**ENVIRONMENTAL PROTECTION AGENCY**
WASHINGTON, D C. 20460

OFFICE OF THE
ADMINISTRATOR

October 1, 1971

MEMORANDUM

TO : Monitoring Conference Participants

SUBJECT: Environmental Monitoring Conference at the Western Environmental Research Laboratory, October 13, 14, and 15, 1971

The attachment to this memorandum consists of:

1. Conference Agenda (including assignments)
2. Assignment of Participants to Workshops
3. Workshop Discussion Guide for Development of an Environmental Monitoring Program Within EPA

To insure the success of this Conference, you are urged to familiarize yourself with the entire contents of the Workshop Discussion Guide. I look forward to a productive conference and the attainment of our objective to provide substantive inputs to the development of an overall environmental monitoring program for the Environmental Protection Agency.

Willis B Foster

Willis B. Foster
Deputy Assistant Administrator
for Monitoring

Attachment

# MEMORANDUM CHANGE

The second item in the attachment, "Assignment of Participants to Workshops," is not included in this transmittal. Instructions will be given at the conference.

# AGENDA FOR THE
# ENVIRONMENTAL PROTECTION AGENCY MONITORING CONFERENCE

Western Environmental Research Laboratory
Laboratory 1, Training Classroom
Las Vegas, Nevada
October 13, 14, and 15, 1971

## Wednesday, October 13, 1971

9:00 a.m. - Welcome - Dr. Melvin Carter, Director, Western Environmental Research Laboratory

Opening Comments - Dr. Stanley M. Greenfield, Assistant Administrator for Research and Monitoring, and Mr. Willis B. Foster, Deputy Assistant Administrator for Monitoring

9:45 a.m. - Organization and Functions of the Office of Monitoring - Mr. H. Matthew Bills, Director, Analysis Division, Office of Monitoring (30 minutes)

Office of Monitoring's Interaction With Other EPA Offices - Mr. Donald C. Holmes, Director, Techniques Division, Office of Monitoring (30 minutes)

Office of Monitoring's Interaction With Other Federal Government Agencies, i.e., NOAA, Interior, etc. - Mr. George B. Morgan, Director, Coordination and Support Division, Office of Monitoring (30 minutes)

11:15 a.m. - Discussion

12:00 noon - Lunch

1:30 p.m. - Current Monitoring Capabilities For:

Air - Mr. Raymond Smith, Office of Air Programs (20 minutes)
Water - Mr. George F. Wirth, Office of Water Programs (20 minutes)
Solid Waste - Mr. Lanier Hickman, Office of Solid Waste Management Programs (20 minutes)

2:30 p.m. - Discussion

3:00 p.m. - Radiation - Mr. Charles Weaver, Office of Radiation Programs (20 minutes)
Pesticides - Mr. E.L.J. Grandpierre, Office of Pesticides Programs (20 minutes)
Noise - Mr. Rudy Marrazzo, Office of Noise Abatement (20 minutes)

4:00 p.m. - Discussion

4:30 p.m. - Adjournment

6:30 p.m. - Cocktails and Dinner - Copper Cart, Las Vegas Blvd. South (across the street from the Westward Ho Motel)

8:30 p.m. - Dinner Speech -"Regional Monitoring Needs" - Mr. Paul DeFalco, Regional Administrator, Region IX (tentative)

Thursday, October 14, 1971

9:00 a.m. - Monitoring Needs For:

Enforcement - Mr. Robert Schaffer, Office of General Counsel and Enforcement (20 minutes)
Research - Dr. Herbert Wiser, Office of Research (20 minutes)

9:40 a.m. - Discussion

10:00 a.m. - Air - Mr. Raymond Smith (15 minutes)
Water - Mr. George F. Wirth (15 minutes)
Solid Waste - Mr. Lanier Hickman (15 minutes)

10:45 a.m. - Discussion

11:00 a.m. - Radiation - Mr. Charles Weaver (15 minutes)
Pesticides - Mr. E.L.J. Grandpierre (15 minutes)
Noise - Mr. Rudy Marrazzo (15 minutes)

11:45 a.m. - Discussion

12:00 noon - Lunch

1:00 p.m. - Seven White Paper Reports

1. An Integrated, Nationwide Environmental Monitoring Program for Short-Term Implementation - Mr. Keith Schwab, Region VIII, Denver

2. Future Monitoring Program and Methods - Mr. Gary Gardner, Region III, Philadelphia

3. Standardization of Methods and Equipment - Mr. Richard Duty, Region VI, Dallas

4. Early Warning Monitoring Network - Mr. Gary O'Neal, Region X, Seattle

5. Requirements for Acquisition of Monitoring Data Especially Dealing With Compatibility and Quality - Mr. Edward Fitzpatrick, Region 1, Boston

6. Development of a Quality Control Program - Mr. Robert Bowden, Region V, Chicago

7. Monitoring Techniques (Remote and In-Situ) - Mr. Gary Fisk, Region VII, Kansas City

20 minutes each - 10 minute presentation and highlights
10 minute discussion

3:20 p.m. - Break Up Into Six Working Panels

1. An Integrated, Nationwide Environmental Monitoring Program for Short-Term Implementation - Mr. Willis B. Foster, Chairman

2. Future Monitoring Program and Methods - Mr. Terry Davies, Chairman

3. Standardization of Methods and Equipment - Mr. Dwight G. Ballinger, Chairman

4. Early Warning Monitoring Network - Mr. H. Matthew Bills, Chairman

5. Standardized Monitoring Data Acquisition: Compatibility Aspects and Standardized Monitoring Data Acquisitions: Quality Aspects - Mr. George B. Morgan, Chairman

6. Monitoring Techniques: Remote Sensing and In-Situ Techniques - Mr. Donald B. Holmes, Chairman

<u>Friday, October 15, 1971</u>

9:00 a.m. - Six Panels Meet

12:00 noon - Lunch

1:00 p.m. - Presentations - Three Panels Present Their Conclusions (30 minutes each)

2:30 p.m. - Discussion

3:00 p.m. - Presentations - Three Panels Present Their Conclusions (30 minutes each)

4:30 p.m. - Discussion

5:00 p.m. - "Program Profile" Wrap Up - Mr. Foster

5:30 p.m. - Adjournment

# WORKSHOP DISCUSSION GUIDE FOR DEVELOPMENT OF AN ENVIRONMENTAL MONITORING PROGRAM WITHIN EPA

## FOREWORD

Seven papers have been prepared to provide a frame of reference for workshop discussion during this meeting. The topics of these papers are:

Paper No. 1 - An Integrated, Nationwide Environmental Monitoring Program for Short-Term Implementation

Paper No. 2 - Future Monitoring Program and Methods

Paper No. 3 - Standardization of Methods and Equipment

Paper No. 4 - Early Warning Monitoring Network

Paper No. 5 - Standardized Monitoring Data Acquisition - Compatibility Aspects

Paper No. 6 - Standardized Monitoring Data Acquisition - Quality Control Aspects

Paper No. 7 - Monitoring Techniques - Remote Sensing and In Situ

Each of these papers presents a section which addresses the overall perspective of the problem in terms of scope and technical and organizational aspects. The intent of this section is to stimulate meaningful and constructive exchange during the workshop sessions. Each paper also presents selected topics for discussion. These should not be considered as constraints but should serve as a point of departure for development of Agency monitoring policies and programs. The objective of each workshop is to prepare inputs along programmatic lines which can be integrated into an overall Environmental Monitoring Program of the Environmental Protection Agency.

PAPER NO. 1

# 1.0 AN INTEGRATED NATIONWIDE MONITORING PROGRAM FOR SHORT TERM IMPLEMENTATION

## 1.1.1 The Scope of a Short-Term Monitoring Program

The short-term monitoring program is primarily an immediate restructuring of the many, existing ongoing monitoring programs within the Environmental Protection Agency. The purpose is to merge and coalesce these monitoring activities into a single program without undesirable duplicities of effort, using the presently available resources. More effective use of available resources will allow expanded coverage in some areas where serious gaps exist.

Planning for a longer term program will continue in parallel with the implementation of the short term program.

### 1.1.1.1 Definition of Monitoring

The report of the Study of Critical Environmental Problems (SCEP) resulting from a summer study in Williamstown, Massachusetts, sponsored by the Massachusetts Institute of Technology* describes monitoring as "systematic observations of parameters related to a specific problem, designed to provide information on the characteristics of the problem and their changes with time." The report continues that monitoring must provide warning of critical changes as well as measurement of the present state of the environment ("baseline").

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*Man's Impact on the Global Environment, Report of the Study of Environmental Problems (SCEP), The MIT Press, Cambridge, Mass., 1970, p. 168.

The SCEP report describes three monitoring techniques*. The first is economic and statistical monitoring. The authors state:

> "If we are concerned with predicting the accumulation of a pollutant in the environment, its rate of input must be known . . . If we are concerned with evaluating the effects of alternative control technologies on pollutant levels, we need quantitative information about the flow of materials which will be altered by control technology to include inputs, wastes, and end products at each stage of the process."

Measurement of resources as well as effluent levels are included in this technique.

The second technique relates to physical and chemical monitoring. These methods are used:

> "to determine the amount of a contaminant in a sample of soil, water, air, or organism. Physical methods are also used to determine a property of an environmental system as a whole, such as the refractive index or the albedo of the atmosphere. . . The essence of good monitoring of this type is to measure what is needed, and no more, with the precision that is needed, and no more, and to maintain standards indefinitely. Traditionally, monitoring of this type is carried out in networks of fixed stations. The entire operation may be completed at these stations or a sample may be taken to a central laboratory for examination or analysis. In either case, central coordination of methods and central standardization is necessary. Monitoring is now extended to measurements on ships, aircraft, and satellites."

The third technique described by the SCEP group is biological monitoring.

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*Ibid., pp. 168-172.

> "Even though our interest in environmental pollution stems from our concern about its effects on living organisms, the concept of using such organisms either individually or as a population or species as tools to monitor the state of the environment is still a relatively untested one. Moreover, although the study of natural ecosystems has long been an important scientific activity in observation and evaluation, changes in these finely tuned systems have not yet been systematized to yield warnings about harmful contaminants. Yet living organisms can serve as excellent quantitative as well as qualitative indices of the pollution of the environment. Plants and animals are continually exposed and can act as long-term monitors that integrate all environmental effects to reflect the total state of their environmental milieu. They can show the pathways and points of accumulation of pollutants and toxicants in ecological systems."

A fourth technique is necessary to meet the requirements of environmental monitoring, namely, social-aesthetic monitoring. The National Environmental Policy Act indicates that environmental quality cannot be obtained through consideration of only the economic, physical and biological parameters. The home, work, leisure, and general surroundings including housing conditions, urban sprawl, transportation congestion, odors, noise, availability of mineral and fuel resources as well as recreation areas and open space, all form a very real part of the environment under consideration.

For its purposes the Office of Monitoring has defined environmental monitoring as: "the systematic collection and evaluation of physical, chemical, biological and related environmental data pertaining to environmental quality, and waste discharges into all media. It may be performed through the operation of regional, nationwide and global networks and special studies of individual areas and sites."

There are three basic types of monitoring systems which can be established, depending on their intended use. These are:

- a scientific system to support research programs -- these are usually established on a specific problem basis to aid in the study of particular problem areas (e.g., establish cause/effect relationships, or support equipment development);
- a legal system to support surveillance, and enforcement programs -- monitoring of noise in the vicinity of airports is a typical example;
- an operational system to support control and abatement and also aid in decision and policy making and dissemination of information to the public -- the National Aerometric Data Bank (NADB) is an example of a system which supports control and abatement operations. Properly extended and used in conjunction with the National Air Surveillance Network it could provide the basis for computing indices to support policy making, and disseminating information to the public.

Except for the differences in the measurement grid and geographical coverage there is no sharp distinction among these uses; to some degree, all three types of systems may utilize elements from a common data base.

#### 1.1.1.2 Short Term and Long Term Needs

The mobilization of present monitoring activities into a coordinated, operating environmental monitoring system is the immediate goal of the Office of Monitoring. The objective is to meet the short term high priority needs of EPA to fulfill its mission through the use of existing resources, and supplemental resources to fill serious gaps in such a program. The time scale is to start implementation immediately and have an operating system in the initial phases within twelve months and full scale operation within twenty-four months. A key tenet of this sytem is to have data collected by the immediate users of the data (EPA Regional Offices, state and local environmental agencies, industrial firms, environmental organizations, etc.), using standardized methods of collection, and to transmit processed data upward through the local, state, regional, federal heirarchy as coordinated information for other uses.

The planning to meet the long term needs for environmental monitoring must proceed in parallel with the implementation of the short term system. The long term system will not only fill gaps in the short term system and expand the capability to monitor the environment, but will provide the basis for analyzing long term changes and trends in the environment in both urban and rural background situations.

### 1.1.2 Monitoring Needs

#### a. General Needs

While the general requirements for monitoring can be identified as providing information for:

(a) the assessment of pollution effects on man and his environment,

(b) the study of pollutant interactions and patterns,

(c) the establishment of ambient environmental quality and emission standards,

(d) the development of control strategies and regulations

(e) the evaluation of the effectiveness of adopted control procedures and preventative measures,

(f) the guidance of future development to minimize pollution impact on the environment by the use of modeling and planning.

b. Specific Needs

The specific needs are categorized by the three types of systems mentioned previously, i.e., scientific and research programs, surveillance for enforcement, and operational programs. The detailed requirements for each are shown in Appendix A.

### 1.1.2.1 Research and Scientific Information

Systems for obtaining information for better understanding the environment and the manner in which man interacts with it are usually systems tailored to run specific experiments under controlled environments. A dense measurement grid around a bound geographical area is typical for assessment of specific environmental problems. Controlled experiments with measurement of changes from a baseline during the course of the experiment requires specific sensor arrangements. Examination of large numbers of biological and human specimens in controlled or uncontrolled conditions often requires examination of existing data in new ways. (See Appendix A).

#### 1.1.2.2 Surveillance for Enforcement

Surveillance to provide information to expose violators of environmental laws and regulations is necessary for both voluntary and compulsory enforcement. Systems for surveillance of this type must be well calibrated and maintained to assure that they will have legal integrity. Often these systems will be portable or mobile and will be used on a strategic basis. The systems must be as good or better than the adversaries in enforcement action. (See Appendix A)

#### 1.1.2.3 Operational Programs

Operational programs use widely dispersed grids of measurement for determining the condition of the environment for control and abatement and for obtaining information for administrative decision making and planning. (See Appendix A)

#### 1.1.2.4 Classification of Present Programs

Table 1, shows a classification of existing EPA programs by the classifications noted above. The table is illustrative and is probably not exhaustive.

### 1.1.3 The Flow and Use of Monitoring Information

The functional components associated with collection and proper use of environmental data are:

1. Sampling System
2. Sensors and Measurement
3. Data Acquisition
4. Information Transmittal

## TABLE I

## Present EPA Monitoring Programs

1. Research and Scientific Information

    A. Air

    - Federal Facilities Air Quality Control Regional Studies
    - Ecological and Surveillance Studies
    - Agricultural and Material Effect Studies
    - Economic and cost control studies
    - Biological effects research studies
    - Photochemical studies
    - CAMP

    B. Water

    - Environmental Criteria and Standards
    - Hydrologic Processes
    - Chemical - Physical Identification of Pollutants
    - Research - Ultimate Disposal Systems
    - Mine Drainage
    - Eutrophication Research
    - Effects of Ocean Disposal with Corps of Engineers
    - Gulf Breeze Estuaries Study

    C. Solid Waste

    - Recycling Process
    - Composition Studies
    - Heat Recovery - Incinerator System
    - Hydrolysis and Pyrolysis Research
    - Separation/Classification System
    - Biodegradable Materials

    D. Radiation

    - Radiation Protection Standards Research
    - Precipitation Networks
    - Human and Biological tissue
    - Technical Support Programs in Office of Water Programs (OWP)

    E. Pesticides

    - Chemical vs Bioenvironmental Methods
    - Persistence Research
    - Ecosystem Stability
    - Bird monitoring

E. Pesticides (cont.)

- Pesticide Transport Mechanisms
- Technical Support Programs in OWP

F. Noise

- EPA/NBS Noise Characteristics Study for various devices.

2. Surveillance and Enforcement

A. Air

- Technical Assistance to state and local programs

B. Water

- Regional Office short and long-term stream monitoring

- Cooperating Federal, State, and local short and long-term monitoring

C. Solid Waste

- Not applicable

D. Radiation

- Technical Support Programs in OWP

E. Pesticides

- Technical Support Programs in OWP

F. Noise

- NSPI

3. Operational Programs

A. Control and abatement

1. Air

- Air Quality Data Bank

  NASN
  Total Suspended Particulate Network
  Membrane Filter Sampling Network

Gas sampling network
Precipitation network
Mercury sampling network
Radiation alert network
Anderson impactor network

- Emission Data bank

2. Water Quality Control Information System (STORET)

    - Fish Kill Information
    - Beach and Shellfish Bed Closings Information
    - Water Quality Standards
    - Water Quality Measurements
    - Municipal Waste Inventory
    - Municipal Waste Implementation Plans
    - Municipal Waste Treatment Plant Operation and Maintenance Information
    - Municipal Waste Treatment Construction Grants Needs Assessment
    - Municipal Waste Treatment Works Contract Awards
    - Voluntary Industrial Waste Inventory
    - Refuse Act Permit Program Industrial Waste Information
    - Industrial Waste Implementation Plans
    - Federal Power Commission Therma Pollution Information
    - Manpower and Training Information

3. Solid Waste

    - Survey of Community Solid Waste Products

4. Radiation

    - Pasteurized Milk Network
    - Institutional Diet Network
    - Surface Water Network (OWP)
    - Radiation Alert Network (OAP)

5. Pesticides

    - Pesticides in water
    - Pesticides in air
    - Human tissue levels
    - Fish kills (OWP)

6. Noise

    - NSPI

B. Administrative

1. Air

    - Air Quality Indices
    - State Emission Inventory Surveys

2. Water

    - Pollution-Duration-Intensity Index (PDI)
    - Priority Action Index

3. Solid Waste

    - National Solid Waste Practices Data Network

4. Pesticides

    - Interagency Data Exchange

5. Radiation

    - NSPI

6. Noise

    - NSPI

5. Storage and Processing

6. Interpretation and Analysis

7. Retrieval and Presentation

Relevant elements associated with these components are outlined in the following subsections. A more detailed discussion is contained in Papers 3, 5, 6, and 7 of this series.

#### 1.1.3.1 Sampling

The selection of a sampling grid, sampling frequency and accuracy, and overaging times are critical in setting up a monitoring strategy. This selection must precede the hardware and software selection process, and must be responsive to the monitoring needs.

#### 1.1.3.2 Sensors and Measurement

For virtually every monitoring application it is necessary to determine standard equipment specifications and methods of measurement and analysis. A balance should be achieved between initial equipment costs and degree of automation and on-site data reduction which will affect operating and maintenance costs.

Quality control guidelines should be developed and implemented in a uniform manner to insure that private, local and Federal authorities maintain the same standards and standard methods. Standard methods and quality control are discussed in detail in papers No. 3 and No. 5.

#### 1.1.3.3 Data Acquisition

This element is concerned with preparation of data, acquired from sensors or survey forms, for subsequent transmission and storage. Standard methods and formats should be utilized to the maximum extent to enter data for subsequent distribution. Procedures for validation and requirements for local processing must be developed.

#### 1.1.3.4 Information Transmittal

The transmission of environmental information is a system function which has a significant interface with the acquisition element. Standard transmission formats indicating time, location of observation, parameter being measured and other relevant identifiers should be utilized for all measurements. Consideration must be given to utilizing common facilities for data entry and transmissions at regional sites. Procedures should be developed for transmitting a variety of data over common communication facilities. This will require development of collection and transmission schedules for sending data from local sites and regions to central storage facilities.

#### 1.1.3.5 Storage and Processing

Data banks should be organized to allow use of common data entry and maintenance software. Some information will be stored locally and pre-processed and aggregated for utilization at higher organizational levels. The nature of the aggregation must be specified for each type of environmental data so that a proper balance of fixed distribution of summary data to higher levels vs special requests for detailed data is achieved. The organization of data files must allow for appropriate cross-referencing to permit effective utilization and correlation of information about a specific pollutant (e.g. trace substance, pesticides) with respect to its presence in all environmental media (air, water, and land).

### 1.1.3.6 Retrieval and Presentation

File maintenance systems provide not only for entry and maintenance of data files but for processing, retrieval and display of output information. Here again, maximum use should be made of standard software packages such as MARK IV, Generalized Information System (GIS), DM-1 and COGENT III.

Format and the manner of output must be geared to the specific application. In many research applications, computer printout in a legible format showing statistical summaries, by time, location or parameter is adequate. For these purposes, rapid update of the data bank (posting) is not as critical as rapid retrieval of the information and minimum turnaround from request to receipt of output reports. In cases of episode monitoring, both rapid posting and rapid retrieval and display are required. In this case, integrated displays should be developed for an Environmental Situation Room (see Paper No. 4).

### 1.1.3.7 Interpretation and Analysis of Environmental Data

One of the most critical needs within the Environmental Protection Agency is the capability to examine environmental degradation in an integrated comprehensive manner across all media. This involves the ability to develop pollution chain analyses, tracing the movement of hazardous substances, trace metals, and other chemical materials through environmental media, including their physical and chemical transformations brought about by interaction with plants and animals. Sophisticated material balance models, transport and diffusion models and other research tools are required to be developed and applied to gain an understanding of these related phenomena. The needs of these multi-media programs will provide specifications for integrated source monitoring and correlations with concentration of substances in various media and their related effects on many biota and materials.

## 1.2 An Integrated Approach

### 1.2.1 The Underlying Philosophy

The basic tenets of an integrated approach to environmental monitoring are:

a. Data is to be collected and analyzed by the primary user of the data. As an example, air and water quality data for a locality are primarily collected by the local government involved. Validation systems such as the Water Quality Surveillance System and the National Air Surveillance Network are primarily the responsibility of the Office of Air Programs.

b. Data is to be obtained by standardized methods and formated in a manner prescribed by EPA. The SAROAD and STORET format are examples.

c. The data collected by immediate users will be processed and transmitted to EPA operated data banks. The transmission of data will move from localities to states, states to EPA regions, regions to EPA headquarters, etc, using common facilitating and formats where feasible. This is now done in the STORET system through use of 104 terminals.

d. EPA Headquarters will receive transmitted data, store these data in identified data files which will have compatible formats. The data files may or may not be on shared facilities.

e. Information obtained from analysis and processing will be transmitted back to data sources as well as to other interested parties.

### 1.2.2 Use of Existing Structures

Two major monitoring systems presently exist in EPA. They are the National Aerometric Data Information System (NADIS) operated by the Office of Air Programs and the Water Quality Control Information System (STORET), operated by the Office of Water Programs. Each of these systems have desirable attributes which should be preserved to form the basis of an integrated system.

#### 1.2.2.1 The NADIS Concept

NADIS already has over, 250 communities and all states and territories providing air quality data in standardized formats (SAROAD) to EPA on a quarterly basis. The flow and means of verification of this data has been established and the cooperation of all the states and nearly all localities has been obtained. .The National Aerometric Data Bank (NADB) is operational and is returning processed information back to all contributors on a quarterly basis. The NADIS concept which is illustrated in Figure 1, is not yet totally implemented in terms of the state processing centers and transmission facilities, but general agreement with states on setting up this system has been reached.

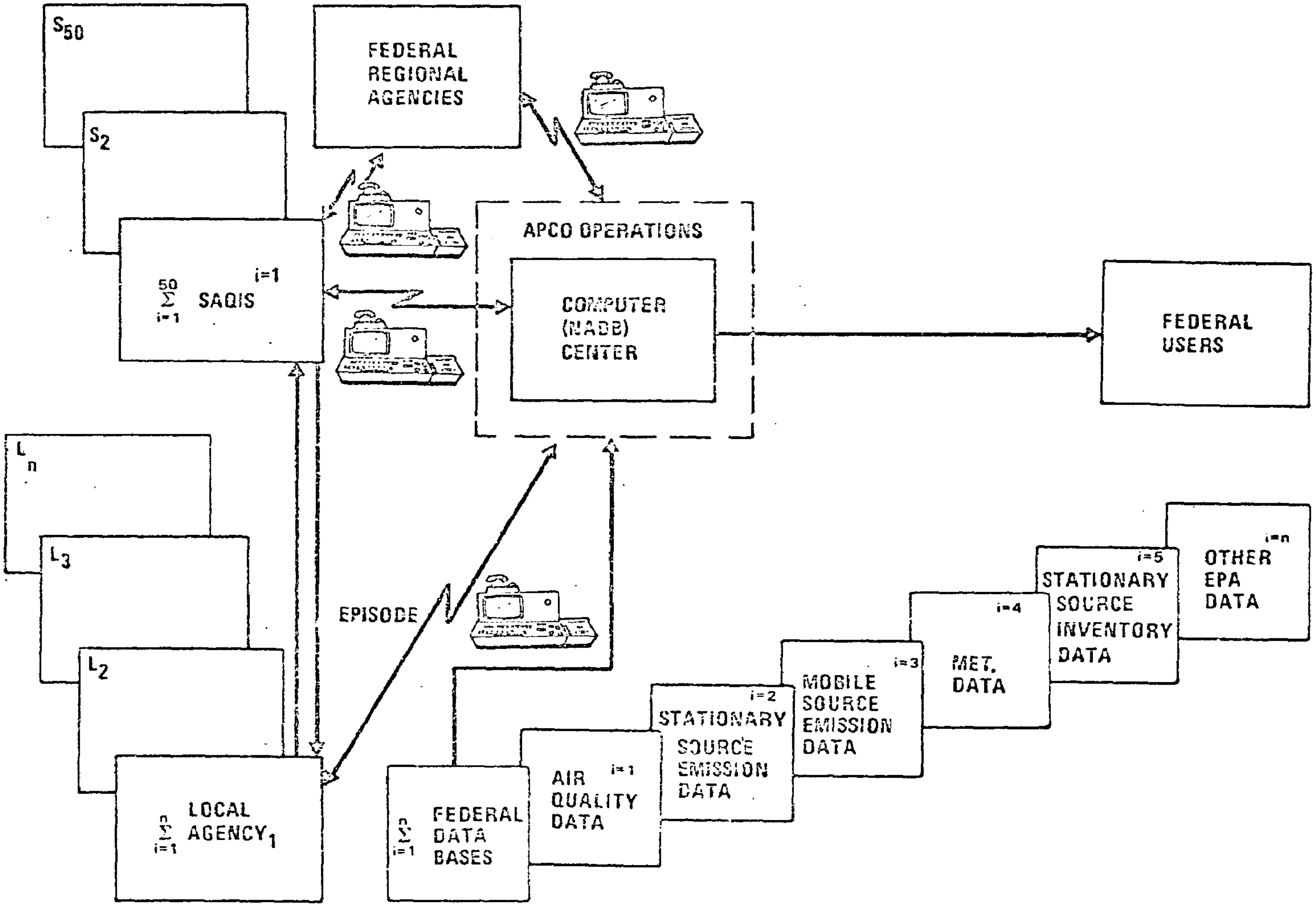

FIGURE 1 - NADIS OVERVIEW

It is felt that this represents considerable headway in obtaining EPA/state/local coordination and should be preserved.

### 1.2.2.2 Water Quality Control Information System (Figure 2)

The file structure and formats for this system have provided means of storage and retrieval of water quality control information. The development of a river mile index specification represent major efforts that must be preserved. The file structure and software for retrieval and use of information is now used by 104 terminal locations (24 are located in State Pollution Control Agencies).

### 1.2.2.3 Other Systems

As indicated in Table 1 other operational programs in radiation and pesticide monitoring exist, but are aimed at monitoring specific pollutants under particular conditions. They do not exhibit the general approaches inherent in the NADIS and STORET systems.

Research and scientific information programs and enforcement surveillance programs exist, but indicate an absence of coordination.

### 1.2.3 Coordination with Other Information Systems

The various existing monitoring systems require coordination with other systems both within and outside of EPA.

#### Intra-EPA

It may be argued that transfer of data between air and water quality data bases may be minimal since they have different statutory bases, but it is now necessary to assure utilization of data in both data bases in a compatible manner. Many aspects of pesticides and radiation monitoring interact with both air and water data and this coordination

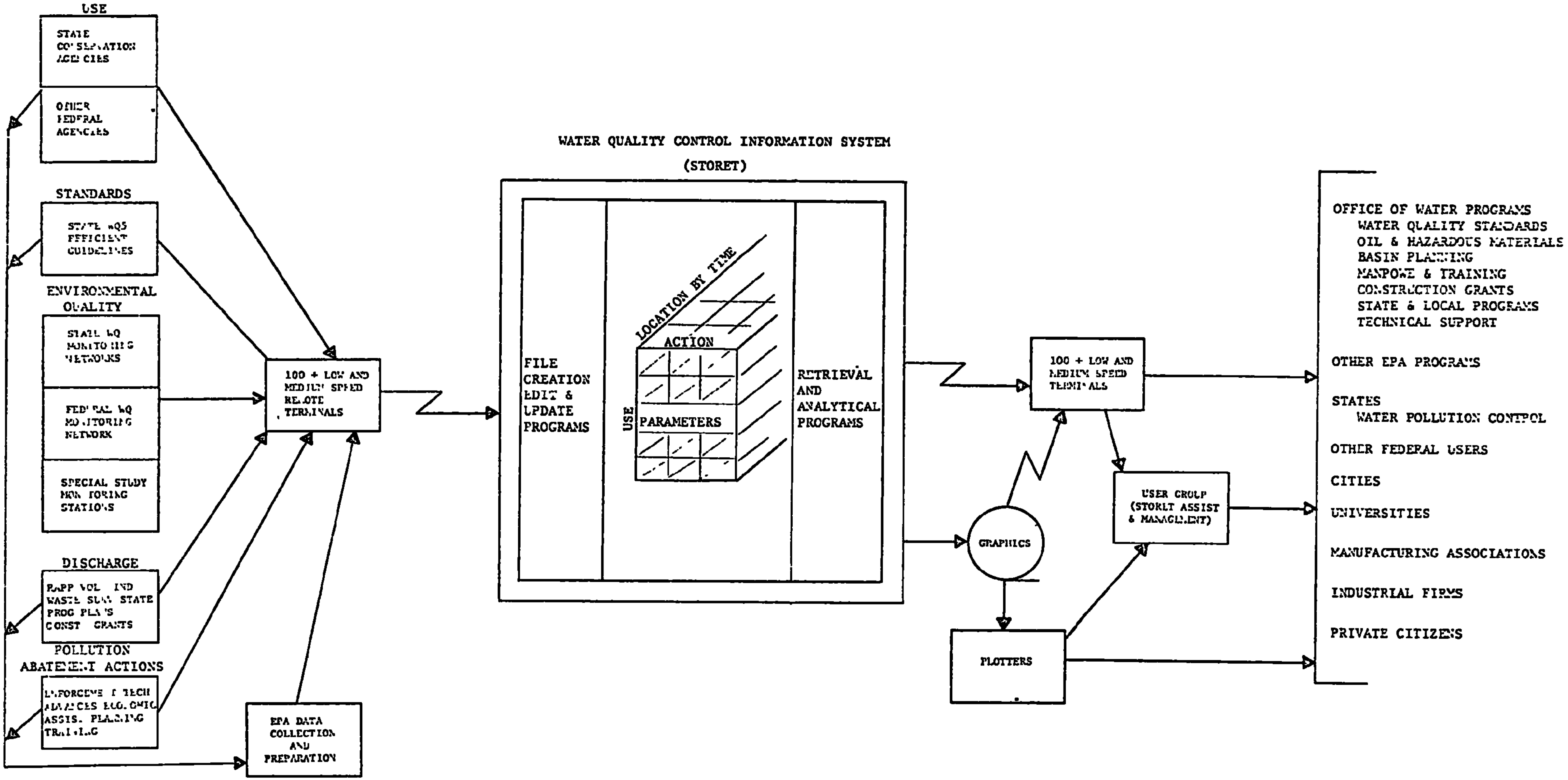

FIGURE 2

WATER QUALITY CONTROL INFORMATION SYSTEM
(STORET)

is necessary. Solid waste data can impact both air and water problems as well as land usage. Noise data may possibly be related to air quality in the meteorological sense.

Analysis and interpretations of data across all data bases must be possible then, through standardization of format and, perhaps, file structures.

Surveillance for enforcement may require close coordination since correction of one type of violation may cause another type, (e.g. effluents used to clean stack gases must also be disposed of elsewhere).

### International and Global

International transfer of information is presently being coordinated by the Office of Monitoring. Support of the upcoming Stockholm Conference on the Global Environment is in progress.

## 1.3 The Structure of a Monitoring System

An overall EPA monitoring system is viewed as a meta-system consisting of many subsystems operating to serve their basic functions, but coordinated through proper planning and design to provide sufficient standardization of methods, formats, and quality control to assure the compatibility and validity of collected information to meet all major needs for this information throughout EPA, local, state, and federal governments and to serve the needs of the public at large.

### 1.3.1 System Components

The major categorized components of the system are indicated along with the various responsibilities associated with the components.

### 1.3.1.1 Research and Scientific Information Operation

The coordination of the wide variety of programs already existing and the planning for new programs is the responsibility of the Office of Monitoring. The operation of those programs will be undertaken by Offices of Research and Monitoring, Media Programs, or Categorical Programs if the programs are laboratory oriented. Where possible, Regional offices shall be responsible for field collection of data, especially when the resources of local governments, states, and private industry are involved.

### 1.3.1.2 Surveillance for Enforcement Operation

The Office of Monitoring is responsible for standardization and coordination of surveillance activities for enforcement. The deployment and operation of these activities will be the responsiblity of the Regional Offices in coordination with the Office of the Assistance Administrator for Envorcement and the General Counsel.

### 1.3.1.3 Operational Networks

#### a. Early Warning Networks

The Office of Monitoring will plan and coordinate this network, but operation will be the responsibility of the Regional Offices using the states, localities, and private sector where feasible. The maintenance of centralized data files and the processing of these files will rest with the Office of Monitoring.

#### b. Abatement and Control Networks

The Office of Monitoring will coordinate the planning and operation of the various abatement and control networks to assure common use of available facilities and compatibility. The Categorical and Media Program Offices will have the responsibility for integrating and analyzing data collected. The regional offices will be responsible for collecting the data and transmitting them upward in the hierarchy. Local, state, and private resources will be coordinated by the Regional offices.

### c. Administrative Information System

Planning information, development of indices, and reports on the state of the environment will be the responsibility of the Office of Monitoring. Regional offices will supply inputs and be responsible for implementation of reporting systems at the Regional level.

### 1.3.2 Basic Structure

A proposed structure for operational networks envisions the use of a NADIS-like concept for the acquisition, preprocessing, and transmission of basic monitoring data with the possibility of upgrading the capability of the Regional offices. The STORET concept also provides a complementary capability in the water area.

The NADIS-like system would allow all types of environmental data to be processed and transmitted upward in the hierarchy of users. The use of shared facilities and communication media is desired, but not required when circumstances warrant departures.

Data files such as NADB and STORET are prototypes of the files envisioned with additional capability to obtain compatibility of files where desirable. Separate files are to be maintained for different networks although the facilities for maintaining the files may or may not be shared as determined by needs and expense.

The storage and retrieval capabilities of the STORET system will also prove to be of value in setting the new structure of an integrated system. Use of remote terminals for data entry is also a desirable feature.

The Clean Air Act as ammended allows EPA to aid states and localities in establishing air quality monitoring systems and reporting and transmission facilities. This enabling legislation makes the implementation of the NADIS concept highly feasible as has already been demonstrated.

### 1.3.3 Responsibilities

Since monitoring has to be carried out where the responsibility for control rests, monitoring networks will, for the most part, be operated by State and local agencies for pollutants where standards have been promulgated and, where necessary, augmented by networks operated by the regional offices. In certain situations the enforcement, media and categorical programs may be required to conduct monitoring activities. In addition, it is the responsibility of the regional offices to collect and analyze the data from the monitoring networks within the regions and to carry out field studies to show compliance with standards. It is envisioned that most of the monitoring will be carried out under the direct guidance of the regional administrators. Specific responsibilities for EPA organizational entities are indicated in Appendix B.

## 1.4 The Short Term Monitoring Program Development

The development of a short term monitoring program requires the means to establish programs with the optimum use of resources for:

### 1.4.1 Research and Scientific Information

1. Coordination of Experiments
2. Identification of Gaps
3. Common Use of Facilities and Sites
4. Compatible Data Storage and Analysis
5. Standardized Dissemination of Results
6. Correlation Among Experiments
7. Supervision and Standardization of Quality Control

### 1.4.2 Surveillance for Enforcement

1. Operation of the Permit Program Under 1899 Act
2. Regional Quick Response Teams
3. Headquarters Standardization of Equipment and Methods and Quality Control
4. Regional Technical Assistance to States and Localities
5. National Quick Response Teams for Special Problems (e.g., Episodes, Spills, Environmental Impact Assessment)

### 1.4.3 Operational Programs

1. Establishment of Data Acquisition Programs and Coordination with Immediate Users of Data
    a. Local
    b. State
    c. Region
    d. Categorical and Air and Water Programs
    e. Coordination with Other Agencies

2. Office of Monitoring Operation of Special Verification Networks for Assurance of Quality Control

3. Common Communication System

4. Shared Facilities when Feasible

5. Separate, but Compatible Data Files (may or may not be on same equipment)

6. Standardized Reporting and Analysis Procedure - Designed to assure that Federal, State, and local officials can meet their statuatory requirements and operation effectively

7. Systems

    a. Air

        Air Quality and Emissions Data (NADB)

        Effects Information

        Coordination with Meteorology Data (NOAA)

    b. Water

        Water Quality Control Information System (STORET)

    c. Radiation

        Coordination of Present Programs

    d. Pesticides

        Coordination of Present Programs

    e. Noise

        Planning for Noise Network

    f. Gaps

        Identification and Planned Inclusion

8. Adminstration Programs

    a. Indices

Air, Water, Pesticides, Radiation, Noise, Solid Waste Practices, etc.

b. Inclusion of Solid Waste Practices Network

c. Management Information and Reporting System

Control Rooms - Manual

Headquarters

Regions

9. Coordinated Planning for System Expansion

The System must be responsive and flexible to meet the changing needs of all programs.

## 1.5 Suggested Discussion Topics

1. Is the definition of monitoring, including the categorization of monitoring programs, suitable?

2. The proposed structure is a skeletal strawman. Is it in the right direction, and is it feasible?

3. What are the specific monitoring needs for each type of program and what are the associated priorities?

4. Are the assignments of responsibilities for the program proper and workable?

5. Is the basic philosophy of the environmental meta-system tenable?

6. What are proper organizational relationships (private, local region, central) consistent with legal jurisdiction and resource constraints to promote effective coordination and standardization of data collection, transfer, and use? What are the most critical problems in this area, and what existing and new programs are required to resolve them?

7. What are the most critical limitations in promoting effective utilization of current data resources within the agency? What are the best alternatives to deal with these limitations?

# APPENDIX A

## DETAILED MONITORING NEEDS BY MAJOR CATEGORIES

1. Research and Scientific Information

Information gained by scientific research is used for:

a. Setting standards - determination of health, biological, economic, and other environmental effects for specific pollutants and ecological systems.

b. Environmental Impact Assessment - investigating the alternatives available for solving existing or potential environmental problems on a specific problem basis.

c. Source - Receptor Relationships - determining the emission or effluent source relationship of specific pollutants to resultant environmental concentrations. Includes modelling of the processes involved. The interaction of pollutants, their decay and dispersion and dilution are included.

d. New Threats - Early identification and quantification of new or newly recognized pollutants.

e. Coordination of Scientific Information - A compatible system is required to assure effective dissemination, exchange, and utilization of available research information. The substance of the information, not the program description is intended here. The description of programs can be better handled by technical information centers or a clearing house such as recommended by the SEQUIP study.

2. Surveillance for Enforcement

a. Legal Evidence of Violations

Monitoring of emission, effluents and pollutant concentration to provide evidence of violations and the extent of the violation.

b. Detection of Violations

Initial detection of potential violations for subsequent investigation as above.

c. Expert Testimony

Providing information from expert witnesses, using the monitoring system capabilities and scientific information, for legal testimony.

d. Utilization of Voluntary Information

Effective use of information received on a voluntary basis from industry such as provided by the permit program of the 1899 Refuse Act.

3. Operational Programs

1) Control and Abatement

a. Background, Ambient and Episode Monitoring Programs

Measurement of environmental parameters and pollutants to determine background mode, ambient conditions in a dynamic environment, and emergency reporting during episodic environmental conditions.

b. Early Warning Program

A program to determine incipient adverse environmental conditions prior to their becoming major problems. This is a network that overlays the background, ambient and episode network although there may be some interaction.

2) Administration and Planning

a. Environmental Trends

Determination of long term trends in the environment such as changes in the albedo, and upper atmosphere. The long term impact of identified changes will have major impact in program decisions that will affect the environment.

b. Environmental Indices

Aggregated measurements for measuring general changes to the environment, for providing measures of program goal attainment, and for dissemination to the public sector.

c. Decision Making Information

Measures of conditions of the environment that provide inputs to selection of program alternatives for control and abatement.

# APPENDIX B

## EPA Organizational Responsibilities for Monitoring Activities

### A. Regional Administrators

To fulfill this monitoring function, the Regional administrators should:

1. Identify regional monitoring needs required to satisfy program objectives;
2. Determine the most effective way to satisfy these needs, i.e., via state support or direct operations;
3. Direct the regional monitoring in accordance with guidance by office of monitoring and using standardized methods and procedures, providing guidance and supervision to State and local monitoring efforts performed through EPA support, and performing direct operations, such as sampling and laboratory analyses, necessary to augment the State and local efforts;
4. Perform special monitoring as assigned by Headquarters;
5. Perform specific short-term field studies to support enforcement actions;
6. Assist State and local officials in their monitoring activities;
7. Collect, review and evaluate regional environmental data needed for regional management and/or prescribed by Headquarters and transmit data to EPA data bank in accordance with prescribed procedure;

8. Identify to AARM monitoring needs that cannot be satisfied at the regional level (methods development, demonstration systems, national network)
9. Assist Monitoring Techniques Division in field testing methods and instruments designed for routine monitoring.

B. Functional Offices

With respect to monitoring, the Enforcement, Media and Categorical offices should:

1. Conduct source sampling activities related to their special requirements;
2. Conduct field studies to support policy planning and decision making;
3. Identify to DAAM national monitoring needs to support program objectives;
4. Operate environmental data storage, translation, and information presentation systems as requested by their programs and to be compatible with other EPA information systems;
5. Coordinate and assist, through the regional administrators, States and local users in the use of EPA information systems;
6. Perform analyses as part of the information system where required.

## C. Office of Monitoring

The Deputy Assistant Administrator for Monitoring should:

1. Develop and operate special monitoring programs for long-term trends, new or newly recognized pollutants and pollutants under consideration for future control;
2. Plan and develop appropriate guidelines for all monitoring systems;
3. Develop and standardize methodology for the collection and analysis of environmental samples and data handling and presentation;
4. Ensure validity and uniformity of environmental quality data so that it can be fully utilized within EPA's information systems;
5. Direct the operation of the U.S. portion of global and international monitoring networks;
6. Provide for technical training and special assistance to regional, State, and local personnel;
7. Provide a public education and information Program;
8. Provide support when requested to the enforcement elements of EPA;
9. Document the overall environmental quality including trends;
10. Provide an overview assessment of the agency's monitoring activities.

## PAPER NO. 2

## 2.0 FUTURE MONITORING PROGRAM AND METHODS

### 2.1 Problem Perspective

The first of this series of papers has described present monitoring programs as those for which implementation actions could be taken immediately with a resulting operational system available any time from the present through the next two or three years. This paper considers future programs and methods to be those for which operational needs will be satisfied five years into the future, and beyond. Plans for these programs must be prepared now and supporting studies must be initiated immediately and revised on a continuing basis to account for the dynamic nature of the environment and to insure that available operational systems will meet requirements in five years.

The continuing effectiveness of overall EPA activities rests largely on the ability to anticipate and resolve future potential environmental problems before they reach the crisis stage. This places emphasis on the need for effective planning to provide guidelines and specifications for industry cooperation in technology development. It will promote orderly and economic implementation of control measures to improve environmental quality. It can minimize adverse consequences to the environment and economy (as well as to the Agency's image) from such incidents as the recommended shift from phosphates to NTA to phosphates in laundry detergents.

Some broad objectives which EPA's future monitoring program should attain are discussed below.

## Detection and Effects of New Pollutants

This objective relates to identification of new pollutants which are being emitted into all environmental media and the determination of acceptable levels based upon economic and health and welfare effects. This requires a concept of search sampling and monitoring of media samples and correlation with epidemiological and other effects. New and improved analytical and pathological techniques including variation in thresholds of human tolerances should be employed for detection along with increased and systematic monitoring of geological effects. The same concept applies to changing acceptable levels of known pollutants for which standards have been defined.

## Integration of Monitoring Across Environmental Media

Data are required for development and application of ecological models which test transport and effects of pollutants across environmental media. This is a difficult technical problem which must be attacked by the Agency and poses a challenge to the proper organization and implementation of an effective research and monitoring effort. Data monitoring requirements must be preceded by research specifications of cross media models (e.g. EQUIPS, Materials Balance, Transport and Diffusion).

## Support of Future Operational Needs

Future monitoring requirements must be responsive to legislative and anticipated technological developments. For example, legislation requiring permits for proper application of pesticides suggests monitoring to determine the effectiveness of the control and application procedures. Similar requirements currently exist for discharging effluents in streams; it is conceivable that in five or ten years permits may be required for weather modification and advanced planning should consider the potential impact on new monitoring needs. The development of environmental impact statements may dictate special monitoring to assist in conducting proper technology assessments. The Agency should continually review all statements with the intent of identifying common data gaps and synthesizing new monitoring requirements.

Three projects dealing with establishing requirements, performing feasibility analyses of advanced techniques and performing advanced development to further prove the merits of new monitoring techniques and systems are discussed in the following paragraphs.

### 2.1.1 Definition and Analysis of Advanced Monitoring Requirements

Three primary objectives of this project are:

1) determination of long term environmental monitoring needs and objectives,

2) provision of the basis for defining and investigating new and advanced monitoring techniques,

3) definition of research requirements for proving new environmental monitoring techniques through conducting and supporting analytical studies and advanced development.

The approach to realizing these objectives must begin with a thorough review and appraisal of present monitoring activities and developments. This appraisal should categorize the types of monitoring needs being served according to:

1) research and scientific - standards development, environmental impact assessment, physical biological and chemical interactions
2) enforcement surveillance - legal action, testimony, violations
3) operational and administrative support - description of status and trends, policy guidance, program evaluation

Gaps in these programs, along with a separation into present and future needs should be made to provide a starting point for projecting future requirements. Other factors and information sources requiring analysis to support these projections include:

1) implications of current and pending legislation
2) impact of population and industrial growth patterns
3) new developments in industrial processes
4) new developments in conventional and remote sensing technology

5) reports of special governmental monitoring committees

6) economic and social projections

Characteristic problem areas should be identified with each of the projected needs. These would relate to considerations such as: a) identification of new pollutants; b) changes in acceptable levels of pollutant amounts and concentrations; c) siting of sensors; d) measurement sensitivity and lower limits of threshold detectability required for scientific, enforcement, or operational purposes; e) need for standardized techniques of measurement and analysis; and f) need for specialized sensing (e.g. biological organisms).

In all media and categorical areas there will be a need for increased emphasis on source and effluent monitoring. An important consideration of this project is development of a means to insure that proper communication of information to meet new monitoring requirements occur between state/local and Regional groups on one hand and between Regional and EPA central headquarters on the other. Inputs to this program should also come from discoveries through the early warning network (see the fourth paper in this series).

Some perspective for future monitoring needs based upon specific details of the current situation is presented in Appendix A at the end of the paper.

### 2.1.2 Feasibility and Evaluation of Advanced Monitoring Techniques

Based upon requirements and objectives of future monitoring needs, proper systems management and planning requires that feasibility of alternative monitoring systems to satisfy the needs be thoroughly examined.

The first phase of this project is-to develop a comprehensive survey of new concepts and techniques for environmental monitoring by EPA, other federal agencies, academic institutions, and industry. This survey will be updated on a continual basis and will provide an inventory of new techniques and concepts. State of the art studies must be conducted and awareness of developments must be maintained (see the fourth paper in this series).

The second phase will match the potential of these concepts with the advanced monitoring requirements which will be developed in parallel. A set of priorities and potential payoffs for innovative concepts and techniques will be documented and reviewed by the operational programs of EPA on a periodic basis. This document will be the basic development strategy for advanced monitoring concepts.

Specific concepts and techniques for innovative approaches to monitoring will be evaluated against the strategy and seed funds will be provided to carry through these selected projects to determine feasibility of the concept. Parallel approaches to meet specific requirements will be pursued through the conceptual phase when this is warranted. Criteria for establishing feasibility will include the economic impact and costs and technological considerations such as compatibility with existing equipment and adaptability to a wide range of utilization. Approaches for establishing feasibility will include paper studies, laboratory models and testing, and pilot experiments. Projects for which feasibility of the conceptual phase is demonstrated will be forwarded to other research and monitoring programs for further development. Wide dissemination of the results of these studies will be made as required.

### 2.1.3 Advanced Development

In order to meet a given future monitoring requirement, it may be necessary to proceed initially along several avenues of approach. At some point the choices will have to be narrowed down to that concept (or two) which seems most feasible in terms of economics, coverage, flexibility, adaptability, etc. The development phase then deals with the initial testing and data validation of the prototype equipment for the advanced technique(s) finally selected.

Whereas many groups within and without EPA may be involved with a particular advanced approach during the early stages (feasibility and evaluation) of its progress, only those groups specifically affected will continue to be involved when the development phase begins. Depending upon available expertise and facilities, the decision will have to be made whether development will be carried out by EPA personnel or by outside contractors.

The development stage serves, in a sense, as the proving ground for radically new concepts or some unique combination of existing ideas and the transition should be made clear where advanced development ends and engineering development begins. The results of preliminary field testing and development should provide detailed, hard specifications as input for the implementation of engineering development and full production by other appropriate branches of EPA.

## 2.2 Suggested Discussion Topics

a) Develop a list of potential monitoring requirements which may be considered long-term based upon lack of current ability to satisfy them (e.g. low detection threshold requirements for specific pollutants related to health effects and other needs, such as enforcement).

b) What methods currently under development can satisfy these requirements?

c) What priorities can be assigned to the known long term requirements identified in a)? What is the rationale? Do we need to investigate a rationale for priority assignment?

d) What approach can be taken to develop a manageable network of standard sites (parameters measured, frequency, method, etc.) for consistent monitoring and reporting of status and trends. Consider proper geographical distribution, and all media and categories.

(Note: Specific problems of selection of sites, criteria for location etc. should be considered in paper #3, Standardization of Methods and Equipment. The proposed discussion item here should concentrate on requirements for standardizations based upon end use e.g. enforcement and surveillance, scientific, administration and operation).

e) Three projects (requirements, feasibility of advanced techniques and advanced development) have been described. Are these adequate for implementation of a continuing long term monitoring program? Do you feel they are adequate as described?

f) What is the best way to insure that future monitoring requirements which are sent from the field to a central focal point at headquarters are properly disseminated to the appropriate EPA research and monitoring organization on a continuing and timely basis?

g) What program and organizational approaches can be taken to insure that the Office of Monitoring develop an integrated system for source, concentration and effects monitoring across all environmental media?

h) What inputs are required to determine the appropriate changes in the number of monitoring sites to meet future needs?

# APPENDIX A

## PRELIMINARY CONSIDERATION OF MEDIA AND CATEGORICAL MONITORING NEEDS

This appendix discusses some examples of the current situation and potential monitoring needs for media and categorical program areas.

### A.1 Air and Water

There are over 3,000 state and local air pollution measuring sites in the United States in addition to the various Federal air pollution networks shown in Table I. Of six air pollutants for which ambient standards have been issued by EPA, only two - $SO_2$ (sometimes sulfation) and particulates - are monitored on an extended geographical basis.

The Continuous Air Monitoring Program (CAMP) operates at six stations. These sites monitor particulates, total oxidants, total hydrocarbons, CO, $SO_2$, $NO_2$ and NO. If the focus of this paper changes from research to actual air quality determinations, then wider geographic coverage is necessary.

Air pollution of the upper atmosphere is an area of great concern, especially with regard to the recent SST issue. The collection of accurate data and the formulation of reliable models are obviously necessary steps in resolving this problem. Except for essentially ground level readings, very few data exist for regions above the order of tens of meters. (The AEC collects radioactivity data in the upper atmosphere). This lack points out the need for pollution vs. height profiles. The Smithsonian Institution has suggested the use of

## TABLE I

## PRESENT CHARACTERISTICS AND POSSIBLE EXTENSIONS OF FEDERAL AIR SAMPLING NETWORKS

In addition to state and local stations EPA obtains air pollution data from its own National Air Surveillance Networks (NASN). This system comprises several different kinds of networks, and their present features are summarized below:

- Hi-Vol Network: suspended particulates, 247 sites, 26 samples/site/year;
- Membrane Filter Network: suspended particulates (no glass filter interference), 50 sites
- Particle Size Network: particle size distribution, 11 sites;
- Gas Sampling Network: several gaseous pollutants, 197 sites, 26 samples/site/year;
- Precipitation Network: dissolved air pollutants in rainwater, 16 sites;
- Mercury Network: airborne mercury, 53 sites,
- Condensation Nuclei Network: one site;
- Radiation Alert Network (RAN): airborne radioactive particles and radioactive contamination of rainwater, 73 sites, continuous daily sampling; this network may be phased out due to decreased atmospheric nuclear testing.
- Pesticide Network: airborne pesticides, 12 sites collecting but method for analysis has not yet been developed; Future, 40-60 sites.

astronomical observatory data (telluric lines and extinction wavelengths) as a possible means for obtaining long-term (30-50 years) atmospheric pollution amounts.

In order to determine relative contributions (e.g., power plants and/or autos) toward air pollution, more emissions data need to be collected from representative sources. This will enable the appropriate agencies to ascertain the effectiveness of various control programs. Motor vehicle certification and recurring maintenance may provide a challenge for development of more effective and lower cost monitoring methods.

Sometimes monitoring is performed too close to sources of pollution which results in deceptively high, nonrepresentative readings for computing an index for a locality. More careful thought needs to be applied in the selection of sites for this purpose. The comments of this and the previous paragraph apply equally well to water pollution monitoring.

With regard to the surface waters of the nation, there are approximately 24,000 water quantity (hydrological data) stations and 10,000 water quality (chemical composition) stations which are operated by local, state, or Federal (principally the Water Quality Office, EPA, and the Geological Survey) agencies. Quantity and quality data are sometimes taken at the same site. The Water Quality Office intends to increase the stream miles covered by water quality monitors from approximately 44,000 stream miles, 5,000 miles of Great Lakes shoreline, and 4,000 miles of coastline and estuaries to 100,000 stream miles, 60,000 miles of Great Lakes shoreline, and 12,000 miles of coastline and estuaries by 1976. These latter figures represent essentially total United States coverage. There is, however, a large disparity in the levels of effort at the various sites in terms of the sampling frequency and the number of parameters measured.

Water pollutants may be classified into physical (undissolved solids, temperature, odor, sediment, oil, etc.) and chemical categories (heavy metals, acids, bases, nutrients, pesticides, etc.). Not only are some of these substances toxic to human, fish, and plant life, but various industries cannot tolerate them in their process water. A more extensive mobile lab network is needed to provide annual or biennial detailed chemical analysis of all major rivers and bodies of water. Aerial surveys and eventually satellite monitoring should be utilized to augment the ground stations, particularly with regard to the physical pollutants.

For water as well as for air monitoring, serious consideration should be given to careful selection of a subset of these sites to serve as standard reference monitoring stations for adequate geographical, urban, remote and pollutant coverage on a systematic basis.

Epidemics of <u>gastrointestinal disease</u> from public drinking supplies are rare now, but the potential for such outbreaks is great, and utilities cannot afford to become complacent and careless in disinfection practices. Untreated ground water, along with distribution system difficulties, has been the most frequent cause of recent outbreaks. The waterborne epidemic of Salmonella typhimurium involving 18,000 persons at Riverside, California, in May and June of 1965 is such an example.

The detection and identification of viruses is a much more complicated procedure than that for bacteria, even if clams, oysters, or other filter feeders are used to concentrate the virus particles. There is no standard simple laboratory procedure for routine examination of water supplies for important pathogenic viruses. Routine virological examination of water would require an enormous drain on resources as compared to bacteriological examination.

It is therefore recommended, pending development of standard routine methods for the detection and identification of pathogenic viruses in water, that drinking water supplies be examined for viral content during viral disease outbreaks. Careful collecting of detailed epidemiological information is required for proper analyses. This is not by any means a routine monitoring task.

### A.2 Pesticides and Hazardous Substances

The dangerous effects of pesticides are a problem in all three media. The current minimal monitoring of pesticides in air is conducted by EPA and by the FDA in eight northeastern states. This capability should be extended with the density of monitoring sites being based upon proximity to areas of application (large agricultural areas) and population density. The Working Group on Pesticides proposed in May 1970 that a program be initiated for monitoring airborne pesticides at a minimum of 40 different locations in the country.

Pesticide monitoring in water and on land is performed much more widely and more frequently than in air. A number of governmental agencies are involved in the National Pesticides Monitoring Program. In general, the present networks seem adequate in terms of the number of sites. However, in view of the tremendous numbers of pesticides on the market and the complex analysis procedures, a better knowledge of regional sales statistics would enable technicians to know what pesticides are most likely to occur, thus eliminating costly, unnecessary testing.

Monitoring of heavy toxic metals chlorinated hydrocarbons, organophosphates, herbicides, halides, and dithiocarbonates which may contaminate food supplies is essential; it is also necessary to determine amounts acquired by other means, such as breathing and skin contamination. Low cost, rapid and accurate monitoring techniques are required in these areas.

### A.3 Radiation

Figure 1 shows that radioactivity in the atmosphere has declined significantly since the cessation of significant atmospheric nuclear bomb testing in the earth 1960's. One should examine whether the monitoring programs designed for measuring radioactive fallout should be re-oriented in some way, consistent with national security.

Recent court decisions relating to the necessity of AEC to file complete environmental impact statements regarding power plant construction suggests greater requirements for monitoring radioactivity and water temperatures in the vicinity of power plants. Since

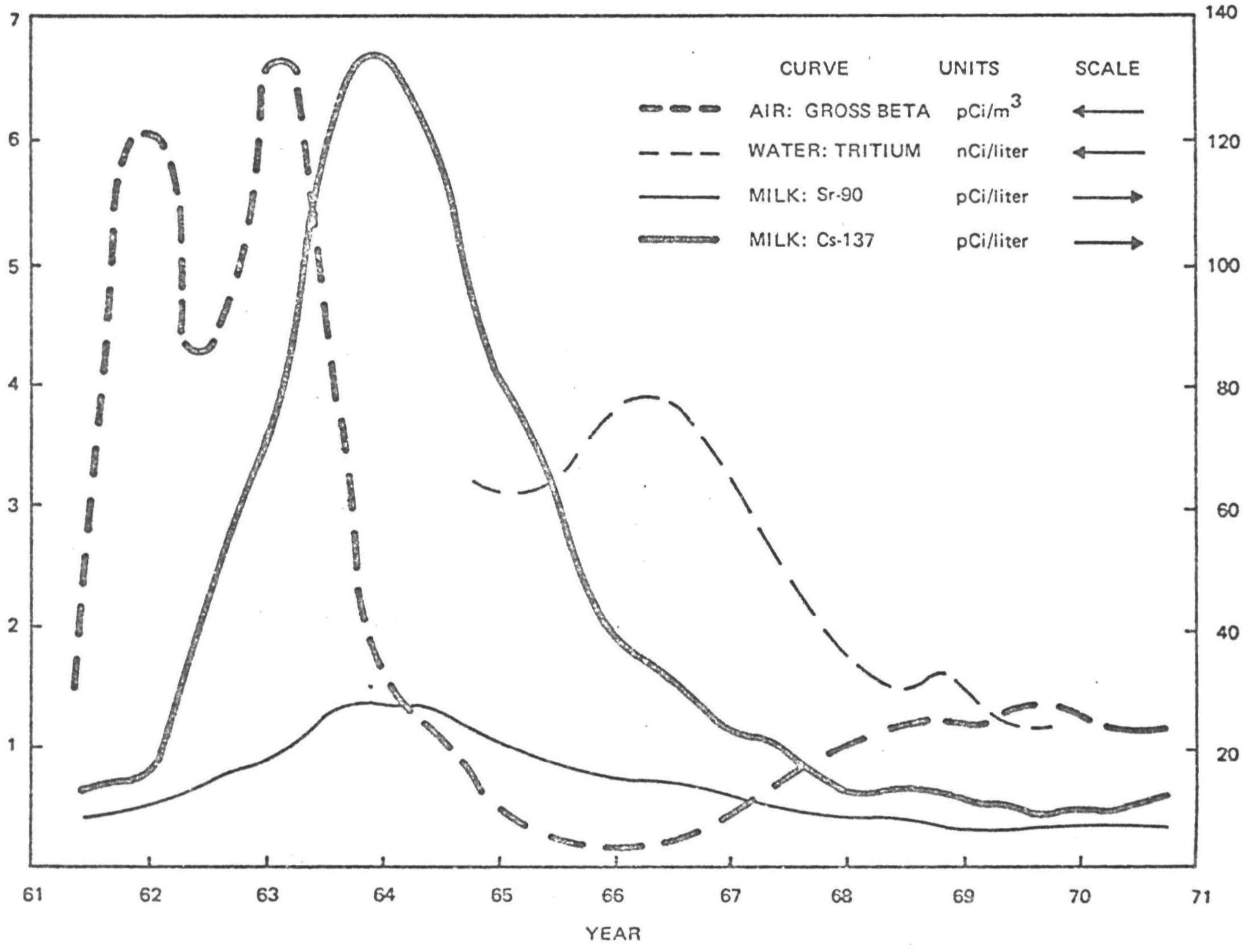

FIGURE 1

SELECTED RADIOACTIVITY TRENDS

indications are that the genetically significant dose (GSD) of radiation from diagnostic x-rays and other non-therapeutic medical sources has increased from 55 millirems currently, to approximately 65-90 millirems currently, a better means should be found for monitoring and computing radiation dosage received by the population. Also, the need for monitoring non-ionizing radiation should be investigated.

### A.4 Solid Waste

Information on solid wastes is most concerned with volume, amounts, composition and source. For planning purposes, the Office of Solid Waste would like to know the composition of domestic and industrial refuse in specific locations for large urban areas as well as for rural locations. Often, monitoring consists of physical sorting of garbage which is costly and time consuming and subsequent recording of volume, composition, weight, etc. Scales are sometimes used in measuring loads at incinerator and landfills. In cases of industrial refuse, the data are likely to be obtained from sampling surveys utilizing interviews or written questionnaires. Future monitoring programs in this area should concentrate on developing effective standard techniques for cases where survey and questionnaire are the main monitoring methods available. Are there other methods, more mechanized, more reliable or less costly, of acquiring these data? Certainly these alternatives should be considered in planning new monitoring programs.

Recycling data are important for economic and environmental policy development and legislative studies. A future monitoring program should be concerned with more effective acquisition of materials input and output data from recycling centers and national trade associations (e.g. National Association of Secondary Materials Industries, Institute of Scrap Iron and Steel, National Solid Waste Management Association).

While it may be technically possible to apply IR photography for determination of landfill composition, requirements are needed for use of this kind of data by the Solid Waste Office in order to develop effective plans along these lines.

### A.5 Noise

Recently the problem of noise pollution has received a great deal of attention, but an organized, carefully conceived monitoring program does not exist. The Bureau of Community Environmental Management has undertaken a few urban surveys, but these are mostly subjective and it would be difficult to make comparisons among cities on a year-to-year basis. The FAA is conducting monitoring in the vicinity of airports to support noise abatement programs. Also the Department of Transportation has several studies underway to determine the amount and effects of highway noise. Since general noise monitoring is relatively new, a modest survey program in a few geographical locations (e.g., selected SMSA's) with an extensive deployment of sensing sites should be sufficient until the problem is better understood.

The EPA has recently contracted for studies to describe noise sources (construction equipment, home appliances, etc.) according to characteristics such as intensity, frequency, pitch and other suitable factors. Also, the National Bureau of Standards is providing assistance to EPA to help prepare a report to Congress on the noise control program. The needs of this program should be sharply focused on determination of monitoring research needs. Low cost reliable devices are required for monitoring, recording and analyzing noise signals from various sources (urban streets, construction sites, office buildings, home environment).

### A.6 Biogeochemical Cycles

There is much talk about ecocycles and many pictures are drawn in ecology textbooks. The processes are described as energy transformations among physical, chemical and biological processes. Relatively little is known about their measurements. Biogeochemical cycles, (such as nitrogen, water, oxygen, carbon, phosphorus) are recognized to be fundamental to the support of life on earth. These cycles are complex and are not yet fully understood. The amount of material transported and the vastness of the geographic scope (i.e., the surface of the earth) render any monitoring attempts currently impractical. However, research into their functioning needs to be continued, and monitoring of some limited portion of the cycles may become possible in the future.

PAPER NO. 3

# 3.0 STANDARDIZATION OF METHODS AND EQUIPMENT

## 3.1 Problem Perspective

In general, the widespread use of an analytical method usually indicates that the method is a reliable means of analysis and this feeling of consensus tends to support the validity of the test results reported. This feeling of consensus is not always valid however, for the method may not have received sufficient screening to uncover possible imperfections. A second but different pitfall of "standard methods" in that when a method has been so designated it tends to inhibit inquiries into the validity of the method. There is always room for improvement. Conversely, the use of a little-known technique forces the data user to place undue faith in the judgment of the analyst. When the analyst uses a "private" method or one not commonly accepted in the field, he stands alone in defining both his choice of the method and the result obtained.

The need for standardization of methods within a single laboratory is readily apparent. Uniform methods between cooperating laboratories are also important in order to remove the methodology as a variable in comparison or joint use of data between laboratories. Uniformity of methods is particularly important when laboratories are providing data to a common data bank, such as STORET, SAROAD, SWIRS, etc., or when several laboratories are cooperating in joint field surveys. The lack of standardization of methods within a single agency raises doubts outside the agency as to the validity of the result reported. If the same constituent is measured by different analytical procedures within a single laboratory or within several laboratories in the same agency, the question is raised as to which procedure is superior, and why the superior method is not used throughout.

The physical and chemical methods used by the Environmental Protection Agency (EPA) should be selected using the following criteria:

1. The method should measure the desired constituent with precision and accuracy sufficient to meet the data needs of EPA in the presence of the interferences normally encountered in the media.
2. The procedure should utilize the equipment and skills normally available in the average pollution control laboratory.
3. The selected methods to be used are in many laboratories or have been sufficiently tested to establish their validity.
4. The method should be sufficiently rapid to permit routine use for the examination of a large number of samples.

The use of EPA methods in Agency laboratories provides a common base for combined data between program elements. Uniformity throughout EPA lends considerable support to the validity of the results reported by the Agency.

Regardless of the analytical method used in the laboratory the specific methodology should be carefully documented. In some pollution reports it is customary to state that Standard Methods have been used throughout. Close examination in many cases indicates, however, that this is not strictly true. In many laboratories the standard method has been modified because of recent research or personal preferences of the laboratory staff. In other cases the standard method has been replaced with a better one. Statements concerning the methods used in arriving at laboratory data should be clearly and honestly stated. The methods used should be adequately referenced and the procedures applied exactly as directed. When the phrase "EPA Methods were used" is to be reported, the exact procedures as detailed in the methods manual should be followed.

Knowing the specific method which has been used, the reviewer can apply the associated precision and accuracy of the method when interpreting the laboratory results. If the analytical methodology is in doubt, the data user may honestly inquire as to the reliability of the result he is to interpret.

As mentioned earlier, the advantages of strict adherence to accepted methods should not stifle investigations leading to improvements in analytical procedures. In spite of the value of accepted and documented methods, occasions do arise when a procedure must be modified to eliminate unusual interference or to yield increased sensitivity. When modification is necessary, the revision should be carefully worked out to accomplish the desired result.

It is advisable to assemble data using both the regular and the modified procedure to show the superiority of the latter. This useful information can be brought to the attention of the individuals and groups responsible for methods' standardization. For maximum benefit the modified procedure should be rewritten in the standard format so that the substituted procedure may be used throughout the laboratory for routine examination of samples. Responsibility for the use of a non-standard procedure rests with the analyst and his supervisor since such use represents a departure from accepted practice.

In field operations the problem of transport of samples to the laboratory or the need to examine a large number of samples to arrive at gross values will sometimes require the use of rapid field methods yielding approximate answers. Such methods should be used with caution and with a clear understanding that the results obtained do not compare in reliability with those obtained using standard laboratory methods. When deviations from standard methods have been used, they should be noted and the results flagged when included in STORET, SAROAD, etc., along with the more reliable laboratory-derived analytical information. The data user is entitled to know that approximate values have been obtained (for screening purposes only) and that the results do not represent the customary precision and accuracy obtained in the laboratory.

### 3.1.1 General Procedure for Developing Standard Methods

We recognize the importance of using the best available scientific methods throughout. The use of legally valid, uniform, precise, and accurate methods will yield important benefits in reliability, improved comparability of data from different sources, and in the consistency of relationships of the EPA with other Governmental Agencies and the private sector.

The Division of Monitoring Techniques is responsible for coordination and/or direction of all standardization activities within EPA to establish reference and standard methods. This activity will insure the development of measurement techniques which will *accurately* access the control of pollutants which have been determined to exhibit adverse effects on human health and welfare.

The pollution of our environment cannot be adequately measured or controlled without the use of methods which have been collaboratively tested by qualified analysts to statistically determine their reliability and bias. Such a method is defined as a *Standard Method*.

To insure comparability of all data while allowing some freedom of choice, it is also necessary to establish some methods as *Standard Reference Methods*. Standard Reference Methods (SRM) insure a basis upon which less precise but more agile techniques may be tested.

EPA will develop such SRM with the advise and assistance from other agencies as required.

Standard Methods should meet the following criteria:

a. Demonstrated utility in the laboratory and in the field.

b. Demonstrated freedom from known interferences.

c. Easily measured chemical and/or physical parameters.

d. Relatively inexpensive and available to all people who are required to use the method.

e. Demonstrated reliability through collaborative testing by a representative (but qualified) sampling of the user population.

f. Demonstrated reliable sensitivity for required pollutant concentration ranges.

g. Acceptable (based on the above criteria) to the Administration and to the general user.

When neither standard methods or standard reference methods are available, measurement techniques which represent the best judgment of an expert user-group should be established - Tentative Method or Approved Method (EPA).

The validity of all pollution measurements depend on strict adherence to all aspects of standard or approved procedures; the proper use of primary/secondary, gaseous, liquid and solid standards to calibrate the analytical methods and equipment, and the proper handling of the data obtained. EPA's standardization activities should provide: (a) primary and/or secondary gaseous, liquid and solid standards; (b) provide procedures for use in calibrating methods and equipment and establish equivalency between the Standard Reference Method and other methods of choice; (c) provide minimum performance specification required for instruments to measure a specific pollutant or class of pollutants in ambient and sources; (d) provide guidelines for certification of analysts; (e) provide assistance to groups responsible for data handling guidelines, and (f) establish control charts to determine the validity of data generated using standard or approved methods.

### 3.1.2 Detailed Procedure for Development of Standards

Candidate methods for standardization are usually obtained from operating divisions within the Environmental Protection Agency and/or from the private sector. These candidates methods are received by the Division of Monitoring Techniques (MTD), for their evaluation, collaborative test direction and promulgation.

Methods recommended for standardization are subjected to the following procedures:

a. Preparation Methods are first cast into a concise format using the decimal system and then extensively reviewed and revised by small groups of scientists who are expert in the area of interest. MTD will be assisted in this effort by the Standardization Advisory Committee (SAC) (The SAC formerly represented all division within EPA), and by the Intersociety Committee (Air Pollution Control Association, American Conference of Governmental and Industrial Hygienists, American Industrial Hygiene Association, American Public Health

Association, American Society for Testing and Materials, American Society of Mechanical Engineers, Association of Official Analytical Chemists, and the American Chemical Society) as required.

b. Preparation of Standard Reference Materials. Before any analytical procedure can be properly evaluated, materials (pollutant species) must be developed. The feasibility of using these materials for calibration and testing must be determined. (This work is being done with EPA support by the National Bureau of Standards).

c. Evaluation. It can be assumed that the originator of a method can obtain usable results with "his" method even if on the spot changes are required. Therefore, one of the most important steps in the Standardization process is an impartial evaluation in the laboratory and in the field by qualified and experienced scientists.

d. Collaborative Testing. Participants in a collaborative test series should be representative of the ultimate users of the method. Since pollution measurements are a matter of concern to many people, the users of the method will include laboratories of the Federal government, state and local pollution control agencies, private industrial plants of many different types, universities, and basic research organizations as required. To date, approximately 150 laboratories have indicated a willingness to participate in the collaborative testing of air pollution methods. A majority of these are state and local air pollution control agencies, although the other types of laboratories listed above are also represented. The various laboratories also vary in size from one- or two-man laboratories up to large organizations with a laboratory staff of several dozen people. A collaborative study is usually done by distributing samples to a group of laboratories for analysis, followed by statistical analysis of the data to provide the desired evaluation of the method. This procedure has been used by many organizations in the standardization of various methods of measurement. The American Association of Analytical Chemists (AOAC) and the American Society for Testing and Materials (ASTM) have been especially active in this field and have published guides to establishing the proper procedure for conducting collaborative or round-robin tests of a proposed method. A test program of this nature has not been conducted in the past to evaluate methods for measuring air contaminants, largely because of difficulty in providing standard samples to a group of laboratories for analysis.

In collaboratively testing for air pollution measurements, it is desirable to develop a system for generating a test atmosphere of known concentration. Where this cannot be done, a group of collaborators come together at a single location and sample a real atmosphere or source. The primary disadvantage here is one of statistical validity. Ideally, a collaborative test should indicate what each participant is capable of doing in his own laboratory, and not at some central location. This method inevitably suffers from the fact that the results more nearly indicate an intralaboratory evaluation than an interlaboratory evaluation.

e. Adoption. Based on the statistical evaluation of the data from the collaborative tests, the Environmental Protection Agency will determine if these methods should be adopted as standard methods. The Intersociety and other groups are free to use these data to decide which methods they choose to endorse.

f. Promulgation. Methods adopted as Standards by EPA will be promulgated to all state and local agencies to be used in implementing National Air Quality and Emission Standards, in the case of air, and like standard methods in the other media and categories.

g. Quality Control. Continuing subsequently to the adoption of each standard method, a quality control procedure will be established to insure the attainment of accurate data. State and local laboratories, on a voluntary basis will be served. This is closely related to standardization of methods in that it is the inverse of collaborative testing. While collaborative testing evaluates the reliability of methods, quality control evaluates the reliability of data from laboratories using the methods.

### 3.1.3 Need for Standard Data Handling Practices

Associated with these monitoring activities is a massive accumulation of data which must be formatted and reduced for quick assimilation. Fortunately, there are a number of institutions throughout the United States which have experience in data reduction and analysis. It would be advantageous for each region to avail themselves of this already existing capability. However, before these channels of data processing are utilized, it is most important that unified standards for formatting and data reduction be established. The alternative to standardization in the realm of data management would be utter chaos. However, standardization of data management practices will be a complex project since no standard guidelines exist now. To delay implementing this objective would only complicate an already difficult task. For this reason and also because data management is so basic to remote and in-situ sensing operations, the standardization of data management practices should receive the very highest priority.

Close coordination between the standards for data coding, storing, retrieving, analyzing and summarizing and the monitoring techniques standard for sensing equipment and method must be developed and maintained.

### 3.1.4 Specific Factors Relating to Standard Methods and Equipment

The procedures described in the preceding paragraphs for implementing measurement standards must consider the following factors:

1. Siting of sensors - develop criteria for each specific application
2. Measurement precision and accuracy
3. Calibration and maintenance
4. Averaging times and averaging methods
5. Measurement errors - bias and random
6. Data entry and reporting - editing and validation
7. Impact on data processing

The definition and initiation of procedures, techniques and equipment characteristics is a function of standard setting. The maintanance procedures relating to these factors is a function of quality control.

## 3.2 Suggested Discussion Topics

3.2.1 Following the performance of the requirements analyses suggested in Section 7.0 for monitoring techniques for all media and categorical programs, a standardization program for such techniques could be developed. A standardization plan can be started in air pollution based on the output of the contracted effort, "EPA Plan for Air Pollution Measurement Techniques Development, Fiscal Year 1972-1977."

3.2.2 Derive a master standardization plan for use of standard methods. Pro's and Con's were addressed in the opening remarks of this paper.

3.2.3 Accelerate an international reference method exchange agreement.

3.2.4 Restructure the Standardization Advisory Committee, the Intersociety Committee to aid in the across the board look at standard methods.

3.2.5 Bring in societies dedicated to remote monitoring such as:

- Instrument Society of America
- Society of Photo-Optical Instrumentation
- American Institute of Aeronautics and Astronautics
- Institutes of Electrical and Electronic Engineers

to start the standard method review.

3.2.6 What defines a "correct" sampling site? Develop a framework for developing such a site standard.

3.2.7 Should the standardization assignment for monitoring and methods be combined with data management organizationally?

## PAPER NO. 4

## 4.0 EARLY WARNING MONITORING NETWORK

### 4.1 Problem Perspective

An early warning system should serve two fundamental needs. The first is concerned with providing rapid and timely data for phenomena which occur and cause immediate hazardous effects to man, vegetation, animal species, and natural resources. Examples of these phenomena are episodes, oil spills and industrial or transportation accidents (e.g. train wreck involving lethal gases). The second need relates to early detection, warning and awareness of events or discoveries which could have potentially disastrous long-term effects on the environment. These phenomena are concerned with known facts such as the build-up of $CO_2$ in the atmosphere, decline of solar radiation as measured on earth and the discovery of high concentration of organic mercury, lead, cadmium and other substances through awareness of their effects on plants and animals at various locations; also, this second need should somehow address the problem of receiving early awareness of environmental hazards which may not yet be known at some specific point in time. A means for responding to these distinct needs is discussed briefly in the following two subsections.

#### 4.1.1 Early Warning For Short-Term Episodes

An early warning network to meet short-term episode needs is characterized by rapid detection, reporting, communication, remedial action and control response. Elements of such a system must provide for centralized display to support management for operational planning and control as well as for rapid dissemination of data and operational instructions for effective and prompt local action. This will allow the managers to be aware of tactical developments and quickly draw upon resources under their control (or request additional resources) to exercise initiatives, capitalize on auspicious developments or take actions to thwart unfavorable developments. One solution to this problem calls for operation of an Environmental Situation Room (ESR), supported by the necessary sensors, communications links, information processors and displays. A functional depiction of an early warning subsystem in support of abatement actions is shown in Figure 1. The input measures and forecasts which are routinely collected and processed by local agencies, private sources and Federal agencies normally would be stored in various central and regional processing centers to support routine operations. Special techniques should also be employed specifically for rapid alert purposes. For example, the Radiation Alert Network provides gross measures of radioactivity so that changes would provide alerts for more detailed monitoring. Also, the National Weather Service issues forecasts relating to alerts of prospective episode conditions and are distributed through the Weather Service channels. More use should be made of utilizing biological techniques for early warning indication. Water samples should be taken routinely to determine the number and types of organisms present. Frequently, a reduction in the number of species indicates presence of toxic substances.

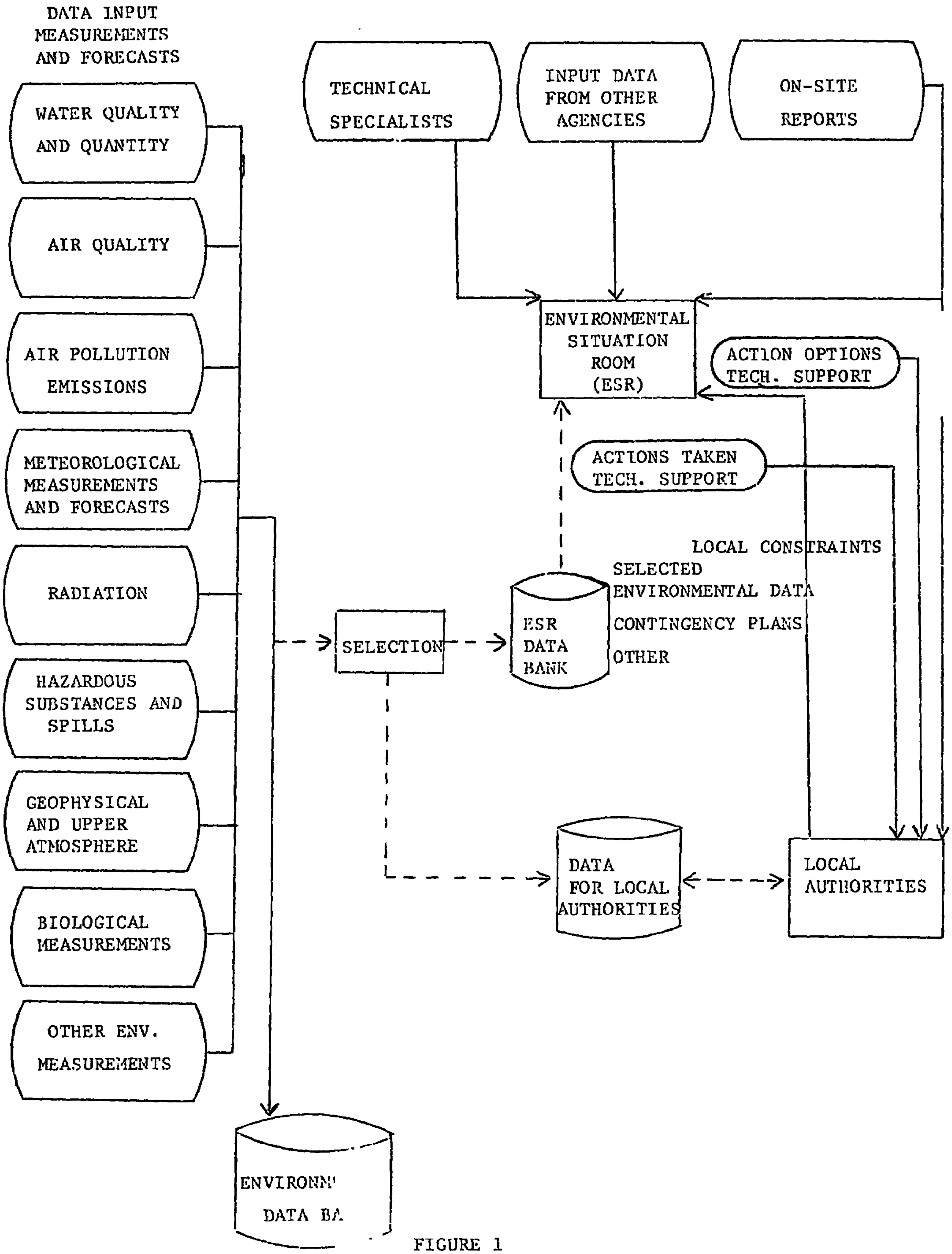

FIGURE 1
FUNCTIONAL DEPICTION OF EARLY WARNING SUB-SYSTEM SUPPORTING ABATEMENT ACTIONS

Data obtained from these special techniques would be selected routinely for analysis required to support the operation of the ESR. Additionally, during critical episodes such as an oil spill, an accident involving transportation of hazardous materials, an air pollution episode or contamination of drinking water in a community, the selection function would be enacted to tap relevant data during its flow for normal operational use. Also, special actions would be taken to increase the surveillance of the affected area. In the case of air pollution incidents, for example, mobile monitoring stations might be dispatched to measure emissions, ambient concentrations and pertinent meterological parameters on a micro-level basis. In the case of accidents, mobile monitoring would also be enacted. In all such instances, on-site reports would be available to local authorities and to the ESR. Information would be sent via teletype, data-phone and by normal telephone communication.

Situation managers in the ESR would have access to all incoming relevant data as well as to technical specialists. A data bank must be maintained to contain the selected environmental data, contingency plans and other technical support information.

Contingency plans for a variety of possible scenarios should have been prepared to allow maximum utilization of standard guidelines, action alternatives and standard operating procedures which could be responsive to a given situation. This would assist in making prompt decisions and avoiding issuance of conflicting instructions and other inconsistencies likely to accompany an environmental crisis situation.

The advantages of having available plans for a variety of situations would increase the effectiveness of federal support, expedite coordination among EPA, other federal agencies and local authorities and promote implementation of proper abatement actions. Direct actions may be taken on a centralized basis; action options, advice and coordinated instructions in any case would be issued in accordance with administrative, legal and other jurisdictional constraints.

Technical support data should be accessible to the ESR manager as required. This could include processed information in the form of population data for major areas, location of key resources and services and transportation facilities. A file of such data should be available in the ESR. Any required data not in the file could be obtained through coordination with other agencies and the local jurisdiction involved.

The ESR should be equipped with specially designed displays for use during emergency situations. A map of the area involved should be available to the scale required by the situation. A status board indicating such items as actions taken (e.g. shutdown orders issued, shutdown accomplished, population evacuated from area A), and numerical parameters of interest should be provided, with capability for interrogation of the ESR data bank. The specifications for such displays should be developed from a detailed requirements analysis.

### 4.1.2 Early Detection of Long Term and New Environmental Hazards.

The central feature of the operational concept presented for this subsystem (Figure 2) is an Environmental Intelligence Analysis Center (ENVIAC). The functions of this center would consist of gathering and sifting through environmental intelligence data, developing environmental models (taking into account activities of other environmental research groups), applying these models and conducting long-term environmental assessment studies. The output of this Center would:

1) Provide warning reports of newly discovered potential environmental hazards

2) Prepare plans for rapid implementation of detailed surveillance of specific pollutants in particular locations as a result of detection of a potential environmental hazard

3) Perform special impact analyses

4) Provide evidence for specific environmental policy recommendations.

Results of items 1) and 3) would be disseminated to research and analysis groups within EPA as well as to other agencies and research establishments. Item 2) would be directed to the operational group within EPA having responsibility for operating special surveillance systems supporting ENVIAC (discussed below). Technical back-up for policy recommendations would be made available to EPA decision makers and other policy groups (e.g. CEQ, OST).

In addition to relying on its own analysts, the Center would be supported by three major elements:

1) Other Research and Analysis Groups

2) Data from Special Surveillance Networks

3) Bibliographic Dissemination Service.

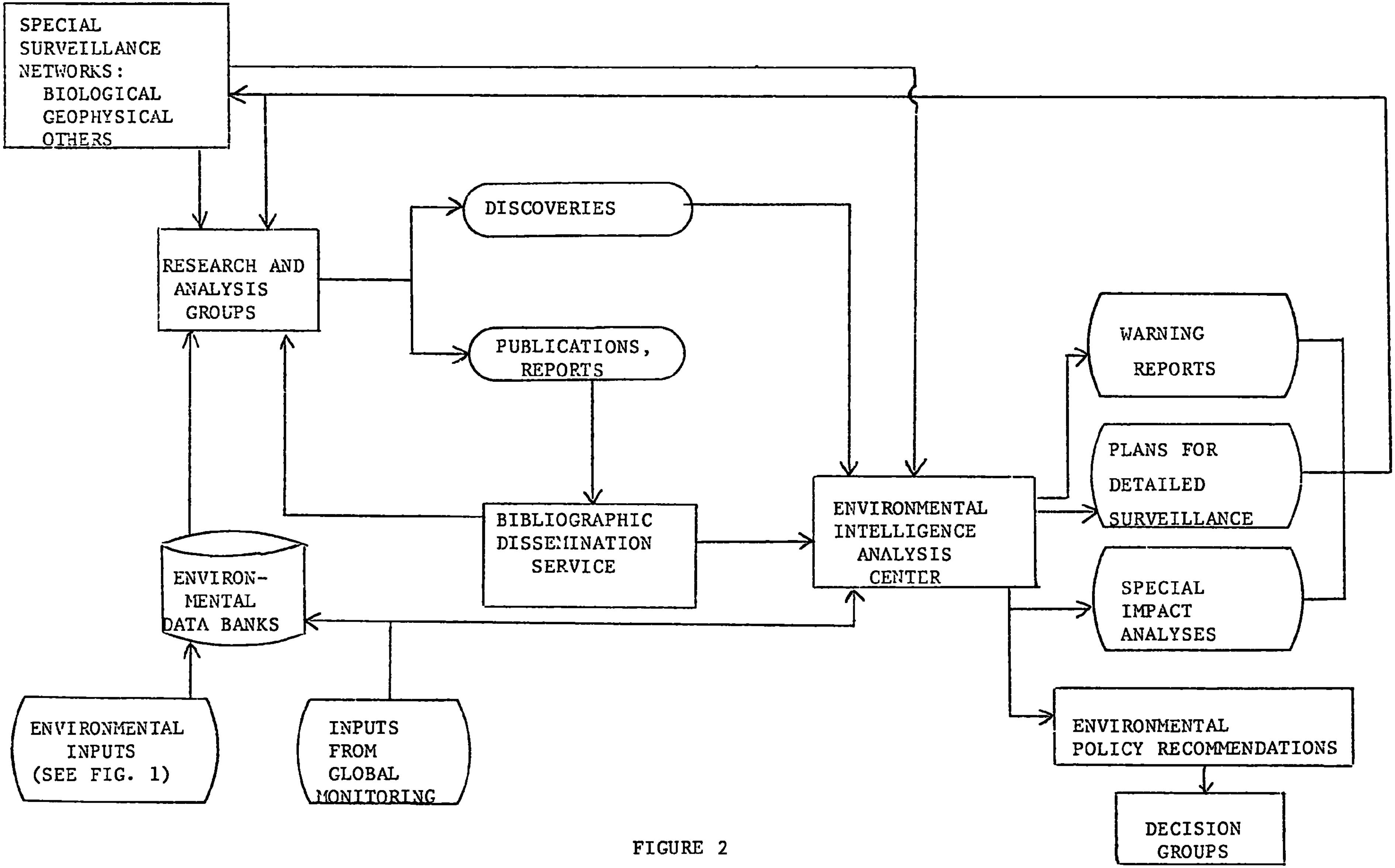

FIGURE 2

FUNCTIONAL DEPICTION OF EARLY DETECTION SUBSYSTEM FOR ACTIONS PERTAINING TO LONG-TERM ENVIRONMENTAL EFFECTS

ENVIAC would also have access to other Federal environmental data banks and would receive inputs from global monitoring sites.

Research and analysis groups will provide two types of output. Discoveries of potential hazards, either through field experimentation or data analysis, should be immediately sent to ENVIAC. Other publications and reports prepared by the environmental research community pertaining to new environmentally oriented scientific discoveries should be classified and disseminated to the Center through a Bibliographic and Dissemination SERVICE. This service should also provide inputs regarding pertinent research in - progress. The recently completed Study of Environmental Quality Information Programs (SEQUIP) for the Office of Science and Technology made some specific recommendations to this effect. These are described in Appendix A to this paper.

The SEQUIP Committee recommended that the Science Information Exchange of the Smithsonian Institution and the National Technical Information Service be combined for this purpose. The Center for Short Lived Phenomena, also of the Smithsonian Institution, currently collects and selectively disseminates information relating to new discoveries and field observations for a variety of subject categories. The MITRE Corporation, in its monitoring system study for the CEQ suggested a Scientific Environmental Research Volunteer in Cooperative Effort (SERVICE) Group to report on new and potentially significant environmental developments. The SEQUIP Committee also recommended that various centers of environmental research allow scientists some time to classify and report on new findings. Better coverage of environmental material in secondary journals is also suggested. There appears to be wide interest in establishing and accomplishing such a system to meet these needs. All that appears to be required is strong leadership and competent management to launch and conclude the design and implementation effort.

Special surveillance networks (including necessary laboratory resources) should be established to provide direct environmental data specifically tailored to support ENVIAC's mission. Data from these networks, which could also be made available to other research groups, would measure parameters such as $CO_2$, atmospheric turbidity and solar radiation and other geophysical and upper atmospheric pollution data. In addition, elements of this network would consist of biological monitoring organisms (indicators, sentinels, bio-assay, detection and accumulation) for detection of quantities of key pollutants. Since there are 2.5 million known chemical compounds and 500 new chemical compounds introduced annually into the environment by industrial countries, there is certainly a problem in selecting the specific substances to be monitored. One possibility is to classify substances on the basis of similar chemical properties and monitor specific representatives in each class. In this way, if subsequent research indicates that another (unmonitored) substance in the class has hazardous environmental characteristics it may be that the representative of the class which was being monitored would have transport characteristics and other properties which were similar to the substance being monitored. In this case, some further clues may be available about the possible intermedia properties of the newly detected hazardous substance.

Any substance chosen for monitoring should be measured in air, water and land, as well as in possible species in which it might concentrate. Correlations should be performed by ENVIAC to attempt to relate concentrations to effluent amounts. Requirements for the surveillance networks include standard methods of analysis and provision of timely dissemination of results to interested specialists. Immediate reporting capability is generally not required. There should be sufficient flexibility in the surveillance networks to receive instructions from ENVIAC for increased surveillance for areas of specialized interest, as dictated by results of intelligence evaluation and other pertinent findings.

### 4.2 Suggested Discussion Topics

a) What are possibilities for early detection and measurements of environmental hazards (e.g. mercury)? The previous section indicated the problem of millions of candidates for monitoring. Do the specific suggestions offered treat the problem adequately? How can they be improved?

b) What relationships must be established among local, private and Federal (Regional and Central) groups? What role will each one play?

c) Develop an overall concept of collection, transmission and dissemination of early warning environmental data. Show input types and sources, functions, outputs and the needs which are satisfied. Show how new industrial processes would be integrated into such a system.

d) What is the proper role for EPA in the development of the bibliographic component of an early warning system?

e) What specific changes, and extensions would you offer with respect to the proposed Early Warning System Operational Concept? For example, what is the interface between the two subsystems described? What are the constituents of the special surveillance networks proposed?

# APPENDIX A-

# REVIEW OF STUDY OF ENVIRONMENTAL QUALITY INFORMATION PROGRAMS (SEQUIP) IN THE FEDERAL GOVERNMENT

## 1 - INTRODUCTION

This Appendix presents a review of the subject document which was prepared under the direction of Dr. Henry Kissman of the National Library of Medicine, who served as chairman of the SEQUIP committee. Thirteen members constituted the committee representing HEW, AEC, Departments of Interior and Agriculture, National Bureau of Standards, NOAA, Defense Documentation Center, EPA and the Library of Congress. The report consists of general findings of the committee and special sections on information technology, water pollution, air pollution, solid waste management, environmental effects of radiation and agriculture chemicals. It also consists of a directory of general information programs and public health information programs as well as a directory of environmental pollution information and data programs. While the task of the committee, as specified by OST, was to investigate broad environmental quality programs, only environmental pollution was considered in the report to limit the scope. The report states, however, that activities associated with data collection and information systems are generally applicable to programs outside the environmental area.

The objectives of the committee's study were threefold:

1. Report on studies of scientific and technical information activities in federal agencies concerned with environmental projects and improvement.

2. Describe generalized information programs (e.g. national libraries, clearing house) which serve the environmental quality field.

3. Assess whether the support activities are sufficient and, if not, determine how they can be improved.

This Appendix summarizes the major recommendations offered in the report.

## 2 - RECOMMENDATIONS

### 2.1 General

1. OMB promote data and information exchange within the Federal establishment by developing procedures for cost recovery.

The committee felt that duplication exists in data and services because operators of information systems are reluctant to offer services outside of their own organizations, because of lack of resources.

2. CEQ create in EPA a NATIONAL ENVIRONMENTAL PROTECTION AND INFORMATION DATA SERVICE (NEPIDS).

Inside of EPA this group would pull together the networks absorbed by EPA, promote standards, coordinate R&D, develop data in the technical environmental areas and answer queries within the agency. Outside of EPA this group would initiate network operations to interface with other environmental data banks, provide information relating to types and status of R&D projects, respond to requests, and work with the National Bureau of Standards and coordinate the information with other agencies.

3. This group should take into account requirements of future economic growth and the global aspects of pollution monitoring.

4. The National Bureau of Standards be assigned responsibility for developing:

a. standards relating to software development and operation of data banks.

b. environmental assessment technology including modeling and simulation.

c. clearing house activities.

d. systems analysis teams to aid agencies in establishing the necessary interface.

It was proposed that a major part of the fundings for this effort be provided by EPA and NOAA. Dr. David Freeman, Chief, Separation and Purification Section, Analytical Chemistry Division, and Dr. David Wagman, Institute for Materials Research were the National Bureau of Standards representatives on the Committee.

5. Continue workshop and symposia activities via a formal mechanism to be established by the Council on Environmental Quality or COSATI.

This recommendation is offered to stimulate communication among those concerned with environmental information programs.

6. The National Referral Center of the Library of Congress develop tools for improved access to technical information in the environmental quality field.

It was specifically recommended that LC publish a directory of U.S. Information Resources in the Environmental Quality Area.

7. A single government-wide clearing house be established to consolidate the activities of such groups as the Science Information Exchange (SIE) of the Smithsonian Institution and the Technical Information Service of the Department of Commerce.

It was further recommended that OMB establish guidelines and enforce government wide mandatory input requirements for standardization on an agency wide basis.

8. A national environmental early warning system for monitoring environmental pollution be incorporated as part of the Center for Short Lived Phenomena of the Smithsonian Institution.

9. Establish a Hazardous Materials Information Center to be operated by the Coast Guard and DOT.

The center would collect information on hazardous materials, cover procedures of handling, and methods of detoxification.

10. A new COSATI panel on environmental quality information and data systems be established to follow up on these recommendations and to extend the SEQUIP study into other non-pollution environmental areas (e.g. wetlands, urban environmental sources).

## 2.2 Bibliographic Services

Fourteen recommendations of a bibliographic nature dealing with data dissemination services, clearing house operations, document indexing, preparation of dictionary and thesaurus and preparation of abstracts were presented. These are not detailed in this Appendix.

## 2.3 Water Pollution

The report mentioned that the Office of Water Data Coordination and the Office of Water Resource Research currently provides a "sinew for an effective federal wide interagency data and information network in the water resource aspects of environmental pollution". STORET was mentioned as a data resource but no comments were made regarding its current effectiveness.

## 2.4 Air Pollution

1. *Use existing programs as a basis for satisfying new needs.*

This recommendation is generally similar to that offered by the MITRE Corporation in a study performed for CEQ.

2. *Unite pollution monitoring with the meteorological data collection system.*

This recommendation has a significant impact on siting and data storage. The report pointed out, however, that a technical unification did not necessarily imply organizational consolidation for operation and administration of the networks.

3. *Expand and optimize air pollution sampling networks.*

4. *Institute administrative and legislative steps required to promote Items 2 and 3.*

5. *Compatibility with and accessibility to existing data banks be a required consideration in the design of federally built or supported data banks.*

6. *Archival problems and uses be a required consideration in the design of future monitoring programs.*

7. *High priority be given to the development of data bank directories and inventories of data sources.*

8. *Initiate a study to determine how to improve secondary literature covered in the field of pollution.*

The SEQUIP Committee felt that much information about pollution appeared in secondary journals relating to other disciplines such as chemistry, physics, oceanography and climatology.

## 2.5 Solid Waste

1. *Expand the resources in the SOLID WASTE INFORMATION RETRIEVAL SYSTEM of EPA.*

2. *Greater emphasis be placed on social and behavioral science aspects of the solid waste problem.*

3. *Establish centers for analysis, evaluation and consolidation of diverse data in the solid waste field.*

Professionals at these centers would devote part time to these activities.

## 2.6 Radiation

The multiplicity of data sources (e.g. AEC, Federal Radiation Council, Bureau of Radiological Health) is considered to be a healthy situation by the committee. They recommend strengthening the supported programs and promote intercommunication among them.

## 2.7 Agricultural Chemicals

1. A clearing house for pesticide information be formally established in the TOXICOLOGY information programs of the National Library of Medicine.

2. Programs on the long term effects of pollutants on man should adopt the approach of the pesticide committee within EPA which emphasize epidemiological research.

PAPER NO. 5

# 5.0 STANDARDIZED MONITORING DATA ACQUISITION - COMPATIBILITY ASPECTS

## 5.1 Problem Perspective

Considering the variety of subjects and the extent of complex interactions which comprise the environment, it is understandable why so many governmental agencies representing various disciplines are concerned with one form or another of environmental monitoring. The first step in eliminating incompatibilities and duplication in a nationwide environmental network is to determine who is gathering what kinds of data. At present the National Referral Center (NRC) in the Library of Congress has the task of directing inquirers; particularly those from outside federal agencies, to locations within the government which might supply various forms of environmental data. In many cases the NRC has information relating to the published output of a particular agency but not the types of raw data that may be involved. An effort should be made to ensure that NRC's referral banks are up-to-date and as complete as possible.

### 5.1.1 Siting

The selection of sampling locations (siting) depends on the specific objectives to be met including a) establishment of existing or baseline information, b) trends, c) standards compliance, d) documentation of violations, e) forecasting, f) planning and management purposes, and g) scientific research. The selection of a monitoring site is also a function of the parameter of primary concern. For instance, when monitoring a particular effluent source in a river, a station immediately below the mixing zone is best suited for temperature data. On the other hand, the best location to measure dissolved oxygen or bacterial levels may be farther away from the source where more complete mixing has occurred. All well and good if these sites monitor the parameter(s) for which they were designed. Often, however, practical constraints dictate that a site designed or located for one purpose (or parameter) also monitor for others. Incompatibilities arise when trying to compare or aggregate data from say, a site well located to monitor dissolved oxygen along with similar data from a site not so designed.

### 5.1.2 Sensors

With regard to sensing devices an obvious requirement is that the sensor and its attendant recording equipment be mechanically and/or electronically compatible. With regard to data requirements when using sensors of the same design and make, the only problem is to make certain that they are calibrated to the same reference standards. Monitoring for a given parameter using sensors based on different designs or analytical techniques requires intercalibration to ensure comparability and proper interpretability of the results. The concept of such calibration measures is covered in paper 3.

### 5.1.3 Processing

Compatibility in relation to the processing of data will be understood as those functions necessary to get the raw data from the sensor into a form suitable for computer input. The availability of data in a clearly defined and well documented format is the basis of an effective processing system. All too often data are recorded in a format that is complicated, confused, incomplete, and insufficiently documented. When such data leave the immediate care of the person responsible for recording them, their utility is effectively lost. Selection of a format need not constrain an agency in any way, particularly if data are recorded in machine-readable form, since the data can then be reproduced with very little difficulty into a variety of forms and formats. For example, an agency could use one format for certain internal records and another format (such as SAROAD*) for interchange of data with other agencies both within and outside EPA.

Most processing of data will require that data be machine-readable, either on cards or magnetic tape. If certain monitoring groups can not afford this, their data can be sent in on forms, and converted in the most effective manner. The directions for filling out such forms should be kept as simple as possible and examples of how to complete the forms are advisable.

Certain types of information are fundamental to most pollution monitoring and are typified by the following SAROAD checklist of data requirements:

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* SAROAD Users Manual, Office of Air Programs, EPA, Research Triangle Park, N.C. (July 1971).

a) Site identification form
b) Pollutants measured
c) Sampling methods (e.g., Saltzman, West Gaeke)
d) Instruments
e) Units in which the measurements are expressed
f) Decimal point location
g) Date of reading
h) Time of reading
i) Sampling frequency
j) Averaging time (duration of sample)
k) Identification of any special codes
l) Special instructions to persons using data

Although the above list was designed specifically for the monitoring of ambient air pollution, many of the items apply to other areas of pollution as well. Certainly for those elements which are common to several programs EPA should establish agency-wide guidelines for common reporting practices. These guidelines should also address the proper form for items which are unique to a monitoring program in a particular office.

There seems to be a lack of cooperation among computer manufacturers in terms of data and programs from one machine being acceptable to another. Even within the same company incompatabilities exist depending upon whether a second or third generation machine is being used. Some of these problems are software related while others pertain to hardware. The following is a list of items, in addition to the above listing of data requirements, which will facilitate conversions from one system to another:

Punched Cards

- a) Identification of any unusual formats, characters, or punching.
- b) Sequence of data cards (e.g., sort sequence, ordering, arrangement).
- c) Identification of machine on which cards were generated.

Magnetic Tape

Hardware related

- a) Reel identification
- b) File number
- c) Recording density (556, 800, or 1600)
- d) Number of tracks (7 or 9)
- e) Parity (odd or even)
- f) Recording code (ASCII or EBCDIC)

Software related

- g) Record length (in number of characters)
- h) Second type (fixed or variable length)
- i) Blocking factor (in number of records/block)

j) Description of file contents
  - indicate parameters observed
  - number of sites reported
  - years spanned
  - approximate number of records

k) Description of file format (record layout)
  - indicate format identification numbers used and observation time intervals

l) Description of file sort sequence
  - identify individual fields
  - indicate major to minor ordering
  - for each field indicate whether ascending or descending

The software problems can often be resolved by programmers at the data processing center. Even so, correction of such incompatibilities is time consuming and should be kept at a minimum. The hardware problems can be solved with clever programming in conjunction with the necessary conversion hardware. Since not all computer centers are so equipped, perhaps one computing facility in each region could be equipped and designated to handle such chores.

### 5.1.3 Commonality of Language and Units

At the present time there exists no dictionary, glossary, or thesaurus of terms used in the overall environmental field. This is largely because environmental quality is not a formal scientific discipline, but a label given to a variety of activities that cut across the normal boundaries of science. Moreover, in many areas, problems require not only technical data but also economic, legal, political and social data.

The problem of terminology inconsistency is compounded when exchanging information with foreign institutions. Given the global nature of environmental pollution, such exchanges will become increasingly important. Already, many countries have made considerable contributions to our knowledge (e.g. Sweden, Japan). An excellent service is provided by the Water Pullution Research Board of Great Britain with its monthly issues of Water Pollution Abstracts.

Even within a single discipline there are differences as to the use of various terms. A notable example is in the field of chemistry and the use of several names for the same compound (i.e., methanethiol vs. methyl mercaptan). The Chemical Abstract Service Registry System has identified and coded some 1.5 million compounds (about 250,000 additions annually) and this program should be promoted on a widescale basis.

The diversity of units of measurement in use by different disciplines and organizations can lead to confusion and misinterpretation. Concentrations in water may be expressed in terms of ppm, milligrams/liter, milliequivalents/liter, molarity normality, or percent by weight or volume. Another problem concerns the use of the British vs. metric system of units. To decide to convert to the metric system at this relatively early stage in environmental monitoring might make sense in light of a) facility of exchange with most foreign institutions, and b) the fact that this country itself may eventually go metric and later more intense confusion would be averted. A year ago the Office of Air Programs suggested a plan for adopting the metric system and phasing out British units and especially mixed units. Judging by the fact that recent legislation on automobile emissions was based on grams of pollutant per vehicle mile, a redoubled effort on an EPA-wide basis is necessary. The transition should occur gradually to allow personnel to become accustomed to the new system and for equipment modifications to be made.

Conversion from one set of units to another is generally a simple (but time consuming) formality involving multiplying by some factor. In some cases, however, conversion can be a nuisance. Some conversions require auxilliary information (e.g. ppm to ug/m$^3$ needs temperature and pressure data to be done correctly) which may or may not be available. If it is not available, it might be neglected or assumed which can lead to the introduction of errors. Often there is a tendency for, say, state agencies to use their own terminology even when filling out federal forms. A rather extreme example concerns a certain state which uses its own state oriented latitude/longitude system in completing SAROAD forms. A more common incompatibility occurs when states use their own pollutant and/or site location code numbers. In the area of water quality the STORET system is trying to unravel the problem of listing of site locations either by "river-mile" or latitude vs. longitude.

### 5.2 Suggested Discussion Topics

a) What is the most effective method for promoting program awareness and reducing duplication of effort in the various areas of environmental monitoring?

b) How can the selection of computer hardware and software be optimally coordinated so as to reduce incompatibilities between systems? Can the cooperation of computer manufacturers be enlisted?

c) What kind of coordinating group should be established to ensure the commonality of language and units used in environmental monitoring? Who should be involved in such a group and what would be EPA's role?

## PAPER NO. 6

## 6.0 STANDARDIZED MONITORING DATA ACQUISITION - QUALITY CONTROL ASPECTS

### 6.1 Problem Perspective

Quality control implies the maintenance of certain prescribed standards of performance or output. Various techniques and models may be employed to assure that quality is designed into a system and/or may be regained if the system should deviate unacceptably from its expected performance. It is sometimes difficult to separate the functions of standardization and quality control. In these papers the former will concern itself primarily with the design and setting of specifications for equipment and procedures (see paper 3) while the latter involves assuring the quality and reliability of data produced as a result of these procedures. Quality control, then, provides for the implementation and continued integrity of standardization. Even within these guidelines there is some degree of interplay and feedback which makes overlap inevitable.

With regard to the paragraphs below, it should be borne in mind that the comments apply not only to monitoring functions "within" EPA (including states and regions) but also to contributing groups outside of EPA such as universities, industries, and other federal agencies. Within the realm of environmental monitoring there are several areas where quality control may be applied such as personnel, equipment, data, and procedures. It should be noted that quality control applies not only to these component aspects by themselves but also to their interrelationships and functioning as a whole system. The following is a proposed outline of functions to be performed by an integrated approach to quality control.

### 6.1.1 Definition of Goals and Objectives of a Monitoring Program

The degree to which quality control is to be applied throughout a program will depend upon the end uses of the data. Therefore, the first step is to define the goals and objectives of a program which, when taken in light of those from other programs, helps establish the bounds of the quality control effort.

### 6.1.2 Guidelines for Establishing a Monitoring Network

In the setting up of a monitoring network quality control plays an important part in the implementation of and assuring the adherence to guidelines in the following areas:

a) Site location - whether a site is chosen on a random basis, as part of a grid, a combination of these two ideas, or specifically for a stated purpose depends upon the use of the data and the parameter(s) measured. Quality control relates to siting in that it is necessary to periodically review siting criteria in light of changing legislation, population and industrial shifts, technological advances in monitoring equipment, etc. Adjacent construction projects could require the relocation of a given site.

b) Type of station - data requirements dictate whether a station should monitor continuously, gather information integrated over a specific time period, or provide grab samples to be analysed in the lab. Are the procedural specifications being adhered to? For instance, in the case of grab samples, are the samples taken from the same location every time, same time of day, etc.?

c) Selection of instrumentation and methods - instrumentation and methods needs will change as the state-of-the-art progresses and quality control should see that these changes are incorporated.

d) Averaging time to be consistent with standards - if regulations require, say, an 8 hour sampling period, quality control should see to it that this time period is not violated beyond certain tolerances.

e) Sampling frequency - in the case of annual averages of $SO_2$, adequate coverage may be maintained with intermittent sampling at frequencies calculated statistically for desired levels of precision and related to the degree of pollution. Quality control might suggest a different sampling frequency if the ambient conditions changed significantly.

f) Instrument maintenance and calibration - with regard to a particular piece of equipment once the desired accuracy, precision, sensitivity, and range have been specified, it is the job of the quality control program to insure that these attributes be maintained throughout its operation. The initial calibration and subsequent recalibrations should be performed according to a schedule deemed necessary for a particular piece of equipment. Obviously there will be unscheduled malfunctions and repairs requiring recalibration.

Quality control should have the responsibility for approving manuals for maintenance and calibration and updating the texts of "standard methods."

The dependability of a piece of equipment will be taken not in terms, necessarily, of its accuracy, but rather with regard to its amount of operational time vis a vis the time it is inoperable due to some breakdown. A certain amount of downtime is to be expected for routine preventive maintenance and proper scheduling can insure an uninterrupted flow of data; i.e., nighttime maintenance for pollutants which are most serious during the day or borrowing standby equipment.

However, unscheduled downtime can result in data gaps which may impair analysis and interpretation. In order to better understand and minimize such breakdowns, careful maintenance logs should be kept indicating such items as type of failure, probable cause, time, date, frequency of malfunction, ease of repair, etc.

With regard to the proper functioning of equipment there are certain external conditions whose quality should be maintained. These include air conditioning for temperature - sensitive equipment, constant line voltage, insurance against power outages or brownouts especially during critical episodes, special shielding, insulation, or isolation of the housing for equipment, and the use of high quality laboratory chemicals and reagents.

g) Questionnaires and surveys - In the case of such areas as solid waste management and epidemiological studies where data are derived mainly from questionnaires and surveys rather than physical measurements or chemical analysis, quality control implies adherence to reliable polling methods and survey techniques and proper statistical analyses and interpretation of results.

### 6.1.3 Training

The effectiveness of the most carefully designed equipment and procedures can be seriously reduced in the hands of unqualified personnel who are not capable nor properly motivated. Providing good job descriptions is a necessary step for weeding out unqualified applicants. Educational programs are then promoted to communicate skills, methods, ideas, objectives, and attitudes. In order to measure an employee's knowledge and determine what training is needed, a series of test questions can be designed to be answered by employees in specific areas.

Such training can take place on two levels:

a) Formal training - in the classroom or at seminars where theory and lab applications are taught primarily from the textbook with some supplemental laboratory work.

b) On-the-job-training - in an EPA or accredited state laboratory with an emphasis on the practical aspects of monitoring.

It may be desirable to provide a program of requalification. This may be necessary when a person's performance (competence and attitude) seem to be waning. Moreoever, changing demands (new equipment, procedures, regulations) often alter requirements of skill and knowledge and increase training needs. Not only does proper training enhance the quality of the data, but it also helps to cut down on the damage and abuse of instruments.

### 6.1.4 Laboratory Certification

To ensure comparability of data, a uniform degree of excellence should be expected from the various governmental and private laboratories providing input to EPA monitoring activities. A certification program with periodic reviews, while not an absolute guarantee of excellence, is a necessity towards establishing a common denominator of quality with regard to

a) Compentency of personnel
b) Adequacy of facilities
c) Use of proper analytical methods
d) Uniformity of data handling procedures

### 6.1.5 Calibration Standards

The quality control program should insure that reference standards for calibration, developed to EPA's specifications, are certified by the National Bureau of Standards. For EPA to enforce standards which it certified itself would present a conflict-of-interest situation.

Calibration techniques and degree may differ for a particular type of equipment depending upon whether it is designed for use in the field or in the laboratory. For field instruments calibration can take place either on-site or at some central laboratory. For the former there is less downtime involved (if necessary tools are readily available) and less chance of damage in transit. On the other hand, more sophisticated calibration equipment and better trained personnel are generally available at a central lab where calibration is a major function. The decision should be based upon such factors as the fragility of equipment, availability of on-site redundant monitoring, and the degree of calibration required.

The question of calibration has special significance during an episode, or emergency condition. For instance, during an air pollution episode, there are several stages of increasing severity where different kinds of pollutant emitters may be required to curtail or shut down their operations. Since these shutdowns can be very costly to a company, they should be based on the best of information. A false alarm could result in a lawsuit being brought against the EPA. Given the fact that air pollution episodes are somewhat predictable because certain meteorological conditions must prevail, there is time for emergency recalibrations to be made on site by special federal teams or by qualified local personnel.

Calibration standards are necessary in order to make interlaboratory calibrations using corroborative, or round-robin, testing. This may be the preferred method for assuring international cooperation of certain countries where EPA field teams may not be invited due to diplomatic considerations.

### 6.1.6 EPA Field Teams

In additon to mailing similar samples to different labs for corroborative testing, it is desirable to have field teams of highly trained experts visit the various labs on a periodic and/or random basis. Since the number of these teams is small, they may be limited to providing interregional and interagency calibrations only. Similar teams could be established by the states, and trained by EPA, to satisfy their own needs. Since the experience and exchange of techniques and information would be valuable, the EPA field teams would be sent to foreign labs on request of the host country.

EPA field teams would be able to perform dynamic calibrations (DC) on instruments where it is desirable not to shut down the equipment and this feature (DC) is not inherent to the equipment. This situation might occur during the air pollution episodes mentioned earlier.

### 6.1.7 Data Handling and Verification

Although this topic is discussed elsewhere (see paper 5), a few remarks are in order here.

Proper validation and editing procedures should be defined and maintained to insure quality contol of data entering the data banks, regardless of source. This might require establishing special units to handle data obtained from sources outside EPA.

In the validation and verification of data, one must be able to discern whether a marked change in data values indicates a real change in the phenomenon or quantity being measured, an equipment or human error, or a set of random events. Various statistical methods are available which should help straighten out such problems. Another verification technique involves the use of redundant equipment or a completely different, but equally reliable, method. Spot checks on data using mobile laboratories is useful in this regard.

An important aspect of quality control related to data handling concerns the publication of data. Typographical errors or ambiguous sentences can impair any good results of the previous efforts. Competent editors with technical training can catch serious errors which may creep into this last stage of data formulation. However, in the event that errors from any part of the total data gathering process get through and are discovered, records of such discrepancies must be maintained in order that corrective action and follow-up may be accomplished.

### 6.1.8 Methodologies, Procedures, and Instrumentation to Meet Future Needs

Present quality control measures are by and large based on retrospect. The quality control program should address possible future needs in terms of new or impending legislation, technical improvements in monitoring, population growth, pollution forecasts, and technological shifts (e.g. nuclear *vs*. fossil-fueled power or the production of a new class of chemicals).

The calibre of data from all sources should be of the same high calibre and mechanisms should be devised to assure compliance. While coordination of quality control programs may take time and require compromises among various governmental groups, adequate legislation could provide the impetus to do so. A more difficult problem arises when trying to enlist the cooperation of groups outside the government, such as universities and industries. Since much of a university's monitoring efforts may be supported by Federal funds, financial pressures can be brought forth. There may also be an incentive for a university to become a certified lab. Industry participation is on a more or less voluntary basis and providing for acceptable compliance could prove difficult. A workable method (e.g. penalties or incentives, working through trade associations, etc.) must be found - hopefully short of legislation.

### 6.2 Suggested Discussion Topics

a) How can the quality of voluntarily supplied data from private sources be enhanced? What is the most effective and least costly method to insure that such data are in compliance with guidelines and standard methods?

b) How can EPA most effectively control the development and specification of Federal quality control guidelines for data for which it has enforcement jurisdiction and responsibility? What are the required procedures for interface with groups such as private industry, the National Academy of Engineering, and the National Bureau of Standards?

c) What are the specific areas of environmental data for which EPA has primary responsibility? What are the areas of interface where EPA should exercise a coordinating function?

d) What mechanisms can be established now to anticipate future quality control requirements?

Paper No. 7

# 7.0 MONITORING TECHNIQUES

## 7.1.0 Problem Perspective

### 7.1.1 Monitoring Techniques, General

The theme of this paper is the state-of-the-art in monitoring techniques for all forms of pollution for which EPA has responsibility. Such a theme naturally invites a wide range of possible discussion topics. In order to bound the problem it has been assumed that monitoring techniques is synonymous with two areas of concern only. The first area is the monitor in which questions of detectors, calibration circuits, signal conditioning and on-site recording are included. The second area of concern is the experimental method. Data transmission, data processing, storage and retrieval, data analysis and data reporting are a part of monitoring techniques but are not discussed in this paper.

Both in-situ and remote monitoring techniques are addressed in this paper. In-situ monitors is that general class of monitors that sense only the condition at the point at which the monitor is placed. All other environmental monitoring techniques are defined as remote techniques.

In this paper all discussions of in-situ versus remote monitoring requirements, have been presented equally in order to engender the selection of the better method as soon as practicable.

In-situ monitors while generally simpler than remote monitors have several shortcomings. In-situ monitors generally require separate sensing elements for each pollutant constituent. Also, since the radius of comprehension of such sensors is small, a considerable number of monitoring sites is required in order to understand the areal extant of the polluted area.

While most remote monitors are not yet developed sufficiently for operational use, they do lend themselves to the sensing of areal coverage questions well. Such monitors are generally more expensive and complex than in-situ sensors but because of the large areal coverage capabilities of remote monitors, the investment in these monitors should prove to be cost effective. Remote monitors thus can be directed to cover wide areas of interest to EPA and will be of great value for supporting the Agency's role in surveillance of environmental quality. Thus a few properly placed remote monitoring systems on platforms capable of reasonable deployment may logically be looked upon as a very likely monitoring technique of the near future. The optimum mix of both in-situ and remote sensors is the kernel of our concern.

### 7.1.2 Organization Considerations

Inherent in the expeditious development of an effective monitoring technique is the manner in which the system is designed, developed and administered. The objectives of overall monitoring system as a whole are:

a. To produce information on environmental levels, trends and patterns of components (solid, liquid or gaseous), trace metals and nonmetals in all urban and non-urban areas of the U. S.

b. Identification and quantification of new or newly recognized pollutants.

c. Increase the basic understanding of the source-receptor relationships, pollutant interactions and decay processes.

d. To develop a bank of environmental data for use by Federal, State, local agencies and the general public.

Such a monitoring system requires interaction among the ten EPA regional offices, the Enforcement, Media and Categorical offices of EPA; and the Office of Monitoring of EPA. EPA may request the assistance of other Federal, national and international organizations in the development of environmental monitors.

The major responsibility in EPA for the development of monitoring techniques rests with the Office of Monitoring. This organization in turn directs and/or coordinates the development of all EPA monitoring techniques.

### 7.1.3 State-of-the-Art in Monitoring Techniques

The integrated nationwide environmental monitoring program - short term and long term (discussed in papers No. 1 and 2) are constructed on the foundation of realizeable techniques in the time framework selected. The systems tradeoffs and the optimum system depend fundamentally and to a large degree on the state-of-the art (SOA) of monitoring techniques. Data transmission and handling techniques today generally outstrip the capability in producing reliable, accurate monitoring techniques.

For ease of discussion of the SOA of monitoring techniques, the discussion below is structured along the following lines. For each media or category, the first breakdown is by Use, listed as follows:

a) Ambient

b) Emission sources - stationary

c) Emission sources - mobile

d) Natural processes (meteorology, hydrology)

e) Effects (biological, societal, economic)

Remote techniques are contained within each Use area.

### 7.1.3.1 Techniques for Air Pollution Monitoring

The development of all monitoring requirements and the analysis of all techniques to satisfy each requirement is the first and fundamental step in the design of the monitoring system. Such a requirements analysis has been performed by the Office of Air Programs with the support of the Esso Research & Development Company* in the time period covering fiscal years 1972 through 1977. Sixth-three tasks for monitor development and ninety-two tasks for methods development were developed with the requirements in each of the areas of Use in Table 7-1-1.

Review of the status in the development of air pollution monitoring at any time, depicted in Table 7-1-1, points out clearly that

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*EPA Plan for Air Pollution Measurement Technique Development Fiscal Years 1972-1977, First Draft, July 1971, CPA 22-69-154.

## TABLE 7-1-1

## AIR POLLUTION MONITORING TECHNIQUES - STATUS OF DEVELOPMENT AS OF JULY 1972

| | | RESEARCH | DEVELOPMENT | TEST AND EVALUATION | COLLABORATIVE TESTS | PROMULGATION | TOTAL | |
|---|---|---|---|---|---|---|---|---|
| AMBIENT AIR QUALITY | S | 3 | 10 | 5 | 4 | 1 | 23 | |
| | M | 3 | 6 | 6 | 4 | 7 | | 26 |
| SOURCE-STATIONARY | S | 1 | 12 | 7 | 1 | 0 | 21 | |
| | M | 2 | 7 | 20 | 13 | 2 | | 44 |
| SOURCES - MOBILE | S | 0 | 10 | 3 | 0 | 0 | 13 | |
| | M | 3 | 15 | 2 | 0 | 0 | | 20 |
| METEOR-OLOGY | S | 0 | 4 | 0 | 0 | 0 | 4 | |
| | M | 0 | 0 | 0 | 0 | 0 | | 0 |
| EFFECTS | S | 0 | 2 | 0 | 0 | 0 | 2 | |
| | M | 1 | 1 | 0 | 0 | 0 | | 2 |
| | | | | | | | 63 | 92 |

S - MONITORS

M - METHODS

Reference: Air Pollution Measurement Technique Development
Fiscal Years 1972-1977, First Draft July 1971,
CPA 22-69-154

the efforts to produce promulgated methods and monitors is an involved process. The comprehension of the state-of-the-art in over one hundred and fifty areas covering five different Use areas requires a considerable effort. Methods and monitors already promulgated are not included in Table 7-1-1.

#### 7.1.3.1.1 Additional Information on Remote Monitors for Air Pollution Assessment

It is interesting to note that of the sixty odd sensor programs approximately fifteen percent are remote monitors. Air pollution surveillance has several promising and interesting new techniques. Included among the instrumentation proposed for detecting air pollutants are infrared sensors, derivative spectrometry, dispersive correlation spectrometry, laser technology and assorted electro-optical techniques.

##### 7.1.3.1.1.1 Active Remote Techniques - Laser Based

At the present time the Environmental Protection Agency is monitoring over 10 atmospheric pollutants throughout the United States. In general, over 90 percent of these pollutants are in a gaseous state in concentrations that vary between 0.01-10 ppm for molecules and 0.01-10 ppb for metal vapors. Progress in monitoring air quality has been impeded in the past by a lack of techniques for detecting pollutants in three dimensions over large expanses of the atmosphere with sufficient resolution in time and space to permit qualitative and quantitative sensing in real time. However, the advent of the pulsed laser coupled with radar techniques (lidar) marked the beginning of major progress in quantitative remote sensing of the atmosphere. More recently, other techniques previously enumerated have also taken on a major importance in the field of air quality surveillance. As a result, a wide range of applications have been explored with increasingly sophisticated techniques. In many of these applications, lasers are used as atmospheric illuminators in preference to other light sources because the monochromaticity of the laser allows discrimination against background noise through the use of narrow band filters. In addition, the high peak power and narrow pulses yield good signal-to-noise ratios and range resolution, even for low cross-section scatterers. Practical laser systems now range in peak pulse power to several hundred megawatts. Pulse widths are as short as $10^{-8}$ seconds and pulse repetition rates are as high as 1000 pps. However, not all the desired characteristics of frequency, power, pulse width, pulse repetition rate, coherence, beam divergence, efficiency, and compact size are available in the same laser.

Since all molecular air pollutants have characteristic absorption spectra throughout the electromagnetic spectrum,it should be possible to detect these pollutants through absorption spectroscopy techniques. However, these techniques have not been practical in the past because the small absorptions (caused by the low concentration of most pollutants) have made it necessary to use very long path length absorption cells. In addition, data collection was very slow due to the limited source strength available from conventional light sources. The recent introduction of a number of different types of IR lasers has made remote sensing of air pollutants a practical reality and demonstrated that these techniques have adequate sensitivity to detect pollutants at the concentrations found in city air.

In order to utilize these intense sources to measure the very weak IR absorptions produced by air pollutants, it is necessary to detect the resonance absorption of the gas rather than the attenuation of the beam as it passes through the sample since the attenuation will be very small for reasonable path lengths and will be hard to detect. Other techniques employed for detecting air pollutants include Mie and Rayleigh scattering, Raman back scattering, and angular scattering phenomena involving polarization effects.

Because of specific molecular interaction, absorption and backscattering, electro-optic techniques employing lasers have the unique capability of identification of atmospheric gases. In addition to studying the properties of the gaseous components of the atmosphere, the distribution, intensity, and dynamics of precipitation, clouds, and aerosol particles are also potentially available for study.

### 7.1.2.1.1.2 Passive Remote Techniques

The techniques cited above using lasers as atmospheric illuminators are examples of active remote sensing techniques. In contrast to this approach other investigators are concentrating on passive methods which require highly sophisticated correlation techniques for detecting atmospheric pollutants. Until recently the passive approach centered ŏn dispersive elements such as gratings and prisms for separating the information content of incoming signals. This method had the disadvantage of requiring long integration times since incoming signals were usually faint. More recently, techniques have been developed, based on interferometric principles, that carry out correlation in real-time. These devices correlate against the fourier transform of the spectrum rather than the spectrum itself. The correlation interferometer may prove to be particularly suitable for application in the infrared due to its large light throughout this region and the fact that almost all gases have complex and characteristic spectral signatures in this region. Instruments of the correlation interferometer type have also been constructed for use in the UV and visible portions of the spectrum and correlation masks have been prepared for many common air pollutants such as $SO_2$, $NO_2$, NO and some of the halogens.

### 7.1.3.1.1.3 Derivative Spectrometry

Still another powerful analytical technique for detection of air pollutants is the derivative spectrometer. This instrument offers an alternate approach to the detection and measurement of substances by measuring the gradient (derivative) of absorbivity or reflectivity with wavelength. This approach has proven very effective for the detection of weak spectral features because the derivative of the proven spectrum exhibits much more structure than is immediately apparent in the absorption or reflectance spectrum itself.

Derivative spectra may be obtained by derivative densitometry of spectrograms or by computer processing of recorded spectra. An alternative approach is the electromechanical or electronic differentiation of the output of a scanning monochromator. A fourth technique is wavelength modulation during spectral scanning employing simultaneous wavelength modulation at high frequency over narrow spectral regions with wavelength scanning at a lower rate.

The sensitivity of the derivative spectrometric technique to faint absorption features makes it valuable for the detection and identification of trace gases in the atmosphere. Care must be taken, however, to compensate for the derivative features due to Fraunhofer lines where detecting atmospheric pollutants using backscattered sunlight.

### 7.1.3.1.1.4 STARTAP Approach

Another remote technique for determining atmospheric pollution on a global scale is the approach given the acronym of STARTAP.* It is based on the extinction of light from astronomical bodies. Preliminary research has indicated that analysis of stellar and solar spectrograms shows promise for identifying various molecular species and atmospheric pollutants. Analysis of atmospheric-extinction data indicates a very good correlation with atmospheric aerosol and particulate levels. With use of observations on

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*Proposal for Project STARTAP (Standardized Techniques for Atmospheric Research through Astronomical Procedures), P-321-7-71, Smithsonian Institution, July 1971.

file at observatories, it has become possible, for the first time, to determine global trends in particulate loading during several decades. The approach makes use of these data and specifies the potential exploitation of unique astronomical observing techniques as a means of providing atmospheric pollution data that may be otherwise unobtainable.

### 7.1.3.1.2 Additional Information on In-Situ Monitoring Techniques for Air Pollutants

Pollutants can generally be referred to as particulates (either suspended or settled) and gases. Particulate matter below 20u in diameter is considered suspended particulate (with special attention being paid to those below 0.1u and respirable fraction). Currently, the prime measurement approach for total suspended particulates is the high-volume sampler, which merely draws air past a filter, where the suspended particulate is captured. The filter is then analyzed gravimetrically. Analyses for metals, soluble ions, cations, anions, etc. are made by chemically analyzing portions of the filter paper. For the measurement of the respirable fraction, inertial devices are used. Various photometric devices, such as the nephelometer and Volz sunphotometer, are used for aerosol measurement.

For measurements of gaseous pollutants, several general principles or techniques are used. These include, but are not limited to, the following:

*Chemiluminescence* relies on the flourescence caused by the chemical reaction of a pollutant gas on a surface treated with a suitable dye (rhodamine B in the case of ozone monitors). The light emitted from the surface is collected in a photomultiplier tube, the resulting current being proportional to the concentration of the pollutant gas.

*Colorimetry* relies on a color change in a liquid reagent, caused by the absorption of an atmospheric contaminant. In some cases, this color change is noted by eye; but in most instruments, the fluid is passed through a flow colorimeter that measures absorption at a fixed wavelength. The resultant color change is proportional in intensity to the concentration of the contaminant.

*Conductimetry* involves the absorption of an atmospheric contaminant in a liquid reagent (the contaminant must be an electrolyte in solution) and subsequent measurement of the electrolyte conductivity, which is then related to the concentration of contaminant in the sample gas. In sulfur dioxide sensors, the gas is absorbed in a deionized water-based reagent. This absorption produces an acid whose conductance can be measured with a conductivity cell. The change in conductivity is proportional to the sulfur dioxide absorbed.

*Coulometry* involves a reaction between the atmospheric pollutant being measured and a substance within an electrolytic cell. This reaction produces a change in the electromotive force, which is related to the pollutant concentration.

*Flame ionization* is used to measure the concentration of organic compounds in the atmosphere. The air sample is burned in a hydrogen-oxygen flame, causing the carbon atoms in the organic material to become ionized. The ions are collected, and the measured charge is then proportional to the organic-pollutant concentration in the air stream.

*Flame photometry* determines pollutant concentrations by measuring the intensity of the visible and ultraviolet spectra emitted by pollutant molecules when the sample gas stream is burned.

*Gas chromatography* relies on the difference in mobility of different molecular species traversing a column of packing material. If a gas sample is introduced at one end of the column, the molecular species move through the column at different rates and appear at the end of the column sequentially, where they can be identified by a variety of techniques, including flame photometry.

*Infrared spectroscopy* determines the concentration of gaseous pollutants by measuring the absorption of electromagnetic energy by the characteristic vibrational excitations of the pollutant molecules. This approach can be used by both remote and in-situ monitoring techniques.

*Microwave spectroscopy* can determine the concentration of any gaseous pollutant with a dipole moment by measuring the absorption of electromagnetic radiation by the characteristic rotational excitations of the pollutant molecules. This approach can be used by both remote and in-situ monitoring techniques.

Nondispersive infrared (NDIR) involves the absorption of infrared radiation by an atmospheric contaminant. An infrared source, usually Nichrom filaments, generates two parallel beams of infrared radiation. One beam traverses a sample cell, and the other traverses a comparison cell containing a nonabsorbing gas. The emergent radiation from both beams is directed to a detector cell, which consists of two gas-filled compartments separated by a flexible diaphragm. An interrupter, or "chopper," located between the radiation source and the cells alternately blocks radiation to the sample cell and to the comparison cell. When the infrared beams are equal, then equal amounts of radiation are entering the detector cell and a "zero" or background reading is recorded. When the gas to be analyzed is introduced into the sample cell, it absorbs (and reduces) the radiation reaching the detector via the sample beam. The beams, therefore, become of unequal strength, thus causing the detector gases to expand or contract and the diaphragm to move in response. This movement, when amplified, gives an indication of the concentration of the sample gas. The NDIR approach can be used by both remote and in-situ monitoring techniques.

Most of these methods, especially the wet-chemical ones, have numerous drawbacks. One overall deficiency of prime concern is the excessive failure rate of almost all air sampling instruments. While much attention has been given to their accuracy, specificity, and similar characteristics little progress has been made in improving the reliability.

of sensor operation and for the integration of the monitoring techniques into a regional system.

7.1.3.2 Monitoring Techniques for Water Quality. A requirements analysis similar to the analysis for air pollution, discussed in Section 7.1.3.1, can be produced for the water quality field. Some of the water pollution parameters of interest are shown in Table 7-1-2 and require precision for measurement of some nineteen of these quantities shown in Table 7-1-3.

The state of the art in in-situ water quality monitoring techniques has not been assembled for this paper. A digest of remote monitors is included below.

7.1.3.2.1 Remote Monitors for Water Quality. The remote surveillance of water surfaces has a history almost as old as the camera itself. Practically speaking, however, it was the scientific developments during and after World War II which placed remote sensing of land and water areas on a sound footing with the development of heat sensitive, or IR, film and radio frequency sounding techniques, or radar. More recently, other technological advances have broadened the scope of remote sensing instrumentation to include spectrometric, radiometric, passive microwave, multispectral and other selected techniques.

Historically, the primary basic sensor used for remote surveillance of water and land surfaces has been the camera and it is likely to remain so for some time because it is still the easiest, cheapest, simplest, and most versatile of remote sensors. Infrared film can readily distinguish

## TABLE 7-1-2

## WATER POLLUTANTS

### OXYGEN DEMANDING WASTES

*BOD
TOC
MBAS
*Nitrates & Nitrites as N
*Phosphorus

### INFECTIOUS AGENTS

Microbiological
*Coliform
*Fecal Coliform

### PLANT NUTRIENTS

MBAS
*Nitrates & Nitrites as N
*Phosphorus

### SYNTHETIC ORGANIC

Chemical Exotics and Pesticides
*Insecticides
*Herbicides
CCE
Oil and Grease

### INORGANIC AND MINERAL SUBSTANCES

Aluminum
Ammonia as N
Antimony
Arsenic
Asbestos
Barium
Beryllium
Boron
*Cadmium
Chlorine
*Chromium (hexavalent)
Cobalt
Copper
Dissolved Oxygen
*Fluoride
Hardness as $CaCO_3$
Calcium
Magnesium
Molybdenum
Iron

### INORGANIC AND MINERAL SUBSTANCES (Cont'd)

*Lead
Manganese
*Mercury
Nickel
*Nitrates & Nitrites as N
*Phosphorus
Selenium
Silver
Sulfate
Strontium
Tellurium
Thallium
Uranyl Ion
Vanadium
*Zinc
Cyanide
Tin

### SEDIMENTS

*Turbidity
Total Residue
Filtrable Residue
Total Dissolved Solids
Hardness as $CaCO_3$

### RADIOACTIVE MATERIALS

*Gross Beta
*Radium-226
*Strontium-90
Thorium
Uranium

### VIII. Thermal

Effluent heat content or temperature rise of effluent.

* Initial set of pollutants to be monitored

## TABLE 7-1-3

## PARAMETERS OF CURRENT INTEREST FOR WHICH SENSORS DO NOT EXIST*

| PARAMETER | RANGES OF CONCENTRATION DESIRED mg/1 | | | PRECISION DESIRABLE mg/1 | | |
|---|---|---|---|---|---|---|
| | L | M | H | L | M | H |
| Organic nitrogen | 0-1 | - | 0-10 | 0.01 | - | 0.5 |
| Ammonia nitrogen | 0-1 | - | 0-10 | 0.01 | - | 0.5 |
| Nitrate nitrogen | 0-1 | - | 0-10 | 0.01 | - | 0.5 |
| Nitrite nitrogen | 0-0.1 | - | 0-2 | 0.01 | - | 0.1 |
| Inorganic phosphorus | 0-2 | - | 0-20 | 0.01 | - | 0.5 |
| Organic phosphorus | 0-2 | - | 0-20 | 0.01 | - | 0.5 |
| COD | 0-50 | - | 0-500 | 1 | - | 10 |
| MBAS** | 0-1 | - | 1-10 | 0.01 | - | 0.1 |
| Acidity or alkalinity | 0-250 | - | 0-1000 | 5 | - | 50 |
| Hardness | 0-250 | - | 0-1000 | 5 | - | 50 |
| Sulfate | 0-100 | - | 0-1000 | 2 | - | 20 |
| Phenols | 0-0.5 | 0-5 | 0-50 | 0.01 | - | 0.1 |
| Calcium | 0-100 | - | 0-1000 | 2 | - | 20 |
| Cyanide | 0-0.1 | 0-1.0 | 0-10 | 0.005 | 0.05 | 0.5 |
| Manganese | 0-0.5 | - | 0.5 | 0.01 | - | 0.1 |
| Zinc | 0-2 | - | 0-10 | 0.01 | - | 0.5 |
| Sodium | 0-100 | 0-500 | 0-5000 | 2 | 10 | 100 |
| Potassium | 0-10 | 0-100 | 0-1000 | 0.5 | 5 | 50 |
| Copper | 0-0.5 | - | 0-5.0 | 0.01 | - | 0.1 |

** Methylene blue active substances.

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*Green, R. S., Monitoring Water Quality for Pollution Control, presented at 12th Annual Analytical Instruments Division (AID) Symposium, Instrument Society of America, on May 11, 1966, at Houston, Texas.

NOTE: Since this paper was presented, decelopments have been made in sensors for nitrate, sulfate, sodium, potassium, and calcium.

between vegetation, bare land surfaces and water as can other conventional color and black and white films, and in addition it lends itself to evaluating thermal pollution, and to some extent, the biological productivity of lakes and streams. Photographic techniques have successfully been used in detecting underwater outfalls, plumes of light-colored effluents resulting from municipal waste treatment discharges, downstream eutrophication from waste discharges, and land drainage wastes which may include leaves and trash washed into streams and whose biological reduction by natural processes may induce deoxygenation. In addition, algae and other biological activity can be imaged very distinctly in IR film.

7.1.3.2.1.1 Multiband Camera. Representative of this class of instrument is the multiband camera. The synoptic multiband camera system combines the taking of a photograph of a very large scene along with the ability to discriminate between objects in that scene. This results from differences in reflecting the various optical wavelengths from sunlight illumination. Stereo images complete this capability.

The synoptic multiband camera system has uses in many applications areas for remotely monitoring water quality and land use conditions. Functional examples include multispectral photographic studies to identify coastal water radiance, water color, wave refraction, algal blooms, sedimentation and water luminance among others.

From identification of these parameters it is expected that several dynamic processes will be delineated, viz., coastal currents, biological communities, refraction patterns from shoaling waves and breaking surf, sea ice, etc. In addition, it should be possible to chart river effluent discharge patterns, shallow water sediment migrations, coastal topography, beach erosion, and shoreline changes. Examination of relationships between seasonal/climate changes and sea surface state for use in oceanographic forecasting should also be possible from these experiments.

These analyses are made possible because spectral differences in reflection have been shown to correlate closely with compositional and textural properties of material types thus providing a means of discrimination. Multiband (or multispectral) photographic techniques have been employed recently with considerable success for such discrimination from NASA, USDA, and USGS aircraft.

Other instruments operating in different regions of the electromagnetic spectrum have more recently been proposed for remote sensing of water and land surfaces. Most of these are still in development or being used in field trials by NASA, USDA, USGS, and DOD as well as investigators in the Private Sector. Some of the more promising of these techniques are briefly described below and illustrated with specific examples.

Closely allied to photographic techniques in that the medium of record is film (or other heat sensitized surface) are multispectral line scanners which generally operate in spectral bands between 0.35u and 15u. This class of instruments is most useful in detecting heated effluents from power plants, industrial processes, monitoring surface temperatures of rivers, lakes, and streams and has been highly effective in detecting oil slicks in coastal waters and lakes. These instruments have the great advantage of operating during the day or night since the thermal IR region ( > 3u) is an emissive region and does not depend on the sun's reflected energy. Generally, these instruments are more costly to operate and maintain and frequently require a computer to analyze the raw data.

In contrast to cameras and line scanners, radiometers, both microwave and IR are non-imaging sensors which measure emitted or reflected electromagnetic energy and display this information on a strip chart or magnetic tape. They operate in the same spectral domain as multispectral imagers as well as at microwave frequencies and are useful in recording spectral signatures of various objects and providing surface temperature measurements.

Considerable success has been obtained by NASA's Ames Research Center, for example, in detecting oil slicks through use of a radiometer and spectroradiometer they have developed. Based on the fact that ordinary sea water reflects blue-green (0.45-0.50u) light most effectively and has almost no reflectance at UV (0.38u) or red (0.6u) wavelengths while oil, on the other hand, has its highest reflection at 0.38u and 0.60u, the oil spills stood out dramatically at these wavelengths. In addition, it was discovered that the polarization of light reflected from the oil differed by about 25 percent from that reflected from the water.

Microwave radiometers have also been used for detecting oil spills and have also been employed for detecting sea ice, surface temperature, and salinity.

The passive microwave imager, in contrast to the radiometer, constructs a picture of a viewed surface such that the light and dark intensities displayed on the image are related to the amounts of microwave energy radiated by the objects in the scene. This is similar to photography but requires specialized apparatus to receive and record the longer, invisible wavelengths involved which are emitted by all objects as a result of their temperatures.

The passive microwave imager has the potential for providing EPA with complete stereoscopic brightness temperature maps of lakes, streams, oceans, etc. This information helps describe the large surface areas that can be rapidly covered by aircraft or spacecraft. Surface features detectable by this technique include surface temperatures and roughness, temperature gradients, and water-ice interfaces, among others. A lengthy list of exemplary applications for this instrument is presented in the March 1966 Prospectus for the Natural Resources Program published by NASA.

One passive microwave imager commonly used for remote sensing utilizes state-of-the-art receivers having internal-noise outputs of about $1^{o}K$. On this basis temperature differentials of approximately $3^{o}K$ will be detectable with a probability greater than 0.9. Estimates of anticipated temperature differentials to be encountered based on surface element differences in roughness and/or dielectric constants point toward expected differentials of $8^{o}K$ or more.

One of the newer passive microwave imaging systems was developed by NASA's Manned Spacecraft Center. This instrument, operating at 10.69 GHZ, uses a two-dimensional phased array antenna to achieve scanning transverse to the flight path. The instrument converts microwave signals to electrical signals which modulate the control grid of a fluorescent tube. The varying light signals on the face of the tube are recorded on 35 mm black and white film. The great advantage of this imager, as with other microwave devices, is its all weather operational capabilities. A disadvantage is its poorer spatial resolution compared with conventional photographic systems. However, this instrument should be useful in monitoring large scale environmental changes during periods of inclement weather when other instruments are rendered inoperable.

In summary, the passive microwave imager provides an essential remote sensor component for monitoring environmental factors related to water surfaces yielding such information as thermal maps, surface structure, and inference on sub-surface features down to tens of centimeters depending on moisture or conductive content.

7.1.3.2.1.2 Altimeter/Scatterometer. Another useful sensor operating in the microwave region is the radar altimeter/scatterometer. This radar instrument produces onboard magnetic tape records whose informational content contains both measurements of the distance of the instrument platform to the Earth (altimetry), and the radar reflection properties of the Earth's surface structures at various angles of elevation from the vertical or nadir direction (scatterometry). This remote sensor operates at radio wavelengths of about 3 centimeters.

An alternate pulse of 4 microseconds width supplies the information on the radar reflection properties of ground surfaces; technically, the scatter cross-section of the ground structure illuminated out to an angle of 60° from the vertical.

By comparing records of a succession of pulses as the aircraft moves forward, a given patch of ground is viewed at different angles so that one can also derive how a given ground element changes its scatter ability with various aspect angles of illumination.

In addition, the altimeter/scatterometer is capable of transmitting and receiving horizontal and vertical polarizations. These are radio waves which generate electrical voltages which are maximum in a direction horizontal or vertical to the ground respectively. Such capability will aid considerable in interpreting water surface roughness.

7.1.3.2.1.3 Sidelooking Airborne Radar . Still another radar sensor is the sidelooking radar which in addition to being a day/night sensor, is capable of functioning in all types of weather as well since it can operate at microwave frequencies which are located in the atmospheric windows. Although this sensor was not specifically designed for pollution detection, it is nevertheless effective in monitoring strip and pit mining operations as well as other large scale features of land and water surfaces. For example, sidelooking radar can also be used to monitor extent and changes in large industrial waste ponds and detecting oil spills.

7.1.3.3 Monitoring Techniques for Noise. Noise is generally defined as "unwanted sound," but there is no generally accepted definition of sound pollution. Among the characteristics of sound that enter into its becoming noise are intensity, frequency, intermittency, inappropriateness, interference with the task of the hearer, unexpectedness and masking effect of other sounds. In addition, culturally associated preferences of the hearer enter into judgments about noise. Thus, while many people would no doubt agree that life is becoming noisier, few are able to suggest quantitative methods for characterizing the noisiness of their environment.

The effects of noise can be though of in terms of a physiological-psychological dichotomy. The major physiological effect of exposure to loud sound is an impairment of hearing, either permanent or temporary. The temporary effect, measured as a temporary shift in hearing threshold, is similar to the phenomenon of not being able to see well in a darkened room after having entered from a well-lighted area. After long-term exposure to excessive noise levels, the threshold shift can become permanent, and the individual becomes "hard of hearing."

Other physiological effects are pain, alternations in respiration circulation, basal metabolic rate, and muscle tension.[1] Many of these are doubtless coupled to psychological effects such as nervousness, anxiety, increased irritability and insomnia. Yet other psychological effects are related to the aesthetic qualities of sound. Indeed, as sounds are added to a quiet environment, the distinction between noise and acceptable sound is likely to be made on aesthetic grounds. Thus, a baby crying in the next apartment or a dog barking across the street will probably be considered disturbing noise, while the profusion of bird, cricket and other animal calls at dusk would be welcomed by many people.

With so many types of attributes, some quantifiable, others so deppendent on cultural and personally variable standards and responses, an all-inclusive index of noise and sound quality of the environment is indeed an elusive goal. One method for calculating an index on the basis of average or reasonable life styles is described in the reference

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[1] Breyssee, Peter A., "Sound Pollution - Another Urban Problem," <u>The Science Teacher</u>, April 1970, pages 29-34.

below[1]. The approach is quite general and adaptable to change in emphasis. The specific exposure values and limits, while based on information from the technical literature, are not rigidly prescribed and can be adjusted to conform to expert consensus without invalidating the overall approach. For further details on a new but within the state-of-the-art noise monitor see the reference below.

7.1.3.4 Radiation. Radioactivity can occur for air, land and water. However, this section deals only with those types of radiation which are capable of injuring man and/or his environment. These include alpha and beta particles, protons, neutrons, cosmic radiation, gamma rays, X-rays, and microwaves. Man is constantly exposed to radiation, both natural and man-made. Natural radiation derives from cosmic radiation and naturally radioactive substances in the earth and instructural materials. Man-made sources include weapons fallout, color TV sets, nuclear power plants, medical uses, kitchen appliances and radar hardware.

The situation regarding radioactive pollution is somewhat unique in that great foresight was involved at the dawn of the nuclear age in terms of strict legislation and a sense of moving forward with caution. Extensive studies, monitoring, and data collection have been performed by the Atomic Energy Commission and branches of HEW for a number of years.

With regard to the overall annual radiation dose which the average man receives, by far the biggest contribution is that of naturally occurring background radiation (reference[*], next page) for which he is not responsible and cannot reduce appreciably. Medical treatment, including

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[1] "Monitoring the Environment of the Nation," Appendix A-2, Mitre MTR 1660, April 1971, pages 91-106.

dental, diagnostic, and therapeutic uses, accounts for a somewhat smaller amount with radioactive pollution also providing a relatively small portion.

Nevertheless, considering the trend toward installing more nuclear power plants and the still uncertain long-term and synergistic effects of radiation, it is necessary to maintain a strong monitoring capability in this area. The United States has good cooperation with Mexican and Canadian authorities with regard to their monitoring activities.

7.1.3.4.1 Monitoring Networks and Quantities/Substances Sampled. Contained in Table 7-1-4 are the names of a number of radiation monitoring networks. The monitoring techniques are contained in the four references listed below.

Information on the monitors and methods has not been performed but it is believed that most networks have been built using AEC approved hardware and procedures.

A unified requirements analysis similar to the analysis for air pollution monitoring techniques should be considered.

7.1.3.5 Monitoring Techniques for Pesticides. In order to trace and assess the movement of pesticides throughout the environment, it

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* "Radiation Biology," Allison P. Casarett, Prentice Hall (1968).

** "Radiation Surveillance Networks," WASH-1148, Robert E. Allen (Nov. 1969).

*** National and International Environmental Monitoring Activities--A Directory, Smithsonian Institution, (Oct. 1970).

**** "Modifications of Environmental Surveillance Network Operations," Bureau of Radiological Health (May 18, 1970).

## TABLE 7-1-4

## Monitoring Networks & Quantities Sampled

| Media or Category | Network or Agency | Sampled Quantities & Substances |
|---|---|---|
| AIR | Radiation Alert Network, APCO/EPA | TSP, gross $\alpha$ , gross $\beta$ , plutonium, pre-precipitation & tap water |
| | Health & Safety Network, AEC | Plutonium, other radionuclides |
| | International Atomic Energy Agency, IAEA | Hydrogen isotopes (deuterium & tritium and oxygen -18 |
| | Some IQSY sites in U.S. | Cosmic radiation |
| | NOAA | Gamma radiation |
| WATER | Tritium Surveillance System | Surface water, precipitation monitoring, gross $\beta$ , tap water |
| | Bureau of Commercial Fisheries | Radionuclides in estuaries and marine environment |
| | Geological Survey & Water Quality Office/ EPA | Radionuclides, gross $\alpha$ , gross $\beta$ . |
| | Bureau of Radiological Health | Drinking water |
| LAND | Soil Conservation Service | Strontium 90 |
| | Health & Safety Lab, AEC | All radioactive contaminants on land |
| EFFECTS - FOOD | Pasteurized Milk Network/EPA | Radiochemical analysis of milk,<br>gamma scan " " " |
| | Institute of Total Diet/EPA | Monthly food and annual water sampled. |
| EFFECTS - HUMAN | Human Bone Network | -- |
| | Alaskan Survey | Cesium - 137 |

is necessary to measure residues in the physical media themselves, as well as in human and animal tissues. Programs for such measuring in soil, water, and air are discussed.

7.1.3.5.1 Soil. Soil is the natural receptacle for pesticides which are applied to crops; residues stored here can be carried into the atmosphere attached to particulates, and into the hydrosphere by runoff. It also is a source of pesticides for soil organisms which can concentrate them and which in turn serve as food for higher organisms (NPMP)[1]. For example, Hunt found in 1965 that in DDT-sprayed elm environment, total pesticide residues (dry weight) accumulated from 9.9 ppm in soil to 140.6 ppm in earthworms to 443.9 ppm in adult robin brains (Hunt)[2].

The U.S. Department of Agriculture conducts a soil pesticide monitoring program which is part of the National Soil Monitoring Program, sponsored by the Federal Committee on Pest Control. The major objective of this program, as determined in 1968, has been to derive a reasonably reliable estimate of pesticide levels in United States soils with reference to land use. This includes:

1. determination of levels of pesticide residues in soils on major land-use areas and, through periodic samples, detection of changes in these levels;

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[1] NPMP, National Pesticide Monitoring Program, Report of the Monitoring Panel, June, 1970.

[2] Hunt, Effects of Pesticides on Fish and Wildlife, U.S. Department of Interior, Fish and Wildlife Service, Circular 226, 1965.

2. determination of pesticide residue levels in crops grown on treated soils;
3. determination of pesticide residues in runoff water of certain agricultural lands;
4. determination of the concentration of certain pesticides at various depths in the soil.

Two major land uses were included--cropland and noncropland. Ten-acre sites were randomly selected at the rate of one site per 40,000 acres of cropland and one site per 400,000 acres of noncropland. That rate of sampling yielded 9,468 cropland sites and 3,822 noncropland sites (about 13,300 total). All soil samples were analyzed for chlorinated hydrocarbon insecticides and arsenic, and analyses for other pesticides were made on the basis of records of their use. Other determinations (crop levels, runoff water level, soil profile studies) were made at selected sites. The sampling schedule was planned to cycle in 4 years; ie.,one-fourth of the sites (3,325) were to be sampled each year.

When initiated in FY 1968, only 6 states were sampled. In FY 1969, cropland was sampled in 43 states and noncropland in 10 states. In FY 1970, cropland was sampled in 35 states. Because of lack of funds, the program had to be redirected in FY 1971, and only a small portion (corn and cotton belts) of the original monitoring efforts were continued. The Monitoring Panel of the National Pesticides Monitoring Program does not feel that under the reduced effort the objectives of the program can be met, and recommends adequate financing and full initiation of the monitoring program (NPMP). Pesticides pose environmental problems of which we are probably only beginning to feel the effects and monitoring of these substances in soil, water, air, and tissue, is an area we cannot afford to neglect. Financing must be provided to bring the program up to standards the Monitoring Panel considers adequate, and then data obtained can be used in an index of changing residue levels. Monitoring of residues in soil organisms, particularly earthworms and beetles, and correlation of this data with soil residues, might also be useful.

7.1.3.5.2 Water. A National Monitoring Program for the Assessment of Pesticide Residues in the Hydrologic Environment has been designed in accordance with the objectives of the National Pesticides Monitoring Program of the Federal Committee on Pest Control, subsequently reorganized under the President's Cabinet Committee on the Environment. It represents a revision of an earlier program initiated in 1967 by the Federal Water Pollution Control Administration (now Water Quality Office) and the U.S. Geological Survey, and involves sampling of both water and bottom sediments. Water samples are to be collected four times a year, and sediment samples twice a year, from 161 sites chosen at random from hydrologic units within the 20 major drainage basins defined by the Water Resources Council. Under the plan, analysis will be made for the following chlorinated insecticides and herbicides:

ALDRIN
CHLORODANE
DDD
DDE
DDT
DIELDRIN
ENDRIN
HEPTACHLOR
HEPTACHLOR EPOXIDE
LINDANE
MALATHION
METHYL PARATHION
PARATHION
TOXAPHENE
2,4-D
2,4,5-T
SILVEX

High, median, and low pesticide levels for the major drainage areas will be reported in the Pesticides Monitoring Journal. Correlation of pesticide levels with other hydrologic data should be attempted.

A request has been made for funding of this program as part of the National Water Data Network implementation in the 1972 fiscal year by the U.S. Geological Survey under Bureau of the Budget Circular A-67 (NPMP). Once again, this is an area of crucial importance. As more and more toxic materials are being released into our environment, we must have some way of assessing the buildup of these materials, and correlating such buildup with levels in biota, as well as with geographical regions and sources. It is recommended that such funding indeed be carried through, and that data on these insecticides be correlated with data on residues in fresh-water fish.

7.1.3.5.3 <u>Air</u>. The atmosphere has been recognized as one of the major routes by which DDT is carried to the oceans and thus becomes widespread throughout the environment (SCEP)[1]. The Monitoring Panel of the National Pesticides Monitoring Program has recommended that air sampling be conducted in a minimum of 40 to 60 separate areas of the country, with boundaries of these areas determined on an arbitrary basis, such as longitude-latitude, and with sampling sites within each area selected and operated according to a random design (NPMP). Monitoring of air over coastal regions might be particularly useful. Funding for such a program must be provided if an adequate picture of the spread of these substances in the environment is to be obtained. Such data,

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[1] SCEP, <u>Man's Impact on the Global Environment</u>, Report of the Study on Critical Environmental Problems, sponsored by the Massachusetts Institute of Technology, 1970.

when obtained, could be used in an environmental index, and should also be correlated with that derived from other programs (soil, water, tissue residues).

Monitoring techniques for pesticides are more logically concerned with the methods used in the air and water media programs and the programs of FDA and DOA. Again it is suggested that a uniform review be performed of all involved agencies and a combined requirements analysis be performed. Automated techniques will be difficult to develop but should not be downgraded for that reason.

7.1.3.6 Monitoring Technique for Solid Waste. The days when communities could count on the ready availability of disposal sites for their solid wastes have nearly passed for many areas, and the problem will soon catch up with others. Open dumping is not only unaesthetic and hazardous to health (harborage and food source for insect and rodent pests, polluting of runoff water, pollution of air when burned, etc.), but land suitable for such outright destruction is becoming scarce. Even the more benign practice of sanitary landfill (area or trench methods) is said to require about one acre per 10,000 people per year.[1] As cities expand there is a very real shortage of new acreage available which is within economic hauling distance of the cities. Deep ravines have greater capacity, but their supply, too, is limited. While incinerators generally offer an efficient and hygienic means of disposing of combustible waste, they produce ash which must be hauled away and disposed of elsewhere, and if not outfitted with proper emission control devices, incinerators can contribute significantly to air pollution.

At the other side of the picture are the wastes being disposed of. Our technology, productive capacity, and inherent system of economic

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[1] Benarde, Melvin A., "Our Precarious Habitat," W. W. Norton & Co. Inc., New York 1970, page 157.

incentive encourage the disposal rather than the re-use of many items. Few are designed for degradability after their prescribed useful lives, since so many items are fabricated of relatively inert plastics, metals and glasses.

Increased per capita consumption of materials also adds to the rate of growth of the solid waste problem. Degradable solid wastes can become especially troublesome when they are generated in too great concentrations for natural decomposition processes to assimilate them. On the other hand, large quantities of concentrated wastes have the potential value of permitting economies of scale when they are treated artificially, especially if there is a market for the end-product of the treatment.

Yet another dimension of the problem is the rising labor and capital costs associated with collection and disposal of solid waste. Trash collection and sanitation personnel demand and receive higher wages reflective of their increased status and critical importance in the scheme of community processes. More demanding treatment requirements and shortages in disposal sites are driving up the unit costs of solid waste management. The premium on extracting nonrenewable resources from the "waste stream" must surely increase. Thus, there are bound to be fundamental readjustments in solid waste management practices, just based on these conventional economic considerations alone.

Simple mass balance considerations suffice to illustrate that the amount of any type of waste discharged at the end of a waste stream is equal to the amount input to the system plus amounts generated within the system by conversion of other types (assumed negligible except for incinerator ash) less those amounts reclaimed from the waste stream for recycling or other re-use. The parameters chosen below to characterize solid waste issues are generally reflective of these input-output considerations and their associated costs.

7.1.3.6.1 Materials Balance Parameters. In a broad sense, the materials balance story of solid waste can be told by filling in the matrix of Table 7-1-5. The source categories are intended to be complete as well as mutually exclusive, and likewise for the disposal categories. Each of these sets of categories is amenable to restructuring or other modification without changing the overall meaning of the parameters. The various cells of the matrix contain the amounts of solid waste from a given source (index = m) disposed in a particular way (index = n). The interesting measures of amount are weight $Wmn$, volume $Vmn$ and, perhaps, combustion energy content $Hmn$. Weights expressed in tons or thousands of kilograms per year for municipalities, states, regions and industrial sectors should be adequate. Similarly, volumes, expressed in cubic meters per year or hectare-meters per year, are expressive of the amount of volume that solid wastes take up. Where the average energy content of the different sources of waste is a meaningful number, a rough indication of the energy picture can be assembled as well. It is anticipated that the "industrial" category would have to be subdivided into several constituent groups of similar materials before energy content figures would be meaningful. Units of energy content are kilocalories per kilogram, or, perhaps, kilowatt-hours per 1000 kilograms (metric ton).

## TABLE 7-1-5

## MATERIALS BALANCE AND COST PARAMETERS

| SOURCE (m) ↓ \ DISPOSAL (n) → | DISPOSAL | | | | | | | | | RECYCLING | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UNMANAGED, UNCOLLECTED, | SPREAD OR PILED ON GROUND | OPEN DUMP | OPEN BURNING | SANITARY LAND FILL | INCINERATION | PIT DISPOSAL | DEEP WELL INJECTION | DISPOSAL AT SEA | . . . | COMPOSTING | SALVAGE OR REPROCESSING | . . . | . . . | TOTAL |
| RESIDENTIAL COMMERCIAL & INSTITUTIONAL:<br>COLLECTED<br>UNCOLLECTED | | | | | | | | | | | | | | | |
| INDUSTRIAL | | | | | | | | | | | | | | | |
| MINING | | | | | | | | | | | | | | | |
| DEMOLITION WASTES | | | | | | | | | | | | | | | |
| AGRICULTURAL | | | | | | | | | | | | | | | |
| SEWAGE TREATMENT RESIDUE | | | | | | | | | | | | | | | |
| DEAD ANIMALS | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | |

WEIGHT $W_{mn}$
VOLUME $V_{mn}$
ENERGY CONTENT $H_{mn}$
COST OF COLLECTION $CC_{mn}$
COST OF DISPOSAL $CD_{mn}$

For further details concerning the mass balance method for monitoring solid waste procedure, see reference below.[1] Monitors per se for solid wastes are non-existent other than weight, volume, distance, and heat content devices or estimation procedures.

Networks for data gathering are discussed in the reference below along with suggested forms of data aggregation.

7.1.4 Platforms In order to obtain some initial remote sensing data it would be desirable to station a light aircraft in each of the ten EPA Regions equipped with a metric camera, IR Scanner and possibly other unsophisticated sensors. Such an instrumented platform would perform many useful functions, including qualitative monitoring of environmental parameters whenever contingency factors so required.

Where broader and systematic monitoring of environmental quality is desired, EPA Headquarters will assign larger and more fully instrumented aircraft which can acquire quantitative data and provide standard data products to each region. The Western Environmental Research Laboratory is being considered as a facility which could provide these extended services in the Western United States. At least one other such facility with aircraft capability will be necessary East of the Mississippi River. DOD, with its many aircraft already equipped with sophisticated sensors such as side-looking radar, multiband cameras and multi-spectral scanners, could provide EPA with an interim capability for monitoring environmental degradation provided an agreement with the DOD can be arranged.

The Regional Offices should also be cognizant of the many remote sensing projects already underway by NASA, USGS, USDA, NOAA, and DOD which

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[1] "Monitoring the Environment of the Nation." Mitre MTR 1660, April 1971. Appendix A-3, pages 149-160.

are acquiring remote and in-situ sensor data. These include aircraft flights such as U-2, P-3, C-130 and RB57, and spacecraft programs such as ERTS and Skylab (See five references below).

- ERTS - General Electric Space Division
- ERTS - Ground Data Handling System,
  NASA Preliminary Description
- Aircraft Remote Sensing Systems,
  NASA/MSC - 04165, May 1971.
- Skylab A-EREP Users Handbook
  NASA/MSC, February 1971.
- Memorandum to ERSPRC from NASA,
  ERTS Simulation Tests Areas with U-2 Aircraft.

In addition, NASA's Earth Observations Office will operate a Data Collection System (DCS) employing in-situ sensors which relay data to satellites for retransmittal to ground stations once the Earth Resources Technology Satellite is launched in March 1972.

### 7.2.0 Suggested Discussion Topics

7.2.1 Make all remote monitoring techniques, vehicles, data transmission, data processing and data analysis research and development planning and funding a function to be performed at the Office of Monitoring level for the present. This should include all satellite, aircraft, ground and water borne mobile and fixed stations where the information gathered includes remote and in-situ monitoring networks. Data gathering by remote monitoring may be delegated to the Federal regional offices at some later date when such systems are more operational in nature. A logical alternative to this suggestion is to establish 2 or 3 sub-national remote monitoring centers within the Office of Monitoring such centers could be loaned to the 10 regional offices as required.

7.2.2 Devise specifications for all monitoring techniques within the EPA organization but delegate and support monetarily the monitor and/or method development in outside agencies where possible.

- Satellite and aircraft sensors when feasible (including ground stations, when practicable) to NASA and/or DOD.
- Radiation sensor development to AEC and HEW, when feasible.
- Noise sensors development to DOT and DOC, when feasible.
- Retain air, water, pesticide and solid waste sensor development in EPA.
- Hydrologic and meteorologic sensor development to DOC, when feasible.

7.2.3 Review the delegation for monitoring techniques development in light of the Ash Federal Government Reorganization Plan in order to minimize the disturbances which will occur during the process of this major Federal reorganization.

7.2.4 Devise sociologic and economic monitoring techniques (monitor and methods) within EPA with committee support from OMB, HEW, HUD, DOC, DOT.

7.2.5 Develop a plan for the monitoring techniques required for 5 to 10 environmental indices. Select indices and techniques on the basis the ability to produce public displays by July 72. Use the NOAA network for dissemination of these indices in addition to the normal channels of communication to the public through the 10 regional offices. Devise a method for measuring the public acceptance of the indices release.

7.2.6 Place special emphasis on the generation of monitoring techniques which can sense the national and global trends of pollution. Develop a plan for this service. Should this service be separate and distinct from the service performed by 10 EPA regional offices?