Volume 1 of 5
ERDA-110

Federal Inventory Of Energy Related Biomedical & Environmental Research For FY 1974 & FY 1975

October 1975

By
Energy Research & Development Administration
Division Of Biomedical & Environmental Research

Overview Document
Prepared For:

Energy Research & Development Administration
Assistant Administrator For Environment & Safety

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Aerospace Report No.
ATR-76(7518)-4

FEDERAL INVENTORY OF ENERGY-RELATED BIOMEDICAL AND ENVIRONMENTAL RESEARCH FOR FY 1974 AND FY 1975

October 1975

Prepared by: The Aerospace Corporation in partial fulfillment of Contract # E(04-3)-1101, PA-4

Under the direction of: The Division of Biomedical and Environmental Research, Energy Research and Development Administration

Environment and Energy Conservation Division

THE AEROSPACE CORPORATION

PREFACE

This inventory provides an overview of federally funded biomedical and environmental energy-related research for FY 1974 and 1975. The inventory is composed of an overview document and four volumes of project abstracts describing the energy programs of participating Federal agencies.

The four volumes of project abstracts are available on request to the Division of Biomedical and Environmental Research, Energy Research and Development Administration, Washington, D. C. 20545.

ACKNOWLEDGMENTS

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The project staff wishes to express appreciation to Dr. Lawrence Myers, University of California at Los Angeles, Mr. William Holman, Division of Environmental Control Technology, Energy Research and Development Administration, Messrs. Wesley C. Greayer and A. Dwight Abbott, The Aerospace Corporation, other Aerospace Corporation staff members and the individuals representing the participating agencies for their time and efforts in providing and collating the data contained in this report.

PARTICIPATING AGENCIES

Energy Research and Development Administration (ERDA)

Environmental Protection Agency (EPA)

Tennessee Valley Authority (TVA)

National Aeronautics and Space Administration (NASA)

Department of Health, Education, and Welfare (HEW)

- National Institutes of Health (NIH)
- National Institute for Occupational Safety and Health (NIOSH)

National Science Foundation (NSF)

Department of Commerce

- National Oceanic and Atmospheric Administration (NOAA)
- Office of Environmental Affairs (OEA)
- National Bureau of Standards (NBS)

Department of Interior

- Bureau of Land Management (BLM)
- Office of Biological Services/Fish and Wildlife Service (OBS/FWS)
- U. S. Geological Survey (USGS)
- Bureau of Mines (BM)
- Bureau of Reclamation (BR)

Department of Agriculture

Department of Defense (DOD)

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I. INTRODUCTION

The Energy Reorganization Act of 1974, PL 93-438, specifically authorizes the Administrator of ERDA to establish programs to minimize the adverse environmental effects of energy projects. These programs are to utilize research and development efforts supported by other Federal agencies in a manner as to be cooperative and avoid unnecessary duplication.

In addition, the Federal Nonnuclear Energy Research and Development Act of 1974, PL 93-577, Section 6, required the Administrator of the Energy Research and Development Administration to submit to Congress a comprehensive energy research, development, and demonstration plan and a companion comprehensive nonnuclear energy program by June 30, 1975. A similar report must be submitted on an annual basis at the time ERDA submits its budget request to Congress. These annual reports must include relative financial contributions by the Federal Government [Section 15b(4)]. This inventory was developed to help fulfill these mandates. This summary document provides an overview and source of information of federally funded biomedical and environmental energy-related research. It is anticipated that such information will help the Administrator (and, specifically, the Assistant Administrator for Environment and Safety) and all other concerned agencies by providing a basis to determine existing research deficiencies and undesirable overlaps in the current research programs of the various Federal agencies. As a consequence, the formulation of future programs can be conducted in an effective and responsible manner.

The inventory was initiated with a letter from Dr. James Liverman, Assistant Administrator for Environment and Safety, ERDA, to other agencies (see Appendix) requesting information on their energy-related Biomedical and Environmental Research, Environmental Control Technology, Waste Management and Transportation research and development programs. This report presents results of the compilation and summarization of the FY 1974 and FY 1975 biomedical and environmental research data received in reply to this request.

In FY 1975, Congress appropriated a $53 million supplement to the Federal budget for energy-related biomedical and environmental research and development. In November 1974, the Report of the Office of Management and Budget (OMB)-appointed Interagency Working Group on Health and Environmental Effects of Energy Use (King/Muir Report), which provided guidance for the interagency distribution of the supplemental funding, was submitted to the OMB and the Council on Environmental Quality. The method of categorization of research needs developed by the Working Group in that report was used for the present inventory. Details of data processing and the results of the present activity are presented in Sections II and III. Section IV contains a discussion of the contents of the inventory, and conclusions drawn from the information obtained are presented in Section V.

Although this inventory attempted to include all federally funded biomedical and environmental research projects, this goal was not fully achieved for a number of reasons. Most notable among these was the difficulty in defining "energy-related" research and, as a consequence, inadvertent omissions were made by the agencies providing information. It is estimated that the report includes perhaps 75 - 80% of Federal energy-related research. Concomitantly, categorization by specific energy technology was also difficult because research projects are often related to more than one energy form or more than one energy technology. This problem was partly resolved, by adding a Multi-technology category which is explained in Section III. Continuing efforts are underway to improve methods of reporting to permit more accurate allocations by environmental research category and by specific energy technologies.

With these limitations in mind, this inventory provides the first attempt at a summarization and overview of federally funded, energy-related biomedical and environmental research for FY 1974 and 1975.

II. DATA PROCESSING

The framework utilized for categorization of research projects in this inventory is similar to that used in the Report of the Interagency Working Group on Health and Environmental Effects of Energy Use (King/Muir Working Group) dated November 1974. That Interagency Working Group found that a categorization structure, based on a matrix of energy technology categories versus environmental categories, provided the best insight for describing health and environmental effects related to the production and use of energy. It further determined that research categories of Characterization, Measurement, and Monitoring; Environmental Transport; Health Effects; Ecological Effects; and Integrated Assessment, in conjunction with various energy technologies, provided useful boundaries for the matrix; therefore, this categorization with associated objectives was used for this inventory.

A. Biomedical and Environmental Research Categories

The five major Biomedical and Environmental Research Categories and definitions are listed as follows:

1. Characterization, Measurement, and Monitoring
   This category includes research required for baseline and developmental studies and all monitoring activities required for these efforts. This category also includes work to ensure availability of measurement tools and procedures for research and monitoring operations.

2. Environmental Transport Processes
   This category includes research and development activities necessary to provide information for an understanding of pollutant transport, conversion, and fate in air, water, and land.

3. Health Effects

This category includes studies to define and quantify the impacts of the various energy technologies in terms of their ultimate effect on human health.

4. Ecological Effects

This category includes research to evaluate the ecological effects associated with energy technology development, as well as all possible procedures for mitigating adverse ecological impacts. Subcategories utilized are as follows:

a. Air/Terrestrial

b. Freshwater

c. Marine and Estuarine

5. Integrated Assessment

Research in this category identifies and quantifies the socio-economic implications of energy technologies and, together with health and ecological effects, provides an essential input to assessment of the impact of energy production and use, on local, regional, and national scales, needed for decision making on energy technology alternatives.

Each of these research categories is subdivided into several objectives (see Appendix I) taken from the Interagency Working Group Report. These objectives have been used to characterize research at a subcategory level.

B. Energy Technologies

The ten energy-related technology categories considered are:

1. Coal

2. Oil and Gas

3. Oil Shale

4. Geothermal

5. Nuclear

6. Solar
7. Hydroelectric
8. Conservation
9. Multi-technology
10. General Science (ERDA information only)

The Multi-technology category incorporates projects which are related to four or more technologies or where the research was supportive in nature and, hence, difficult, or impossible, to assign on a prime technology basis. In the case of ERDA sponsored research, a General Science category was used to separate the supportive but more basic research from the more applied projects.

Since it was usually easier to assign a project to the Multi-technology category, considerable discipline was used to allocate research efforts by technology whenever possible.

C. Funding Splits

Research Categories -- It was generally not difficult to arrive at a unique (and repeatable) classification when assigning projects to a research category or its subcategories (objectives). Therefore, there was no division of funds between biomedical and environmental research categories or subcategory objectives.

Energy Technology Categories -- Projects considered to be related to four or more energy technology categories were classified as multi-technology in nature. Funding for projects related to less than four technologies, however, was distributed evenly among the technology categories to which it was related.

D. Agency Submittals

The data desired on health and environmental research, and the format for its description, were specified with the letter of request (see Appendix). Information obtained from the agencies was transferred to project information sheets (Appendix). Agency replies varied considerably in format and content. Wherever possible, the agency's categorization was used. When requested

information was missing (e.g., project description), a judgment as to correct categorization was made by ERDA project staff. This was done on a project-by-project basis, and, when necessary, discussions were held with agency personnel to ensure that proper conclusions were made.

III. AGENCY FUNDING SUMMARY

The information on funding submitted by all agencies has been summarized and is presented in this section at several levels of detail. Each detail level is shown as figures which graphically portray the distribution of the funds and tables which list the funding levels. The data are presented in three sub-sections:

A. Summary Data

B. Funding by Research Categories

C. Funding by Energy Technology Categories

A discussion of the results obtained by analysis of these funding data is presented in Section IV of this report.

A. Summary Data

Figures 1a and 1b, and Tables 1a and 1b present the total Federal funding (aggregate of all agencies) by energy technology and research categories for FY 1975 and FY 1974. The $53 million special energy supplemental funding (EPA "pass-through" allocation) has been included in the FY 1975 funds. Figure 1a compares the FY 1974 and FY 1975 funding as allocated by research categories, while Figure 1b shows the comparison by energy technology categories. Tables 1a and 1b for FY 1975 and FY 1974, respectively, are arrays of the reported funding levels for the energy technology categories vs research categories.

INVENTORY OF BIOMEDICAL & ENVIRONMENTAL RESEARCH
DISTRIBUTION OF FUNDS BY RESEARCH CATEGORY
FY 1974, FY 1975

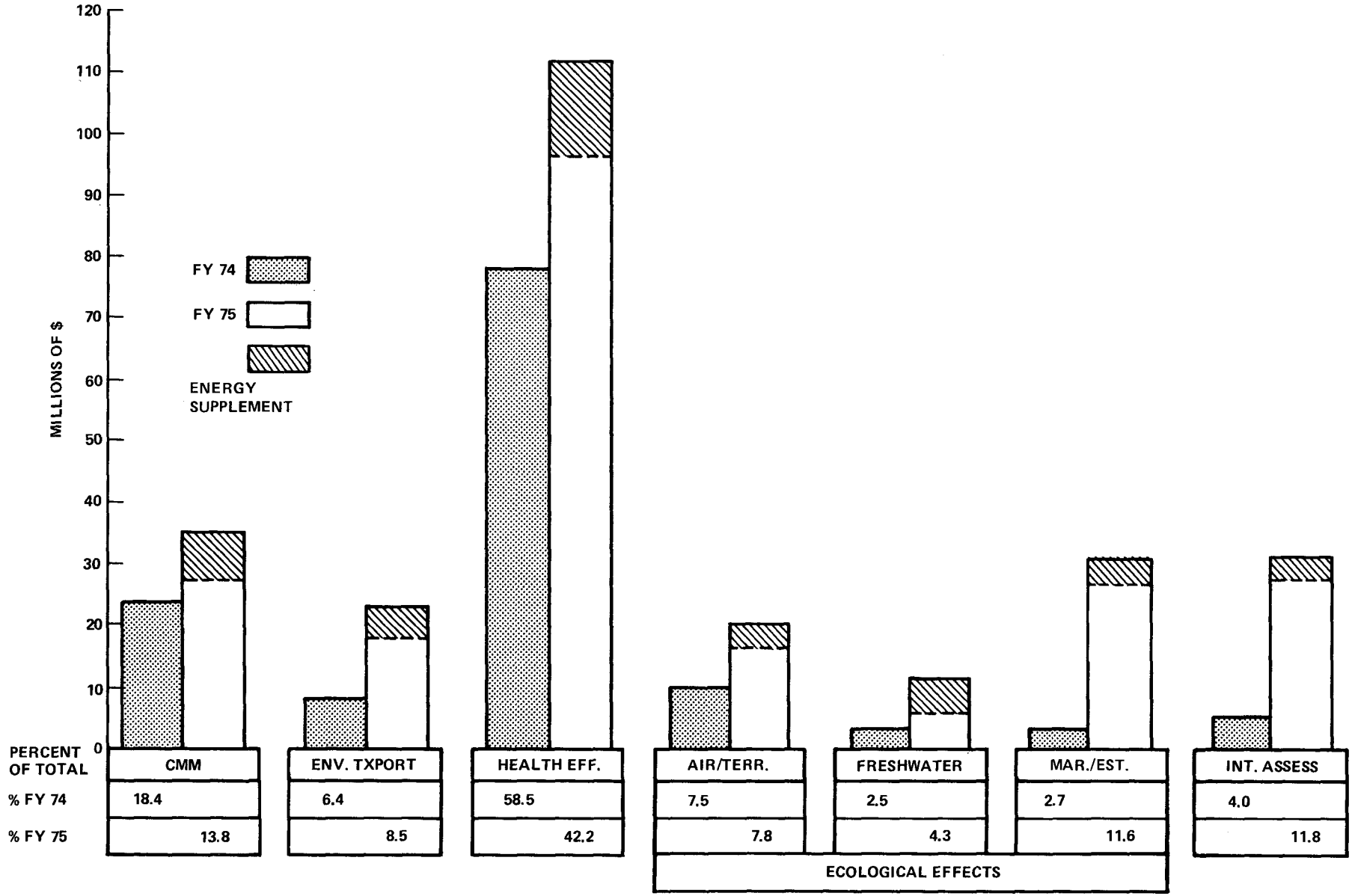

FIGURE 1a

INVENTORY OF BIOMEDICAL & ENVIRONMENTAL RESEARCH
DISTRIBUTION OF FUNDS BY ENERGY TECHNOLOGY CATEGORY
FY 1974, FY 1975

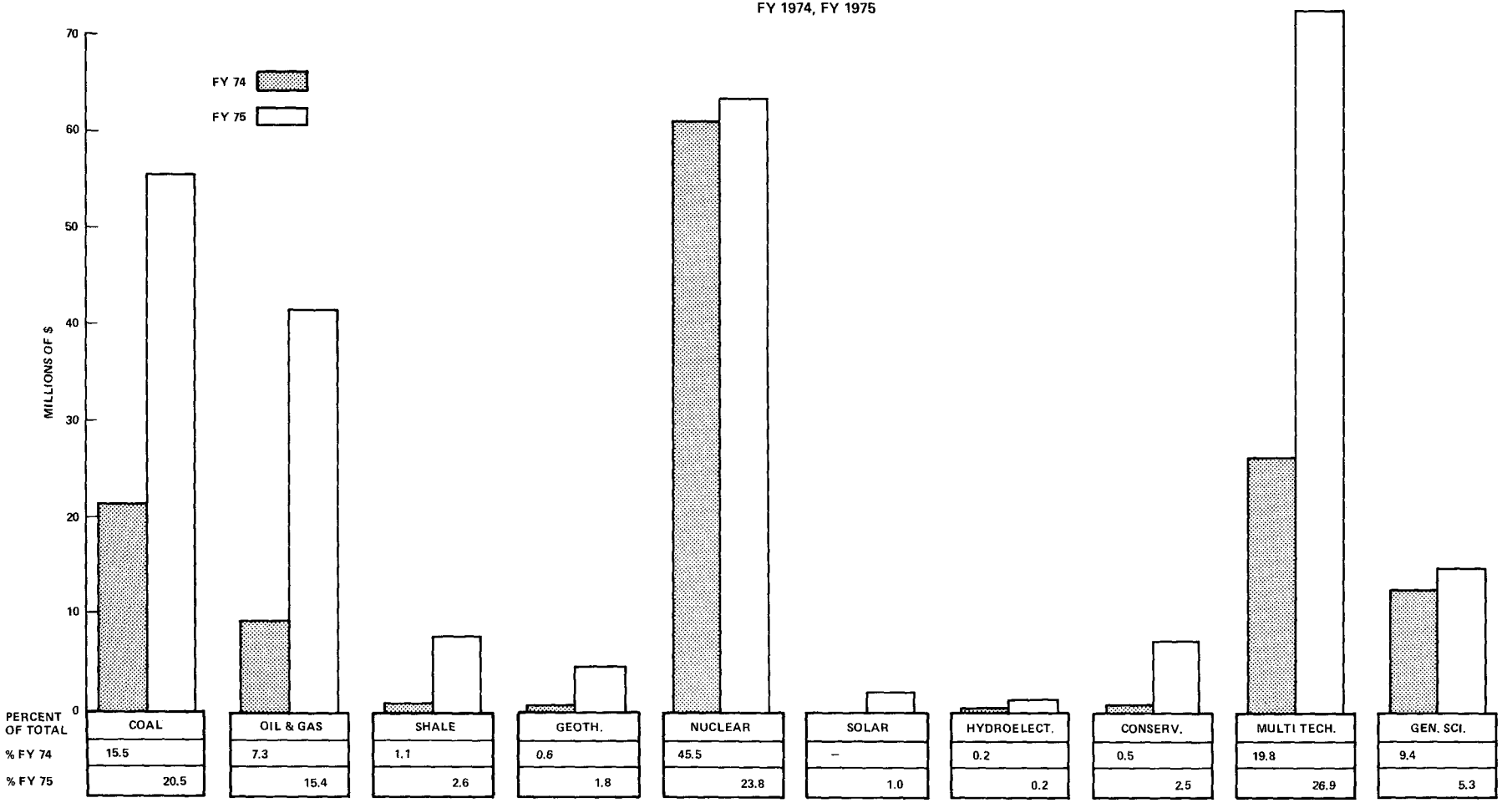

FIGURE 1b

TABLE 1a

RESEARCH CATEGORY VS ENERGY TECHNOLOGY CATEGORY

BIOMEDICAL AND ENVIRONMENTAL RESEARCH - ALL FEDERAL AGENCIES

FY 1975

(DOLLARS IN MILLIONS)

ENERGY TECHNOLOGY → / RESEARCH CATEGORY ↓	Coal	Oil & Gas	Shale	Geothermal	Nuclear	Solar	Hydro-Electric	Conservation	Multi-Technology	General Science	Total	
Characterization, Measurement, and Monitoring	7.91	5.93	2.34	0.92	6.92			1.37	11.58		36.97	
Environmental Transport	5.42	1.61	0.66	0.01	2.85			0.11	11.92	0.41	22.99	
Health Effects	23.75	2.56	1.86	2.19	44.92	2.61		3.54	19.87	12.11	113.41	
Ecological Effects***	12.70	27.23	1.65	0.36	7.51		0.54	0.54	11.48	1.78	63.79	***
Air Terrestrial	6.95	1.99	1.04	0.36	4.86			0.54	4.20	0.95	20.89	
Freshwater	5.16	0.92	0.61		1.44		0.47		2.96	0.04	11.60	
Marine Estuarine	0.59	24.32			1.21		0.07		4.32	0.79	31.30	
Integrated Assessment	5.39	4.14	0.47	1.28	1.64	0.03	0.05	1.26	17.40		31.66	
TOTAL	55.17	41.47	6.98	4.76	63.84	2.64	0.59	6.82	72.25	14.30	268.82	

*** HEAVY-LINED ROW IS TOTAL OF ECOLOGICAL EFFECTS; NOT TO BE DOUBLE COUNTED IN TOTALING COLUMNS.

TABLE 1b

RESEARCH CATEGORY VS ENERGY TECHNOLOGY CATEGORY

BIOMEDICAL AND ENVIRONMENTAL RESEARCH - ALL FEDERAL AGENCIES

FY 1974

(DOLLARS IN MILLIONS)

ENERGY TECHNOLOGY → / RESEARCH CATEGORY ↓	Coal	Oil & Gas	Shale	Geothermal	Nuclear	Solar	Hydro-Electric	Conservation	Multi-Technology	General Science	Total	
Characterization, Measurement, and Monitoring	6.76	5.51	0.98		5.42			0.16	5.79		24.62	
Environmental Transport	1.46	0.76			4.80		0.03	0.03	1.28	0.27	8.63	
Health Effects	9.14	1.47	0.46	0.71	45.04	0.09		0.43	9.82	11.25	78.41	
Ecological Effects***	3.23	2.03			5.08		0.23		5.39	1.11	17.07	***
Air Terrestrial	2.32	0.78			3.26				2.77	0.96	10.09	
Freshwater	0.77	0.29			0.50		0.23		1.54	0.03	3.36	
Marine Estuarine	0.14	0.96			1.32				1.08	0.12	3.62	
Integrated Assessment	0.22	0.06	0.04	0.16	0.64			0.03	4.23		5.38	
TOTAL	20.81	9.83	1.48	0.87	60.98	0.09	0.26	0.65	26.51	12.63	134.11	

*** HEAVY-LINED ROW IS TOTAL OF ECOLOGICAL EFFECTS; NOT TO BE DOUBLE COUNTED IN TOTALING COLUMNS.

B. Funding by Research Categories

Figure 2 and Tables 2a and 2b present the biomedical and environmental research funding at a level of detail in which allocations for each research category are displayed for each agency. Figure 2 displays funding percentages and relative FY 1975 funding levels for each agency as applied to the research categories. Tables 2a and 2b (FY 1975 and FY 1974, respectively) present the reported funding levels of each agency in each research category. In Table 2a (FY 1975), the funding provided by the special energy supplement has been shown separately from the agency base budgets.

Figures 3a to 3g and Tables 3a to 3g present a third level of detail and display FY 1975 funding by objectives within each research category for the various Federal agencies supporting biomedical and environmental research. The figures show the relative levels of funding by research category objectives for each agency and the percentage of the total reported funding within each agency. The tables present the reported funding levels by research objective for each agency. A listing of the objective descriptions for each research category, as defined in the Interagency Working Group Report, is given with each set of figures and tables.

INVENTORY OF BIOMEDICAL & ENVIRONMENTAL
RESEARCH
DISTRIBUTION OF FUNDS BY RESEARCH CATEGORY
AND FEDERAL AGENCY
FY 1975

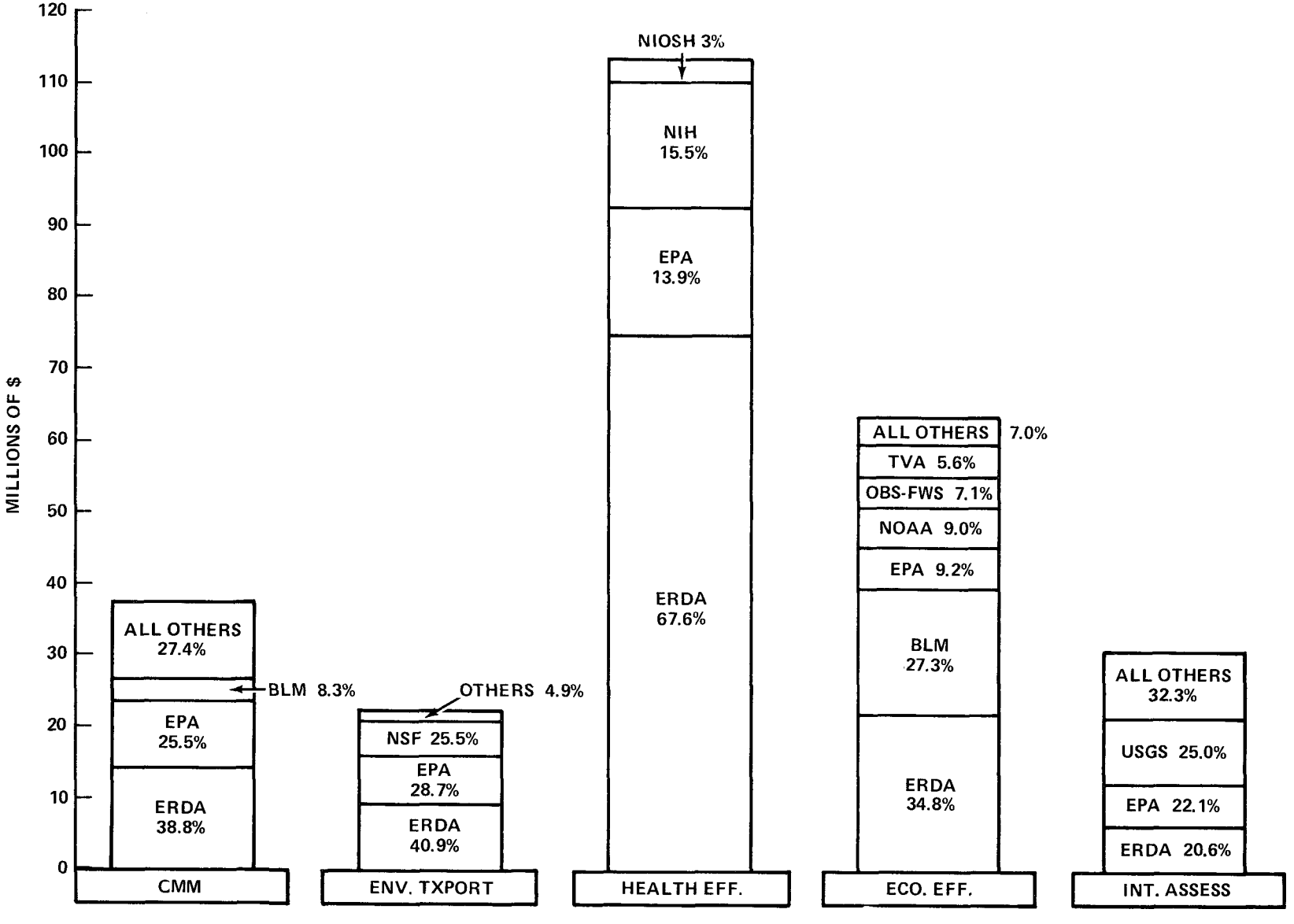

FIGURE 2

TABLE 2a

RESEARCH CATEGORY VS FEDERAL AGENCY

BIOMEDICAL AND ENVIRONMENTAL RESEARCH

FY 1975

(DOLLARS IN MILLIONS)

AGENCY → / RESEARCH CATEGORY ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BLM	OBS/FWS	USGS	BM	B.RECLAM			
	Base Pass-Thru	Base Suppl.	Base P-Thru	Base P-Thru	Base P-Thru	Base P-Thru	Base P-Thru	Base P-Thru	Base P-Thru	Base P-Thru	Base P-Thru	Base P-Thru	Base P-Thru	Base P-Thru	Base P-Thru	Base P-Thru	Base P-Thru	Base P-Thru
Characterization, Measurement, and Monitoring	12.839 1.538	4.807 4.640	0.270 0.285	0.795	0.188	0.349 0.390	2.734	0.214 1.075		0.366 1.190	3.100	0.500	0.390 1.138				0.158	25.915 11.051
Environmental Transport	8.478 0.930	2.442 4.160	0.055 0.335		0.162		5.784	0.093 0.300					0.250					17.264 5.725
Health Effects	70.697 5.978	9.364 6.366			14.365 3.265	1.217 2.159												95.643 17.768
Ecological Effects ***	19.204 2.981	1.854 4.040	2.233 1.340			0.230	0.756	3.338 2.419			17.400	2.246 2.310	0.400		0.181	1.435 1.385	0.033	***49.310 14.475
Air Terrestrial	9.105 0.835	1.095 1.825	0.750 0.645			0.230	0.306	1.700				1.796 0.775				1.269 0.555		16.251 4.635
Freshwater	3.353 1.356	0.376 1.750	1.483 0.695				0.450	0.125				0.435	0.400		0.181	0.166 0.830		6.534 5.063
Marine Estuarine	6.746 0.700	0.383 0.465						1.513 2.439			17.400	0.450 1.100					0.033	26.525 4.774
Integrated Assessment	6.026 0.506	5.103 1.893	0.120 0.302		0.013		3.404	3.221 .100	0.141			0.285	7.911	0.250		0.544 .550	1.296	28.029 3.636
TOTAL	117.244 11.933	23.570 21.099	2.678 2.262	0.795	14.728 3.265	1.796 2.549	12.678	6.866 3.894	0.141	0.366 1.190	20.500	2.746 2.595	8.951 1.138	0.250	0.181	1.979 1.935	1.487	216.161 52.655
	*129.177	44.669	4.940	**0.795	17.993	4.345	12.673	10.760	0.141	1.556	20.500	5.341	10.089	0.250	0.181	3.914	1.487	268.816

*NOT INCLUDED - MEDICAL APPLICATIONS (14.6) AND EDUCATION AND TRAINING (2.9).

** PASS-THRU ONLY - BASE DATA NOT YET AVAILABLE.

*** HEAVY-LINED ROW IS TOTAL OF ECOLOGICAL EFFECTS; NOT TO BE DOUBLE COUNTED IN TOTALING COLUMNS.

TABLE 2b

RESEARCH CATEGORY VS FEDERAL AGENCY
BIOMEDICAL AND ENVIRONMENTAL RESEARCH
FY 1974
(DOLLARS IN MILLIONS)

AGENCY → / RESEARCH CATEGORY ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT. AGR	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BLM	OBS/FWS	USGS	BM	B.RECLAM			
Characterization, Measurement, and Monitoring	8.710	12.773	0.240			0.030	0.984	0.290		0.290	1.300							24.617
Environmental Transport	6.959	1.253	0.096				0.301	0.024										8.633
Health Effects	63.522	2.269			11.425	1.190												78.406
Ecological Effects***	10.407	2.494	1.052				0.284	2.087							0.188	0.502	0.050	17.064 ***
Air Terrestrial	6.051	2.183	0.265					1.110								0.481		10.090
Freshwater	1.873	0.152	0.787				0.284	0.052							0.188	0.021		3.357
Marine Estuarine	2.483	0.159						0.925									0.050	3.617
Integrated Assessment	1.156	0.563	0.085					3.036					0.180			0.218	0.148	5.386
TOTAL	*90.754	19.352	1.473	**	11.425	1.220	1.569	5.437	-0-	0.290	1.300	-0-	0.180	-0-	0.188	0.720	0.198	134.106

*NOT INCLUDED - MEDICAL APPLICATIONS, EDUCATION, AND TRAINING ($15.463).

** BASE DATA NOT YET AVAILABLE.

***HEAVY-LINED ROW IS TOTAL OF ECOLOGICAL EFFECTS; NOT TO BE DOUBLE COUNTED IN TOTALING COLUMNS.

INVENTORY OF BIOMEDICAL & ENVIRONMENTAL RESEARCH
DISTRIBUTION OF FUNDS BY OBJECTIVE
AND FEDERAL AGENCY FOR RESEARCH CATEGORY:
CHARACTERIZATION, MEASUREMENT & MONITORING
FY 1975

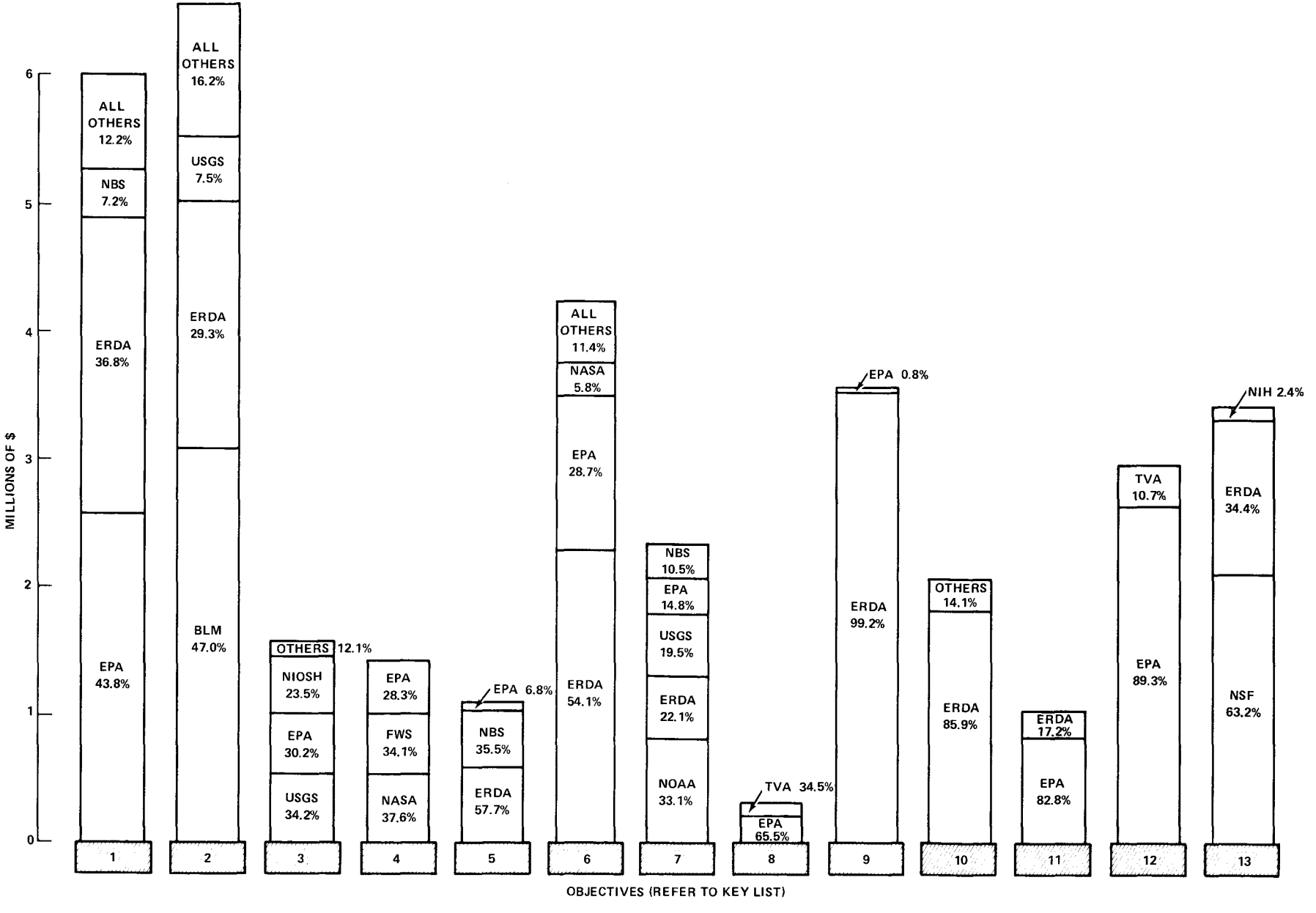

FIGURE 3a

TABLE 3a

RESEARCH OBJECTIVE VS FEDERAL AGENCY - FY 1975
RESEARCH CATEGORY: CHARACTERIZATION, MEASUREMENT, AND MONITORING

(DOLLARS IN MILLIONS)

AGENCY → / Objective Number** ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BLM	OBS/FWS	USGS	BM	B.RECLAM			
1	2.218	2.642				0.200	0.270	0.100		0.440							0.158	6.028
2	1.936	0.305	0.100				0.102	0.250		0.310	3.100		0.495					6.598
3		0.500				0.390	0.200						0.568					1.658
4		0.415		0.550								0.500						1.465
5	0.659	0.078								0.406								1.143
6	2.294	1.215	0.035	0.245		0.149		0.150		0.150								4.238
7	0.528	0.353						0.789		0.250			0.465					2.385
8		0.190	0.100															0.290
9	3.603	0.030																3.633
10	1.783	0.187			0.104													2.074
11	0.180	0.868																1.048
12		2.664	0.320															2.984
13	1.176				0.084		2.162											3.422
TOTAL	*14.377	9.447	0.555	***0.795	0.188	0.739	2.734	1.289	-0-	1.556	3.100	0.500	1.528	-0-	-0-	-0-	0.158	36.966

*DOES NOT INCLUDE MEDICAL APPLICATIONS, EDUCATION, AND TRAINING.

**REFER TO KEY LIST ON FOLLOWING PAGE FOR DESCRIPTION OF OBJECTIVES.

***PASS-THRU ONLY - BASE DATA NOT YET AVAILABLE.

OBJECTIVE DESCRIPTION FOR RESEARCH CATEGORY:

CHARACTERIZATION, MEASUREMENT, AND MONITORING

KEY LIST

Objective Number	Objectives
1	Air Monitoring
2	Water Monitoring
3	Groundwater Monitoring
4	Remote Monitoring
5	Radiation Monitoring
6	Air Monitoring Instrumentation
7	Water Monitoring Instruments
8	Remote Instrumentation
9	Radiation Monitoring Instrumentation
10	Health Effects Instrumentation
11	Solid Wastes Analysis - Instrumentation and Monitoring
12	Quality Assurance
13	Other

INVENTORY OF BIOMEDICAL & ENVIRONMENTAL RESEARCH
DISTRIBUTION OF FUNDS BY OBJECTIVE
AND FEDERAL AGENCY FOR RESEARCH CATEGORY:
ENVIRONMENTAL TRANSPORT
FY 1975

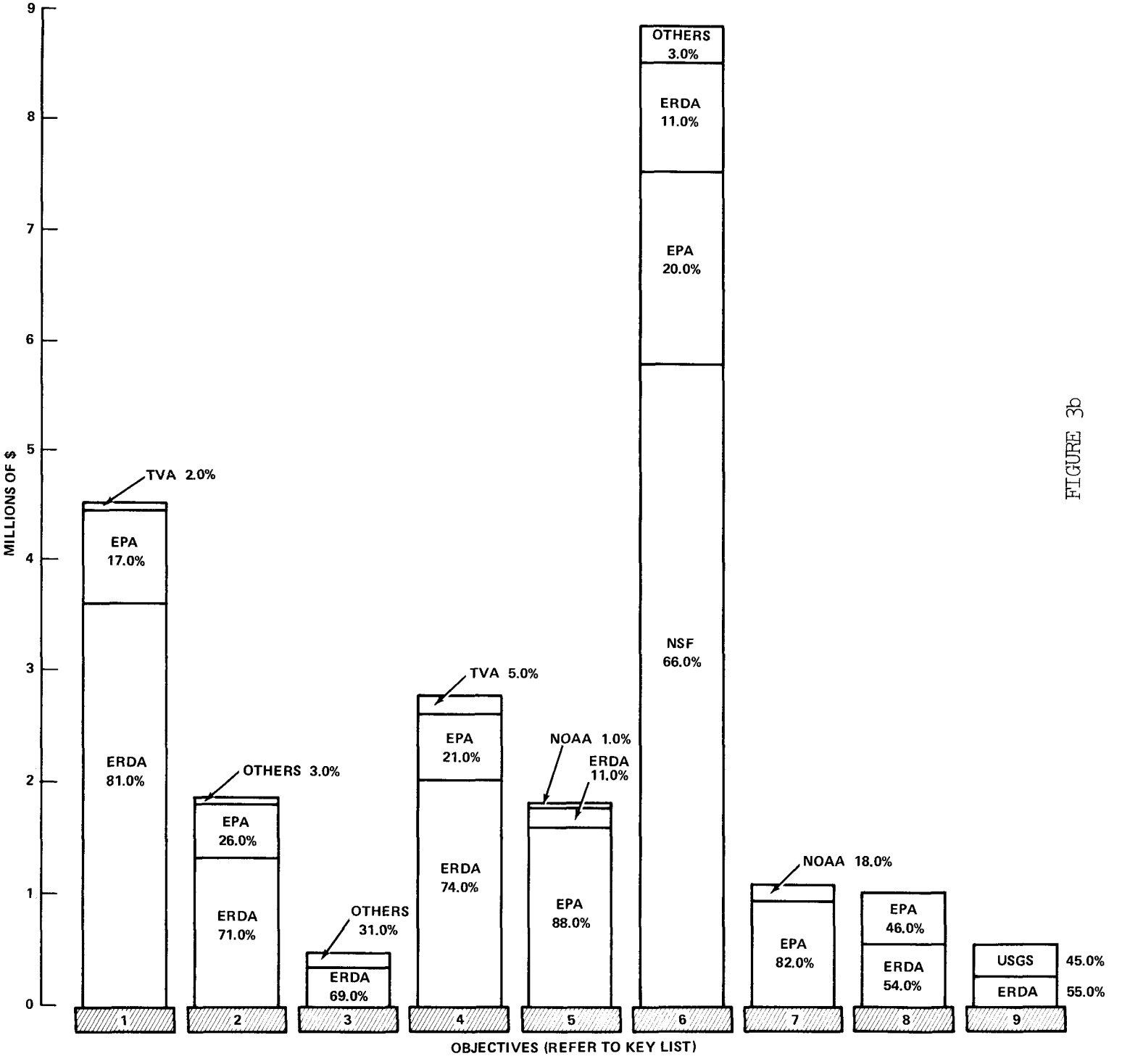

FIGURE 3b

TABLE 3b

RESEARCH OBJECTIVE VS FEDERAL AGENCY - FY 1975

RESEARCH CATEGORY: ENVIRONMENTAL TRANSPORT

(DOLLARS IN MILLIONS)

AGENCY → / Objective Number ** ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BLM	OBS/FWS	USGS	BM	B. RECLAM			
1	3.660	0.747	0.100															4.507
2	1.318	0.486	0.035					0.028										1.867
3	0.337	0.050						0.100										0.487
4	2.053	0.581	0.150															2.784
5	0.207	1.614						0.015										1.836
6	0.984	1.738	0.105		0.162		5.784	0.050										8.823
7		0.932						0.200										1.132
8	0.539	0.454																0.993
9	0.310												0.250					0.560
TOTAL	*9.408	6.602	0.390	-0-	0.162	-0-	5.784	0.393	-0-	-0-	-0-	-0-	0.250	-0-	-0-	-0-	-0-	22.989

*DOES NOT INCLUDE MEDICAL APPLICATIONS, EDUCATION, AND TRAINING.

**REFER TO KEY LIST ON FOLLOWING PAGE FOR DESCRIPTION OF OBJECTIVES.

OBJECTIVE DESCRIPTION FOR RESEARCH CATEGORY:

ENVIRONMENTAL TRANSPORT

KEY LIST

Objective Number	Objective
1	To develop and validate procedures for predicting the atmospheric transport and dilution of pollutants in complex terrain and coastal areas of large isolated plumes, and to scales beyond 100 kilometers.
2	To develop and validate procedures predicting the removal of pollutants by precipitation and in dry weather over various types of terrain and resuspension of pollutants.
3	To determine if, how, and by how much cooling systems and pollutants from energy activities modify the weather or climate including visibility modification
4	To develop and validate procedures for predicting the physical and chemical transformations of pollutants in the atmosphere from energy activities.
5	To develop and evaluate predictive models describing atmospheric behavior of pollutants from emission to removal from the atmosphere for candidate technologies including conservation, to assess the effect of candidate technologies on weather and climate, and to assess the role of weather on candidate technologies.
6	To determine in the hydrosphere the origin, load, transport pathways, transfer rates and fate of pollutants arising from energy activities.
7	To develop analytical, numerical, predictive models of the distribution and dynamics of energy-related pollutants in the hydrosphere.
8	To determine in the soil zone the transport pathways, rates, and fates of pollutants from energy activities.
9	Other

INVENTORY OF BIOMEDICAL & ENVIRONMENTAL RESEARCH
DISTRIBUTION OF FUNDS BY OBJECTIVE
AND FEDERAL AGENCY FOR RESEARCH CATEGORY:
HEALTH EFFECTS
FY 1975

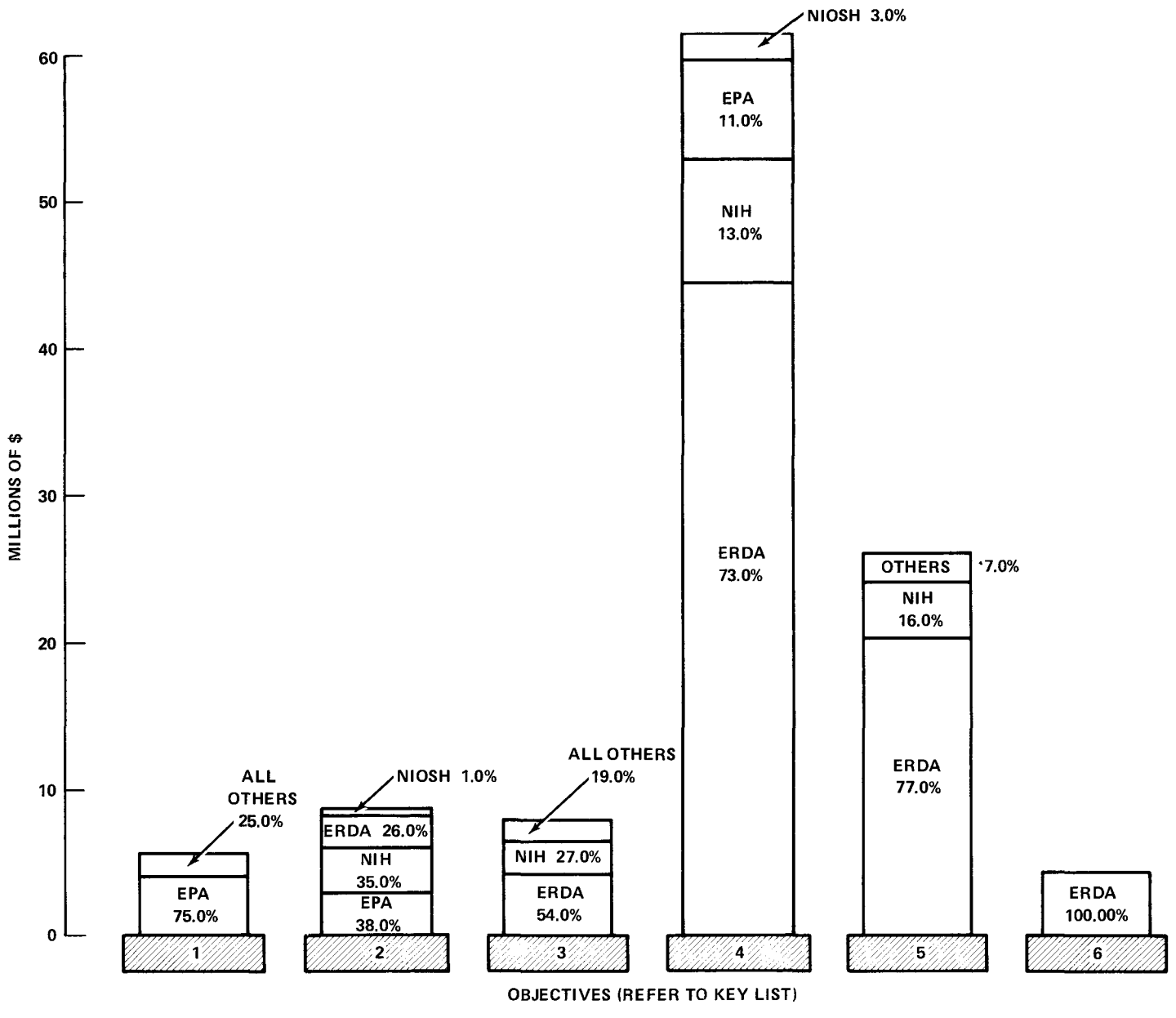

FIGURE 3c

TABLE 3c

RESEARCH OBJECTIVE VS FEDERAL AGENCY - FY 1975
RESEARCH CATEGORY: HEALTH EFFECTS

(DOLLARS IN MILLIONS)

AGENCY → / Objective Number** ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BLM	OBS/FWS	USGS	BM	B. RECLAM			
1	1.130	4.006			0.154	0.047												5.337
2	2.085	3.090			2.817	0.079												8.071
3	4.302	1.004			2.141	0.543												7.990
4	44.666	6.706			8.310	1.891												61.573
5	20.116	0.924			4.208	0.816												26.064
6	4.376																	4.376
TOTAL	*76.675	15.730	-0-	-0-	17.630	3.376	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	113.411

*DOES NOT INCLUDE MEDICAL APPLICATIONS, EDUCATION, AND TRAINING.

**REFER TO KEY LIST ON FOLLOWING PAGE FOR DESCRIPTION OF OBJECTIVES.

OBJECTIVE DESCRIPTION FOR RESEARCH CATEGORY:

HEALTH EFFECTS

KEY LIST

Objective Number	Objectives
1	To identify hazardous agents associated with energy technologies.
2	To develop more sensitive and rapid biological methods to evaluate dose and damage to man.
3	To determine the metabolism and fate of hazardous agents associated with energy technologies.
4	To evaluate the short term and long term hazards of exposure of normal, susceptible and stressed population groups to different levels and combinations of biologically active agents associated with energy technologies.
5	To determine the processes of damage, repair recovery, protection, and amelioration of biological systems exposed to hazardous agents associated with energy technologies.
6.	Other

INVENTORY OF BIOMEDICAL & ENVIRONMENTAL RESEARCH
DISTRIBUTION OF FUNDS BY OBJECTIVE
AND FEDERAL AGENCY FOR RESEARCH CATEGORY:
ECOLOGICAL EFFECTS – AIR/TERRESTRIAL
FY 1975

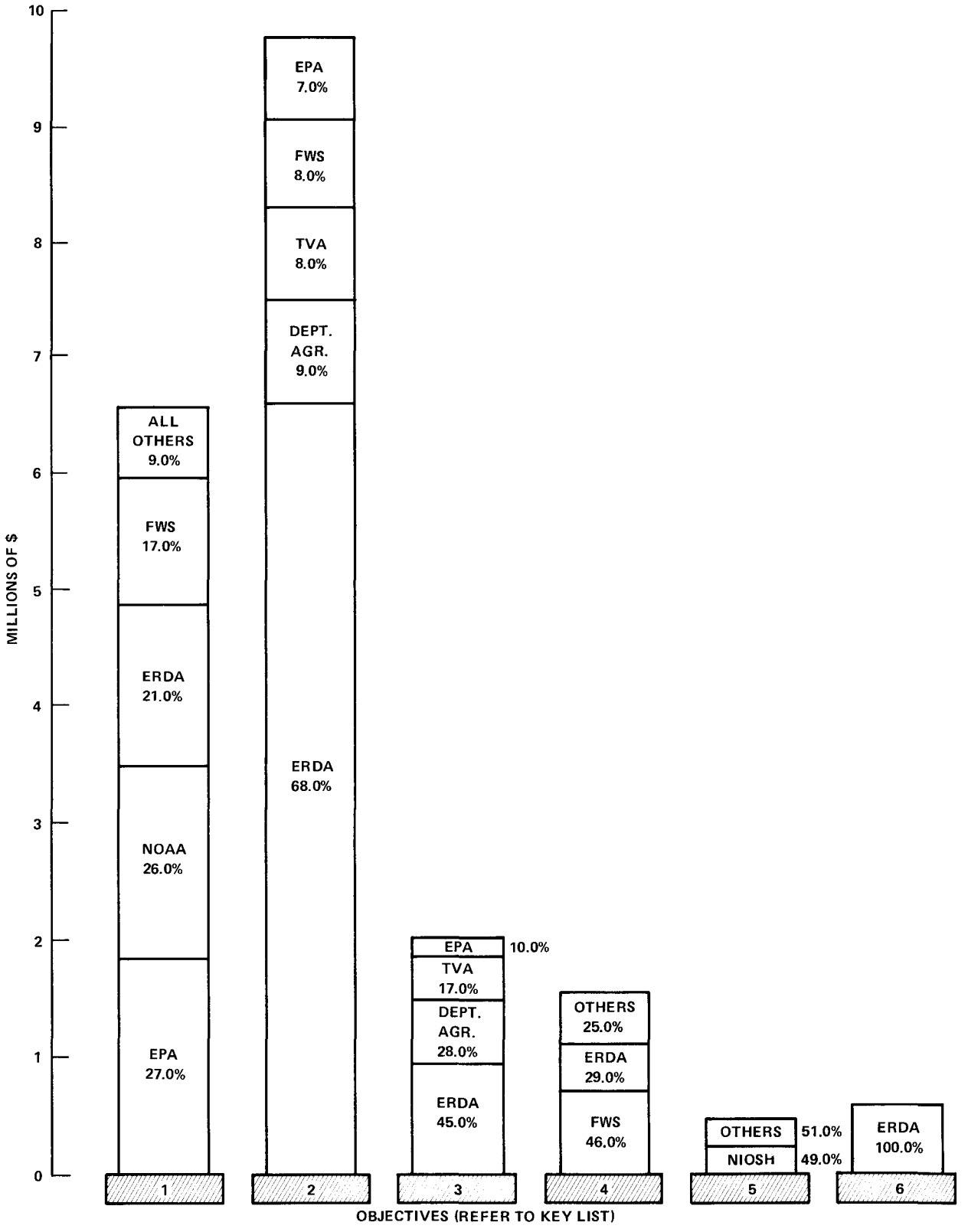

FIGURE 3d

TABLE 3d

RESEARCH OBJECTIVE VS FEDERAL AGENCY - FY 1975

RESEARCH CATEGORY: ECOLOGICAL EFFECTS - AIR/TERRESTRIAL

(DOLLARS IN MILLIONS)

AGENCY → / Objective Number** ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BLM	OBS/FWS	USGS	BM	B. RECLAM			
1	1.366	1.785	0.245				0.220	1.700				1.094				0.113		6.523
2	6.622	0.699	0.810									0.777				0.870		9.778
3	0.921	0.200	0.340													0.556		2.017
4	0.446	0.086										0.700				0.285		1.517
5		0.150				0.230	0.086											0.466
6	0.585																	0.585
TOTAL	*9.940	2.920	1.395	-0-	-0-	0.230	0.306	1.700	-0-	-0-	-0-	2.571	-0-	-0-	-0-	1.824	-0-	20.886

*DOES NOT INCLUDE MEDICAL APPLICATIONS, EDUCATION, AND TRAINING.

**REFER TO KEY LIST ON FOLLOWING PAGE FOR DESCRIPTION OF OBJECTIVES.

OBJECTIVE DESCRIPTION FOR RESEARCH CATEGORY:

ECOLOGICAL EFFECTS: AIR/TERRESTRIAL

KEY LIST

Objective Number	Objectives
1	To develop baseline information for use in evaluating the potential effects of energy technologies including conservation on terrestrial ecosystems.
2	Determine the fate and effects of energy related pollutants on terrestrial ecosystems and evaluate ways to minimize these effects.
3	Determine the immediate and long-term non-pollutant effects of energy technologies including conservation on terrestrial ecosystems and evaluate ways to minimize these effects.
4	Develop the capability to predict effects of energy conservation and development on terrestrial ecosystems.
5	Evaluate the impact of airborne pollutants on materials.
6	Other

INVENTORY OF BIOMEDICAL & ENVIRONMENTAL RESEARCH
DISTRIBUTION OF FUNDS BY OBJECTIVE
AND FEDERAL AGENCY FOR RESEARCH CATEGORY:
ECOLOGICAL EFFECTS – FRESHWATER
FY 1975

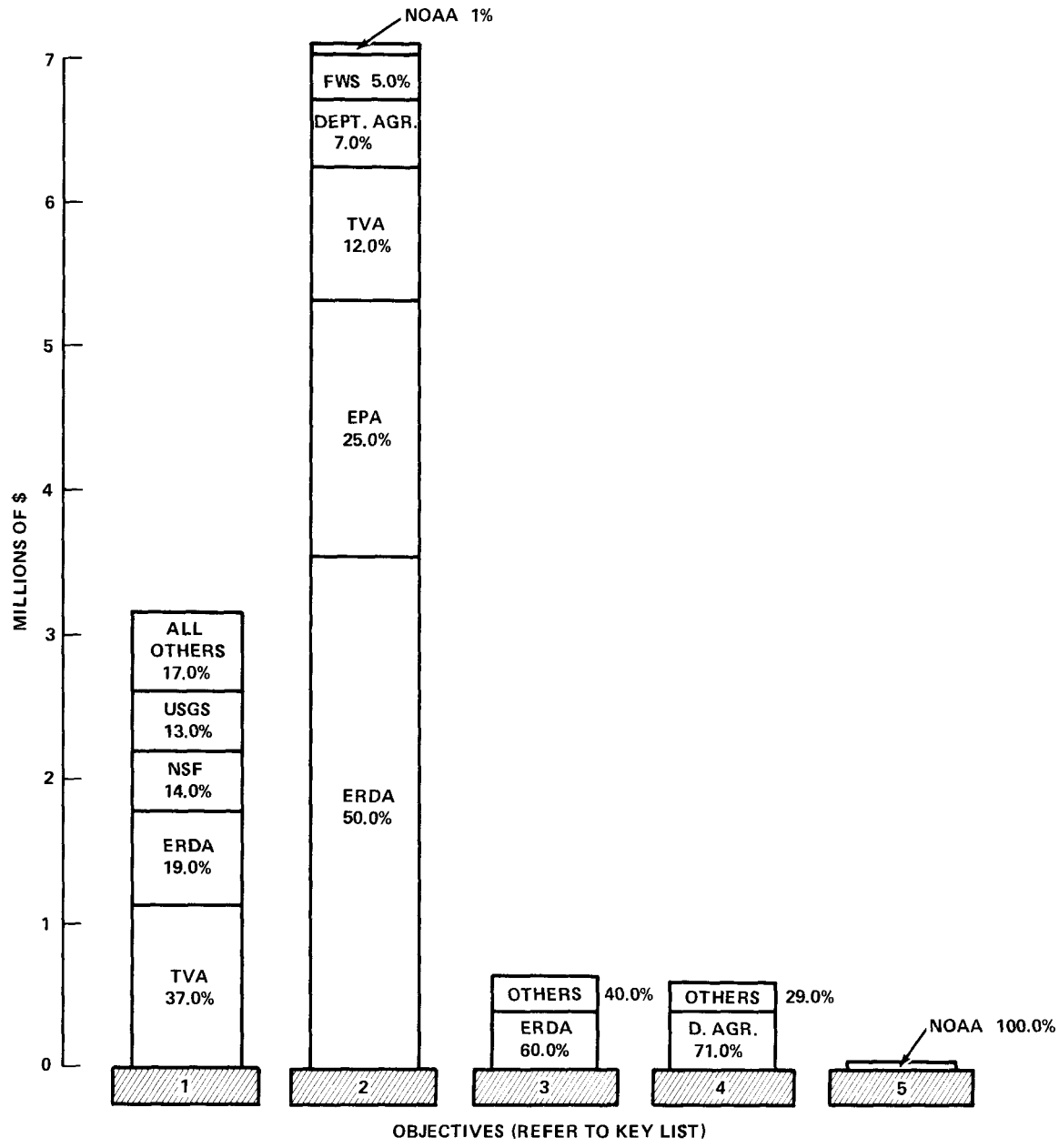

FIGURE 3e

TABLE 3e

RESEARCH OBJECTIVE VS FEDERAL AGENCY - FY 1975

RESEARCH CATEGORY: ECOLOGICAL EFFECTS - FRESHWATER

(DOLLARS IN MILLIONS)

AGENCY → / Objective Number** ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BLM	OBS/FWS	USGS	BM	B.RECLAM			
1	0.596	0.290	1.173				0.450					0.110	0.400		0.181			3.200
2	3.544	1.766	0.928					0.055				0.325				0.478		7.097
3	0.414	0.070	0.077					0.021								0.104		0.686
4	0.155							0.018								0.414		0.587
5								0.030										0.030
TOTAL	*4.709	2.126	2.178	-0-	-0-	-0-	0.450	0.125	-0-	-0-	-0-	0.435	0.400	-0-	0.181	0.996	-0-	11.600

*DOES NOT INCLUDE MEDICAL APPLICATIONS, EDUCATION, AND TRAINING.

**REFER TO KEY LIST ON FOLLOWING PAGE FOR DESCRIPTION OF OBJECTIVES.

OBJECTIVE DESCRIPTION FOR RESEARCH CATEGORY:

ECOLOGICAL EFFECTS: FRESHWATER

KEY LIST

Objective Number	Objectives
1	Develop baseline information for use in evaluating potential effects of energy technologies on freshwater resources and ecosystems.
2	Determine the immediate and long-term effects and biological fate of energy-related pollutants on freshwater resources and ecosystems and evaluate ways to minimize these effects (high priority).
3	Determine the immediate and long-term non-pollutant effects of energy technologies including conservation on freshwater resources and ecosystems and evaluate ways to minimize these effects (high priority).
4	Develop the capability to predict the effect of energy conservation and development on total ecosystems (high priority).
5	Other

INVENTORY OF BIOMEDICAL & ENVIRONMENTAL RESEARCH
DISTRIBUTION OF FUNDS BY OBJECTIVE
AND FEDERAL AGENCY FOR RESEARCH CATEGORY:
ECOLOGICAL EFFECTS – MARINE & ESTUARINE
FY 1975

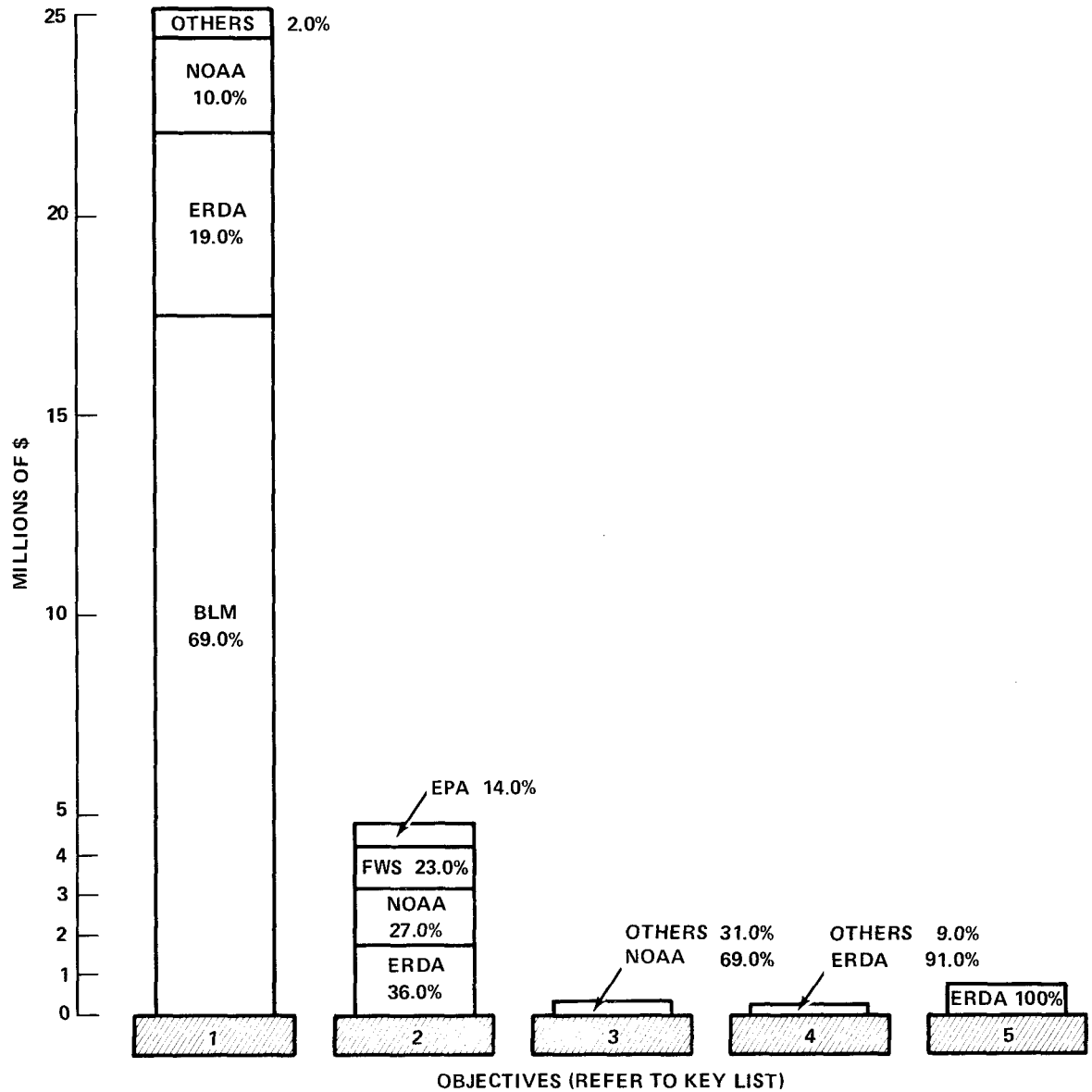

FIGURE 3f

TABLE 3f

RESEARCH OBJECTIVE VS FEDERAL AGENCY - FY 1975

RESEARCH CATEGORY: ECOLOGICAL EFFECTS - MARINE AND ESTUARINE

(DOLLARS IN MILLIONS)

AGENCY → / Objective Number ** ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BLM	OBS/FWS	USGS	BM	B. RECLAM			
1	4.656	0.195						2.427			17.400	0.450						25.128
2	1.777	0.633						1.324				1.100						4.834
3	0.050							0.181									0.033	0.264
4	0.199	0.020																0.219
5	0.854																	0.854
TOTAL	*7.536	0.848	-0-	-0-	-0-	-0-	-0-	3.932	-0-	-0-	17.400	1.550	-0-	-0-	-0-	-0-	0.033	31.299

*DOES NOT INCLUDE MEDICAL APPLICATIONS, EDUCATION, AND TRAINING.

**REFER TO KEY LIST ON FOLLOWING PAGE FOR DESCRIPTION OF OBJECTIVES.

OBJECTIVE DESCRIPTION FOR RESEARCH CATEGORY:

ECOLOGICAL EFFECTS: MARINE AND ESTUARINE

KEY LIST

Objective Number	Objectives
1	To establish descriptions and provide data analysis of environmental parameters including biological, physical, chemical, and geological components and the background concentrations of potential marine and estuarine pollutants in ecosystems impacted by energy conservation and development.
2	To determine the immediate and long-term effects of pollutants on marine and estuarine organisms and ecosystems impacted by energy development.
3	To determine the immediate and long-term non-pollutant effects, including physical and biological changes, on marine and estuarine organisms and ecosystems impacted by energy development and conservation.
4	Develop the capability to predict pollutant and non-pollutant effects on marine and estuarine ecosystems.
5	Other

INVENTORY OF BIOMEDICAL & ENVIRONMENTAL RESEARCH
DISTRIBUTION OF FUNDS BY OBJECTIVE
AND FEDERAL AGENCY FOR RESEARCH CATEGORY:
INTEGRATED ASSESSMENT
FY 1975

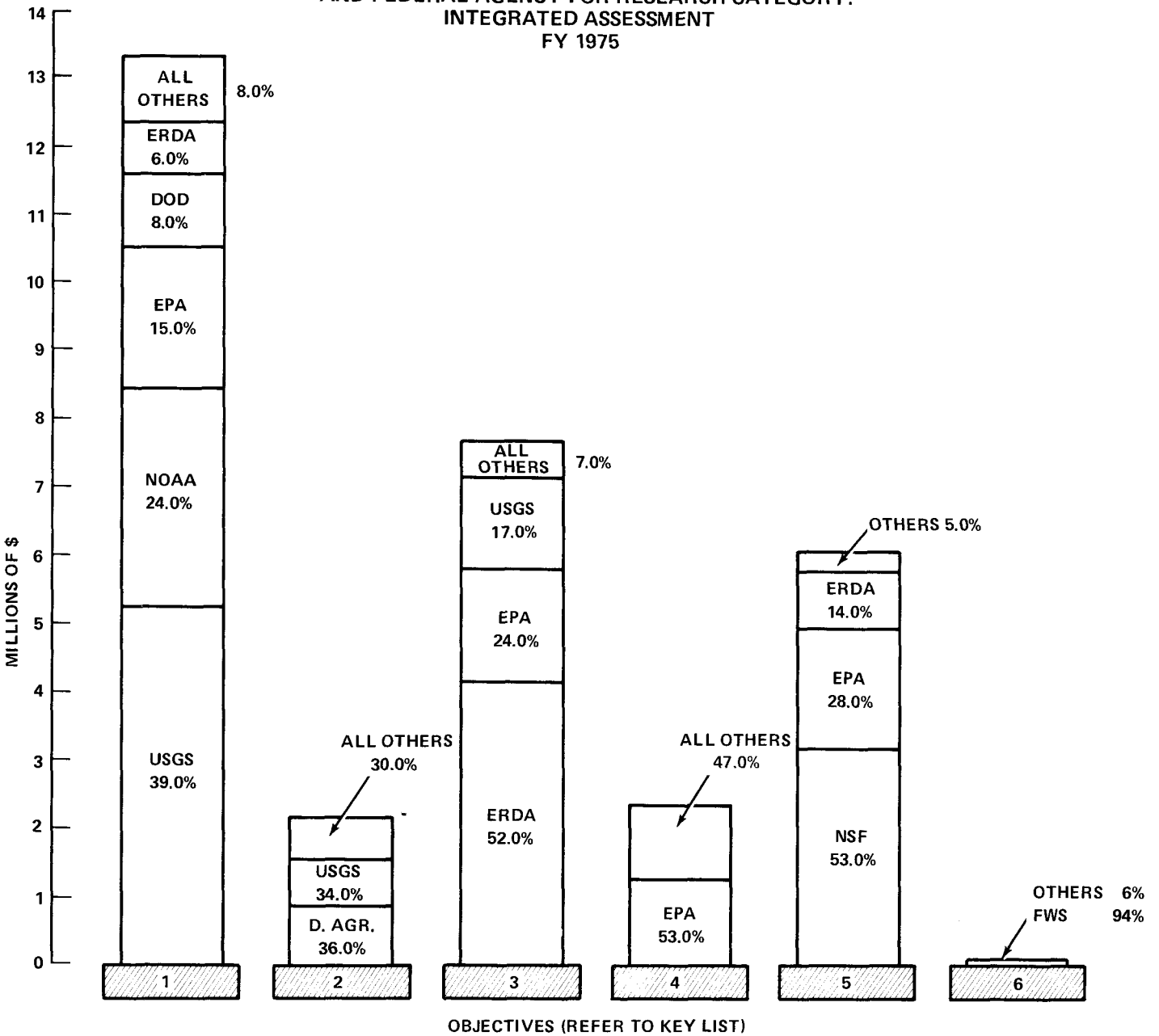

FIGURE 3g

TABLE 3g

RESEARCH OBJECTIVE VS FEDERAL AGENCY - FY 1975

RESEARCH CATEGORY: INTEGRATED ASSESSMENT

(DOLLARS IN MILLIONS)

AGENCY → / Objective Number** ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BIM	OBS/FWS	USGS	BM	B. RECLAM			
1	0.828	2.023	0.272					3.245				0.200	5.235	0.250		0.238	1.034	13.325
2	0.358	0.154	0.113					0.023					0.750			0.786		2.184
3	4.010	1.850	0.037		0.013		0.184						1.311				0.262	7.667
4	0.464	1.247						0.012	0.141				0.410			0.070		2.344
5	0.867	1.722					3.220	0.041					0.205					6.055
6	0.005											0.085						0.090
TOTAL	*6.532	6.996	0.422	-0-	0.013	-0-	3.404	3.321	0.141	-0-	-0-	0.285	7.911	0.250	-0-	1.094	1.296	31.665

*DOES NOT INCLUDE MEDICAL APPLICATIONS, EDUCATION, AND TRAINING.

**REFER TO KEY LIST ON FOLLOWING PAGE FOR DESCRIPTION OF OBJECTIVES.

OBJECTIVE DESCRIPTION FOR RESEARCH CATEGORY:

INTEGRATED ASSESSMENT

KEY LIST

Objective Number	Objectives
1	To manage and integrate research information on environmental control and effects of energy technology systems.
2	To estimate social, economic, and cultural consequences of the environmental effects of alternative energy production and pollution control technologies.
3	To assess the direct and indirect environmental consequences of energy production and control alternatives (whether similar or different in all regions.
4	To evaluate cost/risk/benefit trade-off of energy production and pollution control alternatives.
5	Evaluation of alternative approaches to implementing energy development, prevention of environmental damage and further studies.
6	Other

C. Funding by Energy Technology Categories

Figure 4 and Tables 4a and 4b (FY 1975 and FY 1974, respectively) provide information on funding allocations by energy technology categories for each agency. The figure shows the proportion of funds supporting each energy technology category and the percentage of those funds assigned to each agency. The tables present the actual funding distribution for each agency.

Tables 5a through 5g display FY 1975 funding by energy technology and agency for each research category. These tables provide an overview of the applicability to various energy technologies of the funds spent in FY 1975 within each research category.

INVENTORY OF BIOMEDICAL & ENVIRONMENTAL
RESEARCH
DISTRIBUTION OF FUNDS BY ENERGY TECHNOLOGY CATEGORY
AND FEDERAL AGENCY
FY 1975

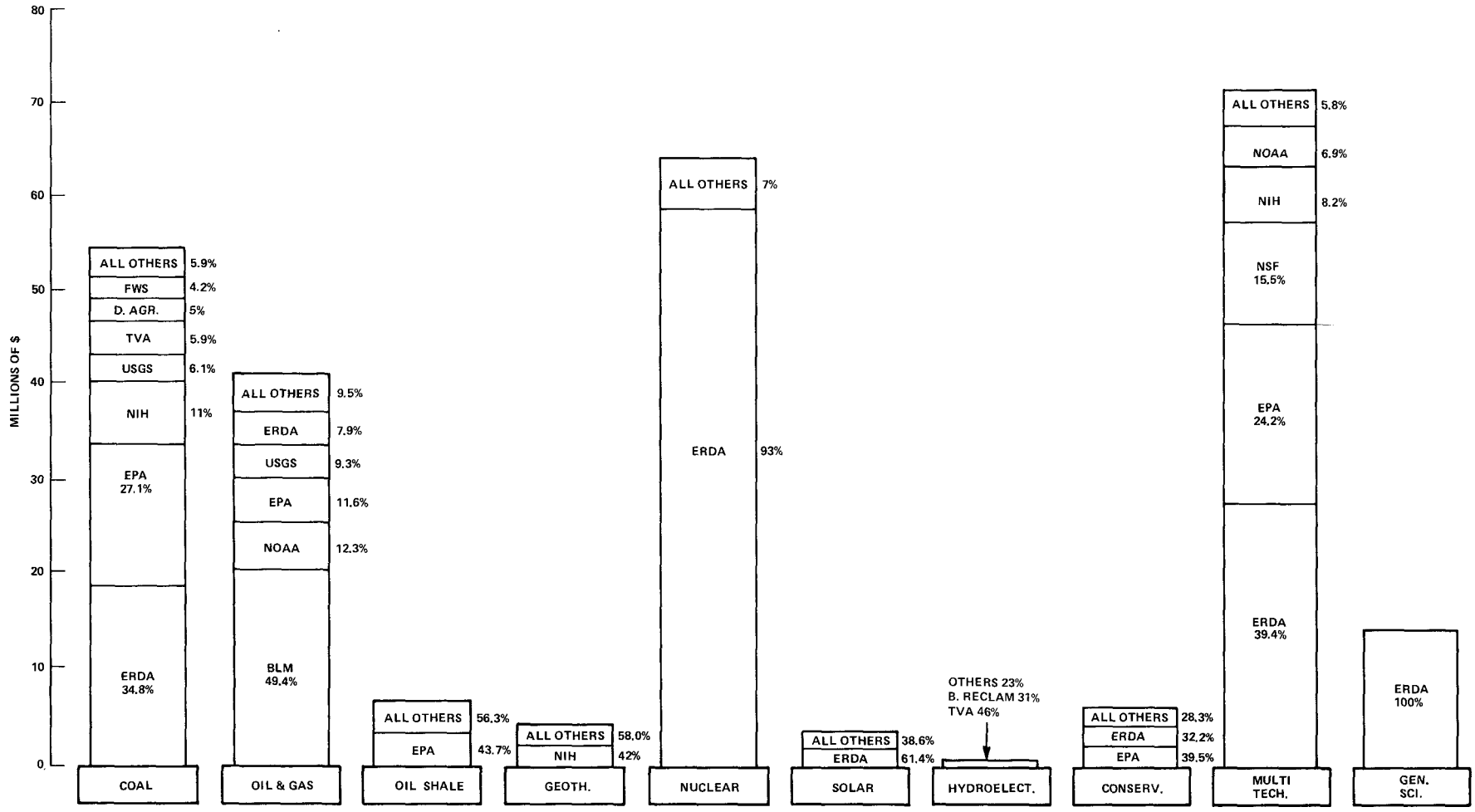

FIGURE 4

TABLE 4a

ENERGY TECHNOLOGY CATEGORY VS FEDERAL AGENCY
BIOMEDICAL AND ENVIRONMENTAL RESEARCH - FY 1975

(DOLLARS IN MILLIONS)

AGENCY → / TECHNOLOGY ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BLM	OBS/FWS	USGS	BM	B. RECLAM			
Coal	19.205	14.953	3.271	0.205	6.065	1.818	0.175	0.403		0.498		2.338	3.368	0.083		2.779		55.166
Oil and Gas	3.288	4.835		0.040	0.689	1.077	0.450	5.103		0.153	20.500	1.302	3.860				0.170	41.467
Shale	0.396	3.056			0.416	0.160		0.092		0.499		0.925	0.691	0.083		0.665		6.983
Geothermal	0.293	0.264			2.000		0.886					0.216	1.070				0.027	4.756
Nuclear	59.368	1.351	1.401		0.690	0.066		0.090		0.406		0.133	0.250	0.084				63.839
Solar	1.626	0.025			0.989			0.005										2.645
Hydroelectric			0.268					0.070				0.067			0.181			0.586
Conservation	2.201	2.697			1.182	0.554			0.141								0.045	6.820
Multi Technology	28.500	17.488		0.550	5.962	0.670	11.167	4.992				0.360	0.850			0.470	1.245	72.254
General Science	14.300																	14.300
TOTAL	*129.177	44.669	4.940	**0.795	17.993	4.345	12.678	10.760	0.141	1.556	20.500	5.341	10.089	0.250	0.181	3.914	1.487	268.816

*DOES NOT INCLUDE MEDICAL APPLICATION, EDUCATION, AND TRAINING.

**PASS-THRU ONLY - BASE DATA NOT YET AVAILABLE.

TABLE 4b

ENERGY TECHNOLOGY CATEGORY VS FEDERAL AGENCY

BIOMEDICAL AND ENVIRONMENTAL RESEARCH - FY 1974

(DOLLARS IN MILLIONS)

AGENCY → / TECHNOLOGY ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BLM	OBS/FWS	USGS	BM	B. RECLAM			
Coal	2.131	10.076	0.724		6.280	0.834		0.046								0.720		20.811
Oil and Gas		6.069			0.580	0.092	0.585	1.181			1.300						0.024	9.831
Shale					0.456		0.984						0.040					1.480
Geothermal					0.713								0.140				0.015	0.868
Nuclear	59.260	0.189	0.673		0.446	0.059		0.065		0.290								60.982
Solar					0.092													0.092
Hydroelectric			0.076												0.188			0.264
Conservation		0.158			0.320	0.138											0.030	0.646
Multi Technology	16.738	2.860			2.538	0.097		4.145									0.129	26.507
General Science	12.625																	12.625
TOTAL	*90.754	19.352	1.473	-0-	11.425	1.220	1.569	5.437	-0-	0.290	1.300	-0-	0.180	-0-	0.188	0.720	0.198	134.106

*DOES NOT INCLUDE MEDICAL APPLICATIONS, EDUCATION, AND TRAINING.

TABLE 5a

ENERGY TECHNOLOGY CATEGORY VS FEDERAL AGENCY

RESEARCH CATEGORY: CHARACTERIZATION, MEASUREMENT, AND MONITORING

FY 1975

(DOLLARS IN MILLIONS)

AGENCY → / TECHNOLOGY ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BLM	OBS/FWS	USGS	BM	B.RECLAM			
Coal	2.319	2.557	0.235	0.205	0.188	0.282		0.283		0.498		0.500	0.837					7.904
Oil and Gas	0.578	0.776		0.040		0.222		0.923		0.153	3.100						0.138	5.930
Shale	0.110	1.059						0.083		0.499			0.591					2.342
Geothermal	0.283	0.063					0.571											0.917
Nuclear	6.045	0.149	0.320							0.406								6.920
Solar																		
Hydroelectric																		
Conservation	0.100	1.127				0.145												1.372
Multi Technology	4.942	3.716		0.550		0.090	2.163						0.100				0.020	11.581
General Science																		
TOTAL	*14.377	9.447	0.555	**0.795	0.188	0.739	2.734	1.289	-0-	1.556	3.100	0.500	1.528	-0-	-0-	-0-	0.158	36.966

*DOES NOT INCLUDE MEDICAL APPLICATIONS, EDUCATION, AND TRAINING.

**PASS-THRU ONLY - BASE DATA NOT YET AVAILABLE.

TABLE 5b

ENERGY TECHNOLOGY CATEGORY VS FEDERAL AGENCY

RESEARCH CATEGORY: ENVIRONMENTAL TRANSPORT

FY 1975

(DOLLARS IN MILLIONS)

AGENCY → / TECHNOLOGY ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	BNS	BLM	OBS/FWS	USGS	BM	B. RECLAM			
Coal	2.590	2.322	0.285		0.162			0.065										5.424
Oil and Gas	0.350	0.947						0.314										1.611
Shale	0.050	0.598						0.009										0.657
Geothermal		0.006																0.006
Nuclear	2.411	0.076	0.105					0.005					0.250					2.847
Solar																		
Hydroelectric																		
Conservation	0.100	0.010																0.110
Multi Technology	3.492	2.643					5.784											11.919
General Science	0.415																	0.415
TOTAL	*9.408	6.602	0.390	-0-	0.162	-0-	5.784	0.393	-0-	-0-	-0-	-0-	0.250	-0-	-0-	-0-	-0-	22.989

*DOES NOT INCLUDE MEDICAL APPLICATIONS, EDUCATION, AND TRAINING.

TABLE 5c

ENERGY TECHNOLOGY CATEGORY VS FEDERAL AGENCY

RESEARCH CATEGORY: HEALTH EFFECTS

FY 1975

(DOLLARS IN MILLIONS)

AGENCY → / TECHNOLOGY ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BLM	OBS/FWS	USGS	BM	B. RECLAM			
Coal	10.336	6.274			5.715	1.421												23.746
Oil and Gas		1.133			0.689	0.740												2.562
Shale	0.236	1.049			0.416	0.160												1.861
Geothermal		0.195			2.000													2.195
Nuclear	43.167	0.995			0.690	0.066												44.918
Solar	1.626				0.989													2.615
Hydroelectric																		
Conservation	1.746	0.200			1.182	0.409												3.537
Multi Technology	7.458	5.884			5.949	0.580												19.871
General Science	12.106																	12.106
TOTAL	*76.675	15.730	-0-	-0-	17.630	3.376	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	113.411

*DOES NOT INCLUDE MEDICAL APPLICATIONS, EDUCATION, AND TRAINING.

TABLE 5d

ENERGY TECHNOLOGY CATEGORY VS FEDERAL AGENCY

RESEARCH CATEGORY: ECOLOGICAL EFFECTS - AIR/TERRESTRIAL

FY 1975

(DOLLARS IN MILLIONS)

AGENCY → / TECHNOLOGY ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BLM	OBS/FWS	USGS	BM	B. RECLAM			
Coal	1.290	1.329	1.138			0.115	0.175					1.455				1.454		6.956
Oil and Gas	0.773	1.097				0.115												1.985
Shale		0.089										0.850				0.100		1.039
Geothermal	0.010						0.131					0.216						0.357
Nuclear	4.583	0.016	0.257															4.856
Solar																		
Hydroelectric																		
Conservation	0.255	0.286																0.541
Multi Technology	2.076	0.103						1.700				0.050				0.270		4.199
General Science	0.953																	0.953
TOTAL	*9.940	2.920	1.395	-0-	-0-	0.230	0.306	1.700	-0-	-0-	-0-	2.571	-0-	-0-	-0-	1.824	-0-	20.886

*DOES NOT INCLUDE MEDICAL APPLICATIONS, EDUCATION, AND TRAINING.

TABLE 5e

ENERGY TECHNOLOGY CATEGORY VS FEDERAL AGENCY

RESEARCH CATEGORY: ECOLOGICAL EFFECTS - FRESHWATER
FY 1975

(DOLLARS IN MILLIONS)

AGENCY → / TECHNOLOGY ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BLM	OBS/FWS	USGS	BM	B. RECLAM			
Coal	1.268	1.016	1.503									0.250	0.400			0.724		5.161
Oil and Gas	0.390	0.084					0.450											0.924
Shale		0.260										0.075				0.272		0.607
Geothermal																		
Nuclear	0.952	0.033	0.457															1.442
Solar																		
Hydroelectric			0.218					0.070							0.181			0.469
Conservation																		
Multi Technology	2.064	0.733						0.055				0.110						2.962
General Science	0.035																	0.035
TOTAL	*4.709	2.126	2.178	-0-	-0-	-0-	0.450	0.125	-0-	-0-	-0-	0.435	0.400	-0-	0.181	0.996	-0-	11.600

*DOES NOT INCLUDE MEDICAL APPLICATIONS, EDUCATION, AND TRAINING.

TABLE 5f

ENERGY TECHNOLOGY CATEGORY VS FEDERAL AGENCY

RESEARCH CATEGORY: ECOLOGICAL EFFECTS - MARINE/ESTUARINE

FY 1975

(DOLLARS IN MILLIONS)

AGENCY → / TECHNOLOGY ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BLM	OBS/FWS	USGS	BM	B. RECLAM			
Coal	0.345	0.061						0.050				0.133						0.589
Oil and Gas	1.137	0.767						3.801			17.400	1.217						24.322
Shale																		
Geothermal																		
Nuclear	0.980	0.020						0.075				0.133						1.208
Solar																		
Hydroelectric												0.067						0.067
Conservation																		
Multi Technology	4.283							0.006									0.033	4.322
General Science	0.791																	0.791
TOTAL	*7.536	0.848	-0-	-0-	-0-	-0-	-0-	3.932	-0-	-0-	17.400	1.550	-0-	-0-	-0-	-0-	0.033	31.299

*DOES NOT INCLUDE MEDICAL APPLICATIONS, EDUCATION, AND TRAINING.

TABLE 5g

ENERGY TECHNOLOGY CATEGORY VS FEDERAL AGENCY

RESEARCH CATEGORY: INTEGRATED ASSESSMENT

FY 1975

(DOLLARS IN MILLIONS)

AGENCY → / TECHNOLOGY ↓	ERDA	EPA	TVA	NASA	DHEW		NSF	DEPT OF COMMERCE			DEPT OF INTERIOR					DEPT AGR.	DOD	TOTAL
					NIH	NIOSH		NOAA	OEA	NBS	BLM	OBS/FWS	USGS	BM	B. RECLAM			
Coal	1.057	1.395	0.111					0.010					2.131	0.083		0.601		5.388
Oil and Gas	0.060	0.031						0.065				0.085	3.860				0.032	4.133
Shale													0.100	0.083		0.293		0.476
Geothermal							0.184						1.070				0.027	1.281
Nuclear	1.230	0.061	0.261					0.010						0.084				1.646
Solar		0.025						0.005										0.030
Hydroelectric			0.050															0.050
Conservation		1.075							0.141								0.045	1.261
Multi Technology	4.185	4.409			0.013		3.220	3.231				0.200	0.750			0.200	1.192	17.400
General Science																		
TOTAL	*6.532	6.996	0.422	-0-	0.013	-0-	3.404	3.321	0.141	-0-	-0-	0.285	7.911	0.250	-0-	1.094	1.296	31.665

*DOES NOT INCLUDE MEDICAL APPLICATIONS, EDUCATION, AND TRAINING.

IV. DISCUSSION OF RESULTS (FY 1975)

This section provides a brief discussion of the FY 1975 results tabulated in Section III. Comments are restricted to those agencies which support the majority of work in each area.

A. Characterization, Measurement, and Monitoring

Funding in the Characterization, Measurement, and Monitoring (CMM) category totaled approximately $37 million, almost 14% of the total energy-related research effort of $269 million. Within the CMM category, 31.3% was considered related to several technologies and, therefore, has been categorized as multi-technology in nature. Research in support of coal, nuclear, and oil and gas accounts for 21.4%, 18.5%, and 16.5% of the CMM funds, respectively. ERDA and the Environmental Protection Agency (EPA) jointly accounted for 64.5% of the CMM funding, while Bureau of Land Management (BLM), National Science Foundation (NSF), National Oceanic and Atmospheric Administration (NOAA), and National Bureau of Standards (NBS) provided the balance for more specialized programs in this category.

ERDA/Division of Biomedical and Environmental Research reported a funding level of $14.4 million for CMM research. The largest allocations supported nuclear ($6.0 million), followed by multi-technology ($4.9 million), and coal ($2.3 million). The effort primarily emphasized instrumentation for radiation monitoring, but has recently been reprogrammed to include air monitoring instrumentation, the latter being more applicable to the multi-technology requirements. In addition to instrumentation development, a significant effort was directed toward air monitoring (objective 1) and water monitoring (objective 2) of radioactive releases from nuclear reactors.

The Environmental Protection Agency reported $9.4 million funding in this category with major emphasis for coal and multi-technology (multi-fuel) related activities. Like ERDA, a significant fraction of this budget was for objective 1; however, unlike ERDA, EPA stressed air monitoring of effluents

from fossil fueled power plants. In addition, due to EPA's regulatory requirements, quality assurance (objective 12) also received significant funding.

The Bureau of Land Management's continuing program of water monitoring ($3.1 million) relates to site specific assessment of local effects of oil and gas exploration activities. Other agencies providing significant contributions to the CMM research programs include the National Science Foundation ($2.7 million), the National Oceanic and Atmospheric Administration ($1.3 million), the National Bureau of Standards ($1.6 million), and the U.S. Geological Survey ($1.5 million). Recent meetings with the National Aeronautics and Space Administration indicated that significant research efforts by this agency may be applicable to the CMM category. To extract the NASA data would require considerable additional effort to query their data banks for extracting the energy-related projects. These data can be available for the next inventory.

B. Environmental Transport

Of the total $269 million spent on energy-related research in FY 1975, approximately $23 million (8.6%) was spent in the area of Environmental Transport. The greatest part (38%) was expended to determine the origin, load, transport pathways, transfer rates and fate of pollutants in the hydrosphere (objective 6). Objective 1, to develop and evaluate procedures for predicting the atmospheric transport and dilution of pollutants, also received a significant portion of the funding (20%). In addition, objective 4, to develop and validate procedures for predicting physical and chemical transformations of pollutants, received 12.1% of the funding. An equal proportion of the funding, approximately 8%, went to both objective 2, procedures for predicting removal of atmospheric pollutants by precipitation, and to objective 5, predictive models for describing atmospheric behavior of pollutants. The remaining funds were divided among the other four Environmental Transport objectives.

In regard to energy-related technologies, the largest share (52%) of the $23 million, was for support of activities that were multi-technology in nature. The remainder was in support of work specifically addressing coal (23%), nuclear (12%), oil and gas (7%), and oil shale (3%).

In the category of Environmental Transport, ERDA, EPA, and NSF jointly accounted for approximately 95% of the funding.

ERDA/Division of Biomedical and Environmental Research programs accounted for $9.4 million with principle funding expenditures in support of nuclear (25.6%), coal (27.5%), and multi-technology (37.1%) related research. The principle focus of research was on objectives 1, 2, and 4. The atmospheric programs considered atmospheric structure, transport, and diffusion of pollutants; included was the continued Multistate Power Production Pollutant Studies (MAP3S). Research in the terrestrial, freshwater, and marine subcategories concentrated on surface mining and offshore oil drilling; transport of pollutants through these media; and chemical and physical interaction of pollutants with soils and sediments.

The Environmental Protection Agency budget accounted for $6.6 million, with 35% of the funding supporting coal and 40% allocated to multi-technology research. EPA's principle focus (unlike ERDA's) was on objective 5, to develop and evaluate predictive models describing atmospheric behavior of pollutants from emission to removal from the atmosphere; and objective 6, to determine the origin, load, transport, pathways, transfer rates, and fate of pollutants in the hydrosphere.

The National Science Foundation accounted for $5.8 million of the Environmental Transport funding with all funds applied on multi-technology research. NSF's program, which focused primarily on objective 6, could, because of the basic nature of its research, have been classified as general sciences.

C. Health Effects

Of the total $269 million reported research funding, the largest portion (42%), was spent in the area of Health Effects. An examination of Table 3c shows that 77.3% of the Health Effects research was expended in support of objective 4 (to evaluate the short-term and long-term hazards of exposures of normal, susceptible, and stressed population groups to different levels and combinations of biologically active agents) and objective 5 (to determine the

processes of damage, repair, recovery, protection, and amelioration in biological systems). The remaining funds were divided among the remaining four objectives.

With respect to energy technology categories, 20.9% of the Health Effects funding was directed for coal, 39.6% for nuclear, 17.5% for multi-technology, and 10.7% for general science. Studies in support of nuclear energy were funded almost entirely by ERDA (96%), reflecting the pre-ERDA mission of the Atomic Energy Commission. Besides ERDA, the funding for Health Effects research was shared by the National Institute of Health (NIH), National Institute for Occupational Safety and Health (NIOSH), and EPA.

ERDA's total expenditures on Health Effects accounted for $76.7 million. Of this amount, 56.3% was in support of nuclear energy developments, 13.5% was in support of coal (primarily coal conversion), 15.8% was categorized as general science, and 9.7% as multi-technology in nature.

The ERDA research program placed heavy emphasis on experimental animal data to be coupled with predictive modeling to man. These research activities included: (1) rapid in vitro and in vivo bioassay to identify carcinogenic, mutagenic, teratogenic or pathophysiological agents; (2) determination of the uptake, metabolism, translocation, deposition, and excretion of toxic chemical agents; (3) quantification of risk estimates for carcinogenic, mutagenic, teratogenic, and pathophysiological effects in experimental animals; (4) acquisition and analysis of all relevant human data, and (5) development of theoretical and animal models to insure the extrapolation of the animal information to man. With regard to nuclear technology, research emphasis centered on evaluating health risks arising from chronic exposures to low levels of internally deposited radionuclides and external electromagnetic radiation that might occur in work areas or in the general environment. Other efforts included a radiological physics program to develop predictive models and theories of chemical and biological effects in terms of the underlying physical processes of radiation interaction.

The studies of adverse health effects of energy-related pollutants were supplemented by basic and applied supportive research (general science and multi-technology) of several types. Such research included pathophysiology of disease induction, molecular and cellular studies to elucidate mechanisms and consequences of damage and inherent protective mechanisms of organisms that function to combat external stresses. Other studies focused on the development of improved methods for the early detection and diagnosis of abnormalities induced by hazardous agents.

Of the almost $18 million,which the National Institute of Health reported to have spent on energy-related research, approximately 98% was on Health Effects research, with only minor contributions in the CMM and Environmental Transport categories. This Health Effects research was primarily in support of coal (32.4%) and research that was multi-technology in nature (33.7%). Additionally, 11.3% of the overall effort was related to geothermal energy. Like ERDA, the primary emphasis of this work was on objectives 4 and 5; however, significant funding was also directed toward problems in objective 2 (to develop more sensitive and rapid biological methods to evaluate dose and damage to man) and objective 3 (to determine the metabolism and fate of hazardous agents).

The Environmental Protection Agency reported spending $15.7 million in the Health Effects category, 39.9% of which was allocated to coal related problems and 37.4% to multi-technology research. Unlike ERDA and NIH, there was substantial emphasis (25.5%) on objective 1 (to identify hazardous agents associated with energy technologies). Most of the objective 1 work was related to coal and other fuels (multi-technology). EPA research on problems related to objectives 2 and 4 was also emphasized. When compared to ERDA and NIH research, the efforts reported by EPA were more in the realm of applied research and were oriented toward shorter term goals.

The energy-related work of the NIOSH totaled $3.4 million. This work was largely related to coal with a small amount spent on oil and gas and on multi-technology research. NIOSH's principle focus was on objective 4, with substantial emphasis on occupational health studies.

D. Ecological Effects

Ecological Effects research is divided into three subcategories: Air and Terrestrial, Freshwater, and Marine and Estuarine. The funding for these subcategories is summarized in Tables 3d, 3e, and 3f, respectively. The total level of support for Ecological Effects research was approximately $64 million of which 33% was in Air and Terrestrial, 18% in Freshwater, and 49% in Marine and Estuarine.

1. Air and Terrestrial

Total funding in this subcategory was approximately $21 million divided as follows: 31% for objective 1, development of baseline information; 47% for objective 2, determination of the fate and effects of energy-related pollutants on terrestrial ecosystems; 10% for objective 3, determination of non-pollutant effects of energy technologies on terrestrial ecosystems, and 7% for objective 4, development of capabilities to predict effects of energy conservation on terrestrial ecosystems.

In relation to energy technologies, work in support of coal accounted for 33% of the funding, nuclear 23%, oil and gas approximately 10%, and 20% was categorized as multi-technology.

Of all the agencies reporting Federal support of research in this subcategory, ERDA accounted for 48% of the funding; EPA 14%; Office of Biological Services/Fish and Wildlife Survey (OBS/FWS) 12%; and National Oceanic and Atmospheric Administration (NOAA) with Tennessee Valley Authority (TVA), 15%.

ERDA allocated $9.9 million in Air and Terrestrial effects research with major emphasis in the nuclear area (approximately 46%), coal (13%), and multi-technology (21%). Of the total $9.9 million, objective 2, received 66.6% of funding and objective 1 accounted for 13.7%. Programs were included which dealt with (a) detoxification and decomposition of toxic substances in ecosystems, (b) development of techniques for determining the effects of various stresses on the ecosystems, (c) understanding the inherent capacities of systems to overcome stresses or react in an adaptive way,

d) development of predictive models for estimation of impacts of energy technologies, and (e) development of techniques to ameliorate these impacts.

The Environmental Protection Agency (EPA) allocated $2.9 million in this subcategory. The EPA program mostly stressed objective 1 with particular emphasis on coal, oil and gas. The program was primarily oriented to air quality studies.

The Fish and Wildlife Service also had significant funding allocation in this subcategory. Of the $2.6 million, over 56% was spent in coal related research with 33% marked for oil shale. Objective 1 (42.5%) and objectives 2 and 4 (29% each) received the primary emphasis. The studies related to reclamation strategies; environmental baseline and animal habitat data in western coal areas; impact of geothermal developments on natural ecosystems, and minimization of adverse ecological effects for oil shale technologies.

The NOAA reported $1.7 million in the Air and Terrestrial category. All funds were committed to multi-technology and to objective 1. This is a continuing program to measure global atmospheric levels of trace constituents.

2. Freshwater

The subcategory, Freshwater, accounted for $11.6 million of funding. Major energy technologies supported were coal effects research (44.5%), multi-technology research (25.5%), and nuclear related research (12.4%).

The majority of funding (61%) was oriented to support objective 1, development of baseline information, and objective 2, determination of effects and fate of energy-related pollutants. Minor funding was spread among the remaining three objectives.

ERDA, EPA, and TVA jointly accounted for nearly 80% of the Freshwater research effort. ERDA reported $4.7 million with major emphasis on objective 2. This program was general with regard to specific pollutants, thus most projects were categorized as multi-technology. EPA Freshwater

research funding was approximately half that of ERDA. It also stressed objective 2, but a larger portion of the projects was related to coal technologies. The TVA reported funding of $2.17 million. TVA also emphasized research related to coal effects, but focused on objective 1, baseline information. The TVA program included water quality measurements in relation to fisheries and Freshwater ecosystems.

3. Marine and Estuarine

This subcategory accounted for $31.3 million of research. The greatest portion was funded by the Bureau of Land Management (BLM) program ($17.4 million). ERDA ($7.5 million) and NOAA ($3.9 million) were other major contributors within the Marine and Estuarine subcategory.

The BLM program was devoted to baseline studies of the Outer Continental Shelf, hence directly related to oil and gas. The program included studies of ambient levels of hydrocarbons, trace metals, sediments, and organisms in water; geology of the mid-Atlantic area; and physical oceanography of various Atlantic regions.

ERDA's Marine and Estuarine program ($7.5 million), unlike that of BLM, stressed multi-technology research; however, ERDA and BLM both emphasized research on objective 1, to establish descriptions and provide data analysis of environmental parameters and background concentrations of pollutants, and objective 2, to determine effects of energy-related pollutants on Marine and Estuarine ecosystems. The ERDA program included research on processes controlling productivity on the coastal shelf, rates and routes of the transfer/transport of material in the ocean, and effects of waste heat discharges on local and migratory fish populations.

The NOAA program ($3.9 million) was nearly all related to oil and gas. Like ERDA, the major emphasis was on objectives 1 and 2. Under objective 1, NOAA concentrated on research determining ecosystem changes that occur in active offshore oil fields in the Gulf of Mexico, and on establishing environmental baselines in the Gulf of Alaska, Bering Sea, and Beaufort Sea. Under objective 2, support was provided to determine the effects of heavy metals and hydrocarbon pollutants on marine organisms.

E. Integrated Assessment

The Integrated Assessment category accounted for nearly $32 million in funding and 12% of the total Federal research program on biomedical and environmental effects. The agencies providing major support were U.S. Geological Survey, ERDA, EPA, NOAA, and NSF. The majority of expenditures ($17 million) was for multi-technology oriented research; coal, oil and gas, and geothermal also had significant funding levels.

The thrust of the Geological Survey's $7.9 million program was in oil, gas, and coal and supported objective 1 (to manage and integrate research information on environmental control and effects of energy technology systems). The program also included development of low cost methods for regional environmental assessment, and investigation of the hydrologic, geothermal, and geophysical impacts in selected areas undergoing geothermal energy development.

ERDA and EPA accounted for approximately $7 million each with emphasis in multi-technology and coal. ERDA also stressed research related to nuclear technology while EPA substantially supported research related to conservation.

The ERDA effort emphasized objective 3, assessment of the environmental consequences of energy production and control alternatives. It included 1) a multi-laboratory regional assessment effort for the evaluation of regional, health, and socio-economic impacts of resource development, 2) probability and statistical studies of effect of cooling towers, and 3) assessments of potential geothermal impacts. EPA funded research was spread over all objective areas 1 through 5 and emphasized support of objectives 1, 3, 4, and 5 equally. NOAA and NSF each accounted for approximately $3.3 million of research, essentially all of which was oriented to multi-technology, but NSF, unlike ERDA, EPA, and NOAA emphasized objective 5, evaluation of alternative approaches to implementing energy development and preventing environmental damage.

V. CONCLUSIONS

A. General

1. The Federal agencies considered in this analysis reported approximately $269 million in energy-related biomedical and environmental research in FY 1975. Considering that some work might not have been reported, and that non-Federal research (state, industry, and other organizations) was not included, the total national funding of biomedical and environmental research in support of energy technology development in FY 1975 may have exceeded $300 million.

2. Comparing the FY 1975 biomedical and environmental research funding with that of FY 1974 shows a 100% increase in expenditure: FY 1975 funding was $269 million compared with $134 million in FY 1974. A significant fraction of this increase (58%) was due to the $78.5 million energy supplement. Of this supplement, $53.0 million was in EPA "pass through" allocations and the remainder was in direct allocations to ERDA/AEC and NSF.

In the various research categories, the most pronounced increase was in Integrated Assessment, increasing from $5.4 million in FY 1974 to $31.7 million in FY 1975. This greatly increased funding was applied to all energy technologies except nuclear which received only a small increase in funding.

3. ERDA/Division of Biomedical and Environmental Research expenditures in FY 1975 accounted for 48% of the total reported funding (see Table 2a); consequently, the ERDA distribution of these funds in the research categories and by energy technologies has a profound effect on the national picture.

4. In the various research categories, 42% of reported Federal funding was in Health Effects (see Table 2a). Since the Health Effects studies in FY 1975 were conducted by several organizations (ERDA, EPA,

NIOSH, and NIH whose inputs were not fully submitted), the funds may have included overlap in some areas. However, the overlap was not considered to be excessive. It will be necessary, in FY 1976, to obtain a more accurate accounting of research in the area and to maintain continuous scientific coordination of best utilization and allocation of funds.

Similar comments apply to Ecological Effects studies. The great number of organizations involved in these studies and their multi-faceted scope makes it mandatory that close surveillance and coordination be made on future research efforts.

5. The Integrated Assessment category, although increased considerably in 1975 funding still only represents 12% of the total funding in biomedical and environmental research. Since the objectives of this category are to provide a comprehensive and integrated picture of energy impacts on man and his environment and to ascertain the tradeoffs which must be made to obtain the energy this nation needs, increased emphasis in this area is deemed appropriate.

6. Twenty-seven percent of all reported FY 1975 Federal funding on energy-related biomedical and environmental research was spent on multi-technology related research. A slightly lesser amount (see Table 4a) was spent on investigations in support of nuclear energy, and was funded primarily by ERDA. In addition, approximately one-fifth of research in FY 1975 was in support of coal technologies, while only 2.5% was in support of conservation technologies. It would appear that, in view of the importance associated with conservation, increased funding of research related to this area should be considered.

7. Advanced energy sources, such as solar and geothermal, received increased funding in 1975, as compared to 1974, but the total expenditure on work related to these energy forms was still small ($7.5 million or approximately 3%). Increased funding for biomedical and environmental research related to these technologies should also be considered in future budget allocations.

B. Extended Remarks

This report provides the first attempt at an overview of federally funded biomedical and environmental energy-related research. The principal goals were to identify the research funding levels, to determine the allocation of funding among the various environmental and energy categories, and to make apparent the trends or shifts from FY 1974 to FY 1975 in these allocations. In addition, it was intended that gaps and overlaps in research efforts would be made apparent.

Based on this overview, several additional conclusions may be made:

1. It is recognized that the goal to identify gaps and overlaps in federally funded research was not fully achieved. The lack of quality and detail in a large percentage of the abstracts submitted by the agencies prohibited a comprehensive assessment of gaps or unnecessary duplication in the Federal R&D program. Attempts are presently underway by ERDA to alleviate this deficiency by improving the reporting process.

2. Despite the lack of specific details of much of the reported research, the project staff feels that no serious overlaps in research exist. Although, in several instances, funding was reported in the same environmental category by more than one agency, the reporting system did not account for differences in goals, missions, and objectives of the reporting agencies. For example, if one considers objective 1 in the Characterization, Measurement, and Monitoring category, where both EPA and ERDA appeared to be conducting air monitoring research at approximately the same funding level, it is clear that ERDA's emphasis was related to nuclear problems while EPA's efforts were oriented toward fossil fuels. Similar comments may be made for ERDA and BLM in water monitoring research.

For increased utility a Federal inventory must be based on a uniform system of record keeping. This, in turn, depends on obtaining current, clear, and complete research project descriptions and abstracts. The project staff suggests that a high priority be placed on insuring this within each agency.

3. To meet the objectives and goals expressed in ERDA-48, "Creating Energy Choices for the Future," ERDA must be both cognizant and knowledgeable in research areas funded by other agencies. As a consequence, the problem of coordination in order to avoid unnecessary duplication becomes more critical in the future. To minimize this problem, ERDA intends to generate, and regularly update, an inventory of energy-related health and environmental research. Future inventories will be more detailed than the present and designed to be used as a management tool to guide future research efforts. Meetings between ERDA and participating agencies to clarify specific research program objectives and discuss projected program directions are in progress.

Appendix

Contents:

1. Sample Information Request Letter to Agencies
   - Enclosure A: Clarifications and Answers
   - Enclosure B: Program Description and Resource Distribution Matrices
   - Enclosure C: Form of Submission

2. Sample Project Information Sheet

   This form was utilized to complete abstracts on all reported projects. These project abstracts are compiled in four volumes available at ERDA/Division of Biomedical and Environmental Research.

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

SAMPLE INFORMATION REQUEST
LETTER TO AGENCIES

Dr. Curt Berklund
Director, Bureau of Land
Management
Department of Interior
18th & C Street, N. W.
Washington, D. C. 20240

Dear Dr. Berklund:

The Federal Nonnuclear Energy Research and Development Act of 1974 requires the Administrator of the Energy Research and Development Administration (ERDA) to submit a comprehensive energy research development and demonstration plan and a companion comprehensive nonnuclear energy program by June 30, 1975, (Section 6 of the Federal Nonnuclear Energy R&D Act of 1974). A similar report must be submitted on an annual basis at the time ERDA submits its budget request to the Congress. We view this first report then as only the beginning of a continuing effort. In support of this work we are attempting to develop a complete catalog of research and development carried out in the United States in four program plan areas related to energy technology -- Biomedical and Environmental Research, Environmental Control Technology, Waste Management and Transportation Programs. Such a compilation will provide an overview of the total R&D effort and will reveal any deficiencies or undesirable overlap that exists in the present or planned research activities of the various agencies.

The purpose of this letter is to seek the help of your agency in obtaining information for this catalog.

The nature and purpose of this task requires that the requested material be reported in uniform fashion by all involved agencies. Submissions should consist of short descriptions of individual research projects and dollar amounts in the format used for the report "Inventory of Current Energy Research and Development" prepared for the Subcommittee on Energy of the House of Representatives Committee on Science and Astronautics frequently referred to as the McCormack Report. Dollar levels should

include FY 1974 and FY 1975. Each description should include, for the benefit of the Congress, an indication of the geographical or regional location (when applicable) in which the effort will be carried out. Enclosures A, B and C and examples 1 and 2 provide further specific clarifications. Please note that our target date for submission is April 30, 1975.

Once this material is provided, ERDA's logistic support organizations (Aerospace Corp., Mitre, TRW) will compile and integrate the materials (keeping agency inputs identified) and, with ERDA's staff, make a preliminary report. This draft will be circulated to the agencies for their critique. A final report will be written incorporating recommendations and circulated to all concerned.

The precise manner in which this critique will be carried out has yet to be determined, but you will be kept informed.

Dr. Robert Blaunstein of the ERDA staff will coordinate this interagency activity. He will be available on a continuing basis and can be reached at 301-973-5355. Also, Dr. Robert Rabin, in charge of the Health and Environmental segment, may be reached at 301-973-3641; Dr. William E. Mott, in charge of the Environmental Control Technology and Waste Management and Transportation segments, can be reached at 301-973-3213.

I fully realize the magnitude of the task we are being asked to carry out and I appreciate your willingness to cooperate in this important endeavor. I feel confident, however, that the usefulness of the report in planning future programs will make us all feel that the result was well worth the effort.

Sincerely,

James L. Liverman
Assistant Administrator
for Environment and Safety

Enclosures:
A. "Clarification and Answers"
B. "Program Description and Resource Distribution"
C. "An Inventory of Energy Research"
Example 1
Example 2

Enclosure A

Clarifications and Answers

1. Target date: April 11, 1975

2. Fiscal year: Complete information is requested for projects supported in FY 74. Information is also requested (a) for projects already given support in FY 75, and (b) in summary form, for projected further support in FY 75.

Meaning of "individual project level": This terminology refers to a small unit of work, usually ranging from a few thousand to possibly a few hundred thousand dollars such as is reported to the Smithsonian Science Information Exchange. The term is equivalent to a "Task" or "Subtask" in the King report ("Report of the Interagency Working Group on Health and Environmental Effects of Energy Use," prepared for the Office of Management and Budget, November 1974, Donald King, Chairman).

Use of matrices: The matrices (Enclosure B) are not to be filled out. They are to serve as a handy guide or index to the categorization required. They show which categories should be used in sorting the projects. (See Form of Submission below.)

Conservation: Conservation (as shown in Enclosure B) is to be considered a technology (equivalent to "Energy Efficiency" in the King report) with the following subcategories: (a) Reduced End-Use Consumption (buildings, industry, transportation, and integrated utility systems), and (b) Increased Efficiency (high temperature gas turbines; advanced cycles, fuel cells, and other concepts; wastes as fuels; advanced auto propulsion; and air, rail, bus and ship systems).

Key to technologies: Technologies in the technology categories of Enclosure B are listed in the King report, Appendix A, "Health and Environmental Problems Associated with Energy Technologies."

Form of submission--Health and Environmental Research (see Enclosure B): This part of the report will have seven main sections, one for each of the matrices in Enclosure B, with the titles shown in the upper left of each matrix. The major subdivisions of each section will be by technology, as indicated across the top of the matrices. The next level of subdivision will be by objective, shown in the left column of the matrices. (See Example 1.) Note that "Conservation" and possibly "Solar" may require an extra degree of subdivision.

Form of submission--Control Technology, Waste Management, and Transportation: The matrix attached to Enclosure 3 in the March 21 letter and subtitled "Gage Category: Control Technology," and the matrices in Enclosure 4 of the same letter titled "Research and Development Program Descriptions for Environmental Control Technology, Waste Management, and Transportation" should not be used. Instead, the report should follow the outline in Example 2. After each topic, project descriptions and funding should be inserted in the form used in the McCormack report.

Handling of Overlaps: Some tasks or subtasks will contribute information on more than one technology. It is extraordinarily important to avoid duplication of support dollars. If projects support coal, oil and shale technologies, include them under coal. At the end of the Oil section, add a footnote as follows:

The following projects listed under coal also contribute to oil

Title	Amount
. . . . .	. . . .
. . . . .	. . . .

Total funding of projects on oil listed under coal . . . .

Add a similar footnote under shale.

For projects on oil and shale, but not contributing to coal, list under oil and footnote under shale.

In general, list the project and funding under the highest ranking appropriate technology in the following list and footnote under other technologies:

Coal
Oil and Gas
Shale
Nuclear
Conservation
Geothermal
Solar
Hydro
Other

Contacts: Through April 11, Dr. Lawrence S. Myers, Jr., will be available to answer your queries and coordinate this interagency activity. He can be reached at 301-973-4223. Dr. Robert Blaunstein of the ERDA staff will be available on a continuing basis starting immediately and carrying on until the job is done. He can be reached at 301-973-4223 or 301-973-5355. Drs. Robert Rabin and William Mott continue to be available as indicated previously.

Example 1

Energy Related Health and Environmental Effects Research

Section I

CHARACTERIZATION, MEASUREMENT, AND MONITORING

A. Coal

1. Air Monitoring

(Insert air monitoring project descriptions and funding at this point, using the format of McCormack Report.)

2. Water Monitoring

(Insert water monitoring project descriptions and funding at this point.) (Continue through objectives 3-13 inclusive to)

B. Oil and Gas

1. Air Monitoring

(Insert projects and funding as above.)

2. Water Monitoring

(Insert projects and funding as above.) (Continue through objectives 3-13 inclusive and through the other technologies to)

H. Conservation

1. Buildings

a. Air monitoring

(Insert project and funding descriptions.)

b. Water monitoring

(Insert project descriptions and funding. Continue through objectives to end, and through technology category "Other," then follow with)

Section II

ENVIRONMENTAL TRANSPORT PROCESSES

A. Coal

1. To develop and validate procedures for predicting the atmospheric transport and dilution of pollutants in complex terrain and coastal areas of large isolated plumes, and to scales beyond 100 kilometers.

(Insert project descriptions as above.)

2. (Second objective in Environmental Transport.)

(Continue in this way through Integrated Assessment.)

Example 2

Research and Development Program Descriptions for Environmental Control Technology, Waste Management, and Transportation

I. Fossil Energy

A. Coal

1. Extraction
2. Preparation & Cleaning
3. Hi-BTU Gasification
4. Low-BTU Gasification
5. *In situ* Gasification
6. Direct Combustion
7. Liquefaction
8. MHD

B. Petroleum and Natural Gas

1. Extraction
2. Refining
3. Storage

C. Shale Oil

1. Extraction
2. Surface Retorting
3. *In situ* Retorting

II. Solar Energy

1. Heating/Cooling
2. Thermal Conversion
3. Photovoltaic Conversion
4. Wind Conversion
5. Biomass Conversion
6. Ocean Thermal Gradient
7. Tidal

III. Geothermal Energy

1. Dry Stream
2. Hot Brine
3. Hot Dry Rock
4. Geopressure Systems

IV. Energy Transmission (Electric)

1. Overhead
2. Underground

V. Energy Storage

1. Fuel Cells
2. Batteries
3. Hydrogen
4. Thermal
5. Etc.

VI. Solid Waste Utilization

1. Space Heating
2. Conversion to Power
3. Conversion to Synthetic Fuels

VII. Nuclear Energy

A. Fission

1. Extraction
2. Processing
3. Conversion
4. Fuel Processing

B. Fusion

1. Fuel Preparation
2. Conversion

VIII. Advanced Transportation Systems

IX. Other

PROGRAM DESCRIPTION AND RESOURCE DISTRIBUTION

King Category: Characterization, Measurement and Monitoring

OBJECTIVES	TECHNOLOGY								
	Coal	Oil and Gas	Shale	Geothermal	Nuclear	Solar*	Hydro	Conservation**	Other
Air Monitoring									
Water Monitoring									
Groundwater Monitoring									
Remote Monitoring									
Radiation Monitoring									
Air Monitoring Instrumentation									
Water Monitoring Instruments									
Remote Instrumentation									
Radiation Monitoring Instrumentation									
Health Effects Instrumentation									
Solid Wastes Analysis - Instrumentation & Monitoring									
Quality Assurance									
Other, please specify									

*Solar includes ocean thermal, heating and cooling, wind, photovoltaic and bioconversion.

**See description in Enclosure A.

PROGRAM DESCRIPTION AND RESOURCE DISTRIBUTION

King Category: Environmental Transport Processes

OBJECTIVES	TECHNOLOGY									
	Coal	Oil and Gas	Shale	Geothermal	Nuclear	Solar*	Hydro	Conservation *	Other	
To develop and validate procedures for predicting the atmospheric transport & dilution of pollutants in complex terrain and coastal areas of large isolated plumes, and to scales beyond 100 kilometers.										
To develop and validate procedures predicting the removal of pollutants by precipitation and in dry weather over various types of terrain and resuspension of pollutants.										
To determine if, how, and by how much cooling systems and pollutants from energy activities modify the weather or climate including visibility modification.										
To develop and validate procedures for predicting the physical and chemical transformations of pollutants in the atmosphere from energy activities.										
To develop and evaluate predictive models describing atmospheric behavior of pollutants from emission to removal from the atmosphere for candidate technologies including conservation, to assess the effect of candidate technologies on weather and climate, and to assess the role of weather on candidate technologies.										
To determine in the hydrosphere the origin, load, transport pathways, transfer rates and fate of pollutants arising from energy activities.										
To develop analytical, numerical, predictive models of the distribution and dynamics of energy-related pollutants in the hydrosphere.										
To determine in the soil zone the transport pathways, rates and fates of pollutants from energy activities.										
Other, please specify										

*Solar includes ocean thermal, heating and cooling, wind, photovoltaic and bioconversion.
**See description in Enclosure A.

PROGRAM DESCRIPTION AND RESOURCE DISTRIBUTION

King Category: Health Effects

OBJECTIVES	TECHNOLOGY *									
	Coal	Oil and Gas	Shale	Geothermal	Nuclear	Solar*	Hydro	Conservation **	Other	
To identify hazardous agents associated with energy technologies.										
To develop more sensitive and rapid biological methods to evaluate dose and damage to man.										
To determine the metabolism and fate of hazardous agents associated with energy technologies.										
To evaluate the short term and long term hazards of exposure of normal, susceptible and stressed population groups to different levels and combinations of biologically active agents associated with energy technologies.										
To determine the processes of damage, repair recovery, protection and amelioration in biological systems exposed to hazardous agents associated with energy technologies.										
Other, please specify										

*Solar includes ocean thermal, heating and cooling, wind, photovoltaic and bioconversion.
**See description in Enclosure A.

PROGRAM DESCRIPTION AND RESOURCE DISTRIBUTION

King Category: Ecological Effects: Air/Terrestrial

OBJECTIVES	TECHNOLOGY									
	Coal	Oil and Gas	Shale	Geothermal	Nuclear	Solar*	Hydro	Conservation*	Other	
To develop baseline information for use in evaluating the potential effects of energy technologies including conservation on terrestrial ecosystems.										
Determine the fate and effects of energy related pollutants on terrestrial ecosystems and evaluate ways to minimize these effects.										
Determine the immediate and long-term non-pollutant effects of energy technologies including conservation on terrestrial ecosystems and evaluate ways to minimize these effects.										
Develop the capability to predict effects of energy conservation and development on terrestrial ecosystems.										
Evaluate the impact of airborne pollutants on materials.										
Other, please specify										

*Solar includes ocean thermal, heating and cooling, wind, photovoltaic and bioconversion.
**See description in Enclosure A.

PROGRAM DESCRIPTION AND RESOURCE DISTRIBUTION

King Category: Ecological Effects: Freshwater

OBJECTIVES	TECHNOLOGY									
	Coal	Oil and Gas	Shale	Geothermal	Nuclear	Solar*	Hydro	Conservation**	Other	
Develop baseline information for use in evaluating potential effects of energy technologies on freshwater resources and ecosystems.										
Determine the immediate and long-term effects and biological fate of energy-related pollutants on freshwater resources and ecosystems and evaluate ways to minimize these effects (high priority).										
Determine the immediate and long-term non-pollutant effects of energy technologies including conservation on freshwater resources and ecosystems and evaluate ways to minimize these effects (high priority).										
Develop the capability to predict the effect of energy conservation and development on total ecosystems (high priority).										
Other, please specify										

*Solar includes ocean thermal, heating and cooling, wind, photovoltaic and bioconversion.
**See description in Enclosure A.

PROGRAM DESCRIPTION AND RESOURCE DISTRIBUTION

King Category: Ecological Effects: Marine and Estuarine

OBJECTIVES	TECHNOLOGY									
	Coal	Oil and Gas	Shale	Geothermal	Nuclear	Solar*	Hydro	Conservation**	Other	
To establish descriptions and provide data analysis of environmental parameters including biological, physical, chemical and geological components and the background concentrations of potential marine and estuarine pollutants in ecosystems impacted by energy conservation and development.										
To determine the immediate and long-term effects of pollutants on marine and estuarine organisms and ecosystems impacted by energy development.										
To determine the immediate and long-term non-pollutant effects, including physical and biological changes, on marine and estuarine organisms and ecosystems impacted by energy development and conservation.										
Develop the capability to predict pollutant and non-pollutant effects on marine and estuarine ecosystems.										
Other, please specify										

*Solar includes ocean thermal, heating and cooling, wind, photovoltaic and bioconversion.
**See description in Enclosure A.

PROGRAM DESCRIPTION AND RESOURCE DISTRIBUTION

King Category: Integrated Assessment

OBJECTIVES	TECHNOLOGY **									
	Coal	Oil and Gas	Shale	Geothermal	Nuclear	Solar*	Hydro	Conservation	Other	
To manage and integrate research information on environmental control and effects of energy technology systems.										
To estimate social, economic and cultural consequences of the environmental effects of alternative energy production and pollution control technologies.										
To assess the direct and indirect environmental consequences of energy production and control alternatives (whether similar or different in all regions.										
To evaluate cost/risk/benefit trade-off of energy production and pollution control alternatives.										
Evaluation of alternative approaches to implementing energy development, prevention of environmental damage and further studies.										
Other, please specify										

*Solar includes ocean thermal, heating and cooling, wind, photovoltaic and bioconversion.
**See description in Enclosure A.

ENCLOSURE C

[COMMITTEE PRINT]

AN INVENTORY OF ENERGY RESEARCH

PREPARED FOR THE

TASK FORCE ON ENERGY

OF THE

SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT

OF THE

COMMITTEE ON SCIENCE AND ASTRONAUTICS

U.S. HOUSE OF REPRESENTATIVES

NINETY-SECOND CONGRESS

SECOND SESSION

BY

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WITH THE SUPPORT OF

THE NATIONAL SCIENCE FOUNDATION

VOLUME I

Serial R

MARCH 1972

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COAL
CONCENTRATION & REFINING

ENGINEERING DEVELOPMENT-
OTHER
(CONTINUED)

<586>CONT.
1972 to study effective and economical methods for drying, handling, and storing western coals and is to be completed in FY 1975.
PUBLICATIONS: See lists of publications issued by the Bureau of Mines.
LOCATION: District of Columbia

<587>
TITLE: Chemical Removal of Nitrogen and Organic Sulfur from Coal
RESEARCH INSTITUTION: TRW, Inc.
ADDRESS: TRW, Inc., 23555 Euclid Ave., Cleveland, Ohio 44117
SPONSOR: Environmental Protection Agency, Office of Air Programs
FUNDING: $69000, FY71: $398000, FY72
DURATION: August 1970 to June 1977
DESCRIPTION: To develop and evaluate TRW's LSR process for removal of nitrogen and sulfur from coal. Determine applicability, limitations, and costs for removing organic sulfur and nitrogen from coal.
LOCATION: California

<588>
TITLE: Bureau of Mines Support for Design, Operation and Test Program Development for the Prototype Coal Cleaning Plant
RESEARCH INSTITUTION: U.S. Dept. of Interior, Bureau of Mines
ADDRESS: U.S. Dept. of Interior, Bureau of Mines, Pittsburgh Coal Research Center, 4800 Forbes Ave., Pittsburgh, Pennsylvania 15213
SPONSOR: Environmental Protection Agency, Office of Air Programs
FUNDING: $75000, FY71: $60000, FY72
DURATION: July 1969 to June 1975
DESCRIPTION: To evaluate and demonstrate the technology and costs involved in optimizing sulfur reduction in coals, evaluate and demonstrate the technology and cost of reprocessing reject material to recover BTU and sulfur values, and to develop correlations between sampling data and the sulfur reduction achievable, and the cost of this sulfur reduction.
LOCATION: Pennsylvania

<589>
TITLE: Agglomo-Separation Study
RESEARCH INSTITUTION: U.S. Dept. of Interior, Bureau of Mines
ADDRESS: U.S. Dept. of Interior, Bureau of Mines, Pittsburgh Research Center, 4800 Forbes Ave., Pittsburgh, Pennsylvania 15213
SPONSOR: Environmental Protection Agency, Office of Air Programs
FUNDING: $100000, FY71: $57000, FY72
DURATION: 1971 to 1973
DESCRIPTION: To identify the controlling variables affecting the efficiency of the agglomeration technique, to develop laboratory scale equipment, to optimize the processing technique and equipment to commercially demonstrate the feasibility of the agglomo-separation process.
LOCATION: Pennsylvania

<590>
TITLE: Coal Preparation
RESEARCH INSTITUTION: U.S. Dept. of Interior, Bureau of Mines
ADDRESS: U.S. Dept. of Interior, Bureau of Mines, Division of Coal, 18th & C Streets N.W., Washington, D.C. 20240
SPONSOR: U.S. Dept. of Interior, Bureau of Mines; Environmental Protection Agency
FUNDING: $884000, FY71: $464000, FY72
DURATION: 1969 to Indefinite
DESCRIPTION: Research is directed at the solution of a major coal preparation problem--the drying of fine sizes of coal and the elimination of air pollution associated with the drying operation. As the result of increasingly stringent air pollution standards, Environmental Protection Agency is supporting studies that attempt to

SAMPLE PROJECT
INFORMATION SHEET

CATEGORY: .....

SUBCATEGORY: .....

TECHNOLOGY: .....

SUBTECHNOLOGY: .....

OBJECTIVE: .....

.....

.....

PROJECT:

TITLE: .....

.....

.....

RES. FACILITY: .....

RES. LOCATION: .....

INVESTIGATOR(S): .....

SPONSOR(S): .....

DURATION: .....

FUNDING: .....

.....

DESCRIPTION:

RELATED TECHNOLOGIES: