

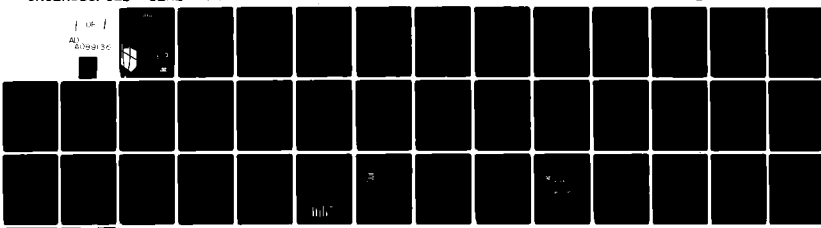
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CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAIGN IL F/6 6/6
ENVIRONMENTAL INFORMATION ACQUISITION AND MAINTENANCE TECHNIQUE--ETC(U)
AUG 80 R E RIGGINS, V T YOUNG, W D GORAN
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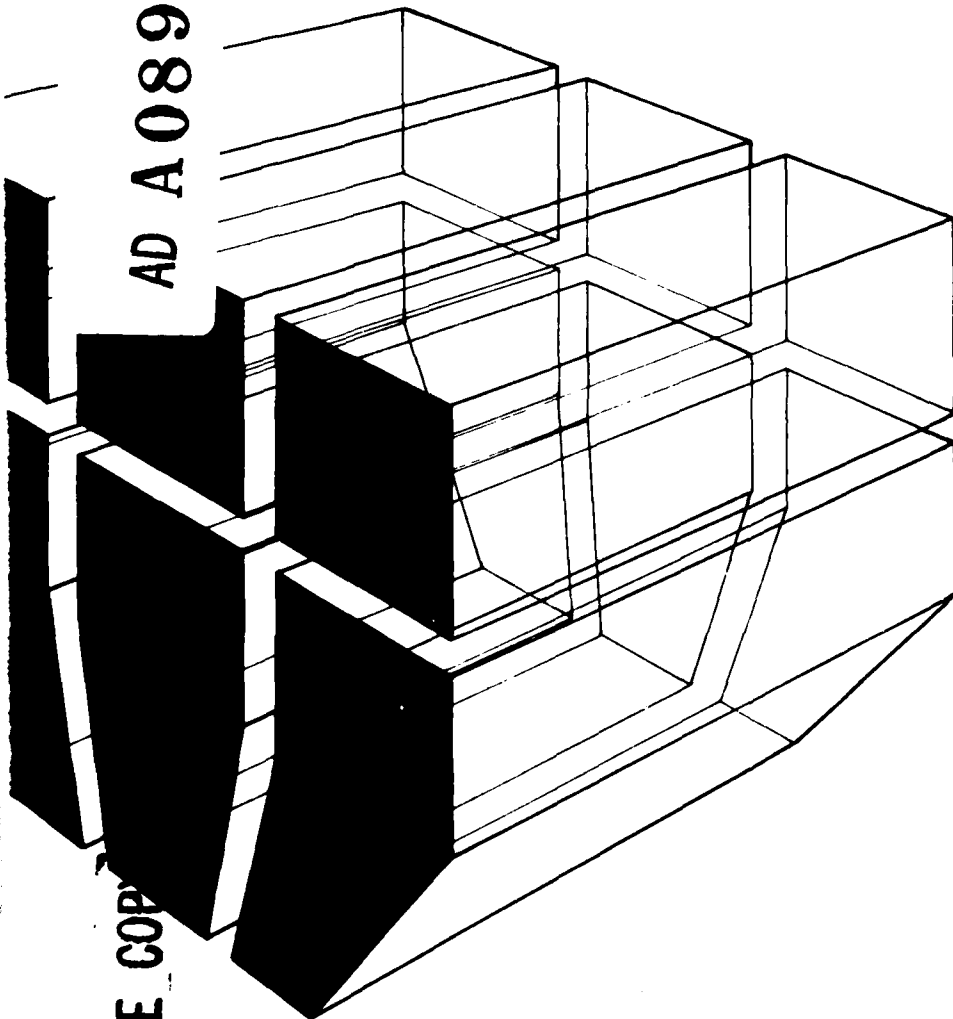


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TECHNICAL REPORT N-96
August 1980

ENVIRONMENTAL INFORMATION ACQUISITION AND MAINTENANCE TECHNIQUES: REFERENCE GUIDE

AD A089136



by
R. E. Riggins
V. T. Young
W. D. Goran

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 14 CERL-TR-N-96	2. GOVT ACCESSION NO. AD-A089 136	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) 6 ENVIRONMENTAL INFORMATION ACQUISITION AND MAINTENANCE TECHNIQUES: REFERENCE GUIDE.	7. TYPE OF REPORT & PERIOD COVERED 9 FINAL rept.	
5. AUTHOR(s) 10 R. E. Riggins V. T. Young W. D. Goran	8. CONTRACT OR GRANT NUMBER(s)	
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. ARMY CONSTRUCTION ENGINEERING RESEARCH LABORATORY P.O. Box 4005, Champaign, IL 61820	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 16 A4762720A896-01-035	
11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE 11 August 1980	13. REPORT NUMBER
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 12 44	14. NUMBER OF PAGES 36	15. SECURITY CLASS. (of this report) Unclassified
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE		
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES Copies are obtainable from National Technical Information Service Springfield, VA 22151		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) environmental impact statements data acquisition		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report provides a guide to techniques for collecting, using and maintaining data about each of the 13 environmental technical specialties in the Environmental Impact Computer System (EICS). The technical specialties are: (1) ecology, (2) environmental health, (3) air, (4) surface water, (5) ground water, (6) sociology, (7) economics, (8) earth science, (9) land use, (10) noise, (11) transportation, (12) aesthetics, and (13) energy and resource conservation. Acquisition techniques are classified by the following general categories: (1) secondary data, (2) remote sensing, (3) mathematical modeling, (4) field work, (5) mapping/maps and (6) expert opinion. →		

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Block 20 continued.

✓ A matrix identifies the most appropriate techniques for collecting information on the EICS technical specialties. After selecting a method, the user may read an abstract of the report explaining that technique, and may also wish to obtain the original document for detailed information about applying the technique.

Finally, this report offers guidelines on storing environmental information for future use, and on presenting that information effectively in environmental documents.



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FOREWORD

This study was conducted for the Directorate of Military Programs, Office of the Chief of Engineers (OCE), under Project A4762720A896. "Environmental Quality for Construction and Operation of Military Facilities"; Task 01, "Environmental Quality Management for Military Facilities"; Work Unit 035, "Unified Approach for Environmental Baseline Acquisition." Mr. V. Gottschalk, DAEN-MPE was the OCE Technical Monitor.

This study was conducted by the Environmental Division (EN) of the U.S. Army Construction Engineering Research Laboratory (CERL), and by the Battelle Columbus Laboratories.

Dr. R. K. Jain is Chief of EN. COL L. J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.

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ENVIRONMENTAL INFORMATION ACQUISITION AND MAINTENANCE TECHNIQUES: REFERENCE GUIDE

1 INTRODUCTION

Background

Evaluating the environmental effects of Army actions requires both identifying the attributes (e.g., air and water) likely to be most affected, and estimating changes in those attributes. The U.S. Army and other agencies in the Department of Defense (DOD) have developed techniques for acquiring information about environmental attributes. However, the descriptions of these techniques are in many separate documents published by several agencies, and may therefore be difficult to easily locate and use.

Since the U.S. Army Construction Engineering Research Laboratory (CERL) has developed the Environmental Impact Computer System (EICS), which categorizes environmental attributes, CERL was assigned the task of developing a concise guide to the techniques most appropriate for gathering information about each attribute.

Objective

The objective of this report is to provide Department of the Army (DA) environmental planning personnel with the guidance necessary to determine the most appropriate techniques for acquiring, using, and maintaining information used in environmental studies, environmental assessments (EAs), and environmental impact statements (EISs).

Approach

CERL contacted Army, Navy, and Air Force agencies to learn what research they had done on gathering environmental information. Reports on this research were acquired and later categorized by collection techniques and EICS attribute. Finally, each report was abstracted, and guidelines for using the abstracts were prepared.

Mode of Technology Transfer

The information in this report will be used to collect the necessary data to support impact assessment via the Environmental Technical Information System (ETIS). Following thorough field use and evaluation, this document will be modified and published in the same manner as all other ETIS user documents.

2 OVERVIEW OF ENVIRONMENTAL INFORMATION

When Army personnel begin an environmental impact assessment, statement or other environmental study, they immediately face several questions: (1) What information is needed? (2) What characteristics of environmental data are critical? (3) What data are readily available? (4) What are the most effective and efficient techniques for collecting data? (5) What are the usual ways of presenting the data? (6) How can these data be synthesized for the environmental analysis? Such questions may be difficult to answer since there is so much complex environmental information. To help personnel select data carefully and present it accurately, this chapter provides an introduction to environmental information and an overview of methods for collecting it.

Definition of Environmental Information

In this report, "environmental information" is any information needed to conduct environmental impact analyses and prepare EAs and EISs. This information is classified under the 13 technical specialties of EICS.

1. Aesthetics
2. Air
3. Earth Science
4. Ecology
5. Economics
6. Energy and Resource Conservation
7. Environmental Health
8. Groundwater
9. Land Use
10. Noise
11. Sociology
12. Surface Water
13. Transportation.

These general categories can be defined even more; for example, Air can be characterized by information such as:

1. Diffusion Factor
2. Particulates
3. Sulphur Oxides
4. Hydrocarbons
5. Nitrogen Oxide
6. Carbon Monoxide
7. Photochemical Oxidants
8. Hazardous Toxicants
9. Odor.

Much environmental information deals with such specific attributes. And with detailed data for all relevant attributes, a data base can be developed to describe each technical specialty.

Important Characteristics of Environmental Information

For environmental data used to prepare EAs/EISs, the following characteristics are of overriding concern.

Availability

The availability of data is always a consideration when seeking information to evaluate a potential project. However, the availability or unavailability of data is often not an absolute. Rather, the *accessibility* of information will determine the number of hours and employees required to collect data. The question, of course, is whether the information is worth the cost of acquisition. Often this tradeoff must necessarily be evaluated before data acquisition is complete. For example, assessing the full ecological impact of a project might require extensive fieldwork. The related costs of such data acquisition and manipulation must be compared to the *value* of that environmental information in assessing the critical impact of a project.

Therefore, two questions must be considered: (1) Is the needed information available; and (2) What level of effort is required to make the data applicable to the project evaluation? Generally, data already gathered and processed (i.e., information from secondary sources such as reports or articles) require less time and effort to use; primary data (information not collected and assembled previously) usually requires a larger investment.

Comparability

To estimate accurately a project's impacts, all environmental information should be *comparable*—thus allowing a frame of reference to be developed by contrasting one body of data with other information. Comparability must be considered at all stages of information acquisition and analysis, and often affects the two major bodies of data in a project's evaluation: (1) the baseline (or environmental conditions without the project); and (2) predicted environmental conditions upon implementation of the project. The accuracy and reliability of the estimates of impact will be greater for analyses that use highly comparable data than for those in which the data are less comparable.

Comparability is influenced by three variables: (1) level of data; (2) degree of quantification; (3) date of acquisition. To be comparable, the information should be at similar levels of detail (equivalent units of measure, for example); data that are not may require conversion to similar units. But in some cases, manipulation of the data to achieve comparability may not be possible.

The degree of quantification also affects the comparability of information. Generally, comparing numerical data is considered easier and more objective than comparing written information, which is likely to be subject to varying interpretations. The range of appropriate quantification will depend on the specific project being assessed.

Finally, data related to the same subject but collected at substantially different times will not be as comparable as data collected in the same time period.

Relevance

Time and money should be spent on gathering only data relevant to project analysis. Relevance is established primarily by use of a screening method (such as EICS) to select environmental attributes that are likely to be impacted. The pertinence of information also may be determined by asking a series of questions:

1. Is this information useful in analyzing the environment-affecting project?
2. Will the information be helpful in profiling existing conditions or assessing impacts?
3. Are the data relevant in terms of their comparability with other available information?

Scope

Environmental information is most valuable if it is current and its time reference is consistent with other comparable data. Likewise, such information is most applicable if its geographic scope focuses on that area affected by the proposed project.

Scope should be assessed before time and money are spent in acquiring and analyzing environmental information. Such an assessment will help to ensure that the environmental information collected will contribute to impact analysis.

Data Acquisition Technique Considerations

CERL's analysis of DOD reports indicates that environmental information may be collected from six sources:

1. Secondary Data
2. Remote Sensing
3. Mathematical Modeling
4. Fieldwork
5. Mapping/Maps
6. Expert Opinion.

But before a technique is selected for gathering information about environmental attributes, a number of factors should be considered—particularly the cost of the method, the acquisition time involved, and data accuracy. Such preliminary considerations should help the user choose the most appropriate means of data collection. However, one cannot assume that cost, time, and accuracy are equally important—their relative significance varies with the user and project.

Beyond these three general considerations are several other factors germane to one or more acquisition techniques. The overviews that follow were developed to highlight considerations which are particularly applicable to a given method. However, the discussion is not intended to provide a definitive analysis of the strengths and weaknesses of each technique. For further information it is recommended that the reader refer to the documents abstracted on pp. 12-27.

Secondary Data

Gathering data from secondary sources is perhaps the most common technique. Secondary data come

from such varied materials as Government reports, scientific literature, and facility monitoring reports. The advantages and disadvantages of this technique with respect to accuracy, time, and cost are discussed below.

Accuracy. The accuracy of data acquired from secondary sources can vary considerably, depending on the recency of the data and on the appropriateness of the sampling or survey techniques. Since environmental attributes constantly change, secondary sources of information can become outdated in a rather short time. The secondary data provided by the Bureau of the Census is an example. A complete census of the United States is taken once every 10 years. Performing such a survey more frequently is probably not economically or logistically feasible, and the Bureau implicitly recognizes the limitations of the decennial census by constantly updating information with special surveys of areas and demographic or economic trends.

The fact that data are current does not alone ensure their accuracy. On the contrary, even the most recent data can be inaccurate if inappropriate surveying was used to compile the information. Therefore, proper sampling is crucial. For example, much of the census data is based on 5-, 15-, and 20-percent samples of the population 10 years ago. Nevertheless, estimates based on these samples can be considered relatively accurate if appropriate sampling methods were used.

Another example of the accuracy problem is the U.S. Geographical Survey (USGS) hydrologic data which are collected periodically for specific areas. This information is geared to a particular time and level of detail. These two characteristics limit the usefulness of the data and may affect the data's accuracy for a given project to be assessed.

Time. The time involved in gathering data from secondary sources is minimal. One can usually obtain Government reports in only a few days by contacting the relevant agency. In some cases, secondary sources may even be more accessible. Public libraries and universities sometimes have census reports; and local planning agencies, in addition to maintaining relevant census documents, prepare and maintain a number of reports containing a variety of secondary data.

Cost. Generally, the cost of getting data from secondary sources is minimal. The expense of purchasing pertinent secondary sources, such as a report, can vary according to the publisher, reproduction costs, and size of the report, but probably is of little significance

compared to the overall costs of assessing environmental impacts.

Of course, as with other techniques of data acquisition, there would be some costs for the staff time required to abstract and format the information so that it is appropriate for the user.

Remote Sensing

Color or color infrared aerial photographs are widely used for environmental studies. Other devices may be appropriate for special problems; for example, multispectral and infrared scanners and radar remotely sense various forms of electromagnetic radiation from a surface.

Accuracy. Accuracy in remote sensing depends on the correct identification of variables, which in turn hinges both on the level of detail available and on what those details reveal about ground conditions. For example, correct evaluation of the vegetative pattern and species distribution may require accurate interpretation of photographs. Level of interpreted detail is determined by imagery scale, with a large-scale format providing greater detail. Of course, data acquired by remote sensing, like other forms of data, are accurate only to the extent that they are current, and thus account for recent changes in environmental attributes.

Time. There are many sources of delay in remote sensing technology. Depending on the sensor, waiting for clear weather may be a constraint. When using electronically sensed data, one might have to wait for a supplier to deliver computer-compatible tapes. And sharing a computer often entails delays.

Interactive computer systems (those allowing the user to query or to change stored information instantly) are the most expensive means of using remote sensing information. The speed of these systems is attractive, but their cost requires objective appraisal of the need for such instantaneous accessibility.

Aerial photos may be obtained quickly if they are already available from a Federal service such as USGS or the U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS). If, on the other hand, new photographs must be taken, some time could be lost as one waits for weather conducive to clear aerial photos. One of the advantages of aerial information is that it permits the user to gain an overall perspective of the landscape. Further, it avoids the inconvenience of conventional field-survey techniques.

Unlike air photography, radar is not so limited by weather or atmospheric conditions. On the contrary, a particular advantage of radar as a data acquisition technique is its day-or-night applicability and its usefulness in nearly all weather conditions. When data must be acquired in a relatively short time, these capabilities can be a tremendous advantage over other techniques.

Cost. Three types of costs are associated with remote sensing technology: capital, maintenance, and operations. Capital costs include both equipment and working space. The expenses of replacement parts and maintenance personnel are maintenance costs. Costs of operations include acquisition of data, equipment charges, and other supplies and services. Operational costs are generally lower than for most other methods of obtaining information, but depend on the availability of trained personnel.

For example, recent technical developments have greatly reduced the capital and maintenance costs of collecting data by radar. Personnel costs are perhaps the most significant expense associated with this technique. The user must either have, or contract, skilled personnel to interpret the information gathered.

In fact, personnel already trained to interpret remote sensing imagery are in short supply. Special short courses are becoming common, and as more colleges and universities include regular courses, the supply of planners trained in remote sensing will increase. Currently, however, the lack of specially trained staff requires paying some people to attend short courses.

Mathematical Modeling

Models are sets of mathematical equations that can yield predictions of environmental attributes or phenomena. Four characteristics of mathematical models are computer-system requirements, aggregation problems, data availability, and application.

Computer-System Requirements. Given the complexity of the simulations which may be involved or the large number of equations that may have to be solved, it is clear that using sophisticated mathematical models often requires access to computers. Even if computer facilities are readily available, the operating costs of these models can be high. However, when models are used several times, they offer significant economies of scale.

Aggregation Problems. In most mathematical models, the level of aggregation is a consideration. Perhaps the

most common aggregation problem is the number of variables employed in the model. For some purposes, models are more useful with the greater detail provided by a large number of variables; but problems of data availability prohibit highly disaggregated models in some cases. Of course, where much aggregation occurs, detailed attributes and associated events may be ignored. On the other hand, a limited number of variables may permit the estimation or simulation of highly complex events which otherwise would not be feasible.

Data Availability. In general, the data needs of mathematical models are particularly demanding. The main difficulty in most models is that data have to be collected from many sources. Because of differences in collection, aggregation, and reporting, data may not be immediately useful in their initial form. Consequently, some effort may be required to normalize data from different sources before inputting to a model.

Application. When using a mathematical model, one should recognize that some models were developed to address a particular problem or to be used in a specific case. Therefore, these models may not have widespread application.

Fieldwork

Fieldwork, in the most general sense, can include a number of activities, but for surveying environmental attributes, interviewing and sampling are most common.

Data Confidence. Fieldwork increases confidence in the data's accuracy because the data are not outdated, and are unique to the site, area, or setting being studied. Many sources of data are old and may not offer a realistic account of the present situation. For example, a large portion of all secondary data on socioeconomic environmental attributes is from the 1970 census.

Fieldwork also permits the user to acquire data unique to the setting or situation being studied. Other sources of data, particularly secondary data, sometimes lack the amount of detail desired. Fieldwork permits the user to select the level of detail that he/she needs, thus ensuring that significant events, circumstances, or attributes are evaluated.

Fieldwork's shortcoming is that the data's scope may be so narrow that generalizations may be very difficult or inappropriate.

Cost. Fieldwork is costly because one or more persons must visit a site to collect relevant information.

Furthermore, data acquired through fieldwork frequently need to be changed to a more useful format before they can be used. When compared with the low cost of collecting data by other techniques—examining secondary sources, for example—it is clear that the added costs of fieldwork must be weighed against the value of increased timeliness, detail, or accuracy.

Mapping/Maps

Use of maps is a common way of obtaining and recording environmental information.

Accuracy. Maps present two problems. First, environmental factors associated with any particular area can change over time; for instance, agricultural land could be converted to residential use. Unless the map has been periodically updated, these changes will be overlooked and information will be inaccurate. Second, the map may not show enough detail. For example, within a 5-acre area there could be multiple uses of land. However, if the map has a small scale in which information is reported only for 5-acre plots, then only the predominant land use is likely to show up in the data. Since other land uses of the same plot are not reported, the data are inaccurate.

Cost. The costs of getting data from a map are generally low compared with other techniques. For example, the cost of collecting existing data on land use for a particular area could be significantly higher when fieldwork is used instead of maps. With fieldwork, personnel would need to survey the area, provide measures of particular uses, and record the information. On the other hand, data can be taken directly from maps and formatted, eliminating time spent in the field.

Expert Opinions

In some cases, data needed for a particular study may be improperly formatted, obsolete, unavailable, or nonexistent. In other cases, the reliability of available data may be suspect. Therefore, it may be useful occasionally to seek the opinion of an expert on the subject.

Reliability. Ideally, since the expert's opinion is based on lengthy experience and observation, the data should be reliable. In fact, information from experts will contain biases that must be offset by sample size, averaging, and bias-detection techniques. Clearly, the user of expert opinion must carefully evaluate the reliability of information obtained. This can be done by judging the expert's credentials, and by making sure that the individual is in fact dealing with his/her area of expertise.

Time. An expert can usually render an opinion promptly and efficiently.

Cost. The cost of obtaining information can vary a lot depending on the type of opinion and detail needed. In some instances, an expert opinion may be free or quite inexpensive. For example, if the user needs a Government official's view on air quality trends in an area, the official has to provide his/her opinion without charge. In fact, the only expense in this case might be the telephone call to the official. But when expert opinion is obtained under a contract—with a consulting firm, for instance—the costs can be substantial.

3 ABSTRACTS OF REPORTS ON ENVIRONMENTAL INFORMATION ACQUISITION TECHNIQUES

Reference Matrix

CERL has developed a matrix (Table 1) to help those writing an EA/EIS decide which of the methods described in Chapter 2 might be most useful for collecting data on a given environmental attribute. The matrix is designed with selected EICS environmental attributes listed on the left, and data acquisition techniques across the top. The matrix consists of cells which contain numbers referring to abstracts of literature detailing use of various acquisition techniques (pp. 12-27). For example, abstract number 9 is in the cell that shows the relation between the environmental attribute "water erosion," and the data acquisition technique "remote sensing." Abstract 9 is an overview of the following document: Lewis E. Link, Jr. and James R. Stabler, *The Use of Remote Sensing Systems for Acquiring Data for Environmental Management Purposes, Report 3—A Nomogram for Computing Optical Density Contrast* (U.S. Army Engineer Waterways Experiment Station, May 1976). The overview can help a reader decide the value of using this technique to collect data for assessing impacts on land use patterns. However, the reader may also wish to obtain the original document for detailed information about applying a given technique.

Generally, the matrix can be used in one of three ways. First, it can identify techniques that may be used to gather the data necessary to evaluate impacts on a particular attribute. Second, the user may be interested in the number and types of attributes that could be assessed by a given technique. Finally, the matrix can identify several data acquisition techniques that could

be compared and evaluated for potential use in assessing impacts for a particular attribute.

Abstract 1

Acquisition Technique(s) Used: Fieldwork, expert opinion, mapping, secondary data: government reports/information, scientific literature, facility monitoring reports.

Title: *Environmental Baseline Descriptions for Use in the Management of Fort Carson Natural Resources: Report 1—Development and Use of Wildlife and Wildlife Habitat Data*, Technical Report M-77-4/ADA048656.

Author(s): Anthony M. B. Rekas.

Publisher: U.S. Army Waterways Experiment Station.

Date: October 1977

Intended Audience: Army personnel involved in environmental studies.

Key Attributes: Mammals.

Abstract: This report outlines a method for developing a baseline profile of specific wildlife habitats. The procedure (as applied to the Fort Carson, Colorado, locale) involved: (1) Identification of key species; (2) Determination of the habitat profile for each species; (3) Location of each required habitat element in the geographic area of interest; (4) Preparation of map overlays indicating the extent of each factor in the geographic area; and (6) Verification of hypothesized or actual habitats.

This method does not require extensive fieldwork to specify the geographic area associated with specific species; rather, the spatial extent of species habitats are developed through secondary information and detailed knowledge of the geographic area and its characteristics. Such characteristic profiles may be augmented with data from remote sensing techniques.

Abstract 2

Acquisition Technique(s) Used: Mapping, expert opinion, remote sensing, field work, secondary data: government reports/information, scientific literature, facility monitoring reports.

Title: *Study of Ecological Inventory and Classification Manual*.

Table 1
Reference Matrix

TECHNICAL SPECIALTIES AND KEY CORRESPONDING ATTRIBUTES	ACQUISITION TECHNIQUES						
	Secondary Data*	Remote Sensing	Mathematical Modeling*	Fieldwork*	Maps/ Mapping*	Expert Opinion*	
(NOTE: ABSTRACTS LISTED ONLY UNDER A TECHNICAL SPECIALTY COVER ALL ITS INCLUDED ATTRIBUTES)							
I. GENERAL (About <u>all</u> attributes)	10,21 26,28,34,35	24,26	26	26	26,28		
II. ECOLOGY							
Mammals	1			1			
Birds							
Fish/Aquatic life							
Vegetation	14	5,7,9	7,9	14	14	14	
Endangered plant/animal species							
Soils		7,9	7,9				
III. HEALTH SCIENCE							
Biological hazards							
Chemical hazards							
Psychological hazards							
IV. AIR							
Particulates	22,30		30	20,22			
Gases and vapor	32		32				
Precipitation	32		32				
Wind direction and speed				8,16			
Insolation				8,16			
Temperature				8,16			
V. SURFACE WATER							
Turbidity	12,31		31				
Temperature	2	2		19			
Depth	2	2		2,6,19,20	2	2	
				2,20	2	2	

* Numbers in these columns refer to abstracts on pp 12 to 27.

Table 1 (Cont'd)

TECHNICAL SPECIALTIES AND KEY CORRESPONDING ATTRIBUTES	ACQUISITION TECHNIQUES					
	Secondary Data*	Remote Sensing*	Mathematical Modeling*	Fieldwork*	Maps/ Mapping*	Expert Opinion*
V. SURFACE WATER (cont.)						
Velocity	2	2		2,20	2	2
Alkalinity and acidity				19,20		
Hydrogen ion concentration (pH)						
Total dissolved solids				6,19,20		
Dissolved oxygen	2	2		2	2	2
Salinity		4	4			
Bod	23	4	4	23		
Pollutants	2	2		2	2	2
Chemical composition				6		
pH				8		
Conductivity				8		
	6,15	6		6	6	6
VI. GROUNDWATER						
Depth of water table						
Availability of groundwater						
Water quality	27,31		31	27	27	
VII. SOCIOLOGY	38					
Demographics						
Housing						
Community profile						
Public services						
Education						
VIII. ECONOMICS	37					
Total income and output						
Employment						
Regional economic stability						
Land and property values						
Public sector revenue						
	2,12	2,17	17,25	2,17	2,17,25	2
IX. EARTH SCIENCE						
Water erosion	6,14	6,7,9	7,9,16	6,14,16	6,14,16	6,14
Wind erosion		7,9	7,9			
Subsurface strata		13		13		
Bedrock		3		3		

* Numbers in these columns refer to abstracts on pp 12 to 27.

Table 1 (Cont'd)

TECHNICAL SPECIALTIES AND KEY CORRESPONDING ATTRIBUTES	ACQUISITION TECHNIQUES						
	Secondary Data*	Remote Sensing*	Mathematical Modeling*	Fieldwork*	Maps/ Mapping*	Expert Opinion*	
IX. EARTH SCIENCE (cont.)							
Soil compaction		3,5		3			
Soil horizon mixing		3		3			
Subsurface vibration		3		3			
Soil moisture content		13		13,18			
X. LAND USE	6,11,12,14	6,17	17,31	6,14,17	6,14,17	6,14	
Compatibility of land uses							
Land use patterns							
Access to environmental resources							
Consumption of land and land resour.			16	16	16		
XI. NOISE	33		33	33	33		
Sound levels							
Disruption of human activities							
XII. TRANSPORTATION							
Disruption of transportation patterns							
Modify/extend facilities							
XIII. AESTHETICS			16	16	16		
XIV. ENERGY AND RESOURCE CONSERVATION							
Changes in consumption/use							
Landforms	15						
Atmospheric resources	15						
Soil resources	15						
Forest resources			16	16	16		
Grassland resources	14		16	14,16	14,16	14	
Cropland resources	6	6	6	6	6	6	
Animal resources							
Freshwater resources	6	6		6	6	6	
Soilwater resources							
Solid waste	29,32		29,32				
Soil resources	14		16	8,14,16	14,16	14	

* Numbers in these columns refer to abstracts on pp 12 to 27.

Author(s): EG & G Washington Analytical Services Center, Inc., for Naval Facilities Engineering Command.

Date: October 1977.

Intended Audience: The manual is specifically addressed to the survey team that will conduct the ecological classification and inventory of a U.S. Navy installation. The method presented has been organized for those who are outside the biological or ecological profession, although some parts may be useful to professionals in these areas.

Key Attributes: Ecology (all); earth science (all); surface water: depth, salinity, velocity, temperature, and chemical composition.

Abstract: The manual sets out the level of effort, the methods and techniques, and the classification system to be used by an interdisciplinary group of regional experts to perform an ecological survey on a Navy installation. The manual suggests inventory elements that are relevant to the requirements of the U.S. Navy. The procedures for conducting the inventory and presenting the data are considered the most appropriate for personnel who will be using the data. The baseline survey's purpose is to establish a beginning point in time as a reference for all future plans and studies, and to avoid having to collect the same information over and over again to meet new requirements.

Abstract 3

Acquisition Technique(s) Used: Remote sensing, fieldwork.

Title: *Determining Presence, Thickness, and Electrical Properties of Stratified Media Using Swept-Frequency Radar*, Technical Report M-72-4/AD752509.

Author(s): J. R. Lundien.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: November 1972.

Intended Audience: Professionals involved in assessing surface and subsurface ground stability for construction purposes, road building, etc.

Key Attributes: Bedrock, soil compaction, soil horizon mixing, subsurface vibration.

Abstract: Swept-frequency radar (microwave energy) is a nondestructive method of assessing the nature of layered subsurface strata. Such quantitative information is useful in predicting vehicle performance, foundation design strength, and carrying capacities of artificial surfaces. Therefore, this mode of investigation has possible applications for environmental impact assessment. Data collected by swept-frequency radar can be used to predict the nature and extent of a project's effects on bedrock soil compaction, soil horizon mixing, and subsurface vibration. However, this data acquisition technique does require fieldwork and specialized equipment.

Abstract 4

Acquisition Technique(s) Used: Mathematical modeling, remote sensing.

Title: *The Use of Remote Sensing Techniques for Detection and Identification of Pollutant Discharges*, Miscellaneous Paper M-73-11/ADA017727.

Author(s): L. E. Link, Jr.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: August 1973.

Intended Audience: Office, Chief of Engineers; U.S. Army Thesis Committee; Mississippi State University, Department of Civil Engineering.

Key Attributes: Surface water: BOD, pollutants.

Abstract: This study evaluates, by quantitative simulation techniques, the capabilities of current photographic remote sensing techniques for detecting and identifying pollutant discharges.

Abstract 5

Acquisition Technique(s) Used: Remote sensing.

Title: *Terrain Analysis by Electromagnetic Tape*.

Author(s): J. R. Lundien.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: September 1976.

Intended Audience: NASA personnel.

Key Attributes: Soil compaction, soil horizon mixing, vegetation.

Abstract: This study was sponsored by NASA to provide information for decisions about the kinds of scientific devices to be included on manned spacecraft. Electromagnetic radiation at radio frequencies can penetrate soil surfaces and indicate subsurface conditions and layering. In addition, such sensors can provide information about the moisture content of soil samples and the presence of surface vegetation at various heights. This acquisition technique has some relevance to data gathering efforts for environmental assessment. However, the technique requires specialized equipment and controlled conditions; it has limited field mobility.

Abstract 6

Acquisition Technique(s) Used: Fieldwork, mapping, expert opinion, remote sensing, secondary data: government reports/information, scientific literature.

Title: *Data Needs and Data Gathering for Areas of Critical Environmental Concern: Part 1: Summary Report, Part 2: Selected Papers from State Programs.*

Author(s): Institute for Environmental Studies.

Publisher: The University of Wisconsin.

Date: September 1975.

Intended Audience: Individuals dealing with related programs.

Key Attributes: Ecology (all); groundwater; water erosion; land use (all); energy and resource conservation; freshwater resources, cropland resources.

Abstract: This report addresses data needs and data-gathering approaches for State definition and management of areas of critical environmental concern. The report results from a one-year "state-of-the-art" review of critical area data needs and data-gathering approaches. The term "area of critical environmental concern" is generally applied to State land-management programs for areas where natural resource values or hazards play a key role in determining the suitability of the land for particular uses.

This report begins with a brief statement of recommendations for data-gathering programs. These are

documented and amplified by later sections of the report. Section 2 broadly examines critical area programs and data requirements of each program phase. Section 3 examines, in greater depth, unmet data needs. Section 4 states general principles in the design of critical area data-gathering programs. Section 5 examines State and local roles in data-gathering. Section 6 considers the Federal role in critical data-gathering. Section 7 lists research needs for critical area data-gathering topics not addressed or only superficially addressed by the study. The Appendix lists critical area programs surveyed by the present study, provides profiles of selected federal data-gathering efforts, and lists workshop speakers and participants.

Abstract 7

Acquisition Technique(s) Used: Remote sensing, mathematical modeling.

Title: *The Use of Remote Sensing Systems for Acquiring Data for Environmental Management Purposes: Report 1—A Procedure for Predicting Image Contrasts in Photographic Remote Sensor Systems*, Technical Report M-74-8/ADA002070.

Author(s): Lewis E. Link, Jr.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: November 1974.

Intended Audience: Army personnel working in the area of environmental management and the application of remote sensing systems.

Key Attributes: Vegetation, soils, wind erosion, water erosion.

Abstract: Remote sensing, as an environmental information acquisition technique, requires sophisticated equipment and trained personnel. However, it has the potential of providing detailed, comprehensive data that can be updated regularly. The usefulness and accuracy of such data is a function of proper instrument calibration and setting. This report outlines a simulation model developed by the U.S. Army to improve the imagery for specific purposes (e.g., focusing on vegetation or soil changes). The model provides a means for selecting a sensor system and mission profile that will make the data collected as useful as possible.

Abstract 8

Acquisition Technique(s) Used: Fieldwork.

Title: *Environmental Baseline Descriptions for Use in the Management of Fort Carson Natural Resources: Report 2--Water Quality, Meteorologic, and Hydrologic Data Collected with Automated Field Stations*, Technical Report M-77-4/ADA046827.

Author(s): Harold W. West and Herman M. Floyd.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: September 1977.

Intended Audience: Army personnel involved in natural resource management.

Key Attributes: Surface water: dissolved oxygen, temperature, pH, conductivity; air: precipitation, wind direction and speed, insolation, temperature; energy and resource conservation: soil resources.

Abstract: This report outlines a field instrumentation acquisition technique for gathering meteorological, hydrological, and water quality data. In addition to the scientific equipment, the technique described includes use of magnetic cassette tape for sensing and recording data, subsequent computer processing and retrieval, and display of data in formats selected by the user.

Abstract 9

Acquisition Technique(s) Used: Mathematical modeling, remote sensing.

Title: *The Use of Remote Sensing Systems for Acquiring Data for Environmental Management Purposes: Report 3--A Nomogram for Computing Optical Density Contrast*, Technical Report M-74-8/ADA026718.

Author(s): Lewis E. Link, Jr. and James R. Stabler.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: May 1976.

Intended Audience: Collectors of terrain data.

Key Attributes: Vegetation, soils, wind erosion, water erosion.

Abstract: This report presents a nomogram for predicting image optical density contrasts on aerial photographs. Report 2 of this series explained the computer simulation model ("the remote sensing simulation model" corresponding to this nomograph). Because computer facilities and personnel who know how to operate remote terminals are not always available, this nomograph was developed to provide an alternative means for planning remote sensing missions, and thus improving remote sensing data acquisition programs. Both the nomograph and the computer simulations examine the effects of major variables that influence informational content of aerial photographs.

Abstract 10

Acquisition Technique(s) Used: Secondary data.

Title: *Computer-Aided Environmental Legislative Data System User Manual*, Technical Report N-56/ADA061126.

Author(s): J. van Weringh, J. Patzer, R. Welsh, and R. Webster.

Publisher: U.S. Army Construction Engineering Research Laboratory.

Date: September 1978.

Intended Audience: Army planners.

Key Attributes: General.

Abstract: The Computer-Aided Environmental Legislative Data System (CELDS) was developed to respond to the Army's need for rapid, easy access to environmental legislation relevant to a specific project or activity. This system, a collection of current Federal and State environmental laws, regulations, and standards, has been developed for those who are not lawyers. Abstracts of the legislation are written in a straightforward, narrative style with all legal jargon and excessive verbiage removed. These abstracts are not intended to replace the original documents or resolve complex legal problems; their sole aim is to provide quick access to current controls on activities that may influence the environment, and to supply informative data for environmental quality management.

Abstract 11

Acquisition Technique(s) Used: Secondary data.

Title: *Environmental Resource Data: Intergovernmental Management Dimensions*.

Author(s): The Council of State Governments, Lexington, KY.

Date: July 1978.

Intended Audience: Local, State, and Federal government personnel involved in designing, coordinating, and implementing environmental information systems.

Key Attributes: Land use.

Abstract: This report examines the issues and alternatives for intrastate data management and Federal-State communication. It provides an overview of the typical types of information that relevant State and Federal agencies provide, and outlines the coordination problems often encountered. Therefore, this document is useful background for professionals involved with environmental assessments.

Abstract 12

Acquisition Technique(s) Used: Secondary data.

Title: *Guidance for Application of Remote Sensing to Environmental Management: Appendix A—Sources of Available Remote Sensor Imagery*, Instruction Report M-78-2/ADA053673.

Author(s): John R. May.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: March 1978.

Intended Audience: Users of remote sensory imagery data.

Key Attributes: Earth science, land use, ecology, surface water.

Abstract: This document is a guide to sources of remote sensor imagery available from Federal and State agencies throughout the United States. Although not all possible agencies were contacted, the major sources of imagery of interest for environmental management at military installations have been identified. Data available in this document are: location, types, characteristics, availability, and costs of remote imagery acquired and held by Federal and State agencies (Tables A-1 through A-3). Some of the characteristics include: agency or organization, type of imagery, range of scales, coverage areas, coverage period and frequency, avail-

ability and characteristics of imagery, products available, and procedures for obtaining imagery.

Abstract 13

Acquisition Technique(s) Used: Fieldwork, remote sensing.

Title: *Terrain Analysis by Electromagnetic Means: Report 5—Laboratory Measurements of Electromagnetic Propagation Constants in the 1.0 to 1.5-GHz Microwave Spectral Region*, Technical Report 3-693/AD881799.

Author(s): J. R. Lundien.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: February 1971.

Intended Audience: Construction site or movement of ground vehicle planners.

Key Attributes: Subsurface strata, soil moisture content.

Abstract: To be able to measure soil strength and trafficability of soils near land sites of interest to the military, the Waterways Experiment Station employed an electromagnetic technique to quickly provide "accurate information on the physical properties of the soil." Tests were performed to determine basic electrical properties of soils at high radio frequencies and to establish correlations between these electrical properties and soil moisture content.

Abstract 14

Acquisition Technique(s) Used: Expert opinion, mapping, fieldwork, secondary data: government reports/information, scientific literature, facility monitoring reports.

Title: *Environmental Baseline Descriptions for Use in the Management of Fort Carson Natural Resources: Report 3—Inventory and Assessment of Current Methods for Range-land Conservation and Restoration*, Technical Report M-77-4/ADA053975.

Author(s): Anthony M. B. Rekas and William L. Kirk.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: April 1978.

Intended Audience: Army personnel involved in soil erosion control.

Key Attributes: Soil resources, vegetation, land use, grassland resources, water erosion, wind erosion.

Abstract: This report focuses on identifying and evaluating various soil conservation methods. Activities included in this identification and evaluation were: a literature survey, a review of methods used by Fort Carson (as well as a mapping of areas where those approaches were used), and an assessment of resulting effectiveness. The conservation methods included: establishing permanent grasses, constructing dams/basins, limiting vehicle traffic, placing critical areas off-limits for maneuvers, pitting and ripping.

Abstract 15

Acquisition Technique(s) Used: Secondary data: government reports/information, scientific literature.

Title: *Environmental Baseline Descriptions for Use in the Management of Fort Carson Natural Resources: Report 5--General Geology and Seismicity*, Technical Report M-77-4/ADA046828.

Author(s): Elba A. Dardeau, Jr. and Marcos A. Zappi.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: September 1977.

Intended Audience: Army personnel involved in environmental studies.

Key Attributes: Landforms, atmospheric resources, soil resources, groundwater (all).

Abstract: This report addresses the physiographic, geologic, seismic, and groundwater characteristics of the Fort Carson Reservation. It also relates these factors to their importance in affecting microclimate, surface hydrology, sedimentation, water availability, and construction practices. This geologic and seismic profile of Fort Carson was primarily developed from secondary information. Such geologic and seismic information is needed to assess the environmental impact of a project undertaking.

Abstract 16

Acquisition Technique(s) Used: Fieldwork, mathematical modeling, mapping.

Title: *Environmental Baseline Descriptions for Use in the Management of Fort Carson Natural Resources: Report 4--Analysis and Assessment of Soil Erosion in Selected Watersheds*, Technical Report M-77-4/ADA052347.

Author(s): Malcolm P. Keown and Harold W. West.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: February 1978.

Intended Audience: Army professionals in the area of environmental management.

Key Attributes: Soil resources, water erosion, aesthetics, forest resources, grassland resources, consumption of land and land resources.

Abstract. This study developed a method for predicting soil erosion levels on a military reservation. Although other general models for soil erosion had been developed previously, they were only applicable to nonmilitary uses of land. The model explained in this report can be used as an assessment tool, as well as an engineering design aid.

Abstract 17

Acquisition Technique(s) Used: Remote sensing, mapping, mathematical modeling, fieldwork.

Title: *Acquisition of Terrain Information Using Landsat Multispectral Data: Report 2--An Interactive Procedure for Classifying Terrain Types by Spectral Characteristics*, Technical Report M-77-2/ADA045871.

Author(s): Horton Struve, Warren E. Grabau, and Harold W. West.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: September 1977.

Intended Audience: Strategic and tactical planners.

Key Attributes: Land use (all), earth science (all).

Abstract: This study outlines a semiautomated procedure for classifying Landsat radiance data in terms of preselected land-use categories or terrain types. The procedure is an interim solution to the problem of mapping very large land areas in terms of relatively crude categories in very short periods of time.

The procedure requires a computer to retrieve spectral signatures from the array of Landsat radiance values, which then are grouped into spectrally similar clusters. The clusters are displayed on a color-coded map overlay. The analyst must provide the final interpretation and classification.

Some ground truth data are essential in order to judge the acceptability of the cluster of values used as a basis for classification.

Abstract 18

Acquisition Technique(s) Used: Fieldwork.

Title: *Environmental Data Collected with Automated Field Station at the Upper Blakeley Island Disposal Area, Mobile, Alabama*, Miscellaneous Paper M-77-5/ADA040004.

Author(s): Margaret H. Smith, Herman M. Floyd, and Harold W. West.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: April 1977.

Intended Audience: Designers of field experiments or prototype disposal techniques.

Key Attributes: Earth science: soil moisture content; air: precipitation, wind direction and speed, temperature, insolation.

Abstract: This report describes the system of instruments and the automated field station used to collect environmental data supporting field experiments on methods of densifying dredged material in containment areas. Data collected by the automated instrumentation included wind speeds, rainfall, wind direction, solar radiation, air and soil temperature, and pan evaporation.

The field station was designed to provide an unattended data-gathering facility capable of measuring environmental and engineering parameters and recording the data on magnetic (cassette) tape at any of

10 different time intervals. As a result of these limited field experiments, it was felt that the Lockheed Electronics Company (LEC) recorder with the Climet sensor provided accurate and reliable measurements of wind speeds.

Abstract 19

Acquisition Technique(s) Used: Fieldwork.

Title: *Water-Quality and Rainfall Data Collected with Automated Field Station, Fort McClellan, Alabama*. Miscellaneous Paper M-76-22/ADA035825.

Author(s): Margaret H. Smith, Herman M. Floyd, and Harold W. West.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: December 1976.

Intended Audience: Personnel concerned with natural resources management and maintenance of environmental quality.

Key Attributes: Surface water: hydrogen ion concentration (pH), dissolved oxygen, temperature, turbidity.

Abstract: This report briefly describes the system of instruments used to collect water-quality and rainfall at one site. This work is an initial phase in upgrading data acquisition procedures for the long-range environmental management program.

A reliable, instrumented environmental data system was developed and field tested to: (1) sense and record, on magnetic cassette tape, selected environmental data on-site, in real time, at sampling rates selected by the user, (2) sort and store the recorded data for computer processing and retrieval, and (3) display the recorded data in tabular or graphic formats specified by the user. To a large extent, the system operates automatically and substantially reduces the costs and errors of manual data recording and handling.

Abstract 20

Acquisition Technique(s) Used: Fieldwork.

Title: *An Automated System for Collecting, Processing, and Displaying Environmental Baseline Data*, Technical Report M-76-11/ADA033359.

Author(s): Harold W. West and Herman M. Floyd.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: November 1976.

Intended Audience: Life-cycle management of Army military facilities.

Key Attributes: Air (all); surface water: depth, velocity, hydrogen ion concentration (pH), dissolved oxygen, temperature.

Abstract: A system for automated collecting, processing, and displaying of environmental baseline data is described. Also discussed are the system's functions: data collection with automated field station data processing, and data display options. The report describes field demonstrations of the system conducted to determine the system's reliability. An estimated cost (1976) of the automated field station and selected array of sensors is provided.

The results indicate that the automated system is a significant step forward in providing a reliable, continuous data-collection device for a variety of environmental and engineering monitoring requirements for Army facilities.

Abstract 21

Acquisition Technique(s) Used: Secondary data: government reports/information.

Title: *Baseline Elements and Information Sources for Environmental Quality Management of Military Installations*, Technical Report M-76-10/ADA033117.

Author(s): Malcolm P. Keown and Marshall R. Weathersby.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: September 1976.

Intended Audience: Army personnel involved in preparing EAs and EISs.

Key Attributes: General.

Abstract: This report was designed to complement CERL's EICS. The report provides a list of environmental baseline elements which would be useful in developing a baseline description of an Army installation

or project site. The scope of the study also included developing a catalog of environmental information sources categorized by EICS elements; this catalog has been computerized and can be accessed through CERL. The appendices contain lists of all EISs prepared for military installations, and of agencies that are sources of final EAs and EISs.

Abstract 22

Acquisition Technique(s) Used: Fieldwork, secondary data: government reports/information, facility monitoring reports.

Title: *The Navy Air Pollution Source Information System (NAPSIS): A Compendium of Input Forms and Report Formats*.

Author(s): Navy Environmental Support Office, Port Hueneme, CA.

Date: January 1979.

Intended Audience: Navy and Marine Corps personnel involved in monitoring air pollution compliance status.

Key Attributes: Air (all).

Abstract: This document describes the Navy and Marine Corps' air pollution source information system and abstracts reports produced from the system. Samples of input/output forms are provided. Data on abatement, monitoring equipment, and emissions are easily accessible.

Abstract 23

Acquisition Technique(s) Used: Fieldwork, secondary data: government reports/information, facility monitoring reports.

Title: *Navy Wastewater Data Processing: A Compendium of Input Formats and Report Formats*.

Author(s): John A. Lucas, Jr.

Publisher: Navy Environmental Support Office, Port Hueneme, CA.

Date: April 1979.

Intended Audience: Personnel monitoring water quality.

Key Attributes: Surface water: pollutants.

Abstract: This document is a collection of currently used source documents (input forms) and output reports produced from these source documents. Three computer files for wastewater data processing are described: (1) water quality data file, (2) water quality station descriptor file, and (3) water quality environmental regulation file. A principal product of the system is the Discharge Monitoring Report (DMR).

Abstract 24

Acquisition Technique(s) Used: Remote sensing.

Title: *Remote-Sensing Practice and Potential*, Miscellaneous Paper M-74-2/ADA035977.

Author(s): Albert N. Williamson, William K. Dornbusch, and Warren E. Grabau.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: May 1974.

Intended Audience: Engineers and scientists interested in obtaining information from remote sensing systems.

Key Attributes: General.

Abstract: This report presents a general overview of the state of the art of remote sensing and introduces some of the capabilities at the U.S. Army Engineer Waterways Experiment Station that have been developed in connection with past projects. The six essential steps that must be completed if a remote sensing system is to produce useful information are: problem specification, ground control data acquisition, remote sensor information acquisition, data manipulation, information extraction, and information presentation. Each of these processes is described in detail. In addition, the instruments needed are shown, and interpretation of their output and the problems associated with interpretation are discussed.

Abstract 25

Acquisition Technique(s) Used: Mathematical modeling, maps.

Title: *Computer Procedure for Calculating and Displaying the Boundaries of a Watershed*, Technical Report M-76-12/ADB01695L.

Author(s): Victor E. LaGarde and Margaret H. Smith.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: December 1976.

Intended Audience: Personnel concerned with water movement and its effects.

Key Attributes: Earth science (all).

Abstract: This document describes a computer program (using information from a topographic map or input) that successfully and economically calculates watershed boundaries. Also included in this document is a description of the computer equipment, a description and copy of the computer program, and a comparison of the computer-calculated and manually interpreted watershed boundaries.

Abstract 26

Acquisition Technique(s) Used: Maps, fieldwork, remote sensing, mathematical modeling, secondary data: government reports/information, scientific literature facility monitoring reports.

Title: *Manual of Procedures for Developing Environmental Baseline Data* (Draft Report).

Author(s): Anthony M. B. Rekas, Malcolm P. McKeown, and Elba A. Dardeau, Jr.

Publisher: U.S. Army Engineer Waterways Experiment Station.

Date: September 1978.

Intended Audience: Land managers and project engineers at Army installations; wildlife biologists or ecologists.

Key Attributes: General.

Abstract: The objective of this manual is to describe methods for identifying, collecting, processing, and displaying environmental baseline data needed for natural resource management on Army installations. The manual outlines procedures for determining relevant baseline elements such as natural resource management objectives, impact of installation activities, and specifications of relevant baseline elements. Data acquisition procedures are also included. Three examples of use

of these procedures are provided: (1) wildlife management, (2) rangeland restoration, and (3) assessment of soil erosion.

Abstract 27

Acquisition Technique(s) Used: Mapping/maps, secondary data, fieldwork.

Title: *Water Quality Data for Army Military Installations*, Technical Report N-63/ADA067253.

Author(s): W. D. Goran and R. E. Riggins.

Publisher: U.S. Army Construction Engineering Research Laboratory.

Date: February 1979.

Intended Audience: Army personnel and other professionals involved in assessing water quality data.

Key Attributes: Water quality.

Abstract: CERL is developing computerized water quality impact assessment models to help satisfy the needs of planners and decision-makers desiring efficient and economical techniques to quantify environmental impacts (in this case, water quality). The successful application of these models depends on the existence and availability of accurate and reliable data. The purpose of this report is to determine the availability of water quality data for 21 selected Army military installations in the United States.

Abstract 28

Acquisition Technique(s) Used: Mapping/maps, secondary data.

Title: *Graphic Materials to Support Biophysical Quantitative Environmental Impact Analysis--Sources of Existing Material*, Technical Report N-68/ADA069097.

Author(s): W. D. Goran and R. E. Riggins.

Publisher: U.S. Army Construction Engineering Research Laboratory.

Date: March 1979.

Intended Audience: Army personnel and other professionals who require environmental information (in

this case, only materials that relate to the biophysical and land use elements of the environment).

Key Attributes: General.

Abstract: This report describes the sources of graphic material that may be used in environmental impact analysis. Information needs for analytical models are investigated and existing sources of graphic information identified and evaluated. Sources of useful graphic materials are listed. Graphic information is further analyzed to determine which formats are most useful for impact analysis. These sources represent processed environmental data such as topographic contour maps, aerial photographs, soil maps, hydrographic maps, drainage data, and remotely sensed imagery.

Abstract 29

Acquisition Technique(s) Used: Secondary data, mathematical modeling.

Title: *Installation Solid Waste Survey Guidelines*, Technical Report E-75/ADA018879.

Author(s): Gary Schanche, Larry Greep, and Bernard Donahue.

Publisher: U.S. Army Construction Engineering Research Laboratory.

Date: October 1975.

Intended Audience: Army personnel and professionals involved in evaluating current management programs, designing new programs and preparing environmental reports in the field of solid waste management.

Key Attributes: Solid waste.

Abstract: This report presents guidelines for developing a comprehensive solid waste management plant. The document assists planners with evaluating current management programs, designing new programs and preparing environmental reports.

The report contains information for determining legal restraints, characterizing specific waste sources, evaluating current management programs and establishing survey requirements. Techniques for determining the physical composition of waste streams and the amounts of waste material are described. Guidelines for developing sampling programs are also presented.

Abstract 30

Acquisition Technique(s) Used: Secondary data, mathematical modeling.

Title: *Air Pollution Survey Guidelines for Army Installations*, Technical Report N-5/ADA029633.

Author(s): Gary Schanche and Bernard Donahue.

Publisher: U.S. Army Construction Engineering Research Laboratory.

Date: July 1976.

Intended Audience: Installation planning, operating, and maintenance personnel.

Key Attributes: Air (all).

Abstract: Comprehensive guidance is not available for defining air pollution emissions at general and detailed levels. To minimize the work involved in such definition, this report outlines procedures which specifically address the information needs of an installation.

The report explains procedures for understanding and quantifying air pollution emissions from Army installations, and indicates possible corrective measures. The report should help installation personnel effectively solicit expert assistance in solving air pollution problems; thus, the document aids preparation of EISs.

Specifically, the report describes methods developed to help installation personnel efficiently gather necessary information about sources of potential air pollution. In addition, selected point sources and their likely emissions are qualitatively described. The report presents an informative description of meteorological factors and their likely interactions with emissions from installations.

Abstract 31

Acquisition Technique(s) Used: Secondary data, mathematical modeling.

Title: *Water/Wastewater Survey Guidelines*, Technical Report N-11/ADA033223.

Author(s): Gary Schanche, Larry Greep, John Cannon, and Bernard Donahue.

Publisher: U.S. Army Construction Engineering Research Laboratory.

Date: November 1976.

Intended Audience: Personnel involved in planning.

Key Attributes: Surface water (all), land use (all), water quality.

Abstract: This report provides comprehensive guidance for defining water pollution emissions at gross and detailed levels. The objective is to assist personnel in planning and performing water/wastewater surveys, and thus to improve data-gathering. The data collected in these surveys can be used (1) to aid in preparing environmental reports and environmental impact assessments and statements, (2) to indicate possible corrective measures for pollution problems, and (3) to assist in effectively soliciting experts' assistance in solving water pollution problems.

The report provides background information on performing mass balances, developing sampling schedules, selecting sampling points, evaluating wastewater sources, and taking flow measurements. Although these guidelines serve as a basis for improving data-gathering, it should be noted that because of the many types of surveys which can be undertaken, this report provides only general guidance, rather than specific directions.

Abstract 32

Acquisition Technique(s) Used: Secondary data, mathematical modeling.

Title: *Pollution Estimation Factors*, Technical Report N-12/ADA033753.

Author(s): Gary Schanche, John Cannon, Larry Greep, and Bernard Donahue.

Publisher: U.S. Army Construction Engineering Research Laboratory.

Date: November 1976.

Intended Audience: Army personnel who need to assess the environmental consequences of actions involving facility operations.

Key Attributes: Air: particulates, gases and vapor; solid waste.

Abstract: This report explains procedures for estimating air and water pollution and solid waste materials resulting from military facility and vehicle operations.

The document identifies pollutant-generating activities resulting from the operation of military facilities and vehicles, and, when possible, develops pollutant estimation factors. To estimate the amount of pollution resulting from an activity, it is only necessary to multiply the emission factor by the activity level (an emission factor is basically the average amount of pollutant discharged per level of a specific activity). Specific examples showing how to apply these factors are supplied at the beginning of each chapter. The emission factor approach should be used only when a rough estimate of the pollutant discharge resulting from a particular activity is required.

Abstract 33

Acquisition Technique(s) Used: Secondary data, mapping/maps, mathematical modeling, fieldwork.

Title: *Environmental Noise Impact Analysis for Army Military Activities: User Manual*, Technical Report N-30/ADA047969.

Author(s): R. J. Goff and E. W. Novak.

Publisher: U.S. Army Construction Engineering Research Laboratory.

Date: November 1977.

Intended Audience: Army personnel who are evaluating the environmental noise impact from Army activities.

Key Attributes: Noise (all).

Abstract: This report provides techniques for evaluating the environmental impact of noise emissions from Army activities. It is designed to be used with CERL-developed computer systems to produce an integrated approach to environmental impact assessment.

The manual explains methods for determining and documenting environmental noise levels, procedures for determining the impact of these levels on the environment, methods for mitigating these impacts, and directions for preparing comprehensive impact assessments or statements.

Abstract 34

Acquisition Technique(s) Used: Secondary data.

Title: *Compendium of Administrators of Land Use and Related Programs*, Technical Report N-40/ADA057226.

Author(s): R. M. Lacey, H. E. Balbach, and J. J. Fittipaldi.

Publisher: U.S. Army Construction Engineering Research Laboratory.

Date: July 1978.

Intended Audience: Army planners of EAs.

Key Attributes: General.

Abstract: This report is primarily a compendium of the names, addresses, and telephone numbers of Federal agency and State government officials with control over or interest in plans and programs related to land use. Nineteen categories of State-level programs are included with at least one point of contact listed. Twenty-eight Federal government agencies are identified whose programs may require coordination with Army activities. (A regional or State point of contact is listed for each of these Federal agencies.)

Abstract 35

Acquisition Technique(s) Used: Secondary data.

Title: *Clearinghouse Information System: Description and User Instructions*, Technical Report N-53/ADA059176.

Author(s): R. Webster and B. Griffin.

Publisher: U.S. Army Construction Engineering Research Laboratory.

Date: August 1978.

Intended Audience: DA personnel charged with producing and coordinating environmental planning documents.

Key Attributes: General.

Abstract: In 1969, the Office of Management and Budget (OMB) identified the agencies with which Federal agencies have to coordinate their activities. These agencies were designated as State, regional, and local clearinghouses. Because hard-copy listing of these agencies would require continuous updating, CERL was asked to investigate the possibility of making this information available as a subsystem to the Environmental Technical Information System (ETIS). To satisfy this objective, CERL obtained the most recent

OMB computer tapes identifying the clearinghouses, developed the Clearinghouse Information System (CHIS) as a subsystem of ETIS, and produced a concise user's manual for implementation of CHIS.

Abstract 36

Acquisition Technique(s) Used: Fieldwork, mapping/maps, secondary data, remote sensing (aerial photos).

Title: *Guidelines for Terrestrial Ecosystems Survey*, Technical Report N-89/ADA086526.

Author(s): W. D. Severinghaus.

Publisher: U.S. Army Construction Engineering Research Laboratory.

Date: May 1980.

Intended Audience: DOD personnel.

Key Attributes: Ecology (all).

Abstract: Surveys of the flora and fauna in possible areas of impact are needed as a portion of EISs. A serious concern in surveying is the shortage of time available to gather information that is consistent in both quantity and quality. This report helps installations methodically and economically gather and maintain data on the installation's terrestrial biota.

Terrestrial biota information acquisition is divided into three stages. Although the level of accuracy and detail is proportional to the number of stages completed, the completion of any one stage will give valid and useful information. Stage I (use of maps, overlays, and tables) estimates the amount of habitat and types of vegetation and animals existing on the installation. Stage I is intended to give more information at a more detailed level than presently exists at most installations. Stage II involves a field verification of the information gathered in Stage I. Stage III documents population densities and other ecological parameters of various organisms on the installation.

Abstract 37

Acquisition Techniques Used: Secondary data.

Title: *Economic Impact Forecast System, Version 2.0: User's Manual*, Technical Report N-69/ADA073667.

Author(s): J. W. Hamilton and R. D. Webster.

Publisher: U.S. Army Construction Engineering Research Laboratory.

Date: July 1979.

Intended Audience: DOD personnel involved in the socioeconomic aspects of environmental impact analysis.

Key Attributes: Sociology (all), economics (all).

Abstract: Many court decisions have confirmed that when environmental impact statements are prepared, the requirement for adequate assessment of socioeconomic impacts should be given as much consideration as those impacts which are primarily biophysical. To address the need for a systematic approach to socioeconomic impact assessment, the Economic Impact Forecast System (EIFS) was developed. It provides information useful for calculating socioeconomic changes caused by DOD actions. EIFS points out severe problems early in the decision-making process so that alternatives may be considered. Conversely, if no significant impact is apparent, adequate environmental impact assessment documentation is still available. EIFS provides users with (1) access to selected Department of Commerce statistics regarding the socioeconomic characteristics of any multi-county area in the U.S.; and (2) a readily implemented analysis technique for assessing the magnitude and significance of potential socioeconomic impacts on those areas.

Since the original development of EIFS, implementation of some modifications to the multiplier and other equations have further refined the model. This manual presents user instructions for this modified and updated version of the system.

4 PRESENTATION OF ENVIRONMENTAL INFORMATION

When environmental information has been collected and analyzed for its relevance to the project being evaluated, the data should be effectively presented to readers of environmental analyses. The following discussion outlines some of the formatting options that may be used.

Figures

Figures must be planned carefully; six principles should be kept in mind as the organization of the text and accompanying figures takes form.

Each Figure Must Function as an Integral Part of the Text

Because the relationship between a figure and the text of a report is perfectly clear in an author's mind, he/she may not bother to make it clear to the reader. The reader can be helped in at least three ways:

1. Have the figure placed as close as possible to the first reference to it in the text.
2. Phrase the reference to the figure so it generally describes the contents of the figure, instead of merely indicating the existence of the figure: "Figure 1 indicates the pertinent land uses near the site," rather than "Figure 1 shows land uses."
3. Give the illustration a fully descriptive title that relates the figure to the text. For example, rather than "Figure 1. Total Dissolved Solids," use "Figure 1. Total Dissolved Solids in Major Water Sources." Whenever possible, avoid making the title a verbatim combination of the X/Y axis titles.

In-Text Figures Should Be Used Whenever Feasible

Figures need not be full page, although it is best to roughly sketch them on a full page as an aid to the draftsman. In fact, coherence and continuity of the report are often better when figures are photographically reduced and placed in the text at the point they are discussed, rather than on separate pages. By the photo-offset process, many figures can be reduced for in-text placement without losing significant detail. This principle applies to all types of figures.

Each Figure Should Be as Simple and Bold as Possible, and Yet Be Meaningful Without Reference to the Text

Remove unnecessary detail and do not try to include more than one major idea in a figure. If a figure contains all data that relate to the major idea, or if one figure does the job of two or more figures, the illustration probably will appear cluttered. A much better effect is achieved by presenting essential information in two smaller figures.

In simplifying figures, keep in mind, of course, that enough data must be included so that each figure is meaningful without detailed reference to the text. When a reader studies the figure, he/she should not have to go back to the text to find out what it means.

The Terminology and Data Used in Figures Must Agree with Those in the Text

Because figures and text are usually prepared at different times, the terminology must be carefully checked.

For example, "Site 7," discussed in the text, may have become "Location 7" (or even "Location 8") in a figure. Similarly, "local residents," "population," and "households" may have been used synonymously, to the reader's confusion. In figures, abbreviations for terms not abbreviated in the text should be used only where necessary to conserve space; standard abbreviations are acceptable for units.

The data given in figures should also be checked against those in the text to make certain that they agree exactly.

Related Figures in a Series Should Be Set Up Similarly

The significant similarities (and dissimilarities) among comparable groups of data presented in a series of related figures are emphasized by setting up all the figures in the same form. For example, a series of figures showing related data might have the same coordinate scales and titles, be of the same size, and have their legends and other detail information arranged similarly. If this is done, the reader's attention is not diverted from the contents of the figures by variations in styles and format.

Sometimes it may be possible to reduce, photographically, several or all of the figures in a series and arrange them on a single page to gain even greater emphasis. Alternatively, they may be combined into one figure.

Under- or Over-Illustration Should Be Avoided

Generally, figures can be of great assistance in communicating and summarizing crucial data. However, using them too much can hamper the reader's comprehension and the order of critical issues. Therefore, judgment is necessary in deciding where and how often to employ figures in presenting environmental information.

Flowcharts

A flowchart is a graphic representation of the decision process; it shows major decision points, their inputs, and alternatives. Figure 1 shows an example flowchart with its characteristic elements. It illustrates the decision-making process involved in acquiring a home. The "entry" point is labeled "transfer," the assumption being that a transfer from one area of the country to another starts the process. The three alternatives are to build, buy, or rent. Since this flowchart analyzes the "build" path, "rent" and "buy" are shown as "exit" points which, in turn, become "entry" points on their own flowcharts. Entry and exit points are conventionally shown inside the "race track" symbol used here.

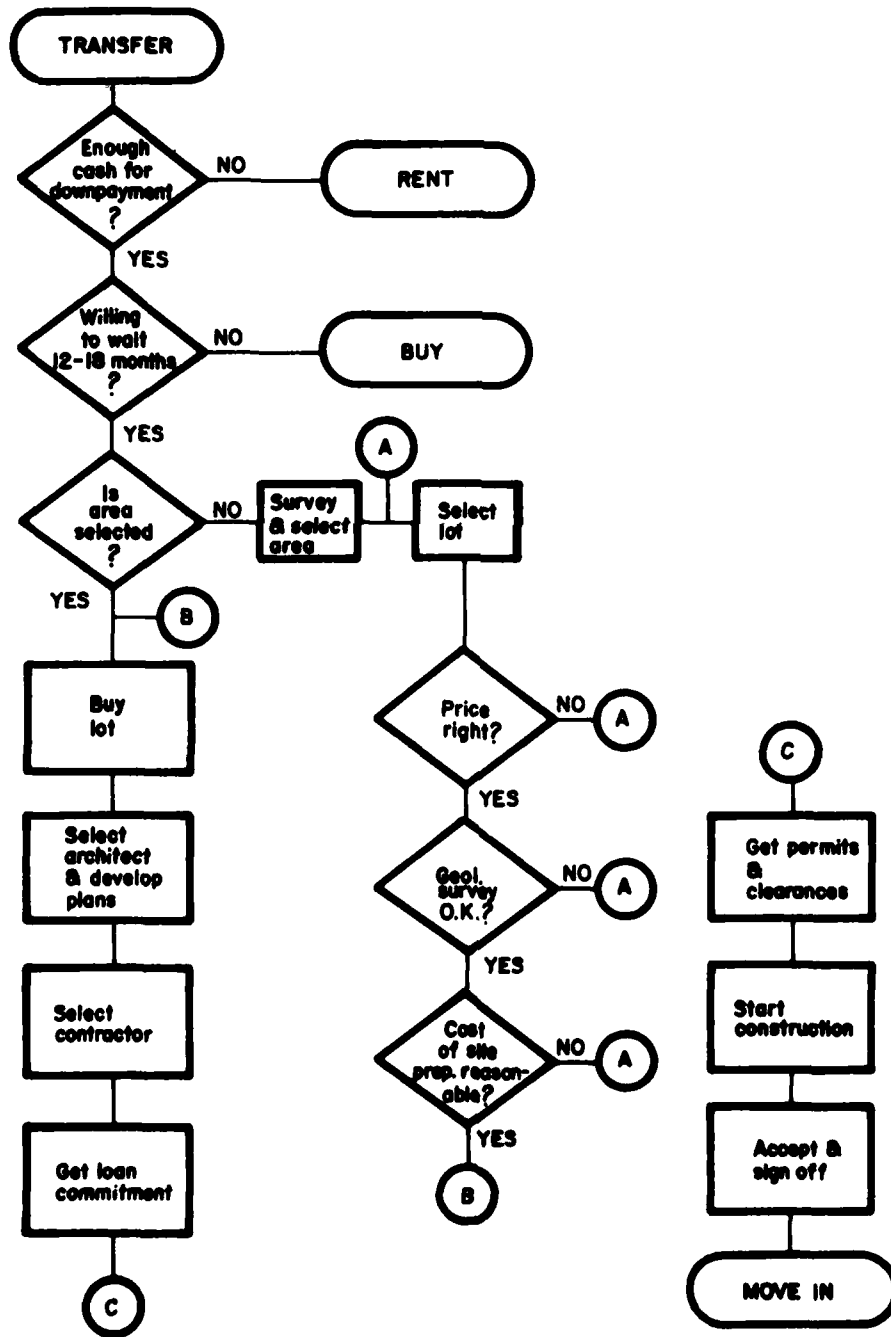


Figure 1. A flowchart.

The "connectors" labeled A, B, and C are useful devices for keeping the diagram from getting cluttered and unreadable. Connectors are used when the flowchart must be continued to another chart on the same page to avoid crossing or using too many lines. The diamond shape of the decision block is also conventional.

Column Charts

Column charts (Figure 2) are used for showing discrete quantities in discrete periods—e.g., dollars per month, tons per quarter, number of shares traded per day, gallons per hour. The "independent variable," expressed by the height of the column—i.e., measured along the vertical axis—can be anything that can be measured and expressed as a quantity (dollars, tons, carloads). The column chart conveys at a glance period-to-period comparisons of measured quantities.

Columns can be grouped to display changes in related quantities, and individual columns can be segmented to show the composition as well as the changes in composition of each column total. To avoid distortion—frequently unfair and self-serving—columns should always start at zero-base line.

Bar Charts

Bar charts are ideal for comparing large numbers of different categories, whereas other types of charts are oriented more toward representing value versus time for a single, or at least relatively few, categories (Figure 3).

Bar charts differ from column charts in that the values to be displayed and compared are plotted horizontally instead of vertically. The decision on which type

to use hinges on which is easier to draw in the available space, which is less cluttered and hence more pleasing to the eye. The data will usually dictate whether a column or bar chart will be used.

Line Charts

Unlike the column and bar charts, which show discrete totals, line charts show continuity and thus suggest a movement and rhythm that bar charts do not. Line charts are used typically to show cumulative values (such as units delivered or dollars expended)—usually with a separate plotted line showing projected totals for comparison with actual totals, and also a "time now" line or arrow to fix the point in time for which the chart is current (Figure 4). A solid line is conventionally used for actual values, and a broken or dotted line for projected values.

Band Charts

Band charts are similar to line charts, except that the area below the top line, which represents the total, is subdivided into bands, or strata, each representing a subtotal. As can be seen in Figure 5, a band-chart representation of related values provides a very effective comparison.

Pie Charts

Pie charts are generally considered the easiest to read of all types of charts (Figure 6). They are limited, however, to showing percentage of the whole.

Rate Charts

Rate charts, also called ratio charts, are used to compare the rate of change of two or more grossly unequal quantities. To make a realistic graphic comparison,

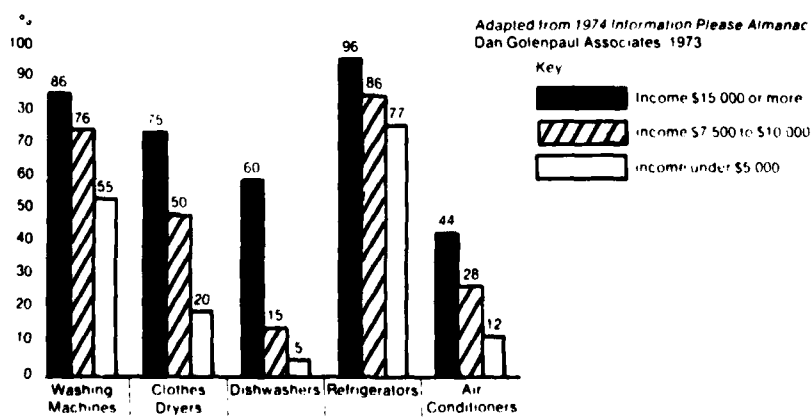


Figure 2. A column chart.

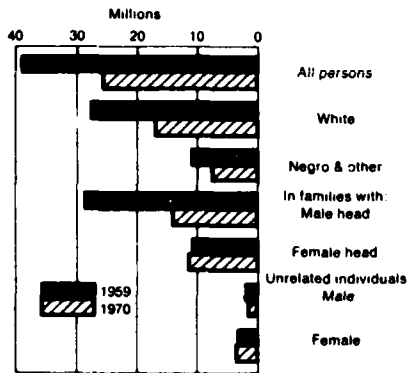


Figure 3. A bar chart.

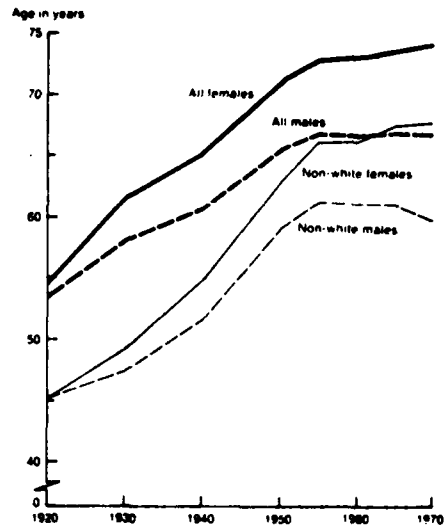


Figure 4. A line chart.

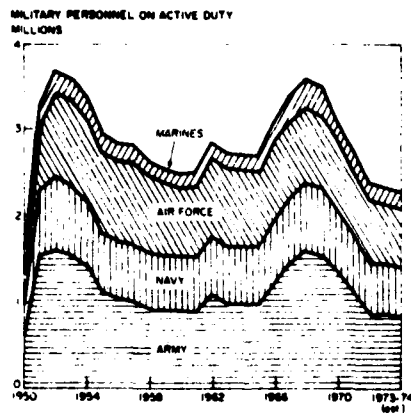


Figure 5. A band chart.

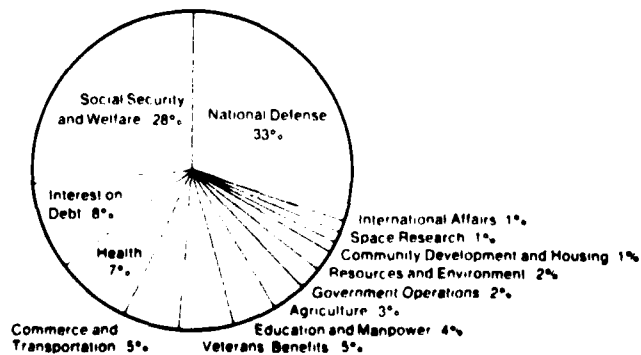


Figure 6. A pie chart.

it may be necessary to use a logarithmic scale where the divisions, as on a slide rule, get smaller as the value gets larger.

Figure 7 illustrates how the rate scale eliminates distortion by using semilogarithmic graph paper for plotting curves, representing unequal magnitudes. The reason for semilogarithmic paper is that the logarithmic scale is necessary only along the vertical axis, not along the horizontal one, which usually represents time.

Tables

Anything that is measured in relative numbers and units can be presented in tabular form. Although isolated data can be addressed within the text, clusters of data are sometimes difficult for the reader to assimilate directly from textual material. Therefore, tables are often the most appropriate form of presentation for data clusters.

A table could be nothing more than an indented listing, informally correlating subjects with data. Such a listing need not be identified as a table and will not be referenced in the text other than by its introductory phrase. It need not have row or column headings. Since informal tables are an integral part of the text, they should not be long enough to disrupt the reading pace. Such informal tables do not require a caption and reference number.

A formal table format is appropriate when the data are complex/lengthy, cannot be conveniently integrated into the text, and require identification for subsequent reference. The initial task in developing tabular material

is to determine what the table is supposed to communicate. This will require identifying the subjects and appropriate data categories.

Row and column headings should be brief; the available space does not permit wordiness. Nevertheless, the table must be as descriptive as possible; use footnotes if necessary.

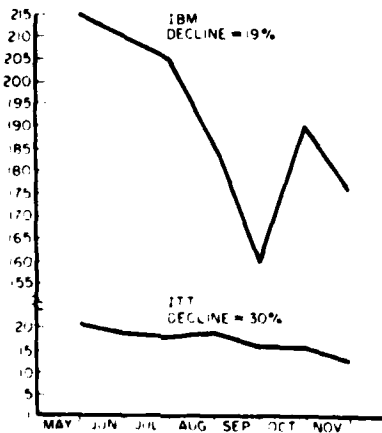
In addition, complete identification of categories can help the reader interpret the table. Standard abbreviations may be used both in the headings and text of the table.

5 ENVIRONMENTAL INFORMATION MANAGEMENT

After environmental information is gathered, it should be stored so that it can be quickly found when needed. Now, Army installations often collect a lot of environmental information but misplace it. This chapter explains how to store and catalogue information so that it can be easily retrieved.

Cataloguing and Referencing Materials

An organizational system that is comprehensive for all forms of information sources—textual, tabular, graphic and photographic—should be established as early as possible. If a collection of materials is already large or likely to grow considerable, a formal cataloguing system (such as the Library of Congress or Dewey Decimal system) might prove useful. However, catalogu-



Comparison of identical data plotted on arithmetic (left) and logarithmic scales.

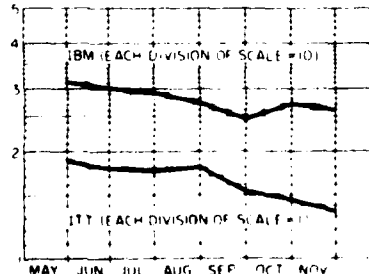


Figure 7. A rate chart.

ing systems are simply tools to help locate materials, and for most smaller collections a simple subject reference card file (with perhaps a title or author cross-reference) should be adequate. The system should be clearly explained (in a brief manual or booklet), easily understood by persons using the materials for the first time, and preferably similar to some existing reference system rather than unique to a particular collection.

With any cataloguing system, each item in a collection, whether a book, report, map or photograph, should be assigned a reference number. The reference number should be printed directly on the item as well as on a card in the reference file. On books, this number is usually printed on the spine and inside the cover. The number on reports is often on the cover, or just inside the cover; while on maps, the number is placed along the margin. For photographs without margins, the number may have to be printed on the back. Each storage shelf, drawer, or file should also then be assigned a range of reference numbers, such as G3923/.C5D5 to G3923/.R9CZ. The number on a card in the reference file will refer users first to the shelf where the item is stored and then to the location of the item along the shelf.

Of the standard cataloguing systems, the Dewey Decimal system is difficult to adapt to maps, photographs and other nontextual materials. On the other hand, the Library of Congress system is easily adapted to various types of materials and requires no specialized training for cataloguers. Using the Library of Congress system to assign a number, for example, to a vegetation map for Chatahoochee County, GA (Fort Benning area) the designation G3923/.C5D5 would be printed along the map margin. All designations for maps and remote sensing materials are listed in the Library of Congress Catalogue, Class G; thus, the reference designation G. The designation 3923 indicates Georgia; .C5 indicates Chatahoochee County; D denotes the subject classification—biogeography; and 5 further limits this subject class to vegetation. Figure 8 is a sample index card from a reference file that would refer to this map. To catalogue a vegetation map for the entire Fort Benning installation, which includes parts of three counties in two states, a special "cutter" or cataloguing number should be used to designate Fort Benning as a distinct geographic unit. Such a number, though not provided in any catalogue, would already be assigned and could be obtained by contacting the Library of Congress cataloguing section, Geography and Map Division, in Washington, D.C.

Specific Reference Systems for Maps and Remotely Sensed Imagery

Each major Federal agency that produces maps and remote sensing imagery has its own referencing methods. For both ordering and referencing, users should become familiar with some of these methods.

USGS Products

The geographic coordinate system is the major referencing system for USGS maps, and index sheets are the major reference tools. Most USGS maps—which include topographic, geologic, hydrologic, land use, orthophoto and several other types—have as boundaries parallels of latitude and meridians of longitude, rather than political boundaries (such as States and counties), or natural features (such as coastlines or rivers). Each map sheet is called as a quadrangle, and each quadrangle is named for some prominent natural feature or cultural landmark within this mapped area. Adjacent maps are identified by name in the margin. To improve referencing these quadrangle maps, however, USGS is now considering initiating a map numbering system based on each sheet's southeast corner.

For each topographic series, USGS publishes and periodically updates index maps. The large scale series (1:24,000 and 1:62,000) are indexed together on base maps for each individual state. Intermediate scales (1:100,000 and 1:250,000) are indexed on national base maps and smaller scales (1:1,000,000 and smaller) on international base maps. Since the large scale series provide the most detailed information, these maps (and, in turn, the State-base index sheets) are likely to receive the most use. The usefulness of these State indexes can be improved by drawing installation outlines directly onto the State index sheets or simply shading all relevant quadrangles. Figure 9 shows a file card on which Fort Campbell has been outlined on indexes for Kentucky and Tennessee. The card should be stored in a subject reference file under "Fort Campbell Topographic Maps."

Defense Mapping Agency

Topographic maps produced by the Defense Mapping Agency (DMA) are also organized by geographic grids for each of the various scale series. Index maps are published in catalogues and each map quadrangle is assigned a specific name and number within each series. However, the installation special maps, though still having quadrangle format for boundaries, are produced by shifting from the normal grid pattern in order to center a map around an installation.

G3923	Chatahoochee County, Georgia
C5D5	
1978	
Vegetation Map of Chatahoochee County, Georgia	
Color map 45 x 60 cm.	
Scale 1:75,000	
Georgia Dept of Natural Resources	
1978	
* THIS IS AN EXAMPLE, NOT AN ACTUAL MAP.	

Figure 8. Sample index card.

FORT CAMPBELL
TOPOGRAPHIC MAPS INDEX
1:24,000 AND 1:62,500
DRAWER NO. 0502

Figure 9. Fort Campbell file card.

Aerial Photography

Aerial photographic imagery is generally referenced by county, date, and flight line. The USDA's Agricultural Stabilization and Conservation Service (ASCS), which has extensive holdings throughout the United States, catalogues its imagery by county, year of acquisition, and number of index sheets per county. These index sheets are reduced mosaics of the actual imagery. Each print is then also identified by date, flight line, and print number; this identification system is usually the most practical system for reference and storage. For prints that come for other sources or are not individually identified, some similar system could be adapted to meet specific needs.

USGS's Earth Resources Observation Satellite (EROS) Data Center

This center, which provides several types of remote sensing imagery, uses the geographic coordinate system as an initial reference to materials. Upon request, the center will conduct a computer search for available imagery of a particular geographic area with either center point or corner coordinates as reference.

Soil Survey Maps

Prepared by the SCS, these maps are generally produced for a single county area and referred to by county name. The maps are usually multiple sheets in a bound report, which includes an index map for orienting and referencing each map sheet.

Field Specimens

If it is useful or necessary to collect plants or animals, there are specific procedures for cataloguing these specimens. A bound notebook should be used as a catalogue, and each collected item should be entered and assigned a number as it is added to the collection. These numbers should be assigned sequentially, and for each specimen there should also be listed: scientific name, if known; common name (optional); location of the collection site (by coordinates or in reference to a known site, such as a town); county and State of collection; date of collection and person(s) collecting. Such collections may include mounted plant clippings, preserved herbs, small mammals, insects, fish, or other aquatic biota. It is probably advisable for such collections to be kept at a nearby college, university or museum because these specimens, to be properly maintained, should be in air-tight cases and periodically fumigated to prevent damage.

Storage Methods and Equipment

Conventional shelving and vertical files generally provide adequate protection and storage for books,

reports and other textual materials. However, maps and remotely sensed imagery are often cumbersome both to use and store. Effective use of these materials requires spacious, well-lit areas; special tools and equipment for measuring, drafting and viewing; and a large area of unobstructed table space. Good storage requires temperature and humidity control and special filing equipment.

Maps and remote sensing materials should be stored in an environment where air temperature is between 65° and 75° F (18° and 24° C), and the humidity is between 30 and 50 percent. The stability of the storage environment is important because paper-base materials shrink and expand with significant atmospheric changes, which affects the accuracy and reliability of these sources. Also, photographic materials can fade with frequent exposure to strong light, especially sunlight, and should be stored in darkness or dim light. All materials should be covered to protect from dust and other damage.

Specialized equipment for storage of maps and remote sensing imagery includes horizontal cases with file drawers, horizontal shelves, hanging files, tubes and tube slots, as well as conventional vertical files. Often, collections of graphic and photographic materials vary so much in size and bulk that several types of storage facilities are required.

Horizontal Filing Equipment

Horizontal map cases provide good protection and allow for the placement and removal of materials without folding, rolling, or attaching to clips. These cases can be obtained in several sizes, can be set on legs and can be stacked on top of each other. Drawers that are too high, however, are difficult to open, and stacking also prevents the use of case tops as working surfaces. On the whole, multiple drawer map cases are a good system for organization of materials. And large file folders, which can be obtained from many paper companies, allow for further protection and separation within the drawers. These cases are, however, quite expensive. A new five-drawer case, properly constructed, will cost over \$500. Horizontal shelves are a less expensive option. These shelves can also be of varying sizes and, used with file folders, provide most of the advantages of map cases.

Tubes

Materials stored in tubes must be rolled, which causes considerable wear of frequently used items, and rolled materials are often difficult to flatten for use. However, tubes do provide good protection and are especially

useful for transporting materials. Also, tubes are available in various lengths and can easily accommodate materials. But using tubes for general storage requires the purchase or construction of a storage unit with pigeonholes to organize the tubes; this arrangement usually makes access to materials difficult.

Hanging Files

These files are not advisable for general storage because they have limited capacity and do not provide adequate protection unless the entire hanging file unit is enclosed or the materials plastic coated. Hanging files generally require more space than other systems to store the same amount of materials. Hanging files can, however, provide quick access and display for materials associated with a specific purpose or project.

Vertical Files

Conventional vertical files are generally well suited for a 9 in. by 9 in. (22.9 cm by 22.9 cm) aerial photograph, but are too small for most maps and other

remote sensing materials. Other vertical filing units are impractical unless supportive backings are attached to the maps and photographs.

6 CONCLUSION

This report has provided DA environmental planning personnel with the guidance necessary to determine the most appropriate techniques for acquiring, using, and maintaining information for environmental studies, EAs, and EISs. A matrix identifies the most appropriate techniques for collecting information on the EICS environmental technical specialties. After a method has been selected, the user may read an abstract of the report explaining the technique, and may also wish to obtain the original document for detailed information about applying the technique.

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Army Instl. and Major Activities (CONUS)

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 ATTN: Facilities Engineer
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 Army Matls. and Mechanics Res. Ctr.
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 Harry Diamond Laboratories
 Dugway Proving Ground
 Jefferson Proving Ground
 Fort Monmouth
 Letterkenny Army Depot
 Natick Research and Dev. Ctr.
 New Cumberland Army Depot
 Pueblo Army Depot
 Red River Army Depot
 Redstone Arsenal
 Rock Island Arsenal
 Savanna Army Depot
 Sharpe Army Depot
 Seneca Army Depot
 Tobyhanna Army Depot
 Tooele Army Depot
 Watervliet Arsenal
 Yuma Proving Ground
 White Sands Missile Range

FORSCOM

FORSCOM Engineer, ATTN: AFEN-FE
 ATTN: Facilities Engineers
 Fort Buchanan
 Fort Bragg
 Fort Campbell
 Fort Carson
 Fort Devens
 Fort Drum
 Fort Hood
 Fort Indiantown Gap
 Fort Irwin
 Fort Sam Houston
 Fort Lewis
 Fort McCoy
 Fort McPherson
 Fort George G. Meade
 Fort Ord
 Fort Polk
 Fort Richardson
 Fort Riley
 Presidio of San Francisco
 Fort Sheridan
 Fort Stewart
 Fort Wainwright
 Vancouver Bks.

TRADOC

HQ, TRADOC, ATTN: ATEN-FE
 ATTN: Facilities Engineer
 Fort Belvoir
 Fort Benning
 Fort Bliss
 Carlisle Barracks
 Fort Chaffee
 Fort Dix
 Fort Eustis
 Fort Gordon
 Fort Hamilton
 Fort Benjamin Harrison
 Fort Jackson
 Fort Knox
 Fort Leavenworth
 Fort Lee
 Fort McClellan
 Fort Monroe
 Fort Rucker
 Fort Sill
 Fort Leonard Wood

INSCOM - Ch, Instl. Div.
 ATTN: Facilities Engineer
 Vint Hill Farms Station
 Arlington Hall Station

WESTCOM

ATTN: Facilities Engineer
 Fort Shafter

NDW

ATTN: Facilities Engineer
 Cameron Station
 Fort Lesley J. McNair
 Fort Myer

HSC

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 ATTN: Facilities Engineer
 Fitzsimons Army Medical Center
 Walter Reed Army Medical Center

USACC

ATTN: Facilities Engineer
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V Corps

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VII Corps

ATTN: AETSDEH (5)

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US Army Installation Support Activity,

Europe
 ATTN: AEUES-RP

8th USA, Korea

ATTN: EAFE
 Cdr, Fac Engr Act (8)
 AFE, Yongsan Area
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 AFE, Area II Spt Det
 AFE, Cp Humphreys
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reference guide / by R. E. Riggins, V. T. Young, W. D. Goran. --
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