Assurance Laboratory to support the Superfund program.

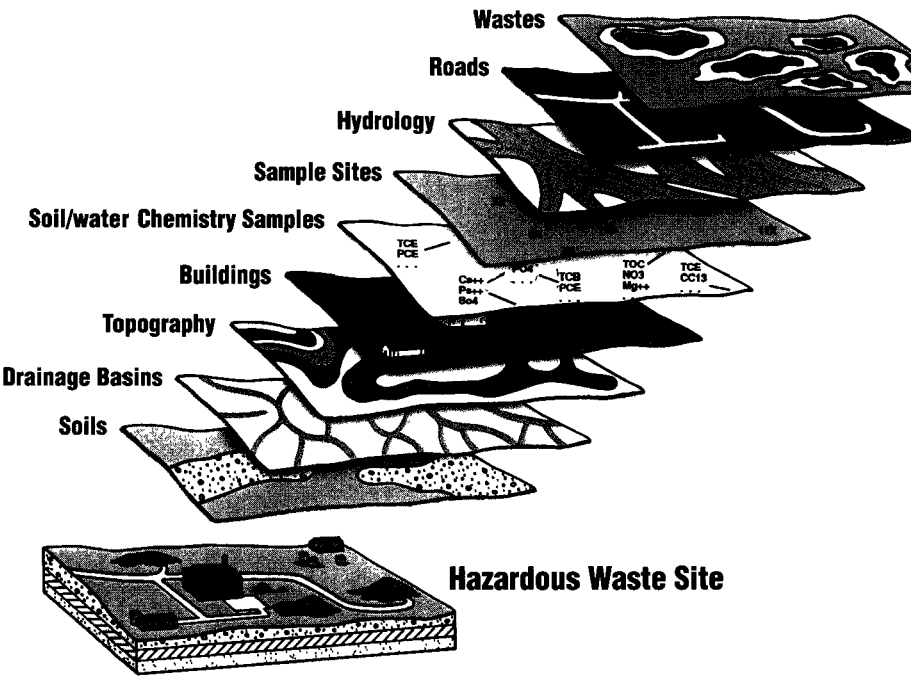
Advanced Monitoring Systems Division

The Advanced Monitoring Systems Division develops, optimizes, and field tests methods, systems, and strategies for monitoring the condition of the environment and for assessing the exposure of critical receptors. The Division develops, adapts, optimizes, and applies methods and techniques for measuring environmental pollutants as they transcend the media criteria for designing minimum adequate configurations. In addition to developing pollutant-specific strategies for integrated

measurement determinations, it conducts environmental quality studies and validates theoretical approaches through field investigations. In support of this mission, and to fulfill other Agency measurement requirements, the Division develops or adapts and reduces to practice rapid, wide-area monitoring methodology and techniques; this includes three-dimensional air mass pollutant measurements and remote sensing of specific environmental pollutant parameters. The Division develops and puts into practice systems designed to provide interactive computer-based data for environmental assessments and assessing exposure impacts on critical environmental components. It also acquires and interprets photographic and other remotely sensed data for environmental assessments and to support other Agency needs. The Division develops and provides the Agency airborne monitoring capability and provides emergency response monitoring in the event of pollution episodes or accidental releases of contaminants into the environment.

Geographical Information Systems

Data Layers

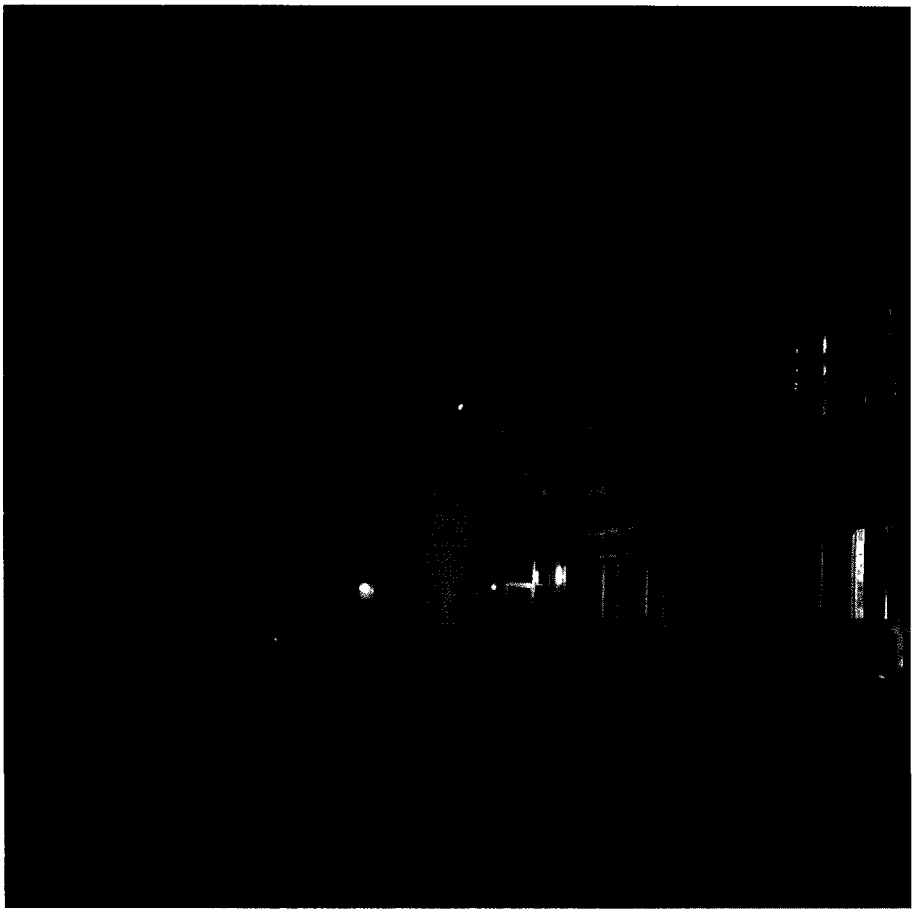


Nuclear Radiation Assessment Division

EMSL-LV, through its Nuclear Radiation Assessment Division, maintains extensive radioanalytical and field radiological monitoring capabilities to monitor environmental radioactivity levels around nuclear weapons testing sites in Nevada and elsewhere. Under a Memorandum of Understanding with the Department of Energy, the Division collects radiological surveillance data and performs research on pathways to determine the actual and potential radiation exposure to man and the environment from nuclear testing. These capabilities are used to assist in radiation accident emergencies such as the Three Mile Island incident. The Division operates a whole body counter for determining radionuclide body burdens in the population and serves as a radioanalytical quality assurance center for drinking water sample analyses.

Exposure Assessment Research Division

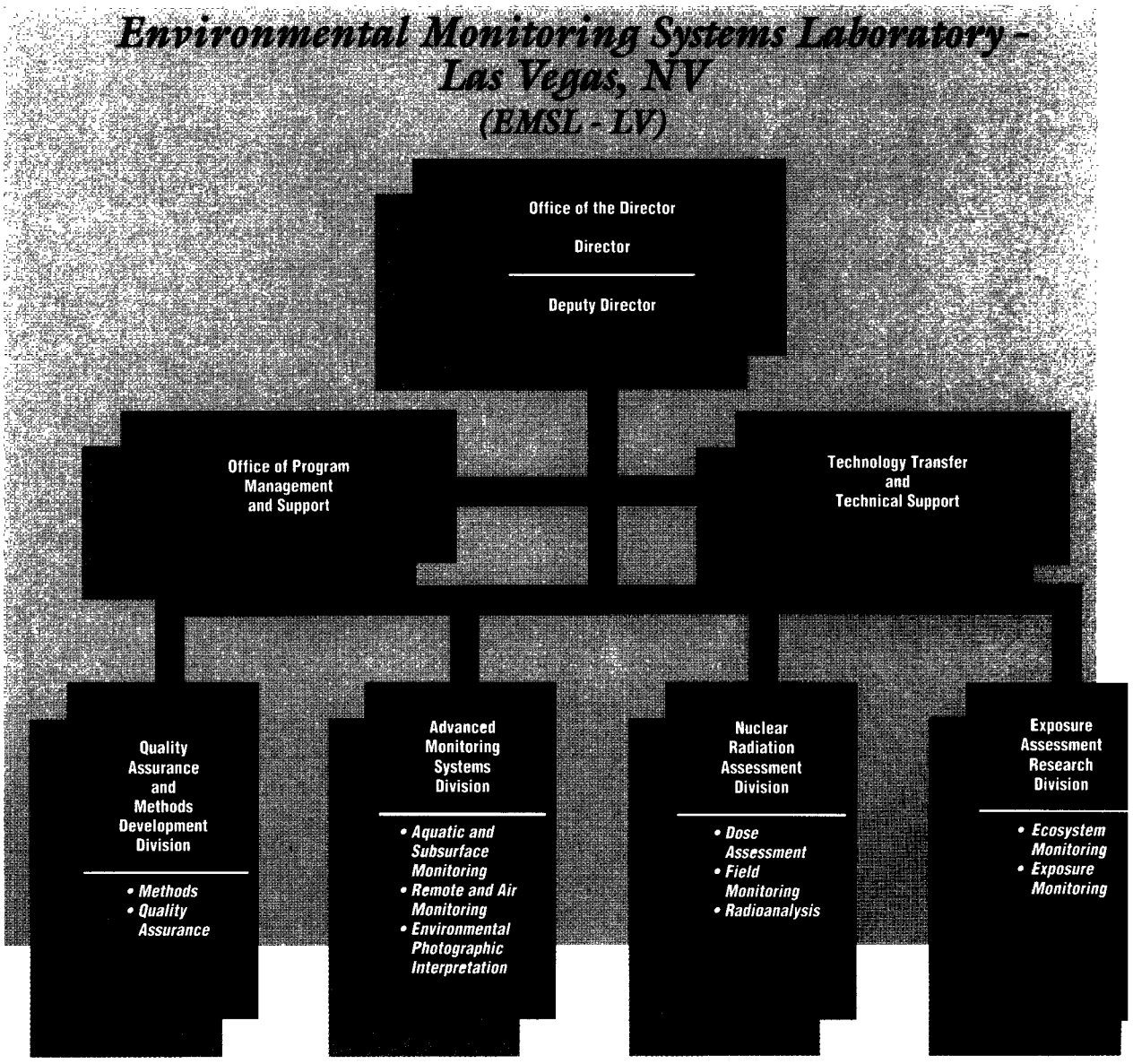
The Exposure Assessment Research Division is divided into two program areas: exposure monitoring and ecosystem monitoring. The exposure monitoring program has research efforts in total



EMSL-LV complex located on the campus of the University of Nevada, Las Vegas.

eographic Information Systems

IS) Data Layers.



human exposure modeling (microenvironment characterization and human activity pattern analysis), biomarkers of exposure, pharmacokinetic modeling, consumer product modeling, methods for assessing dermal exposure, measurement and monitoring methods for airborne microorganisms including genetically engineered microorganisms, and the development and evaluation of immunochemical methods for environmental pollutants. The ecosystem monitoring program has research efforts in field quality assurance, soil/sediment sampling methods, classical and spatial statistics, and monitoring methods for municipal waste facilities. This program also provides quality assurance support to the Aquatic Effects Research Program which is part of the Agency's acid deposition research effort. The program is also responsible for the monitoring of terrestrial ecosystems (forest, agroecosystems, and deserts and rangelands) as part of OMMSQA's Environmental Monitoring and Assessment Program (EMAP).

Atmospheric Research and Exposure Assessment Laboratory

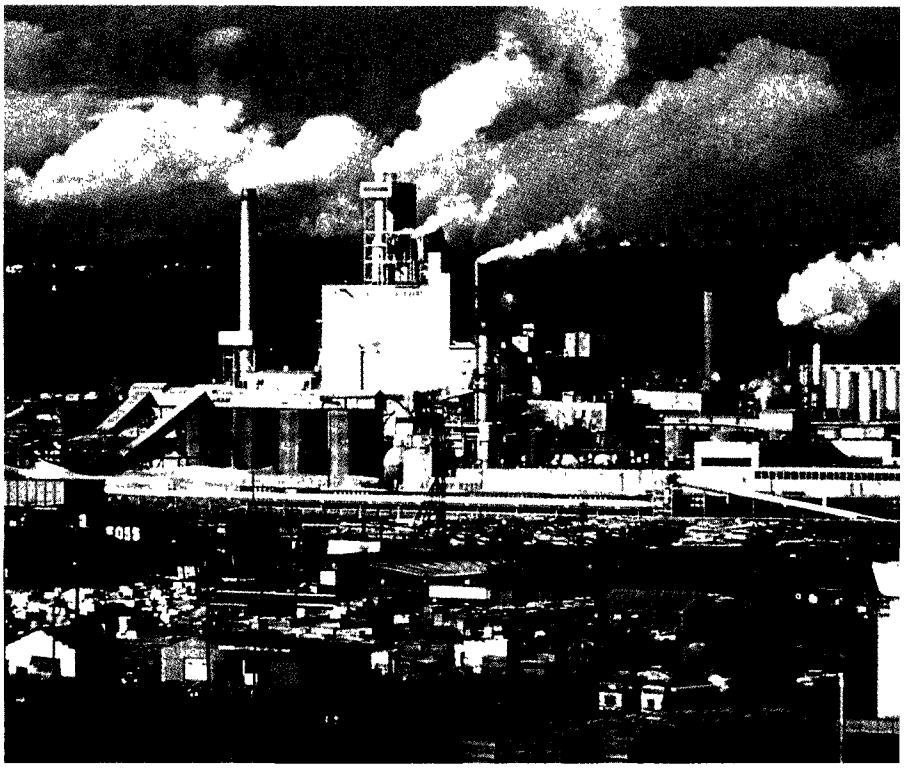
Research Triangle Park, NC 27711
(919-541-2106;
FTS 629-2106)

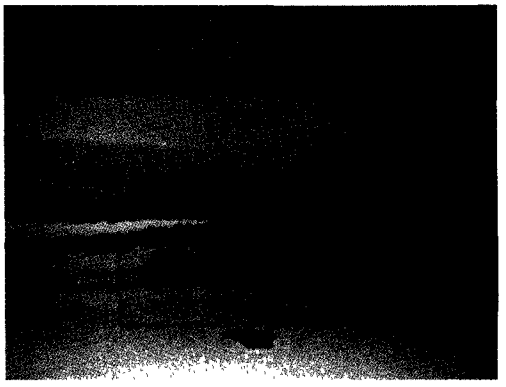
The Atmospheric Research and Exposure Assessment Laboratory (AREAL) conducts intramural and extramural research in the chemical, physical, and biological sciences. This research is designed to:

- Characterize and quantify present and future ambient air pollutant levels and resultant exposures to humans and ecosystems on local, regional, and global scales;
- Develop and validate models to predict changes in air pollution levels and air pollutant exposures and determine the relationships among the factors affected by predicted and observed changes;
- Determine source-to-receptor relationships relating to ambient air quality and air pollutant exposures, developing predictive models to be used for assessments of regulatory alternatives derived from these relationships either directly or indirectly;
- Provide support to Program and Regional Offices and to state and local groups, in the form of technical advice, methods research and development, quality assurance, field monitoring, instrument development, and modeling for quantitative risk assessment and regulatory purposes;
- Develop and carry out long-term research in the areas of atmospheric methods, quality assurance, biomarkers, spatial statistics, exposure assessment, and modeling research to solve cutting edge scientific issues relating to EPA's mission; and
- Collect, organize, manage, and distribute research data on air quality, human and ecosystem exposures, and trends for Program and Regional Offices, ORD, the scientific community, and the general public.

AREAL has an annual budget of $40 million; 74 percent of this amount is allocated for extramural research and 26 percent is devoted to in-house research. AREAL currently employs a staff of 219, with the majority found in the disciplines of chemistry, meteorology, and physics.

AREAL's research program is divided among five divisions: Chemical Processes and Characterization Research Division, Methods Research and Development Division, Exposure Assessment Research Division, Atmospheric Sciences Modeling Research Division, and Quality Assurance Division. Other





major components of the Laboratory are the Office of the Director, the Program Design and Integration Staff, and the Program Operations Staff. Figure 4 provides an overview of AREAL's organizational structure.

Chemical Processes and Characterization Research Division

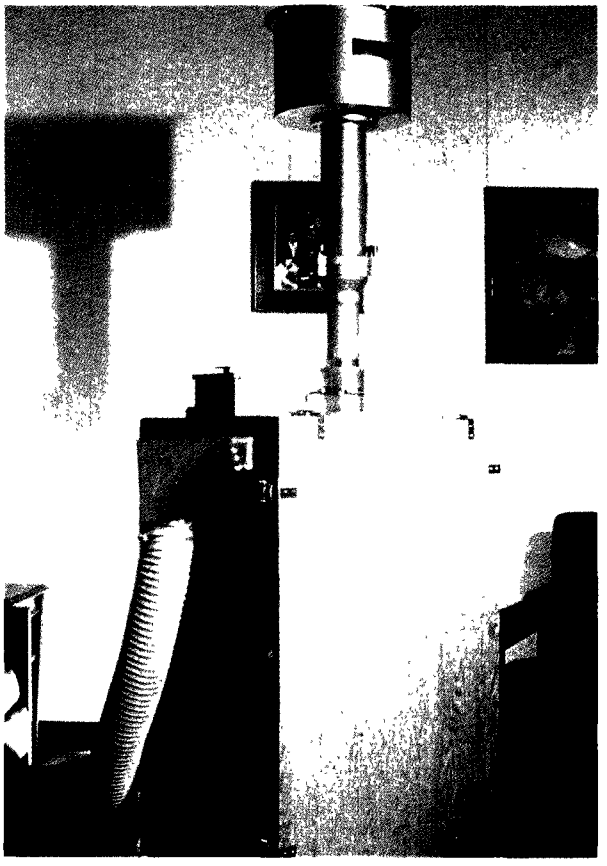
AREAL conducts chemical process and characterization research to measure and characterize the chemical composition of the atmosphere and emissions, as well as the physical properties of ambient air pollution. The overall objective of this research is to quantify the relationship between the atmospheric composition of air pollution and emissions from both mobile and stationary sources. In addition, AREAL devises statistical models and analysis techniques to demonstrate the links between atmospheric concentrations of pollutants and their probable sources. Research is also under way on new vehicle, fuel, and emission control technology on the chemical and physical nature of pollutants emitted to the atmosphere.

Methods Research and Development Division

The Methods Research and Development Division seeks to devise and test methods for determining and quantifying pollutants in ambient air, indoor microenvironments, and other environmental samples. Through this program, AREAL explores technical and cost-saving opportunities for upgrading the instruments and the monitoring and analytical methods used in compliance efforts, problem identification and characterization efforts, and status and trends efforts. In addition, it develops, evaluates, improves, and field tests cost-effective air pollution monitoring methods and measurement technology for use in network operations, field studies, human exposure assessment studies, and global climate change studies.

Exposure Assessment Research Division

In general, the Exposure Assessment Research Division develops exposure assessment techniques, conducts exposure assessments, designs environmental monitoring networks related to AREAL's mission, and collects and disseminates data on air quality and human and ecosystem exposures. The Division develops and applies human activity pattern models and predictive source-to-microenvironment exposure models, and develops and applies statistical and mathematical theory related to environmental monitoring and research data. This Division also performs exposure analyses on direct and indirect pathways of air pollution effects for human health and ecosystem risk assessments developed within the Agency.



Prototype air sampling device for collecting trace levels of semivolatile organic compounds in indoor air.

Atmospheric Sciences Modeling Research Division

The objective of the Atmospheric Sciences Modeling Research Division is to develop predictive models on local, regional, and global scales for assessing alterations in air quality and air pollutant exposures that result from changes in ecosystem management and regulatory decisions. In addition, this Division performs and directs the interagency

AL's research efforts ude monitoring and eling source-to-receptor tionships to determine ient air quality.

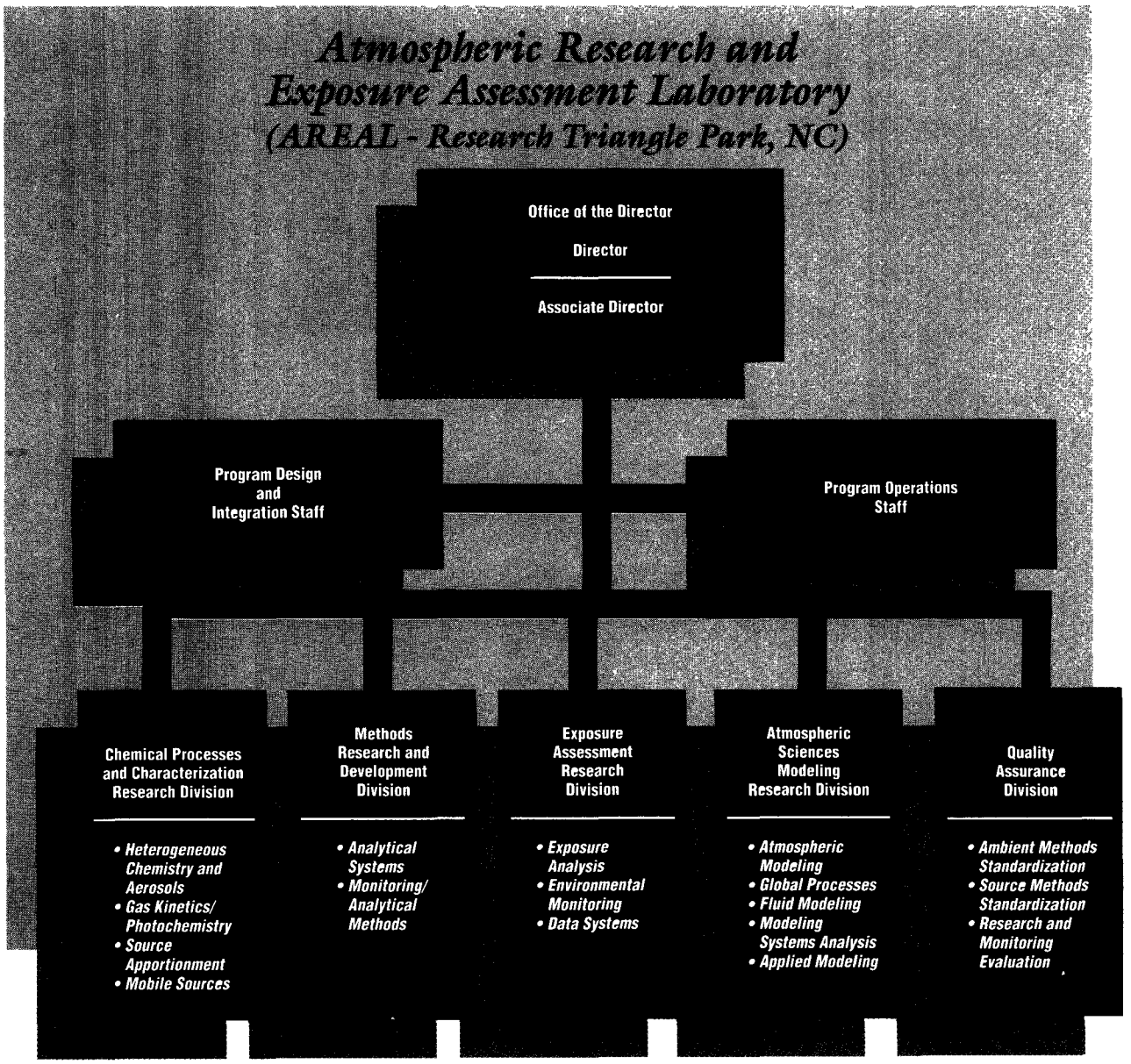
AL's atmospheric research lies stratified flow of atmos- ric pollutants over landscapes etermine dispersion character- :s of air pollutants. (left, om)

meteorlogical wind tunnel is l to determine flow patterns moke emitted from industrial ks. (right, bottom)

research necessary to support ecological risk assessment. The support includes quantitatively evaluating changes in regional air quality resulting from global climate fluctuations, modeling techniques that describe atmospheric physical processes affecting buoyant and dense gas pollution dispersion under unique meteorological situations, terrain features, and source configurations. This Division also implements modeling software design and systems analysis.

Quality Assurance Division

The Quality Assurance Division's objective is to develop and implement the EPA-wide air pollution quality assurance program. The Division develops materials, systems, and procedures to assess the quality of air measurement data submitted to EPA. It also evaluates, improves, describes, and standardizes the methodologies used for measuring pollutants in the ambient air and in stationary source emissions. In addition, the Division implements EPA's program for formal designation of reference and equivalent methods in support of the National Ambient Air Quality Standards and coordinates the development of the quality assurance requirements of EPA's monitoring regulations.



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