# THE ROLE OF THE ENVIRONMENTAL MANAGER IN THE AIR FORCE

by

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# INTRODUCTION

The Air Force has long been involved in pollution abatement in the operation of sanitary sewer treatment plants, in the control of its boiler plants and in its solid waste disposal operations. There were not, however, any coherent programs or policies for pollution abatement until fairly recently. As the President and the Congress became more concerned with environmental pollution, the Air Force responded with regulations to bring the Air Force plant into compliance with the policy of the federal government. In 1970 the pollution abatement specialist position began to evolve in the operations of Air Force Bases. The title is not official and there is not a job description of his duties. The Air Force has several job descriptions for Sanitary Engineers, one which pertains to water pollution, and one which pertains principally to air pollution abatement.[1] It has also delineated a set of duties to be performed by a committee through an environmental coordinator.[2]

[1]Standard Position Description Base Civil Engineering Position B-1 and Position B-7 pp. 113-115, 131-135.

[2]AFR 19-1, "Pollution Abatement and Environmental Quality, "Department of the Air Force, Washington, D.C., Feb. 20, 1974.

It appears, although it is not clear, that the Air Force intends that the environmental coordinator will be the primary environmental manager at each level of command. As the job evolved at one Air Force Base, the environmental pollution specialist was concerned with aspects of gaining funds for projects, furnishing advice on federal and state regulations, and discovering and correcting pollution sources. He was also the Base Environmental Coordinator. There did not seem to be any real understanding of the limits of the areas in which the environmental pollution specialist was required to work, and the entire program seemed to be founded on chaos.

The Air Force has established policy which states its intent to comply with federal, state and local laws and regulations.[3] Despite its policy, the management of environmental quality in the Air Force is largely one of crisis management. Problems in pollution abatement may be seen and programs to correct them scheduled years before the law requires a change, but funding necessary for the program will not be made available until confrontation with state, local or federal authority is eminent. The reason that necessary funding does not become available until a crisis exists is simple. Pollution abatement projects must compete with other pollution

[3]AFR 19-1.

abatement projects and with all other budget items for limited funds; consequently, only the most urgent project gets funded, and a pollution abatement project is never considered urgent if the compliance deadline is not at hand.

In this atmosphere it became apparent that the role of the environmental manager as he functions in the Air Force needed to be defined both in regard to his duties and to his authority. Secondly, there appeared to be a need for a tool for the environmental manager to use to select projects designed to abate pollution either by changed practices, or by development of capital facilities.

This thesis will explore the current literature on pollution abatement management in an attempt to find common ground between environmental pollution abatement management in the Air Force and in other areas. Secondly, it will explore in detail the law as it applies to the Air Force Environmental Pollution Abatement program and to the environmental manager. Thirdly, it will explore in detail those Air Force Regulations which establish the Air Force Policy and which constitute the parameters within which the Air Force environmental manager must operate. In order to discover what is the present practice at other Air Force bases in staffing environmental positions, in funding pollution abatement projects and in establishing project priorities, questionnaires were mailed to the Base Environmental Coordinator at 73 Continental United States Air Force bases.

Finally, in order to guide the environmental pollution abatement program away from its present crisis response to environmental problems, a systems analysis model will be developed which will be designed to aid the Air Force environmental manager in setting project priorities, and in selecting the most appropriate of several alternate programs for correcting pollution problems. Hopefully, such a system will permit environmental managers to use limited resources in the most beneficial manner.

# REVIEW OF THE LITERATURE

There are three U. S. Air Force Regulations which are the primary guides to agency policy on pollution abatement. They are AFR 19-1, "Pollution Abatement and Environmental Quality;" AFR 19-2, "Environmental Assessments and Statements;" and AFR 91-9, "Water Pollution Control Facilities." Of the three, the first two are by far the more important. AFR 19-1 deals with Air Force Policy on environmental pollution abatement, establishes the Environmental Protection Committee and the Environmental coordinator and describes their duties.[1] AFR 19-2 deals entirely with the preparation of Environmental assessments and statements as required by the National Environmental Policy Act of 1969 and Executive Order 11514. It delineates both the areas which require an environmental assessment or statement and the mechanics of preparation of the statements.[2] There are several Air Force Research papers dealing with certain aspects of pollution abatement such as the absorption of spilled oil, but no research on the central problem of ways to compare

[1]AFR 19-1.

[2]AFR 19-2, Environmental Assessments and Statements, Department of the Air Force, Washington, D. C. January 20, 1972.

projects in different mediums in order to select the best pollution abatement projects to promote, assuming that the various projects must compete for a limited amount of funds.[3]

The U. S. Environmental Protection Agency (hereafter EPA) has published more material on all types of pollution through its Office of Research and Development than any other single organization. For example, their Bibliography of R. & D. Research Reports lists approximately 1000 Research Reports published by them prior to July 1973.[4] Most of their works, however, apply to regional planning problems, or to other areas which are generally outside the scope of this paper. One six-volume work, Studies In Environment was written with a larger public in mind than an Air Force Installation. Because the larger population allows for an economic trade-off between causes and effects which is not available to an Air Force Base, the data gathered in Studies In Environment do not

[3]Eugene E. Mazewski and Ronald H. Kroop, Aviation Fuel Spill Containment Using Absorbent Materials (Kirkland Air Force Base: Air Force Weapons Laboratory, 1974). Esso Research and Engineering Company, Disposal/Recycle Management System Development For Air Force Waste Petroleum Oils and Lubricants (Kirtland Air Force Base: Air Force Weapons Laboratory, 1974).

[4]U. S. Environmental Protection Agency, Bibliography of R. & D. Research Reports (Washington, D. C.: U. S. Environmental (Protection Agency, 1973).

apply directly to the problems of the Air Force manager. There are, however, several areas where the information can be adapted to the Air Force. In Studies In Environment, the authors found the subject of environmental management to be incredibly broad, wide ranging and complex. They also found that the bureaucratic structures which have arisen to carry out legislative mandates dealing with environmental problems have ill-defined lines of authority and unclear responsibility. The new offices formed to control environmental responsibilities tend to crisis response at all levels. Regulatory agencies evidenced an overreliance on regulatory type tools when economic tools such as cost-benefit studies and modeling methodologies might yield better quantification and predictive results for environmental managers.[5]

Studies In Environment defined the environmental manager as any public figure who had power or authority over certain elements of the natural resource environment. It also defined environmental concerns to be air, water, land, biological systems, minerals and energy along with the beneficial and adverse impacts on

[5] Maury Selden and Lynn G. Llewellyn, Studies In Environment, Vol. I, Summary Report (6 Vols.; Washington, D. C.: EPA, 1973) pp. 62-63.

those environmental concerns. It is clear that the authors had in mind principally those environmental managers in regulatory public agencies, however, their definition can be adapted to the Air Force environmental manager.[6]

There are a number of books on the subject of air and water pollution and on environmental management. Among them are Environment: A Challenge to Modern Society, by Lynton Keith Caldwell; Economic Thinking and Pollution Problems, by D.A.L. Auld; Battle for the Environment, by Tony Aldous; and Quality of the Environment, by Oris C. Herfindahl and Allen V. Kneese. All of these books are aimed at areas of management other than the rather restricted area in which the Air Force environmental manager must operate.

Caldwell does not define environmental management as much as he attempts to explain why environmental management is in a state of chaos. He does, however, give some thought to the definition of environmental management. At the operational level, environmental management consists of (1) monitoring environmental change; (2) checking environmental deterioration;

[6]Ibid., pp. 59-60.

(3) preventing environmental deterioration; and (4) repairing damage already done.[7] Caldwell's description of operational level management will apply to the Air Force Environmental Manager, but it is not broad enough to encompass all of his duties.

Aldous, like Caldwell, does not offer a definition of environmental management, but rather discusses some of the problems in environmental management. Aldous does believe that planning is the principle tool by which environmental management can be advanced.[8]

Auld attempts to approach the management of pollution problems from an economic aspect. His thesis is that pollution should be charged by the government to the polluter according to the toxicity of the pollutants discharged to the air or water. In that way the polluter would have the choice of paying for pollution through a a tax or paying for the necessary equipment to reduce the pollution. He admits that one of the principle faults with his economic cost system of pollution

[7]Lynton Keith Caldwell, Environment: A Challenge to Modern Society (Garden City, N. Y.: Anchor Books, 1971) p. 160.

[8]Tony Aldous, Battle for the Environment (Glascow: Collins Sons Ltd., 1972) pp. 34, 272.

abatement is the fact that it is hard to ascertain the cost of damage from air pollution.[9]

A two-volume work sponsored by the Environmental Protection Administration attempted to survey the state of the art in water pollution control benefit-cost analysis. The results were rather discouraging from the point-of-view of the authors but are helpful in the fact that they analyze many of the current approaches to benefit-cost analysis in water pollution problems. The authors of the two volumes find that the data on the value of benefit derived from pollution abatement is seriously lacking. Most benefit-cost studies showed that water quality of intake water had little effect on the cost of purification of the water.[10] The principal value of these books to the Air Force Environmental Manager would be in gaining insight into the present state of the art in benefit-cost techniques.

There are many works available on general management theory and on systems analysis. They are usually

[9] D.A.L. Auld, ed., Economic Thinking and Pollution Problems (Toronto: U of Toronto Press, 1972) pp. 4-9.

[10] Samuel G. Unger, M. Jarvin Emerson, David L. Jordening, State of the Art Review: Water Pollution Control Benefits and Costs Vol. I; David L. Jordening, James K. Allwood, Research Needs and Priorities: Water Pollution Control Benefits and Costs, Vol. II (Washington, D. C.: USEPA 1973).

geared to areas of management with much more narrow ranges of operation and much better methods of cost assessment than is available in the field of pollution abatement. Among the literature treating systems analysis which can be adapted to the needs of the Air Force Environmental Planner are: Management: A Systems Approach, by David I. Cleland and William R. King; Systems Analysis Techniques for Planning - Programming - Budgeting; and System Analysis: A Tool For Choice, by E. S. Quade; Planning - Programming - Budgeting, A Systems Approach to Management edited by Fremont J. Lyden and Ernest G. Miller; and The Systems Approach by C. West Churchman.

Cleland not only treats the theory of systems but also attacks the mechanics of designing a system step-by-step.[11] Quade in the two works listed above defines systems analysis, explains its uses, and discusses advantages which can be obtained from the development of systems analysis.[12]

Lyden and Miller collected a group of previously

[11] David I. Cleland and Willian R. King, Management: A Systems Approach (New York: McGraw-Hill, 1972).

[12] E. S. Quade, Systems Analysis Techniques For Planning - Programming - Budgeting (Santa Monica, Calif., The Rand Corp., 1966) and Systems Analysis: A Tool For Choice (Santa Monica, Calif., The Rand Corp., 1972).

published articles by authorities in budget and systems analysis. These articles touch on a number of aspects of systems analysis while attacking the larger subject of planning - programming - budgeting.[13]

Churchman's book is written for the layman. In his book Churchman attempts to discuss systems analysis in terms understandable to those who are not familiar with systems analysis or its vocabulary.[14] Because it is not a technical work it would serve well as an introductory work to systems analysis.

All of the above mentioned literature pertaining to systems analysis are adaptable to one of the management tools needed by the Air Force Environmental planner. Among the methodological and theoretical research needs listed by Jordening and Allwood are: 1. Development of methods and procedures to identify and quantify water associated benefit and cost functions relating specific benefits to specific functions; 2. Extension and refinement of accounting measures for uncertain water quality

[13]Fremont J. Lyden and Ernest G. Miller, Planning Programming Budgeting: A Systems Approach to Management 2nd ed., (Chicago: Rand McNally College Publishing Co., 1973).

[14]C. West Churchman, The Systems Approach (New York: Dell Publishing Company) originally printed (New York: Delacorte Press, 1968).

associated costs and benefits; 3. Formulation of a measure of value that can be used as a common denominator additive measure to effectively evaluate all intangible and indirect nonmonetary costs and benefits associated with changes in water quality; 4. Quantification of complex water quality substitution effect; 5. Assessment of alternative political, legal and institutional arrangements needed to perform water pollution control management functions; 6. Procedures to project and evaluate alternative distributions of benefits and costs through time by the use of social discount rates to compute present value; 7. Estimates of net social benefits attributable to water pollution control measures. Though they do not specifically call it that, Jordening and Allwood are calling for management tools which, used together, would constitute a systems analysis concept.[15]

Flynn and Reimers state that a continuing systematic effort to identify serious national, regional or local pollution problems and pollutants is needed along with a refinement of screening and ranking parameters which are essential for making factual selections of the most

[15] David L. Jordening and James K. Allwood, Research Needs and Priorities: Water Pollution Control Benefits and Costs, Vol. II (2 Vol., Washington, D. C.: U. S. Environmental Protection Agency, 1973) pp. iii-iv.

serious problems.[16] These are a part of systems analysis. Herfindahl and Kneese have also indicated that a decision model is a primary requirement in improving environmental quality.[17] Selden and Llewellyn suggest that economic tools such as modeling methodologies and cost benefit studies would yield better predictive results and quantification for environmental managers than the present deadline date programs.[18]

The Air Force environmental manager is not unlike the environmental manager of other levels of government. Selden and Llewellyn have said, "...the crisis type response to environmental problems exists at all levels of government. Newly drafted regulations are the palliative employed to solve crisis type problems. And, overreliance on regulatory-type tools sometimes hampers the search for solutions."[19]

[16] James E. Flynn, Robert S. Reimers, Development of Predictions of Future Pollution Problems (Washington, D. C.: U. S. Environmental Protection Agency, 1974).

[17] Orris C. Herfindahl and Allen V. Kneese, An Economic Approach to Some Problems in Using Land Air and Water (Washington, D. C.: Resources for the Future, Inc. 1965) pp. 82-93.

[18] Selden and Llewllyn, Studies In Environment, Vol. I. p. 63.

[19] Ibid.

It begins to become apparent that many of the experts in the field of pollution abatement today believe that a major need for the environmental manager is a set of tools with which to analyze their programs and compare costs to benefits as a means of selecting programs. The Air Force environmental manager can also benefit from such a development.

## LEGAL ASPECTS OF THE AIR FORCE ENVIRONMENTAL PROGRAM

Environmental pollution law goes back at least 75 years. The first federal legislation on the subject was the Refuse Act of 1898.[1] This act was apparently soon forgotten as a tool for pollution control until 1966 when the Supreme Court gave it a broad interpretation in United States versus Standard Oil Company.[2] There is no record that this particular law has been used against a federal agency but there is a real possibility that it can be used against federal employees as individuals for violation of the Federal Refuse Act.[3]

After the Refuse Act of 1898 was passed, environmental pollution abatement policy was practically nonexistent until the Federal Water Pollution Control Act was passed in 1948. Section 9 of the Federal Water Pollution Control Act declared that it was the intent of Congress that federal departments and agencies would cooperate with the Department of Health Education and Welfare and with State, interstate agency, or municipality

[1]30 Stat. 152, 33 U.S.C. 407.

[2]United States v. Standard Oil Company, 384 U. S. 224 (1966).

[3]Grant C. Reynolds, "An Ephemeral Survey of Environmental Law," J.A.G. Law Review, Summer 1971. p. 175.

in preventing or controlling pollution of waters from discharges from federal facilities.[4]

The Water Quality Improvement Act of 1970 amended the Water Pollution Control Act of 1948 to provide that every federal facility would insure compliance with applicable water quality standards in the operation of that facility. In 1971 the State of California sought an injunction and monetary relief against the Commanding General of Fort Ord, California, not the government, under the terms of the Federal Water Pollution Control Act as amended. The Courts found for the plaintiff.[5]

Executive order 11507 ordered the Federal Government to provide leadership through the design, maintenance, and operation of its facilities to protect and enhance the quality of our air and water resources. The executive order stated that all federal facilities are required to conform to air and water quality standards, either State or Federal. The order also stated that actions necessary to bring the facilities into compliance must be underway by December 31, 1972.[6]

[4]Ibid., p. 172.

[5]Grant C. Reynolds, "An Ephemeral Survey of Environmental Law," p. 173.

[6]Executive Order No. 11507, 35 F.R. 2573, 5 Feb. 1970.

Probably the strongest statute now in effect pertaining to environmental policy is the Clean Air Act as amended. This act promulgates the strict automotive emissions standards for 1975. It is not that provision which is important to the Air Force. Section 118 requires all Federal agencies to comply with Federal, State or interstate and local requirements for control and abatement of air pollution to the same extent that any person is subject to the requirements. The President can exempt individual federal emission sources on an annual basis if it is in the national interest, but only if the technology to control the pollution is not available and the operation of the source is necessary to the national security.[7]

Federal activity in the area of solid waste disposal has not been very pronounced to date. The Solid Waste Disposal Act provided for research, demonstration projects, and grants for local planning.[8] The Resource Recovery Act of 1970 requires EPA to establish guidelines for solid waste recovery, collection, separation, and disposal systems which are adaptable to appropriate

[7]Grant C. Reynolds, "An Ephemeral Survey of Environmental Law," p. 170.

[8]Ibid., p. 175.

land use plans and which are consistent with air and water quality standards and the public health and welfare. Under Section 201 of this act, federal agencies are required to comply with these guidelines and to require contractors using or operating federal facilities to comply with the guidelines.[9]

Noise pollution is the newest form of environmental degradation to be attacked. The Noise Pollution and Abatement Act of 1970, passed as Title IV of the Clean Air Act Amendments of 1970, is the first federal law passed on the subject. The Act, a very weak one, provides for the establishment in EPA of an Office of Noise Abatement and Control, directs it to study the problem of noise and to consult with federal agencies carrying out activities which create objectionable noise. The law does not provide for the establishment of noise standards or make provisions for enforcement of the law.[10]

In the opinion of Grant C. Reynolds, Deputy Assistant Counsel, Department of the Air Force, probably the most significant piece of legislation in the environmental field is the National Environmental Policy Act of 1970.

[9]Ibid., p. 175.

[10]Ibid., p. 176.

In Mr. Reynold's opinion, the secret of this act is not that it lays down rules, but that it requires the generation of a piece of paper which must be produced by someone coordinated with many other people, and approved by various layers of authority. This piece of paper is the environmental impact statement. The impact statement forces those involved in a project to consider the alternatives available in a given project. Because approvals are required at various levels up to the Departmental Assistant Secretary level of the affected department, Reynolds believes that approving authorities are more inclined to consider environmental alternates before approving questionable projects. The law also requires public hearings if the environmental assessment indicates the possibility of substantial environmental quality deterioration. All of these aspects make it difficult for a decision maker to overlook environmental problems.[11]

In the past federal government agencies have claimed protection from state statutes on the grounds of sovereign immunity. This defense is not adequate in the case of environmental pollution as several federal agencies have found. In one case a state sidestepped the sovereignity issue by claiming that a commanding officer was not protected by sovereignity because he had violated the

[11] Ibid., pp. 176-177.

limitation of his authority. The authority he violated was Section 9 of the Water Quality Act which stated "...each federal agency shall --- insure compliance with applicable water quality standards."[12]

Several existing environmental pollution laws give plaintiffs with standing a right to sue federal agencies in environmental cases. The courts have given a very broad interpretation as to standing so that almost any private individual or purely conservation organization such as the Sierra Club, can claim standing at least in environmental matters and sue.[13] In view of the possibilities for legal action in environmental matters, federal installations have little choice but to comply with all federal, state and local environmental protection laws.

As each new law has been enacted the Air Force has promulgated regulations which were intended to comply with the law. The most important Air Force regulation relative to dealing with Environmental Quality are AFR 19-1 "Pollution Abatement and Environmental Quality," AFR 19-2

[12]State of California v. Major General William B. Davidson, Jr. -F. Supp- (N.D. Cal., 1971) as quoted in Reynolds, p. 172.

[13]Reynolds, "An Ephemeral Survey" pp. 178-180.

"Environmental Assessments and Statements;" and AFR 91-9 "Water Pollution Control Facilities." There are numerous other Air Force regulations which touch upon aspects of environmental pollution but these three by far most strongly influence Air Force policy in regard to environmental pollution.

Specifically AFR 19-1[14] is intended to implement the National Policy on Environmental Quality. It states Air Force Policy in detail and specifies the machinery through which the policy will be promulgated. AFR 19-1 deals with air, water, noise, solid waste and electro-magnetic energy, and the Occupational Health and Safety Act. In addition it directs action toward multiple use of natural resources through land management programs to enhance, fish, wildlife, woodlands, open space, and outdoor recreation. It is by far the most important and most far reaching of the AFR's dealing with environmental pollution.

AFR 19-2[15] deals specifically with the preparation of Environmental Assessments and Statements. It was

[14]AFR 19-1, "Pollution Abatement and Environmental Quality," Dept. of the Air Force, Wash., D. C., Feb. 20, 1974.

[15]AFR 19-2, "Environmental Assessments and Statements," Dept. of the Air Force, Wash., D. C., Jan. 20, 1974.

issued to help the Air Force meet the requirements of The National Environmental Policy Act of 1969 and Executive Order 11514 dated March 7, 1970. As previously mentioned, these acts and orders required the writing of an environmental assessment or statement for any program or project which was controversial, might be controversial, or for any project or program which might significantly affect the quality of the environment. The intent of these acts and orders was to force those people who are responsible for the beginning of new projects at the lowest level of command to come under the scrutiny of their superiors and the public and through that means rather than through any legal means to cause those responsible for new projects to search for the best possible alternative for a given project. AFR 19-2 provides in great detail a guide for the preparation of environmental assessments and statements. The regulation is so restrictive in its guidance that it may stifle any real initiative on the part of the writer of the Environmental Assessment.

AFR 91-9[16] is the regulation which deals with the operation and maintenance of Water Pollution Control Facilities. The principal purpose of AFR 91-9 is hidden.

[16]AFR 91-9, "Water Pollution Control Facilities," Dept. of the Air Force, March 5, 1973.

It appears to be instructions for the operation of Waste Water Treatment facilities. Actually it implements Executive Order 11507 and 33 USC 422(PL 92-500) both of which require that federal agencies comply with all federal, state and local requirements regarding control and abatement of pollution. AFR 91-9 sets up regulations for permitting local, federal or state agencies to inspect facilities and/or records, and states Air Force policy regarding Water Pollution Control facilities. The tenor of this regulation is not as cooperative as the first two mentioned in this chapter. It complies with the requirement of the law but grudgingly.

It becomes apparent that the Federal Government and the Air Force have established a policy dedicated to protecting and enhancing the environment. The problem then is not to discern the policy, but to determine how the policy can be implemented.

SCOPE OF THE ENVIRONMENTAL MANAGER'S RESPONSIBILITY

The environmental manager outside the Air Force may be charged with one of several areas of responsibility. In the case of the Air Force environmental manager there is an implication that he is expected to be involved in air, water, noise, and solid waste pollution problems as well as land use management, outdoor recreation planning, timber management and game and fish management. In addition, the Air Force environmental manager may be expected to preserve, restore and protect historic and cultural sites or archaeological resources under Air Force jurisdiction. Air Force policy as stated in AFR 19-1 enunciates all of these items. The regulation does not assign responsibility specifically; therefore, one must use some deductive reasoning to discover who is responsible for this work.[1]

AFR 19-1 establishes the Environmental Protection Committee at Headquarters USAF and all major command and base levels. The Environmental Protection Committee is responsible for all general and specific policy enumerated in AFR 19-1. Further, AFR 19-1 directs that an environmental coordinator be appointed at each level.

[1]AFR 19-1.

The environmental coordinator is either the Chairman of the Environmental Protection Committee or the Executive Secretary. The Environmental Coordinator is in effect the manager of the Environmental Protection Committee. As such it can be deduced that the environmental coordinator is the primary environmental manager.[2]

The appointment of the environmental coordinator is the prerogative of the commander at all levels, except at Headquarters USAF. At Headquarters USAF, the Director of Civil Engineering appoints the committee chairman and the environmental coordinator. At this level the director of Civil Engineering is charged with all matters pertaining to pollution, pollution abatement, and the environment. At lower levels of command the base commander has the prerogative of appointing the environmental coordinator. Because of the difference in primary duties of the appointing officers, the primary environmental manager at Headquarters USAF will probably be an engineer, but at lower levels, he might not be an engineer.[3]

At all levels of command the environmental coordinator is charged with the responsibility, through his committee of:

[2]AFR 19-1.

[3]Ibid.

1. Coordinating and solving environmental protection problems.

2. Reviewing and coordinating policies.

3. Representing the Air Force in dealing with local or Federal Governments or with private individuals.

4. Arranging for accumulation of data for environmental quality reports required by the Air Force.

5. Making special studies or reviews, preparing or reviewing environmental assessments or statements.

6. Preparing the minutes of environmental meetings.[4]

The above duties do not necessarily require the services of a person trained in the sciences or engineering. All of the above duties could be accomplished by a person trained in management with advice from environmental specialists. However, at Headquarters USAF where the director of Civil Engineering is assigned other duties the environmental coordinator has, in addition to the previously listed committee duties, duties in the following areas:

1. Coordinating any environmental protection which may alter existing policy.

2. Developing engineering plans and specifications to meet health and welfare requirements.

[4]Ibid.

3. Consulting with other federal agencies in development and implementation of techniques for waste management and oil spill plans.
4. Developing programs to comply with environmental protection statutes.
5. Supervising utility and waste disposal practices.
6. Requesting Air Force funds for environmental protection measures.
7. Seeing that appropriate coverage of environmental matters is made in Air Force leases.
8. Establishing requirements for environmental pollution control.
9. Making annual report to DOD on pollution control projects.
10. Requesting, when necessary, waivers from national environmental standards where required by national defense needs.
11. Establishing compatible use zones adjacent to air installations taking into consideration noise and other environmental matters.[5]

At lower levels of command, if the environmental coordinator is appointed from the Civil Engineering Staff, it can be expected that his duties will be similar to those listed immediately above for the Headquarters USAF environmental

[5]Ibid.

coordinator. If, on the other hand the environmental coordinator is not an engineer, he could not be expected to assume those engineering functions such as design, development and specification writing which are assigned at Headquarters USAF. An ecologist or a planner might be better equipped than an engineer to direct environmental control projects, write environmental assessments, and develop techniques for waste management and oil spill protection. An engineer would be required to develop engineering plans and specifications and to supervise utility operations.

From this point discussions will be limited to the environmental manager at the base level. By Air Force regulation the environmental coordinator is the environmental manager, and the terms may be used interchangeably.

Pages 27 and 28 listed the duties which accrued to the environmental manager because of his position on the environmental protection committee as well as the duties which were assigned to him because of his position in the engineering staff at the Headquarters USAF level. It can safely be assumed that at the base level if the environmental manager is a member of the Civil Engineering staff, his duties will be roughly similar to those of the Headquarters USAF environmental manager. If he is not an engineer, he could function as well in the majority of his duties. He would find it necessary to depend upon the civil engineering staff for technical aid in those engineering duties listed in pages 27 and 28. In fact the field of environmental pollution abatement is so broad and the various engineering fields are so specialized that being an engineer does not in itself assure competence in the field of pollution abatement. For example, the two positions within Base Civil Engineering which are directly related to pollution abatement are the positions Sanitary Engineer B-1 and Sanitary Engineer B-7.[6] Although both positions are listed as Sanitary Engineer, only the B-1 position is concerned with design, maintenance and operation of domestic and industrial facilities and related water pollution abatement. The B-7 Sanitary Engineer is charged with air pollution abatement, a field which is likely to be alien to a person trained as a sanitary engineer. That field could be better served by a mechanical engineer, all of whose fields are more closely related to air pollution abatement than the sanitary engineer trained in sewage treatment work. The environmental manager is the liason between his base commander and all non Air Force contacts regarding

[6]Standard Job Description.

environmental pollution matters. The environmental manager may discover environmental pollution problems himself and report them to the state or local authorities, or he may, in extreme cases, first be made aware of problems when state or local authorities serve him with a notice of violation. Once apprised of a violation, the environmental manager is expected to recommend a solution to the problem to his superiors. The solution may be his own or it may be one he sought from experts in the field. Once he has made a recommendation he is for all practical purposes incapable of doing anything further to alleviate the problem until his recommendations have been received by authority, approved and funded. He is, however, expected during that time to answer all inquiries from local, state or other federal authorities, and he is held accountable by the Air Force even though he is incapable of action without approval and funding.

The environmental manager is expected to review all programs, all construction projects, and all new activities or major changes in existing activities to insure that they either have no adverse environmental consequences, that environmental safeguards are provided in case of potential adverse effects, or that the good accomplished outweighs possible environmental deterioration. In the case of the leasing of Air Force real property to others, it is the responsibility of the environmental manager to see that environmental protection measures are written into the lease to give environmental protection consistent with the planned use of the leased property. As a part of the review process it is the duty of the environmental manager to write an environmental appraisal or an environmental statement for each new program, each new construction project or each new outlease of real property. Substantial changes in the number of flights or changes in the type aircraft used requires assessments.

The environmental manager is expected to be informed of all new Federal, state and local regulations concerning pollution and to assure that the base remains in compliance with the regulations as they change. Major changes in regulations usually, but not always, are passed with enough lead time to permit installations to change their plant to comply. Unfortunately, the lead time required for budgeting purposes is so long, that even a year or two of lead time is often not enough to get new projects funded. For example, a change in the Maryland State regulation which was published in October 1974 states that Rotary Cup Oil burners must be removed from all furnaces 5,000,000 BTU/hr and smaller prior to 1 July

1976.[7] The regulation was not received by one base until January 1975. If the conversion costs less than $50,000 it can be scheduled from O&M funds and be completed on time. If the conversion costs more than $50,000 an emergency project must be instituted in order to get funding in time. If the project costs more than $50,000 but does not receive emergency status, it would require three years to get funding.

If the environmental manager is an engineer, he is also charged with the supervision of design work, and the preparation of contract plans and specifications for environmental protection projects. In addition he is expected to review all construction project plans and specifications to insure that adequate environmental safeguards are included in the project to insure protection of the environment both during and after completion of construction. The environmental manager is required to supervise all waste disposal practices to assure that they meet requirements. He is required to submit funding requirements for future year budgets for environmental protection matters. Submittal of requirements does not, however, insure that funding will be appropriated.

[7]Maryland State Department of Health and Mental Hygiene, 10.03.39, Regulations Governing the Control of Air Pollution in Area IV as amended Oct. 18, 1974.

The environmental manager then is not a manager in the sense that a line manager is. The military organization is essentially a line organization and the environmental manager functions in a staff position. Both terms are used in the classic sense used by Etzioni.[8] That is to say the line administers and has the authority while the staff advises the administrator on what action to take. It may well be that a large part of the environmental manager's problem stems from the fact that once he has offered his advice he has no further authority to act. As a staff man it is the duty of the environmental manager to meet with other agencies to negotiate solutions, to conduct studies to discover alternate solutions, to keep abreast of new developments and new regulations in the field, and most importantly to advise his line supervisor. Once he has advised his line supervisor, the environmental manager becomes impotent to act until his advice is accepted or acted upon by line personnel.

[8] Amitia Etizoni, Modern Organizations (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1964) p. 80.

## SURVEY OF PRESENT PRACTICES

Air Force interest in environmental pollution abatement goes back several years; however, the role of the environmental coordinator dates back only to 1972 and the publication of AFR 19-1, "Pollution Abatement and Environmental Quality." AFR 19-1 directed the formation of the Environmental Protection Committee and the environmental coordinator. The original regulation has been revised once, on February 20, 1974, to reflect changes in the National Pollution Discharge Elimination System.[1] All Air Force installations have had three years in which to establish an environmental protection program. Further, the environmental manager at each base should be able to estimate if his installation would be in compliance with national law by July 1, 1975, the date specified by federal law.[2]

Because the program was new, there was a possibility that various bases had developed different techniques for meeting the requirements of AFR 19-1. There was also the possibility that different installations would have different problems. A questionnaire was perceived to be the best

[1]AFR 19-1.

[2]Federal Water Pollution Control Act, 33 USC 1251 Sect. 201; Clean Air Act, 42 USC 1857 Sect. 110.

method for surveying the environmental pollution abatement program at other installations.

A questionnaire was mailed to 73 continental U. S. Air Bases addressed to the Environmental Coordinator. A copy of the questionnaire is shown in Appendix I. Among the questions I hoped to answer was how pollution problems were ranked by category, by the experts. The ranking of expenditures in pollution abatement programs against their perceived importance, the method of selecting projects to complete, the method of setting project priorities. One question was intended to show degree of expertise in the field of pollution abatement, and also possibly, to show a correlation between the expertise of the environmental coordinator and the degree of success of his base's pollution abatement program. There were 73 Air Force Bases identified in the continental United States. The Air Force Bases were selected by the fact that they contained the words "Air Force Base" in their names which identified them as full time, fully-staffed installations as opposed to those part time or temporary installations used as Air National Guard or Air Force Reserve training installations. Although all Air Force installations are expected to meet the requirements of AFR 19-1 and AFR 19-2, the Air Force Bases would be the ones which would have the most serious pollution problems, and which would be most likely to have full time environmental specialists.

Of the 73 questionnaires mailed, 39 were returned at the time the statistics were reduced for a 53% return. There were several surprises in the data, and a few confirmations of hypotheses.

All statistical tests were taken from Introduction to Statistics, by Herbert Friedman.

Question 1 was intended to discover the civilian grade or military rank of the base environmental coordinator, his educational background, and the number of years of experience in pollution abatement. It was pointed out earlier that the environmental coordinator was not required to be an engineer except at the Headquarters USAF level.

Question 1a. requested the job title and GS grade or military rank of the environmental coordinator. A problem developed immediately. Military rank and civilian grade are not directly comparable. Equivalent salaries were selected as the basis for comparison. Using that method, the following ranking resulted.

1. 2 Lt
2. GS 7
3. 1 Lt
4. GS 9
5. Capt
6. GS 11
7. GS 12
8. Lt Col
9. GS 13

The $X^2$ single sample test was used.[3] The formula is:

$$X^2 = \sum \left[ \frac{(O - E)^2}{E} \right]$$

O = Observed Frequency
E = Expected Frequency

The $X^2$ statistic measures the differences between observed and expected values and takes the expected values into account.[4] Cells were set up to show both the observed and the expected values for the various grades. The expected values were obtained from the null hypothesis that any difference in grade would be from chance or random factors. Thirty-eight people completed this portion of the questionnaire.

$$E = \frac{38}{9}$$

$$E = 4.22$$

| Grade | Observed | Expected |
|---|---|---|
| 2 Lt | 6 | 4.22 |
| GS 7 | 1 | 4.22 |
| 1 Lt | 3 | 4.22 |
| GS 9 | 1 | 4.22 |
| Capt | 2 | 4.22 |
| GS 11 | 13 | 4.22 |
| GS 12 | 10 | 4.22 |
| Lt Col | 1 | 4.22 |
| GS 13 | 1 | 4.22 |

Values from the above cells were substituted for O and E in the $X^2$ formula given above, with the result that

[3]Herbert Friedman, Introduction to Statistics (New York: Random House, 1972) p. 24.

$X^2 = 38.28$. From Tables for df = 8, the probability value (p) is found ($p < 0.001$), which is significant.[5] The conclusion from this test is that the null hypothesis is rejected. It appears that the Air Force environmental coordinators will tend to be a GS-11 and GS-12.

Question 1b. asked for the undergraduate degree of the environmental coordinator. Again the $X^2$ statistic was used. In this test there were 38 who answered. There were five different engineering degrees, three BS degrees not in engineering, and four people who had no college degrees. Cells were set up for each of seven designations.

| Degree | Observed | Expected |
|---|---|---|
| BSCE | 18 | 5.43 |
| BSME | 6 | 5.43 |
| BSEE | 3 | 5.43 |
| BSGE | 2 | 5.43 |
| BSSanE | 2 | 5.43 |
| BS | 3 | 5.43 |
| No BS | 4 | 5.43 |
| Total | 38 | |

$$E = \frac{38}{7}$$

$$E = 5.43$$

The expected value reflects the null hypothesis that no engineering degree would be more prevalent than any other.

[5]Ibid., p. 288.

The values for O and E were substituted into the $X^2$ formula given on page 38. $X^2 = 36.04$, df = 6. From Tables, $p < 0.001$.[6] The null hypothesis can be rejected, and it can be stated that most responding Air Force environmental coordinators will be civil engineers.

Returns from the questionnaire indicated that 13 people had done work toward advanced degrees. An attempt was made to ascertain if there was any correlation between advanced degree work and position grade. The Spearman Rank-Order Correlation was used.[7] The formula is:

$$r_s = 1- \left[\frac{6\sum(d^2)}{N(N^2-1)}\right]$$

d = difference in ranks
N = number of subjects

In order to accomplish the test, the data were set in a table and ranked by grade and advanced degree. Grade and degree ranks were set from 1 to 38 as suggested by Friedman.[8] Substituting the $d^2$ from Table I into the formula above, and for N=38, $r_s=0.19$. From Tables[9] $p > 0.10$. The conclusion is that the correlation between

[6]Ibid.

[7]Ibid., p. 80.

[8]Ibid., p. 51.

[9]Ibid., p. 300.

TABLE 1

GRADE - DEGREE CORRELATION

| Subject | Grade | Rank G | A Degree | Rank AD | d G-AD | $d^2$ |
|---|---|---|---|---|---|---|
| A | 1 | 3.5 | 6 | 33.5 | -30 | 900 |
| B | 1 | 3.5 | 1 | 13 | - 9.5 | 90.25 |
| C | 1 | 3.5 | 1 | 13 | - 9.5 | 90.25 |
| D | 1 | 3.5 | 1 | 13 | - 9.5 | 90.25 |
| E | 1 | 3.5 | 1 | 13 | - 9.5 | 90.25 |
| F | 1 | 3.5 | 1 | 13 | - 9.5 | 90.25 |
| G | 2 | 7 | 1 | 13 | -6 | 36 |
| H | 3 | 9 | 7 | 37.5 | -28.5 | 812.25 |
| I | 3 | 9 | 6 | 33.5 | -24.5 | 600.25 |
| J | 3 | 9 | 1 | 13 | - 4 | 16 |
| K | 4 | 11 | 6 | 33.5 | -22.5 | 506.25 |
| L | 5 | 12.5 | 1 | 13 | - 0.5 | 0.25 |
| M | 5 | 12.5 | 6 | 33.5 | -21 | 441 |
| N | 6 | 20 | 6 | 33.5 | -13.5 | 182.25 |
| O | 6 | 20 | 1 | 13 | 7 | 49 |
| P | 6 | 20 | 2 | 26 | - 6 | 36 |
| Q | 6 | 20 | 1 | 13 | 7 | 49 |
| R | 6 | 20 | 1 | 13 | 7 | 49 |
| S | 6 | 20 | 1 | 13 | 7 | 49 |
| T | 6 | 20 | 1 | 13 | 7 | 49 |
| U | 6 | 20 | 1 | 13 | 7 | 49 |
| V | 6 | 20 | 1 | 13 | 7 | 49 |
| W | 6 | 20 | 6 | 33.5 | -13.5 | 182.25 |
| X | 6 | 20 | 1 | 13 | 7 | 49 |
| Y | 6 | 20 | 1 | 13 | 7 | 49 |
| Z | 6 | 20 | 1 | 13 | 7 | 49 |
| AA | 7 | 31.5 | 1 | 13 | 18.5 | 342.25 |
| BB | 7 | 31.5 | 1 | 13 | 18.5 | 342.25 |
| CC | 7 | 31.5 | 1 | 13 | 18.5 | 342.25 |
| DD | 7 | 31.5 | 1 | 13 | 18.5 | 342.25 |
| EE | 7 | 31.5 | 1 | 13 | 18.5 | 342.25 |
| FF | 7 | 31.5 | 3 | 27 | 4.5 | 20.25 |
| GG | 7 | 31.5 | 7 | 37.5 | -4 | 16 |
| HH | 7 | 31.5 | 4 | 28 | 3.5 | 12.25 |
| II | 7 | 31.5 | 1 | 13 | 18.5 | 342.25 |
| JJ | 7 | 31.5 | 5 | 29 | 2.5 | 6.25 |
| KK | 8 | 37 | 6 | 33.5 | 3.5 | 12.25 |
| LL | 9 | 38 | 1 | 13 | 25 | 625 |
| | | | | | | 7399.25 |

position grade and advanced degrees is not significant.

A final test was run using data extracted from Question 1. The Spearman Rank-Order Correlation formula shown on page 40 was used. In this test the environmental coordinators were ranked according to two measurements, grade and years of experience in the environmental pollution field. The object of the test is to find a relationship between the two measurements. If there was a perfect relationship, $r_s$ would be equal to 1.00; if there was no relationship at all $r_s$ would be equal to 0. The relationship could be either positive or negative. If the relationship was negative, those with the most experience would have the lowest position grades. The raw data were set up as shown on Table 2. The grades were ranked from one to nine as explained on page 38 of this paper. From Table 2, $d^2 = 3380$; $N = 38$. Substituting those figures into the formula on page 40, $r_s = .63$. From Table M[10] $p < 0.01$. The conclusion is that there is a significant and moderate to high correlation between years in environmental work and position grade.

Questions 2 and 3 were intended to discover if the base environmental coordinator or any staff members were working full time in that position, and to determine the

[10]Ibid.

TABLE 2

GRADE - EXPERIENCE CORRELATION

| Subject | Grade | Rank G g | Years | Rank Y y | g - y d | $d^2$ |
|---|---|---|---|---|---|---|
| A | 1 | 3.5 | 0 | 1 | 2.5 | 6.25 |
| B | 1 | 3.5 | .5 | 3.5 | 0 | 0 |
| C | 1 | 3.5 | 1 | 8 | -4.5 | 20.25 |
| D | 1 | 3.5 | 1 | 8 | -4.5 | 20.25 |
| E | 1 | 3.5 | 1 | 8 | -4.5 | 20.25 |
| F | 1 | 3.5 | 1.5 | 12 | -8.5 | 72.25 |
| G | 2 | 7 | 1 | 8 | -1 | 1 |
| H | 3 | 9 | 2 | 14.5 | -5.5 | 30.25 |
| I | 3 | 9 | 2.5 | 17.5 | -8.5 | 72.25 |
| J | 3 | 9 | 2.5 | 17.5 | -8.5 | 72.25 |
| K | 4 | 11 | 3 | 22.5 | -11.5 | 132.25 |
| L | 5 | 12.5 | .5 | 3.5 | 9 | 81 |
| M | 5 | 12.5 | 2 | 14.5 | -2 | 4 |
| N | 6 | 20 | 0 | 1 | 19 | 361 |
| O | 6 | 20 | 1 | 8 | 12 | 144 |
| P | 6 | 20 | 1 | 8 | 12 | 144 |
| Q | 6 | 20 | 2 | 14.5 | 5.5 | 30.25 |
| R | 6 | 20 | 3 | 22.5 | -2.5 | 6.25 |
| S | 6 | 20 | 3 | 22.5 | -2.5 | 6.25 |
| T | 6 | 20 | 3 | 22.5 | -2.5 | 6.25 |
| U | 6 | 20 | 3 | 22.5 | -2.5 | 6.25 |
| V | 6 | 20 | 3 | 22.5 | -2.5 | 6.25 |
| W | 6 | 20 | 4 | 27 | -7 | 49 |
| X | 6 | 20 | 5 | 29.5 | -9.5 | 90.25 |
| Y | 6 | 20 | 9 | 35 | -15 | 225 |
| Z | 6 | 20 | 25 | 38 | -18 | 324 |
| AA | 7 | 31.5 | 1 | 8 | 23.5 | 552.25 |
| BB | 7 | 31.5 | 3 | 22.5 | 9 | 81 |
| CC | 7 | 31.5 | 5 | 29.5 | 2 | 4 |
| DD | 7 | 31.5 | 5 | 29.5 | 2 | 4 |
| EE | 7 | 31.5 | 5 | 29.5 | 2 | 4 |
| FF | 7 | 31.5 | 6 | 33 | -1.5 | 2.25 |
| GG | 7 | 31.5 | 6 | 33 | -1.5 | 2.25 |
| HH | 7 | 31.5 | 6 | 33 | -1.5 | 2.25 |
| II | 7 | 31.5 | 10 | 36 | -4.5 | 20.25 |
| JJ | 7 | 31.5 | 12 | 37 | -5.5 | 30.25 |
| KK | 8 | 37 | 2 | 14.5 | 22.5 | 506.25 |
| LL | 9 | 38 | 3 | 22.5 | 15.5 | 240.25 |

N = 38

$(d^2) = 3380$

size of the staff engaged in pollution abatement work. The answers received did not lend themselves to analysis. The raw data did show that nine of those environmental coordinators responding spent 70% or more of their time in environmental matters. Only eight bases had any full time employees in environmental pollution abatement, but the eight stations had a total of 30 full-time employees in pollution abatement. These were not necessarily stations in which the environmental coordinator spent the major portion of his time in environmental work.

Question 4 was asked to discover which problems demanded the greatest amount of the environmentalist's time. No statistical analyses were made with these figures; instead, an average time percentage was calculated. Of those answering, the largest amount of time, 17%, was spent in writing environmental statements. Approximately 9% of the time was spent in project design. Approximately 6% of time was spent in review of environmental statements, and in review of pollution abatement projects. Only 4% of the time was spent in meeting with local or state pollution authorities.

Questions 5, 6 and 7 were intended to investigate how many projects were in some stage of accomplishment at the present time related to air, water, and noise. The $X^2$ single sample test was used. The formula is given on page 38. In this test, the three questions were combined to give four categories. The categories were planning, design, funding, and under construction. The problem was set up as in the previous $X^2$ tests. The null hypothesis was that there will be no deviation across cells; any deviation will be due to chance or random factors. The cells were set up as follows:

| | Planning | Design | Funding | Construction | Total |
|---|---|---|---|---|---|
| O | 104 | 46 | 29 | 17 | 196 |
| E | 49 | 49 | 49 | 49 | |

df = 3

Placing the observed and expected values in the $X^2$ formula, $X^2$ is found to be 90.98. From tables[11] for df = 3, the probability is found, $p < 0.001$. The null hypothesis is rejected. There tends to be more projects in the planning stage than in any other stage.

Question 8 was intended to investigate the amount of time which lapsed between planning and funding for pollution abatement projects. When the question was formulated, it was assumed that the time lapse would be identical in air, water, or noise abatement. Certain discrepancies

[11]Ibid., p. 288.

appeared in the data which made them suspect. Because of the peculiarities of military budgeting procedure, the minimum time necessary to fund an emergency project is 18 months, unless the necessary funds can be obtained from base operations and maintenance funds. That is not possible except for small projects of less than $50,000 in size. For projects which cannot be classed as emergency, three years are normally required for funding. After funding, a minimum of 45 days and an average of three months are required between funding and beginning of construction. Because of these time constraints, any statement that a minimum time lapse of less than 18 months between beginning of planning and beginning of construction is unrealistic. Further, there is no reason to believe that one activity would be funded faster than another, yet the data indicated that the average time lapse for all water projects was 2.5 years, for all air projects 1.7 years, and for all noise projects 1.6 years. Since these figures appear unreliable, no attempts were made to draw conclusions based on them.

Question 9 asked if the major delay occurred in planning, design, or funding. The $X^2$ single sample formula was used in the same manner as described for Question 1a. The null hypothesis is that there will be no difference in time delay between planning, design and funding, any deviation would be from chance or random factors. Cells were set up for each of three designations.

| | Planning | Design | Funding | Total |
|---|---|---|---|---|
| O | 11 | 0 | 27 | 38 |
| E | 12.6 | 12.6 | 12.6 | |

$$E = \frac{38}{3}$$

$$E = 12.6$$

$$df = 2$$

Substituting O and E data into the $X^2$ formula, $X^2 = 29.26$. From Table F[12] $p < 0.001$. The null hypothesis is rejected. The subjects who believe that the greatest delay is in funding were significantly more than the number who believed that the major delay was in planning.

Question 10 was posed to attempt to discover who selected the priorities for pollution abatement projects. As the question was stated, any number of answers were possible, however, only two answers emerged, higher headquarters and base programmers. Because this became a two cell test, df = 1, but because df = 1, there is a possibility that an incorrect value for p. may be obtained. To correct the error, the $X_c^2$ (Chi squared corrected for continuity) is used.[13]

[12]Ibid., p. 288.

[13]Ibid., p. 21.

Formula[14] $X_c^2 = \sum \left[ \frac{(0 - E - 1/2)^2}{E} \right]$

The cells are set up as in the $X^2$ test.

| | Base | Higher Hdq. | Total |
|---|---|---|---|
| 0 | 9 | 20 | 29 |
| E | 14.5 | 14.5 | |

The null hypothesis is that there is no difference between the number of decisions made at base and at higher command; any difference would be due to chance or random factors. By substituting values for O and E in the formula, $X_c^2 = 3.448$; $p < 0.10$ from tables.[15] The null hypothesis cannot be rejected.

Question 11 asks the respondents to grade five factors which might influence decisions on which of several projects to choose for accomplishment. Respondents were asked to grade the given factors in descending order of importance from 6 to 1. Five probable factors were furnished, and the respondents were asked to enter any other factor which they might think was important. At the time the question was formulated, it was thought that the survey would prove that one of four outside groups would exert the most influence upon the decision maker's choice. Availability

[14]Ibid., p. 24.

[15]Ibid., p. 288.

of funds was added because funding is always a factor in the selecting of projects. It was not thought that it would prove the most important consideration. To test this question, the Single-Factor Analysis of Variance[16] was used.

Formula

| Source | df | SS | MS | F |
|---|---|---|---|---|
| Columns | C-1 | $\sum \left(\frac{T_{ci}^2}{N_{ci}}\right) - \frac{T^2}{N}$ | $\frac{SS_c}{df_c}$ | $\frac{MS_c}{MS_w}$ |
| Within = Error | N - C | $SS_t - SS_c$ | $\frac{SS_w}{df_w}$ | |
| Total | N - 1 | $\sum\sum(X^2) - \frac{T^2}{N}$ | | |

$$\text{where } \frac{T^2}{N} = \frac{(\sum\sum X)^2}{N}$$

The raw scores were not always graded from 6 to 1 as requested; therefore, the scores were weighted before placing them in Table 3. The scores were weighted as suggested by Friedman.[17] The following results were found by substituting values from Table 3 into the formula above. With F calculated, p was found by entering Table E.[18]

[16] Ibid., p. 168.

[17] Ibid., p. 51.

[18] Ibid., pp. 282-287

TABLE 3

INFLUENCES UPON PROJECT SELECTION

| a | $a^2$ | b | $b^2$ | c | $c^2$ | d | $d^2$ | e | $e^2$ | f | $f^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 9 | 4.5 | 20.25 | 6 | 36 | 4 | 20.25 | 2 | 4 | 1 | 1 |
| 1.5 | 2.25 | 6 | 36 | 3 | 9 | 5 | 25 | 4 | 16 | 1.5 | 2.25 |
| 2.5 | 6.25 | 4 | 16 | 6 | 36 | 5 | 25 | 2.5 | 6.25 | 1 | 1 |
| 3 | 9 | 5 | 25 | 5 | 25 | 5 | 25 | 2 | 4 | 1 | 1 |
| 6 | 36 | 3 | 9 | 4.5 | 20.25 | 2 | 4 | 1 | 1 | 4.5 | 20.25 |
| 6 | 36 | 3 | 9 | 3 | 9 | 3 | 9 | 3 | 9 | 3 | 9 |
| 5 | 25 | 3 | 9 | 4 | 16 | 1 | 1 | 2 | 4 | 6 | 36 |
| 4 | 16 | 5.5 | 30.25 | 5.5 | 30.25 | 3 | 9 | 2 | 4 | 1 | 1 |
| 2.5 | 6.25 | 2.5 | 6.25 | 6 | 36 | 2.5 | 6.25 | 2.5 | 6.25 | 5 | 25 |
| 6 | 36 | 3 | 9 | 5 | 25 | 4 | 16 | 2 | 4 | 1 | 1 |
| 5 | 25 | 2.5 | 6.25 | 6 | 36 | 2.5 | 6.25 | 2.5 | 6.25 | 2.5 | 6.25 |
| 2.5 | 6.25 | 4.5 | 20.25 | 6 | 36 | 4.5 | 20.25 | 2.5 | 6.25 | 1 | 1 |
| 3.5 | 12.25 | 3.5 | 12.25 | 3.5 | 12.25 | 3.5 | 12.25 | 3.5 | 12.25 | 3.5 | 12.25 |
| 6 | 36 | 4 | 16 | 3 | 9 | 5 | 25 | 2 | 4 | 1 | 1 |
| 6 | 36 | 4 | 16 | 3 | 9 | 2 | 4 | 1 | 1 | 5 | 25 |
| 6 | 36 | 5 | 25 | 4 | 16 | 3 | 9 | 2 | 4 | 1 | 1 |
| 6 | 36 | 3 | 9 | 5 | 25 | 2 | 4 | 4 | 16 | 1 | 1 |
| 6 | 36 | 4 | 16 | 5 | 25 | 3 | 9 | 2 | 4 | 1 | 1 |
| 4 | 16 | 3 | 9 | 5 | 25 | 2 | 4 | 1 | 1 | 6 | 36 |
| 4 | 16 | 5 | 25 | 6 | 36 | 3 | 9 | 2 | 4 | 1 | 1 |
| 5 | 25 | 3 | 9 | 4 | 16 | 2 | 4 | 6 | 36 | 1 | 1 |
| 6 | 36 | 4.5 | 20.25 | 2 | 4 | 2 | 4 | 2 | 4 | 4.5 | 20.25 |
| 6 | 36 | 4.5 | 20.25 | 4.5 | 20.25 | 2 | 4 | 2 | 4 | 2 | 4 |
| 6 | 36 | 3 | 9 | 3 | 9 | 3 | 9 | 1 | 1 | 5 | 25 |
| 6 | 36 | 3 | 9 | 4 | 16 | 2 | 4 | 5 | 25 | 1 | 1 |
| 6 | 36 | 3 | 9 | 3 | 9 | 5 | 25 | 1 | 1 | 3 | 9 |
| 5.5 | 30.25 | 3.5 | 12.25 | 3.5 | 12.25 | 1.5 | 2.25 | 1.5 | 2.25 | 5.5 | 30.25 |
| 2 | 4 | 4.5 | 20.25 | 4.5 | 20.25 | 2 | 4 | 2 | 4 | 6 | 36 |
| 2 | 4 | 5.5 | 30.25 | 5.5 | 30.25 | 4 | 16 | 1 | 1 | 3 | 9 |
| 3 | 9 | 5 | 25 | 5 | 25 | 2 | 4 | 1 | 1 | 5 | 25 |
| 6 | 36 | 3 | 9 | 3 | 9 | 3 | 9 | 3 | 9 | 3 | 9 |
| 2 | 4 | 4 | 16 | 5 | 25 | 3 | 9 | 1 | 1 | 6 | 36 |
| 6 | 36 | 4 | 16 | 5 | 25 | 2 | 4 | 3 | 9 | 1 | 1 |
| 6 | 36 | 3 | 9 | 5 | 25 | 2 | 4 | 1 | 1 | 4 | 16 |
| 6 | 36 | 5 | 25 | 4 | 16 | 3 | 9 | 2 | 4 | 1 | 1 |
| 5.5 | 30.25 | 5.5 | 30.25 | 4 | 16 | 2.5 | 6.25 | 2.5 | 6.25 | 1 | 1 |
| 4 | 16 | 2 | 4 | 3 | 9 | 5 | 25 | 6 | 36 | 1 | 1 |
| 3 | 9 | 4.5 | 20.25 | 4.5 | 20.25 | 2 | 4 | 6 | 36 | 1 | 1 |
| 3 | 9 | 6 | 36 | 4 | 16 | 5 | 25 | 2 | 4 | 1 | 1 |

| Source | df | SS | MS | F | p |
|---|---|---|---|---|---|
| Columns | 5 | 177.46 | 35.49 | 17.84 | $<.001$ |
| Within=Error | 228 | 445.04 | 1.99 | | |
| Total | 233 | 622.50 | | | |

The probability value indicates that there is a significant difference between the importance of funding and the other five areas listed as possible influencing factors in the selection of environmental pollution abatement projects. Funding is the factor which will probably bear the most influence.

Question 12 asked if the environmental coordinator attempted to weigh the relative merits of one environmental project against another in the same medium. As worded, the respondent had two choices of an answer, yes or no. To test this question, the chi square corrected formula was used. The formula is given on page 48 of this thesis. There were 18 respondents who answered yes, and 18 who answered no. The remainder did not answer the question. The cells were set up for each possible answer.

| | YES | NO | TOTAL |
|---|---|---|---|
| Observed | 18 | 18 | 36 |
| Expected | 18 | 18 | |

df = 1

By substitution into the formula on page 48, $X_c^2 = 0.278$.

From Table F[19] $p > 0.20$. There is no significant difference between those who compare the relative merits of projects within a given medium, and those who do not.

Question 13 asked if the environmental coordinator made any attempt to weigh the relative merits of an environmental project in one medium against one in another medium, for example, a water pollution abatement project against an air pollution abatement project. Because it is more difficult to compare projects in different media to each other than it is to compare projects in the same medium, it would be reasonable to assume that there would be fewer people who attempted to compare projects from different media than from the same medium. The raw score comparison of the responses from questions 12 and 13 did show that there were fewer people who tried to compare projects from different media. In this question, as in question 12, there were 36 who responded. The chi square corrected test was used as in question 12. The cells were set up for each possible answer.

| | YES | NO | TOTAL |
|---|---|---|---|
| Observed | 14 | 22 | 36 |
| Expected | 18 | 18 | |

$df = 1$

[19]Ibid., p. 288.

By substituting figures from the cells above into the $X_c^2$ formula, $X_c^2 = 0.681$. From Tables,[20] $p > 0.20$. There is no significant difference between the number of people who answer yes and those who answer no.

Question 14 asked the respondents to list in order of importance the four fields addressed by the Air Force environmental pollution abatement program. The fields to be judged were air, water, solid waste and noise. In order to test this question the Single-Factor Analysis was used. See page 49 for the formulae. The raw data from the questionnaires were weighted as suggested by Friedman[21] before placing them in Table 4. After substituting values from Table 4 into the formula on page 49, the following values were derived.

| | df | SS | M | F | p |
|---|---|---|---|---|---|
| Column | 3 | 772.88 | 24.29 | 33.83 | $<0.001$ |
| Error | 152 | 109.12 | .72 | | |
| Total | 155 | 182.00 | | | |

The computed F=33.83 was found to have a p= 0.001 in Tables.[22] The probability value indicates that a significant number of the environmental coordinators believe water pollution abatement is the most important area of concern.

[20] Ibid.

[21] Ibid., p. 51.

[22] Ibid., pp. 282 - 287.

TABLE 4

RELATIVE IMPORTANCE OF POLLUTION ABATEMENT PROJECTS

| Subject | Air | | Noise | | Solid Waste | | Water | |
|---|---|---|---|---|---|---|---|---|
| | $X_a$ | $X_a^2$ | $X_n$ | $X_n^2$ | $X_s$ | $X_s^2$ | $X_w$ | $X_w^2$ |
| A | 4 | 16 | 3 | 9 | 1 | 1 | 2 | 4 |
| B | 2 | 4 | 1 | 1 | 3 | 9 | 4 | 16 |
| C | 2 | 4 | 1 | 1 | 3 | 9 | 4 | 16 |
| D | 3 | 9 | 1 | 1 | 3 | 9 | 3 | 9 |
| E | 2 | 4 | 1 | 1 | 4 | 16 | 3 | 9 |
| F | 2 | 4 | 1 | 1 | 3 | 9 | 4 | 16 |
| G | 3 | 9 | 1 | 1 | 2 | 4 | 4 | 16 |
| H | 2 | 4 | 1 | 1 | 3 | 9 | 4 | 16 |
| I | 1 | 1 | 2 | 4 | 3 | 9 | 4 | 16 |
| J | 4 | 16 | 1 | 1 | 2 | 4 | 3 | 9 |
| K | 2 | 4 | 1 | 1 | 3 | 9 | 4 | 16 |
| L | 4 | 16 | 2 | 4 | 1 | 1 | 3 | 9 |
| M | 1 | 1 | 2 | 4 | 3 | 9 | 4 | 16 |
| N | 4 | 16 | 1 | 1 | 2 | 4 | 3 | 9 |
| O | 3 | 9 | 2 | 4 | 1 | 1 | 4 | 16 |
| P | 2 | 4 | 1 | 1 | 3 | 9 | 4 | 16 |
| Q | 2 | 4 | 1 | 1 | 3 | 9 | 4 | 16 |
| R | 3 | 9 | 1 | 1 | 2 | 4 | 4 | 16 |
| S | 3 | 9 | 1 | 1 | 2 | 4 | 4 | 16 |
| T | 3 | 9 | 2 | 4 | 1 | 1 | 4 | 16 |
| U | 3 | 9 | 2 | 4 | 1 | 1 | 4 | 16 |
| V | 2 | 4 | 3 | 9 | 1 | 1 | 4 | 16 |
| W | 2 | 4 | 2 | 4 | 2 | 4 | 4 | 16 |
| X | 2 | 4 | 1 | 1 | 4 | 16 | 3 | 9 |
| Y | 1 | 1 | 2 | 4 | 3 | 9 | 4 | 16 |
| Z | 2 | 4 | 1 | 1 | 3 | 9 | 4 | 16 |
| AA | 1 | 1 | 2 | 4 | 4 | 16 | 3 | 9 |
| BB | 1 | 1 | 3 | 9 | 3 | 9 | 3 | 9 |
| CC | 2 | 4 | 3 | 9 | 1 | 1 | 4 | 16 |
| DD | 2.5 | 6.25 | 2.5 | 6.25 | 2.5 | 6.25 | 2.5 | 6.25 |
| EE | 3 | 9 | 2 | 4 | 1 | 1 | 4 | 16 |
| FF | 4 | 16 | 1 | 1 | 2 | 4 | 3 | 9 |
| GG | 2 | 4 | 1 | 1 | 4 | 16 | 3 | 9 |
| HH | 3 | 9 | 1 | 1 | 2 | 4 | 4 | 16 |
| II | 3 | 9 | 1 | 1 | 2 | 4 | 4 | 16 |
| JJ | 4 | 16 | 1 | 1 | 3 | 9 | 2 | 4 |
| KK | 1 | 1 | 4 | 16 | 3 | 9 | 2 | 4 |
| LL | 4 | 16 | 2 | 4 | 1 | 1 | 3 | 9 |
| MM | 2 | 4 | 1 | 1 | 3 | 9 | 4 | 16 |
| Totals | 96.50 | 272.25 | 62.50 | 124.25 | 93.50 | 259.25 | 137.50 | 501.25 |

Question 15 asked respondents to rank expenditures for pollution abatement projects. The material was weighted as in question 14, and as in question 14, the Single-Factor Analysis of Variance was used. The weighted figures are shown in Table 5. After substituting values into formula on page 49, the following values were derived.

| | df | SS | MS | F | p |
|---|---|---|---|---|---|
| Column | 3 | 70.80 | 23.6 | 30.84 | 0.001 |
| Error | 148 | 113.20 | .765 | | |
| Total | 151 | 184 | | | |

The computed F=30.84 was found to have a $p = < 0.001$ in Tables.[23] The results indicate that there is a significant probability that a larger amount of money will be spent on water pollution abatement projects than on any other pollution abatement project.

Question 16 was asked to discover if the majority of the Air Force Bases would be in compliance with present State and EPA Standards. No tests were performed, but the raw scores indicated that of those who answered, 14, or 36% expected to be in compliance while 25, or 64% did not expect to be in compliance.

Question 17 was asked to determine if either a cost-

[23]Ibid.

TABLE 5

RANKING OF EXPENDITURES
ON POLLUTION ABATEMENT PROJECTS

| Subject | Air | | Noise | | Solid Waste | | Water | |
|---|---|---|---|---|---|---|---|---|
| | $X_a$ | $X_a^2$ | $X_n$ | $X_n^2$ | $X_s$ | $X_s^2$ | $X_w$ | $X_w^2$ |
| A | 4 | 16 | 1 | 1 | 2 | 4 | 3 | 9 |
| B | 3 | 9 | 1 | 1 | 2 | 4 | 4 | 16 |
| C | 2 | 4 | 1 | 1 | 3 | 9 | 4 | 16 |
| D | 2 | 4 | 1 | 1 | 4 | 16 | 3 | 9 |
| E | 4 | 16 | 2 | 4 | 3 | 9 | 1 | 1 |
| F | 2 | 4 | 1 | 1 | 3 | 9 | 4 | 16 |
| G | 3 | 9 | 1 | 1 | 2 | 4 | 4 | 16 |
| H | 3 | 9 | 1 | 1 | 2 | 4 | 4 | 16 |
| I | 2 | 4 | 1 | 1 | 4 | 16 | 3 | 9 |
| J | 3 | 9 | 1 | 1 | 2 | 4 | 4 | 16 |
| K | 2 | 4 | 1 | 1 | 3 | 9 | 4 | 16 |
| L | 4 | 16 | 1 | 1 | 2 | 4 | 3 | 9 |
| M | 2 | 4 | 1 | 1 | 4 | 16 | 3 | 9 |
| N | 4 | 16 | 1 | 1 | 2 | 4 | 3 | 9 |
| O | 3 | 9 | 1 | 1 | 4 | 16 | 2 | 4 |
| P | 3 | 9 | 4 | 16 | 2 | 4 | 1 | 1 |
| Q | 2 | 4 | 1 | 1 | 3 | 9 | 4 | 16 |
| R | 3 | 9 | 1 | 1 | 2 | 4 | 4 | 16 |
| S | 3 | 9 | 2 | 4 | 1 | 1 | 4 | 16 |
| T | 4 | 16 | 1 | 1 | 3 | 9 | 2 | 4 |
| U | 3 | 9 | 1 | 1 | 2 | 4 | 4 | 16 |
| V | 2 | 4 | 2 | 4 | 2 | 4 | 4 | 16 |
| W | 2 | 4 | 1 | 1 | 4 | 16 | 3 | 9 |
| X | 1 | 1 | 2 | 4 | 3 | 9 | 4 | 16 |
| Y | 2 | 4 | 4 | 16 | 1 | 1 | 3 | 9 |
| Z | 1 | 1 | 2 | 4 | 3 | 9 | 4 | 16 |
| AA | 1 | 1 | 3 | 9 | 2 | 4 | 4 | 16 |
| BB | 3 | 9 | 1 | 1 | 2 | 4 | 4 | 16 |
| CC | 3 | 9 | 1 | 1 | 3 | 9 | 3 | 9 |
| DD | 2 | 4 | 1 | 1 | 3 | 9 | 4 | 16 |
| EE | 2 | 4 | 1 | 1 | 4 | 16 | 3 | 9 |
| FF | 2 | 4 | 1 | 1 | 3 | 9 | 4 | 16 |
| GG | 4 | 16 | 1 | 1 | 2 | 4 | 3 | 9 |
| HH | 1 | 1 | 2 | 4 | 3 | 9 | 4 | 16 |
| II | 2 | 4 | 2 | 4 | 2 | 4 | 4 | 16 |
| JJ | 3 | 9 | 4 | 16 | 1 | 1 | 2 | 4 |
| KK | 2 | 4 | 1 | 1 | 3 | 9 | 4 | 16 |
| LL | 3 | 9 | 1 | 1 | 2 | 4 | 4 | 16 |
| Totals | 97 | 277 | 56 | 112 | 98 | 280 | 129 | 465 |

benefit analysis or an understanding of pollution damage would be of more help in selecting pollution abatement projects. Thirty-six people answered the question, with 33% favoring the cost-benefit analysis, and 67% favoring a better understanding of pollution damage.

Question 18 was added because it was believed that pollution abatement adjacent to the facility but not connected to the facility would have a bearing on the public sentiment exerted upon the installation by local civic groups and governmental bodies to force the Air Force to control pollution. The data gathered were not useful because it could not be determined that city size alone offered any measure of pollution. If the question had been more carefully formed, or if a question had been included requesting data on non-Air Force related pollution, perhaps a correlation between pollution in the nearby communities and civic group interest in Air Force pollution abatement projects might have been established.

# DISCUSSION

The Air Force has consistently met each new Federal regulation or federal policy pronouncement with a regulation of its own which established Air Force policy designed to comply with the wishes of Congress or the President. In its regulations, the Air Force usually established procedures which were intended to guide those persons at lower levels in the Air Force who were charged with the origination of pollution abatement projects. One can draw an inference from the various Air Force regulations that the Air Force is genuinely interested in meeting its responsibilities to the public in the area of pollution abatement. When one attempts to draw a conclusion as to the Air Force's intentions from specific actions the intent becomes less clear. There are indications that the Air Force is attempting to meet its obligations, but there are indications that its success in meeting its obligations in the field of environmental pollution abatement is mixed. A first indication of the Air Force intent to meet its obligation can be inferred from the study of the first question in the statistical information in the previous chapter. The Air Force has staffed its environmental coordinator post with middle management people in the higher middle management grades. Two thirds of the environmental coordinators answering the questionnaire were GS-11 or above. All but 4 of those answering had BS degrees and of those with degrees, all but 3 were BS degrees in engineering. Approximately one-third had done work toward advanced degrees. The data gathered indicated that the environmental coordinator would probably be an engineer and probably would be a civil engineer.

While there were more civil engineers in the environmental coordinator post than any other type engineer, there is no reason to believe that civil engineers are especially well equipped to serve in that position, or that any kind of engineer is required. If it is true that an engineer is required in the environmental coordinator position, a sanitary engineer would be expert in the area of water pollution abatement and in solid waste, but he would be poorly equipped to function in the field of air or noise pollution abatement. A mechanical engineer may be proficient in the design of air pollution control equipment and in the design of noise attenuating facilities but he would not have the necessary expertise in solid waste or water pollution abatement. Because the environmental coordinator must deal with such a broad field, it is possible that an individual with a broad general scientific background, and good management capabilities might be better equipped to serve in the environmental coordinator post. The environmental coordinator would be able to draw any specialized advice needed from experts in the various fields.

Although the environmental coordinators generally are experienced and trained engineers, only 9 of those answering spend 70% or more of their time engaged in environmental duties. That fact might indicate that the environmental coordinator is assigned those duties as a secondary task. The questionnaire was not designed in a way which would allow that theory to be tested.

Data gathered from question 4 of the questionnaire tends to indicate that the environmental coordinator need not necessarily be an engineer, for only nine percent of their time on the average was spent in engineerig design work. Seventeen percent of their time was spent in writing environmental assessments, and six percent of their time was spent in reviewing environmental assessments. While engineering training may be helpful in writing and reviewing environmental assessments, engineering training is not a prerequisite. An ecologist would be better equipped through training to write an environmental assessment because he would be better able to assess environmental changes which would result from given actions. Question 4 was not exhaustive enough to make a positive statement regarding the need for using engineers as environmental coordinators. To do that, it would have been necessary to query the respondents on each of the duties listed in AFR 19-1.

The data collected in questions 5, 6, and 7 of the questionnaire indicate that there are more projects in planning stage than in all other stages combined. Taken alone, that fact does not appear to be important, but combined with the data collected from questions 9 and 11 the indication is strong that funding is a major inhibiting factor in the attempts to abate environmental pollution. Data from question 9 indicated that a significantly larger number of jobs were delayed in the funding process than in either design or planning. Data from question 11 indicates that funding probably has more bearing on the selection of projects than any of the other factors listed in the questionnaire.

Both questions 12 and 13 were asked to discover if attempts were made to weigh the relative merits of one project against another either in the same medium or in different media. It was assumed that an affirmative answer to these two questions might indicate that the environmental coordinators attempted to use some form of systems analysis, or that systems analysis would be a useful tool for the environmental coordinators. The null hypothesis could not be rejected as a result of the statistical tests; therefore, no conclusion could be drawn from that question.

Data from question 14 tended to indicate that the environmental coordinator believed that water pollution was more important than either of the other three types of pollution listed. With the results of question 14 indicating that environmental coordinators believed that water pollution was more important, it was not surprising that the data from question 15 indicated that more funds were expended upon water pollution abatement than any other form of pollution abatement.

To summarize, the following conclusions may be drawn. The Air Force has attempted to staff its environmental coordinator positions with highly qualified technicians, but the technicians may not be assigned to the post as their primary duty. The technicians selected as environmental coordinators are not necessarily selected from technical fields which best qualify them as environmental coordinators. The availability of funds is a major factor in accomplishing environmental pollution abatement projects. A large percentage of the Air Force installations will not be in compliance with state or EPA requirements by July 1, 1975.

From the discussion above it would appear that there are several areas where the Air Force could improve its pollution abatement program. One of the immediately available improvements would be to make the environmental coordinator position a full time position or at least make the environmental portion of the duties the primary part of the position. Future environmental coordinators should be selected from technical fields more closely related to environmental pollution abatement than civil engineering.

The most obvious place for improvement is in the area of funding. It has been indicated that funding is one of the most critical areas of concern. There is no reason to believe that funds intended to be used for pollution abatement projects will increase appreciably. If available funds cannot be increased, it is necessary to find methods to use available funds to the best possible advantage. In order to use funds to the best advantage it is necessary to find some means of selecting projects to fund from a number of possible projects in several different media. Any project comparison must be based on some type of cost-benefit analysis or through some form of analysis which can be used to compare various facets of one project with another.

## A SUGGESTED ANALYSIS TECHNIQUE

Robert Calkins said, "Decision-making is crucial ... because it is through that process that goals are set, plans are made, means are chosen and policies and actions are determined that affect both the internal organization and its external relations and often govern the effectiveness and the success of the enterprise."[1] He also believed that few decision-makers know how they arrive at their decisions. Calkins maintained that a better understanding of the decision making process will lead to better rational decisions.[2]

Dror said that policymakers tend to rely more on their intuition, judgement, or other external processes in decision-making than on rational processes. He also believed that decision-makers were usually biased more toward "intuition" than "information" and more toward "guess than estimate." Dror believed the policymakers tend to adopt extrarational processes because there are too many barriers which prevent the policymakers from using rational processes.[3]

[1]Robert D. Calkins, "The Decision Process in Administration." Business Horizons, Fall 1959 Vol. 2, No. 3, p. 20.

[2]Ibid.

[3]Yehezkel Dror, Public Policy Making Reexamined (Scranton, Pennsylvania: Chandler Publishing Company, 1968) pp. 83-85.

Braybrook and Lindblom believed that the decision-maker uses a strategy called incrementalism in dealing with decisions. In incrementalism the policymaker is interested in marginal, or incremental changes. In incrementalism, when the policymaker considers changes in policy or in objectives he compares alternatives which are similar to the status quo. The policymaker concentrates his evaluation on margins or increments by which value outputs or value consequences differ from policy to policy.[4]

In incrementalism only those policies are considered whose known or expected consequences differ from each other only incrementally, or for that matter differ only incrementally from the status quo. By limiting his attention to policies which differ only incrementally from the status quo, the decision-maker then attends to a smaller variety of alternatives than he might otherwise consider. Finally the incrementalists believed that limiting consideration only to incremental changes help the analyst to overcome problems he might have because he does not have adequate information, theory or other ways of dealing adequately with nonincremental alternatives.[5]

[4]David Braybrook and Charles E. Lindblom, A Strategy of Decision (New York: The Free Press of Glencoe, 1963) pp. 83-85.

[5]Ibid., pp. 86-89.

Simon said "...administration man sacrifices - looks for a course of action that is 'good enough',"[6] Simon believed that the decision-maker does not try to optimize his decisions, but only seeks decisions that suffice.

From the foregoing, one could draw the conclusion that decision-makers generally do not seek the optimal solution but instead seek solutions that suffice; that they do not seek solutions radically different from the present situation, but they seek solutions only incrementally different than the present practice; and that decision-makers are inclined to use intuitive processes rather than rational processes in decision-making. Lindblom maintained that it is not possible to use the rational processes because it is not possible to consider all the alternatives.[7] Conversely, Ball and Gilbert stated that while the intuitive approach may be generally the most suitable approach to decision-making, and often the only possible approach to some problems, there are times when the problem is so critical or so complex that the decision-

[6]Herbert A. Simon, Administrative Behavior (2nd Ed. New York: The Macmillan Company, 1961) pp. XXV.

[7]Charles E. Lindblom, "The Science of 'Muddling Through'," Public Administration Review, Vol. XIX, No. 2, Spring 1959, pp. 79-88.

maker needs a more concrete guide than intuition to direct him.[8] Systems analysis techniques can be used by the Air Force environmental coordinator to analyze pollution abatement programs.

Systems analysis techniques have been used by decision-makers to analyze problems in a rational manner so that they may choose the best among alternative decisions. Systems analysis is or attempts to be quantitative and it takes an overall rather than a piecemeal view of a project. It permits the use of a wide variety of scientific or mathematical techniques within its framework. Systems analysis also permits the inclusion of political or other nonscientific factors which might have a bearing on the decision.[9] Wildavsky stated that systems analysis is very similar to operations reasearch, but the following distinction can be made between the two. The less that is known about objectives, the more they conflict, the larger the number of elements to be considered, the more uncertain the environment, the more likely it is that it will be called systems analysis. Wildavasky believed systems analysis

[8]Roger E. Ball and Allan A. Gilbert, "How to Quantify Decision-Making," Business Horizons, Vol. I, No. 1, Winter 1958. p. 73-79.

[9]E. S. Quade, Systems Analysis; A Tool for Choice (Santa Monica, California: The Rand Corporation 1972).

requires more judgement and intuition and less reliance on quantitative methods than operations research.[10]

Systems analysis techniques are suggested as an aid to the Air Force environmental coordinator when he attempts to select the optimum program for improving air or water quality. The objective in using the systems approach is to bring more rational thought processes into use in decision-making in project selection. Systems analysis techniques can be devised to permit the use of any scientific or quantitative techniques available and at the same time permit the use of intuition and judgement in the selection process in cases where the available scientific knowledge is not adequate for decision-making.

Quade[11] stated that there are five steps in the analysis process. They are:

1. The objective or objectives. The objectives must be ascertained and a method must be devised to measure the extent to which the objectives can be attained by various choices.

[10] Aaron Wildavsky, "The Political Economy of Efficiency," The Administrative Process and Democratic Theory, Louis C. Gawthrop, ed., (Boston: Houghton Mifflin, 1970) p. 317.

[11] E. S. Quade, Systems Analysis Techniques For Planning-Programming-Budgeting (Santa Monica, Calif: The Rand Corp. 1966) pp. 6-8.

2. The alternatives. The alternatives are the means by which the objectives may be attained. Alternatives need not be similar to each other, be obvious substitutes for one another, or be designed to perform the same specific function.

3. The costs. The costs are the resources which when used for accomplishing a particular alternative are no longer available to be used for other purposes. Costs can usually be measured in money.

4. A model (or models). The model is a simplified representation of the real world cause-and-effect relationships of the question studied. The model may be a set of mathematical equations, a computer program or a purely verbal description of the situation in which intuition alone is used to predict the consequences of various choices.

5. A criterion. A criterion is a rule or standard which is used to rank the alternatives in order of desirability and to choose the most promising. It provides a means for comparing cost to effectiveness.

Some primary objectives in environmental pollution abatement programs are listed below.

1. To bring air and water quality, noise levels, and solid waste disposal practices into acceptable limits from the standpoint of state, federal and local laws and regulations.

2. To bring air and water quality, noise levels, and solid waste disposal practices into acceptable limits from an aesthetic standpoint.

3. To protect natural resources including vegetation, wildlife and marine life from damage caused by pollution.

4. To improve the health and welfare of the population through the improvement of environmental quality.

In addition to the primary objectives which would apply to any of the projects considered in the analysis, there also might be secondary objectives relating to the specific project alternatives. For example, a project proposal may require the reduction of particulate matter from a given heating plant. The available means of reducing particulate matter could include placing dust collectors on the stacks, converting from residual oil to distilled oil, or closing the plant. Any of the three alternatives would meet the primary objectives, but if a secondary objective were to continue to furnish maximum heat at the plant, the third alternative would not be acceptable.

The alternatives would include all the methods which might be used to bring a given facility into compliance with air and water pollution law, or to reduce pollution discharges even though the discharges are within legal limits. The alternatives would include all construction projects which would bring the pollutant discharge to acceptable levels as well as any new method of operation, or any change in programs which might be accomplished to reduce pollutant levels. In the example mentioned earlier the problem to be corrected was excessive particulate matter at a heating plant. There were three general alternatives mentioned; converting to distillate oils, installing a dust collector, or closing the plant. While there are three general alternates mentioned, each of the first two can each be accomplished by at least three methods. There are at least three different types of dust collectors available on the market which will reduce particulate matter to acceptable levels. There are also three or more types of burner available which can be installed to burn distillate fuels, and which will, when properly fired, burn clean enough to reduce particulate matter to acceptable levels. The third alternate, to close the plant, might be accomplished by at least two methods; either stop using heat, or buy heat from a commercial supplier of heat if one is available. For the general alternatives, there are actually eight readily identifiable alternatives available to bring particulate emissions into compliance with present legal limits. There may be at least as many more alternates available if one searched for them, but it would be prudent to limit consideration to those already mentioned because they offer a reasonable number of choices for each of several methods of correcting the problem. As Quade pointed out, "Time and money costs obviously place sharp limits on how far any inquiry can be carried."[12]

The costs must be established for every alternative considered. For construction projects which are alternatives, the procedure for estimating costs is well defined and reasonably accurate results are easily obtained. For alternatives which attack the problem through altered operations, calculating the costs may become more difficult. In the particulate problem used as an example previously, the cost of installing each type of dust collector or each type of distillate fuel burner can be accurately estimated. Operating costs for each installation after completion can also be estimated with a high degree of accuracy. It is much more difficult to estimate the costs involved in closing the heating plant entirely if no alternate method of obtaining heat is planned. If the plant were closed, costs chargable to that alternate would legitimately include loss of employee labor due to discomfort from cold, and loss of equipment due to freezing. Regardless of the difficulty, it is necessary to establish costs for all alternatives considered. Because money costs of various alternates are easily comparable, and more easily understood,

[12]Ibid., p. 22.

money costs are normally used. Other methods of measuring costs may be used if they are available and if they can be used to compare the costs of one alternate to another. Finally, it should be noted here that costs, insofar as they can be ascertained, should include not only the direct cost involved in putting a given project into effect, but should also include such items as discomfort or the lowering of the quality of life. The costs associated with the failure to implement a project should also be ascertained. Those costs could be the resources lost through damage from unabated pollution, and the fines levied for failure to comply with regulations.

The model is the heart of systems analysis. The function of the model is to provide a way to forecast the outcome of each of the various alternative actions. While it is not absolutely necessary that the model be based on mathematical formulation to indicate the optimum choice among alternatives, a mathematical model can be a valuable aid. Whether the model is mathematical, A Delphi process, or a scenario, the great advantage to the model is that it offers a precise framework and terminology through which it provides a means of communication and feedback which enables analysts to exercise their judgement.[13]

[13]Ibid., p. 10.

The model which will be developed herein is a linear mathematical model. It will permit the display in a chart form the major project areas, the alternatives considered in each project area, and finally it will indicate the criterion. The model will not display the objectives, but the objectives must be listed before any other part of the analysis process can be addressed. Four objectives were listed on pages 69 and 70. Let it be assumed that they are the objectives in this analysis.

The heart of the proposed model is the ranking or grading system. Each of 6 items will be given a numerical grade from 0 to 10. In some cases the ranking will be done on an intuitive or judgemental basis, in other cases there may be mathematical tools available for assigning a score to each segment of the model. The 0 to 10 score was selected arbitrarily to keep the total scores low and manageable. A point system ranging from 0 to 100 or from 0 to 1000 could be used as well except that it might be more difficult to proportion the grades when using larger numbers. Several general rules should be noted. Tie grades are permissible. In assigning grades, the most important or most desireable item in a column is assigned the grade of 10. If two items are judged to be of equal importance they receive identical grades.

The first step after defining the objectives is to survey the actual and potential pollution sources. Every actual or potential source of pollution should be listed. Once the sources are listed the severity of the pollution emanating from each source must be rated. The rating must be largely a judgemental decision. Grading for Column (a) of Table VI (page 84) should be based upon the local, state and federal pollution control regulations and their definition of severity. For example, if an air pollution source's emissions were approximately three times above the allowable, it would be very severe and be graded 10. If the source's emissions were only slightly greater than the legally allowable maximum it would be of minor severity and would be graded perhaps 1 or 2. Each source would be graded similarly. In areas where there are no noise pollution regulations, if the above rating concept is used, the noise pollution severity would always be 0 because the grades in Column (a) are based upon applicable regulations.

The next consideration is the time available to correct the pollution before the legal deadline. A pollution source which is already past the legal compliance deadline will of course receive the maximum number of points. A source which is several years away from the legal deadline would receive a minimum score. If there are no sources which are past the deadline, but there are sources which are so near the deadline that compliance within the time remaining is questionable, then those sources should receive the maximum number of points. The awarding of points for Column (b) of Table VI is one requiring judgement on the part of the analyst. The process is simplified because at this point the analyst considers only two areas in awarding points; the time available and the time required to bring the pollution source into compliance. The item requiring more time to correct than is available before legal compliance is mandatory should receive the highest rank. The item with the longest time span available before mandatory compliance and the shortest completion time would have the lowest grade. Severity is not considered here since it was considered in Column (a).

Column (c) notes the visible effects of pollution. The visibility of pollution may not be directly related to its seriousness but if a particular type of pollution is visible it is more likely to be a source of complaints from neighboring landowners. In the interest of good public relations, it is therefore advisable to give some weight to visibility. An incinerator which produces a plume of ash laden smoke would rate higher than another incinerator which produced no visible smoke but which emitted a high volume of photo-chemical oxidants which might have an ultimately more serious effect on the community. The measure of pollution severity in Column (a) should address the problem of severity whereas Column (c) is especially intended to give some influence in the decision process to aesthetics.

Column (d), Local Public Priorities, is intended to permit local public interests to influence the decision process. The reasoning is somewhat similar to that for Column (c). In this column the rating process would address not the pollution source so much as it would address the medium. For example, both an incinerator and a heating plant would pollute the same medium, air; therefore, they would each receive the same numerical rank. The analyst must use his knowledge of the local community, and possibly complaints from neighbors to the Air Force Base, in assigning numerical grades in this column. It is possible that interest in various kinds of pollution would vary from locality to locality.

Where there are several alternates available for abating pollution each is analyzed in Columns (e) and (f). The alternates available for correcting a particular pollution source may vary from construction projects to changed operations procedures. All reasonable available alternates should be considered. It is here that an effort should be exerted to find solutions other than those which are immediately obvious. If available alternates become too numerous the analyst will discover that time does not permit analysis of all alternates. It is necessary that the analyst use good judgement in selecting alternates so that his search for alternates will be neither too narrow nor too broad.

The costs represented in Column (e) can be extremely difficult to assess. If the alternate being costed is a construction project, the costs involved may be obtained from the engineer's estimate. If the alternate being costed is the curtailment of a program, or the cessation of operations of a facility, then the costs may not be so easily identifiable. In construction projects the cost is usually considered to be the cost required to build and equip the project. In the cessation of operation of a facility the cost may be the loss of production from that facility. In addition, the first cost may not necessarily be a good indicator of the true cost. When operating costs, maintenance costs and useful life of various projects over a period of years are considered along with their first costs, the project with the low first cost may, over time, be more expensive than the project with the more expensive first cost. In military cost comparisons such items as depreciation, present value cost streams and opportunity costs are not usually considered. At local levels of government and in private enterprise they would be considered.

In many types of systems analysis, benefit-cost ratios are used rather than a construction cost or construction cost plus operating cost. In the analysis of pollution abatement projects benefit-cost analyses are not practical at present because the benefits which accrue from abatement of air pollution cannot be readily expressed in monetary terms. One approach that has been used to express benefits is reduced death rates. A comparison of morbidity and mortality statistics with air pollution indices suggest that communities with the heaviest air pollution loads tend to rank high in death rates from a number of diseases. Fiscal benefits cannot be ascertained because no one is certain which pollutants or combination of pollutants are the irritants. It has not been ascertained at this time what level of air pollution can be tolerated without serious damage to man or the environment.[14] A similar problem exists with water quality benefit-cost analysis. While the cost required to purify water can be ascertained, it is not clear what quality of water is acceptable in a given stream.[15] As in air, an explicit evaluation of the health effects of water pollution is not feasible at this time.[16]

[14] Herfindahl and Kneese, Quality of the Environment, pp. 29-30.

[15] Ibid., p. 19.

[16] Ibid., p. 29.

In the interest of simplicity, the costs in Column (e) will include the first cost plus the estimated additional costs for the first 5 years. If the alternate is a construction project, the cost would be the original cost of construction plus the operations and maintenance costs for the first 5 years. If the alternate is one in which no construction is involved, the cost would cover the same period but would be calculated differently. An example of the latter would be a proposal to improve effluent from a sanitary sewer plant by ceasing operation of the plant and discharging the sewage to the nearest publicly owned sanitary sewer system. The first cost for that proposal would include the cost of fees and permits required to connect to the public sewer system plus the cost of demolition or of mothballing the existing plant. The 5 year cost would include the fees charged by the public utility for sewer service multiplied by the number of thousands of gallons discharged annually over the next 5 years.

Because it is necessary to consider alternates with wide variations in costs it is not practical to use a grading system where the grade of each project cost would be proportional to each other cost. The present state of research does not permit the use of cost-benefit ratios in the weighting of costs, but this model can be adapted to that use when the necessary information becomes available. For the present, it is necessary to use a linear cost ranking procedure. To determine the numerical rank of each project cost, each cost must be listed in descending order from highest cost to lowest cost. The most expensive cost receives the numerical rank "1", the next highest cost receives the rank "2". That system continues until each cost is ranked. Column (e) is the only column which is not ranked from one to ten. The cost which receives the highest rank is the lowest cost of completion. The exact numerical rank is determined by the total number of alternates being considered. As in other columns, if two costs are identical, they would receive an identical rank.

Column (f) assesses the time required to complete a given project. In this column, only the projects proposed to improve one particular pollution source are ranked against each other. Generally, there would be no more than four or five alternates which would correct a given source. The time required to complete projects may vary widely, perhaps from a minimum of one year to a maximum of five years. The alternate with the shortest completion time for a given source should receive a rank of "10" and the alternate with the longest completion time should receive a rank of "1". All other alternates proposed to correct the same source would be ranked proportionately between the highest and lowest grades according to the time required for completion. If proportioning results in fractional ranks, the figure may be rounded off to the nearest whole number. Ties are permissible. The time required to complete the project must include the estimated time required from beginning of planning to the completion of the project and the beginning of operation. If the proposed alternate includes a construction project, the time would include planning, programming of funds, design of the project, advertisement of bids, contract letting, construction time, and time required after completion of construction to place into operation. If the proposed alternate does not include a construction project, it should include the time required from planning through completion of the alternate and placing it into operation.

Once all elements within the systems model have received their numerical grades, the figures are placed in the formula given below.

$$2a + b^2 + c + d + e + f + bf = T$$

The above formula was developed on the assumption that any pollution source which was so severe that it would constitute an immediate threat to the environment or to the health of individuals would receive such a high priority that it would not be subject to a systems model.

In the formula above, "a" is doubled to permit severity of pollution to have more influence on the final ranking of proposals than most other items. By squaring b any value b 6 will be larger than the maximum possible sum of c, d and f combined. This arrangement permits all of the other lettered columns combined to influence the choice of project, but it permits b to have a larger influence. If b had been cubed for any value b 6 the value for $b^3$ would be so large that the total of the other columns could not influence the selection of projects. The large influence is permitted b because the model assumes that the only pollution sources being considered are those which will become illegal at some future date. It must be assumed that any pollutant source so dangerous as to be lethal would be stopped immediately regardless of cost. With those assumptions the legal requirements represented by b become very important. Columns c, d, e and f are permitted some influence in selecting projects but no overriding influence. The time available to correct a pollution source and the time required to correct the source are interrelated. To permit the relation between these two elements to influence the project selection b representing the time available is multiplied by f which represents the time required to complete the project. An example of the proposed system analysis model is shown in Table VI on pages 84 and 85. Note that in the example the two air pollution sources

TABLE VI

A SYSTEMS ANALYSIS MODEL

| ENVIRONMENTAL POLLUTION SOURCES | (a) SEVERITY OF POLLUTION | (b) TIME AVAILABLE BEFORE POLLUTION BECOMES ILLEGAL | (c) VISIBILITY OF POLLUTION | (d) LOCAL PUBLIC PRIORITIES |
|---|---|---|---|---|
| INCINERATOR | 5 | 6 months 10 | Visible 10 | No interest 0 |
| HEATING PLANT | 5 | 6 months 10 | Not visible 0 | No interest 0 |
| WASH RACK | 10 | 1 year 5 | Slightly visible 5 | Interest in water 10 |

TABLE VI (continued)

A SYSTEMS ANALYSIS MODEL

| ENVIRONMENTAL POLLUTION SOURCES | AVAILABLE MEANS OF CORRECTING POLLUTION | (e) COST OF CORRECTING | | (f) TIME REQUIRED TO COMPLETE PROJECT | | TOTAL POINTS | |
|---|---|---|---|---|---|---|---|
| INCINERATOR | Remodel | $125,000 | 2 | 9 months | 10 | 232 | 1st Priority |
| | New Plant | $175,000 | 1 | 1 year | 5 | 176 | |
| HEATING PLANT | Convert to Oil | $ 10,000 | 7 | 2 months | 10 | 227 | 2nd Priority |
| | Dust Collector | $100,000 | 3 | 1 year | 5 | 168 | |
| WASH RACK | Sanitary Lagoon | $ 25,000 | 4 | 3 months | 10 | 124 | |
| | Separator | $ 20,000 | 5 | 6 months | 5 | 95 | |
| | Connect to Sanitation System | $ 15,000 | 6 | 3 months | 10 | 126 | 3rd Priority |

receive higher ranks primarily because of the short time available to correct the pollution sources before they become illegal. Note also that bf was the influencing factor in selecting the alternate which would be most suitable for correcting the pollution source.

Obviously there will be a continuous need for feedback. As pollution sources are corrected, other sources will become critical. Sources which receive a low priority because several years will elapse before compliance becomes mandatory, will as time passes, become more critical. New sources of pollution will be found.

The principal advantage to this systems analysis technique is that it offers a means to compare pollution abatement projects in several dissimilar mediums to each other through a grading system which is common to the various mediums. The technique requires that each element of each project be weighted against every other project on several important factors. By weighting each element separately it is easier for the analyst to assign a meaningful grade to the element, than it would be if he tried to rank project priorities for the total job. Because the analyst must assign the numerical grades to each columnar item before he calculates the total points for the various projects the possibility of unconsciously influencing a project priority through personal bias is lessened.

## SOME SUGGESTED FURTHER AREAS FOR RESEARCH

The systems model suggested herein depends largely upon the judgement and intuition of the analyst because there are not enough facts available to permit more scientific analysis. In order to do more scientific analysis, a better understanding is needed of the exact level at which air or water impurities can be tolerated without adversely affecting the environment. It is necessary to identify and quantify both the direct and indirect costs of polluting our resources and of cleaning them after they are polluted. Specific benefits and costs must be related to specific pollutants. The explicit evaluation of the effects of air or water pollution on health is not now feasible, but tests may be performed to aid in estimating the cost of achieving various levels of air and water standards.

There must be a system devised to compare the cost of implementing a project to damages to persons or property if the project is not implemented.

Cost-benefit ratios are much used as a criterion in systems models. At present, pollution abatement information does not permit adequate cost-benefit analysis especially where both air and water pollution abatement projects are compared to each other. Work is needed to permit such cost-benefit analysis.

It would be interesting to discover what, if any, impact state water and air pollution regulations have upon the amount of money appropriated for pollution compliance on Air Force Bases in the state. Are funds diverted from states which have less stringent regulations to states with more stringent regulations? A related study might endeavor to find if Air Force Bases in states with strict compliance regulations have a better record of compliance with pollution abatement regulations than Air Force Bases located in states with less stringent pollution abatement regulations.

## SUMMARY AND CONCLUSIONS

The Air Force has established policy which states its intention to comply with federal, state, and local regulations on environmental pollution. It has ordered the establishment of committees at base level to oversee each base's activity in that direction. Whenever a new federal law is enacted or an executive order issued, the Air Force issues new regulations designed to comply with the letter and the spirit of the new document. Despite obvious efforts to comply with environmental pollution abatement regulations, the Air Force has not been successful in bringing its bases into compliance with state, local, and federal regulations.

The Air Force Environmental Manager may be expected to be involved in air, water, noise, and solid waste pollution problems and also to be involved in land use planning, outdoor recreation management, timber management, and game and fish management programs. The environmental manager outside the Air Force does not usually have such a broad responsibility. Returns from a questionnaire which was mailed to 73 Air Force Bases indicates that a large number of the Air Force Environmental managers hold BS degrees in Civil Engineering. A degree in Civil Engineering might furnish background knowledge useful in water pollution abatement or solid waste disposal through landfill operations, but it would not be related to noise pollution, air pollution, outdoor recreation management, or fish and game management programs.

The same questionnaire showed some other interesting facts. There are many more pollution abatement projects in the planning stage than there are in the design, funding, or construction stages. This might indicate that while pollution abatement needs might have been identified, the needs are not being met. The most significant delay in the completion of proposed projects occurred at funding. Another question indicated that funding was the most important single factor in influencing the selection of a given project. The stress on funding can be explained by the fact that funds for all projects are limited, and that the pollution abatement projects must compete with all other programs for necessary funds. The questionnaire also indicated that a significant number of the respondents believed that water pollution was a more serious problem than air, noise, or solid waste pollution. Not surprisingly, it was also shown that more money was spent on water pollution abatement than on any other medium.

Because funding bears so much influence on the projects which are selected for completion it would seem to be advisable to devise a method for selecting the projects which are more important and therefore more in need of being funded so that limited funds can be used to the best advantage. A systems model was developed which permits the comparison of various pollution sources and the comparison of alternates for correcting the pollution sources. Through comparison, the most critical pollution source can be selected for funding. As technical information becomes available, the model can be expanded to use the new technology.

There are several areas where additional research should be made. Much work needs to be done in cost-benefit analysis. Specific benefits and costs must be related to specific pollutants.

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February 20, 1975

TO THE BASE ENVIRONMENTAL COORDINATOR

I am an engineer employed by the Air Force in environmental pollution control. I am working on a Master's Thesis in management of environmental problems. It would be extremely helpful to me if you would complete as much of the inclosed questionnaire as you can and return it to me in the inclosed stamped, self-addressed envelope.

If you have any comments or observations you might like to add, please feel free to do so in the remarks space, or add sheets as necessary.

I shall be happy to share any meaningful information which may be developed from this research with interested persons. If you would like to receive information, include your name and address with the completed questionnaire. No individual or base will be identified either in the thesis or in the compilation of statistics.

Thank you very much for your help.

Sincerely yours,

Eugene M. Smith, Jr.

QUESTIONNAIRE

1. What is the professional background of the Environmental Pollution Abatement Specialist in your organization?

a. Job Title and GS Grade or Military Rank ____________________

b. Undergraduate degree ____________ Field of Study __________

c. Graduate degree(s) ______________ Field(s) of Study _______

d. Years of experience in Environmental Pollution. _____________

2. What percentage of his time does the pollution abatement specialist spend in that field? ______

3. Excluding maintenance and operations employees, sewer plant operators, etc., how many others are employed in pollution abatement?

Full time ______ Part time ______

4. What percentage of his time does the pollution abatement specialist spend in each of the following operations?

a. Writing Environmental Assessments or Statements ______

b. Reviewing Environmental Assessments or Statements ______

c. In meetings with state or local environmental pollution enforcement officials ______

d. In design of pollution abatement projects ______

e. In review of pollution abatement projects ______

5. How many air pollution abatement projects do you have in planning

______; design ______; funded ______; under construction ______.

6. How many water pollution abatement projects do you have in planning

______; design ______; funded ______; under construction ______.

7. How many noise pollution abatement projects do you have in planning

______; design ______; funded ______; under construction ______.

8. What is the average time lapse from beginning of planning to beginning of construction for environmental pollution abatement jobs?

Water ______ Air ______ Noise______

9. In your opinion does the major delay occur in planning ______; design ______; or funding ______?

10. Who selects the job priorities?

11. How are pollution abatement projects most often selected for construction? (grade 6 for most often; 1 for least often)

a. Availability of funds to do the project ______

b. Pressure from State Environmental Agencies ______

c. Pressure from EPA ______

d. Pressure from Local Governments ______

e. Pressure from local private citizens ______

f. Other (Specify ______

12. In selecting proposed environmental projects for completion, do you make any attempt to weigh the relative merits of one environmental project against another in the same medium ie. one air project against another air project? ______

13. Do you make any attempt to weigh the relative merits of one environmental project in one medium against the relative merits of an environmental project in another medium ie. a water pollution abatement project against an air pollution abatement project? ______

14. Grade the following fields of pollution abatement in order of importance in your opinion (4 most important; 1 least important)

Air Pollution ______
Noise Pollution ______
Solid Waste ______
Water Pollution ______

15. For your station since 1970 rank the expenditures on pollution abatement projects (4 largest expenditure; 1 smallest expenditure)

Air Pollution ______
Noise Pollution ______
Solid Waste ______
Water Pollution ______

16. Do you expect your installation to be totally in compliance with present State and EPC Standards for air and water pollution abatement by 1 July 1975? ______

17. In your opinion which of the following would be more helpful to you in selecting projects?

a. A method of comparing economic damage from a particular type of pollution with the cost of cleaning up that pollution. ______

b. A method for deciding which type of pollution is most harmful to a population. ______

18. What is the population of the nearest city to your installation?

________________________

a. Name of city ______________________________

b. Distance from your installation ____________

c. Is its principal business manufacturing__________;

commercial __________; agricultural __________

REMARKS

RAW DATA FROM QUESTIONNAIRES

| No. | 1a. | 1b. | 1c | 1d | 2 |
|---|---|---|---|---|---|
| 1 | 1 Lt | BS CE | JD | 2.5 yr | 30% |
| 2 | GS 11 | BS CE | MS San E | 25 yr | 20% |
| 3 | 2 Lt | BS Me | - | 1 yr | 80% |
| 4 | GS 12 | BS CE | - | 5 yr | 100% |
| 5 | GS 9 | BS Eng | MS Eng | 3 yr | 50% |
| 6 | Capt | BS CE | - | 2 yr | 5% |
| 7 | GS 12 | BS CE | - | 5 yr | 70% |
| 8 | GS 11 | BS CE | - | 3 yr | 27% |
| 9 | GS 11 | BS CE | Mgmt (no Deg) | 2 yr | 70% |
| 10 | GS 11 | BS CE | - | 1 yr | 30% |
| 11 | GS 11 | BS CE | - | 0 yr | 75% |
| 12 | GS 12 | BS ME | - | 6 yr | 60% |
| 13 | GS 12 | BS ME | - | 1 yr | 75% |
| 14 | GS 12 | BS CE | - | 6 yr | 100% |
| 15 | GS 11 | BS CE | - | 3 yr | 66% |
| 16 | 1 Lt | BS E | - | 2.5 yr | 45% |
| 17 | GS 7 | - | - | .7 yr | 10% |
| 18 | GS 11 | BS ME | - | 1 yr | 5% |
| 19 | GS 13 | BS ME | - | 3 yr | 10% |
| 20 | 1 Lt | BS CE | MS CE | 2 yr | 10% |
| 21 | 2 Lt | BS CE | - | 1 yr | 20% |
| 22 | 2 Lt | BS CE | - | 1.5 yr | 50% |
| 23 | GS 12 | BS EE | EE (20 hr) | 5 yr | 40% |
| 24 | GS 12 | BS CE | PhD Env Engr | 3 yr | 60% |
| 25 | GS 11 | BS EE | - | 3 yr | 50% |
| 26 | GS 11 | BS CE | - | 3 yr | 20% |
| 27 | GS 11 | BS San E | MS San E | 9 yr | 35% |
| 28 | GS - | BS CE | - | 2 yr | 40% |
| 29 | GS 12 | BS San E | San E (30 hr) | 10 yr | 50% |
| 30 | GS 11 | - | - | 5 yr | 98% |
| 31 | Lt Col | BS ME | MS Mgmt | 2 yr | 10% |
| 32 | GS 12 | BS Me | - | 6 yr | 15% |
| 33 | GS 11 | ME (no Deg) | - | 4 yr | 20% |
| 34 | GS 11 | BS Forestry | - | 3 yr | 40% |
| 35 | 2 Lt | BS CE | - | 1 yr | 5% |
| 36 | Capt | BS Aero E | MS Eng Mgmt | .5 yr | 50% |
| 37 | 2 Lt | BS EE | MS EE | .5 yr | 50% |
| 38 | 2 Lt | BS Env | - | - | 30% |
| 39 | GS 12 | BS Mgmt | Mgmt (45 hr) | 12 yr | 100% |

RAW DATA FROM QUESTIONNAIRES
CONTINUED

| No. | 3f. | 3p. | 4a. | 4b. | 4c. | 4d. | 4e. |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 2 | 10% | 5% | 1% | 5% | 4% |
| 2 | 0 | all | 1% | 1% | 15% | 2% | 1% |
| 3 | 0 | 20 | 5% | 5% | 10% | 15% | 20% |
| 4 | 1 | - | 15% | 30% | 30% | 5% | 10% |
| 5 | 0 | 15 | 10% | 10% | 5% | 5% | 10% |
| 6 | 0 | 20 | 1% | 1% | 0 | 1% | 1% |
| 7 | - | - | 80% | 10% | 3% | 5% | 2% |
| 8 | - | - | 2% | 5% | 2% | 1% | 2% |
| 9 | - | 1 | 35% | 5% | 1% | 15% | 5% |
| 10 | - | - | 15% | 0 | 0 | 0 | 0 |
| 11 | - | - | 10% | - | 2% | 1% | 10% |
| 12 | 0 | 2 | 50% | 10% | 5% | 25% | 10% |
| 13 | 6 | - | 20% | 1% | 1% | 10% | 5% |
| 14 | 7 | 6 | - | 25% | 10% | 40% | 10% |
| 15 | - | 12 | 15% | 5% | 10% | 15% | 5% |
| 16 | 0 | 22 | 25% | 20% | 5% | 25% | 25% |
| 17 | 0 | 3 | 15% | - | 5% | 15% | 10% |
| 18 | 0 | 1 | 2% | 1% | 1% | 1% | - |
| 19 | - | - | 10% | 5% | 1% | - | - |
| 20 | 0 | 0 | 5% | 0 | 1% | 3% | 1% |
| 21 | 5 | 0 | 1% | 1% | 0 | 0 | 1% |
| 22 | 0 | 2 | 1% | 0+ | 0+ | 0 | 0 |
| 23 | 0 | 1 | 10% | 3% | 5% | 20% | 5% |
| 24 | 2 | 1 | 25% | 15% | 5% | 15% | 5% |
| 25 | 0 | 2 | 25% | 10% | 0 | 0 | 10% |
| 26 | 0 | 0 | 10% | 1 | 2% | 70% | 17% |
| 27 | 0 | 0 | 20% | 0 | 1% | 5% | 0 |
| 28 | 0 | 0 | 10% | 10% | 0 | 5% | 1% |
| 29 | 1 | 2 | 15% | 15% | 1% | 5% | 5% |
| 30 | 0 | 19 | 50% | 10% | 10% | 10% | 20% |
| 31 | - | 2 | 5% | 0% | 2% | 5% | 1% |
| 32 | - | 10 | 5% | 1% | 2% | 4% | 2% |
| 33 | 0 | 5 | 10% | 0 | 1% | 0 | 1% |
| 34 | - | - | 30% | 10% | - | - | - |
| 35 | - | - | 5% | 1% | 1% | 1% | 1% |
| 36 | - | - | 15% | 5% | 0 | 0 | 5% |
| 37 | 4 | 16 | 30% | 1% | 1% | 1% | 1% |
| 38 | - | - | 15% | 10% | 1% | 2% | 2% |
| 39 | 2 | 1 | 20% | 5% | 10% | 5% | 10% |

RAW DATA FROM QUESTIONNAIRES
CONTINUED

| No. | 5p | 5d | 5f | 5c | 6p | 6d | 6f | 6c | 7p | 7d | 7f | 7c |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 10 | 3 | 1 | 0 | 0 | 4 | 4 | 0 | 4 | 1 | 0 | 0 |
| 2 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 3 | 1 | 1 | 0 | 0 | 2 | 1 | 0 | 1 | 3 | 0 | 0 | 0 |
| 4 | 2 | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 5 | 1 | - | - | - | 1 | - | - | - | 0 | 0 | 0 | 0 |
| 6 | 1 | - | - | - | 1 | - | - | - | - | - | - | - |
| 7 | - | - | - | - | 2 | - | - | - | - | - | - | - |
| 8 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 12 | 1 | 1 | 0 | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 13 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 14 | - | - | 1 | 1 | - | - | - | - | - | - | - | - |
| 15 | 1 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 1 | 2 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 0 | 0 | 1 | 0 | 8 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 18 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | 0 | 1 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | 1 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 23 | - | - | - | - | - | - | - | - | - | - | - | - |
| 24 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 | 1 | 0 | 0 | 0 |
| 25 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| 26 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 27 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 28 | 0 | 0 | 0 | 0 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 0 |
| 29 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 2 | 1 | 1 | 0 | 3 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 32 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 34 | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 35 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 36 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 37 | 1 | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 1 | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 3 | 0 | 0 | 0 | 0 |

RAW DATA FROM QUESTIONNAIRES
CONTINUED

| No. | 8W | 8A | 8N | 9p | 9d | 9f | 10 |
|---|---|---|---|---|---|---|---|
| 1 | 3 yr | 3 yr | - | | | X | Base Programs |
| 2 | 2 yr | - | - | | | X | Base Programs |
| 3 | 2.5 yr | 2.5 yr | 2.5 yr | X | | | Base Financial Bd |
| 4 | .75 yr | .75 yr | 1 yr | | | X | |
| 5 | 5 yr | 2 yr | - | X | | | |
| 6 | 5 yr | - | - | X | | | Air Force |
| 7 | 1 yr | 1 yr | 1 yr | X | | | Programs |
| 8 | 2.5 yr | 3.3 yr | - | | | X | CE Fac Bd |
| 9 | 3 yr | - | - | X | | | |
| 10 | 2 yr | - | - | | | X | |
| 11 | 3 yr | 3 yr | - | X | | | |
| 12 | 2 yr | 2 yr | 3 yr | X | | | Command |
| 13 | - | - | - | | | X | |
| 14 | .5 yr | .5 yr | .5 yr | | | X | Facilities Bd |
| 15 | - | - | - | X | | | Facilities Bd |
| 16 | 5 yr | - | - | | | X | Headquarters |
| 17 | 3 yr | 1 yr | 1 yr | | | X | SAC |
| 18 | 3 yr | - | - | | | X | Command |
| 19 | 2 yr | 3 yr | - | | | X | |
| 20 | 4 yr | 4 yr | - | X | | | Higher Hdqtrs |
| 21 | 3 yr | 2 yr | - | | | X | Higher Hdqtrs |
| 22 | 3 yr | 2 yr | - | | | X | Facilities Bd |
| 23 | 2 yr | 2 yr | 2 yr | X | | | Management |
| 24 | 1.5 yr | 2 yr | 2 yr | | | X | Higher Hdqtrs |
| 25 | 1 yr | 0 | 1 yr | | | | |
| 26 | 1 yr | 1 yr | 1 yr | | | X | TAC |
| 27 | 5 yr | | | | | X | |
| 28 | 2 yr | - | - | | | X | TAC |
| 29 | 3 yr | 3 yr | 3 yr | | | X | Command |
| 30 | 2.5 yr | 2.5 yr | 2.5 yr | | | X | Command |
| 31 | 2 yr | 1 yr | 1 yr | | | X | Command |
| 32 | 2 yr | 2 yr | 2 yr | | | X | Command |
| 33 | 2 yr | - | - | | | X | Facilities Bd |
| 34 | 3 yr | 2 yr | - | | | X | Command |
| 35 | 1.5 yr | - | - | X | | | |
| 36 | 2 yr | 2 yr | - | | | X | Command |
| 37 | 2 yr | 2 yr | - | | | X | Command/Congress |
| 38 | 1.5 yr | 1 yr | - | | | X | Command |
| 39 | 5 yr | 2 yr | - | | | X | Base Civil Engr |

RAW DATA FROM QUESTIONNAIRES
CONTINUED

| No. | 11a | 11b | 11c | 11d | 11e | 11f | 12 | 13 |
|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 4 | 5 | 4 | 1 | - | yes | yes |
| 2 | - | 4 | 1 | 3 | 2 | - | - | - |
| 3 | 3 | 4 | 6 | 5 | 3 | 2 | no | yes |
| 4 | 4 | 6 | 6 | 6 | 3 | 1 | no | no |
| 5 | 5 | 3 | 4 | 2 | 1 | 4 | no | no |
| 6 | 6 | - | - | - | - | - | yes | yes |
| 7 | 5 | 3 | 4 | 1 | 2 | 6 | yes | yes |
| 8 | 4 | 6 | 6 | 3 | 1 | - | yes | no |
| 9 | - | - | 6 | - | - | 5 | no | no |
| 10 | 6 | 3 | 5 | 4 | 2 | 1 | no | no |
| 11 | 4 | - | 6 | - | - | - | - | - |
| 12 | 1 | 3 | 6 | 3 | 1 | - | no | no |
| 13 | - | - | - | - | - | - | no | no |
| 14 | 6 | 4 | 3 | 5 | 2 | 1 | yes | yes |
| 15 | 6 | 4 | 3 | 2 | 1 | 5 | yes | yes |
| 16 | 6 | 5 | 4 | 3 | 2 | - | yes | yes |
| 17 | 6 | 3 | 5 | 2 | 4 | 1 | yes | yes |
| 18 | 6 | 4 | 5 | 3 | 2 | 1 | no | no |
| 19 | 4 | 3 | 5 | 2 | 1 | 6 | yes | no |
| 20 | 4 | 5 | 6 | 3 | 2 | 1 | yes | no |
| 21 | 4 | 2 | 3 | 1 | 5 | - | yes | yes |
| 22 | 5 | 3 | 1 | 1 | 1 | 3 | no | no |
| 23 | 6 | 5 | 5 | 1 | 1 | 1 | no | no |
| 24 | 5 | 3 | 3 | 3 | 2 | 4 | yes | yes |
| 25 | 6 | 3 | 4 | 1 | 5 | - | yes | no |
| 26 | 6 | 1 | 1 | 5 | 0 | 1 | no | yes |
| 27 | 6 | 3 | 3 | 1 | 1 | 6 | no | no |
| 28 | 1 | 4 | 4 | 1 | 1 | 6 | yes | yes |
| 29 | 3 | 6 | 6 | 5 | 1 | 4 | no | no |
| 30 | 5 | 6 | 6 | 3 | 0 | 6 | yes | no |
| 31 | 6 | - | - | - | - | - | no | no |
| 32 | 2 | 4 | 5 | 3 | 1 | 6 | yes | yes |
| 33 | 6 | 4 | 5 | 2 | 3 | - | no | no |
| 34 | 6 | 3 | 5 | 2 | 1 | 4 | yes | yes |
| 35 | 6 | 5 | 4 | 2 | 1 | - | yes | no |
| 36 | 3 | 2 | 3 | 1 | 1 | - | no | no |
| 37 | 3 | 1 | 2 | 4 | 5 | - | - | - |
| 38 | 3 | 4 | 4 | 1 | 6 | - | no | no |
| 39 | 3 | 6 | 4 | 5 | 2 | - | no | no |

RAW DATA FROM QUESTIONNAIRES
CONTINUED

| No. | 14A | 14N | 14S | 14W | 15A | 15N | 15S | 15W | 16 | 17a | 17b |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4 | 3 | 1 | 2 | 4 | 1 | 2 | 3 | No | - | - |
| 2 | 2 | 1 | 3 | 4 | 3 | 1 | 2 | 4 | No | X | |
| 3 | 2 | 1 | 3 | 4 | 2 | 1 | 3 | 4 | Yes | | X |
| 4 | 4 | 2 | 4 | 4 | 2 | 1 | 4 | 3 | Yes | X | |
| 5 | 2 | 1 | 4 | 3 | 4 | 2 | 3 | 1 | Yes | X | |
| 6 | 2 | 1 | 3 | 4 | 2 | 1 | 3 | 4 | Yes | | X |
| 7 | 3 | 1 | 2 | 4 | 3 | 1 | 2 | 4 | Yes | | X |
| 8 | 2 | 1 | 3 | 4 | 3 | 1 | 2 | 4 | No | | X |
| 9 | 1 | 2 | 3 | 4 | 2 | 1 | 4 | 3 | No | | X |
| 10 | 4 | 1 | 2 | 3 | 3 | 1 | 2 | 4 | No | | X |
| 11 | 2 | 1 | 3 | 4 | 2 | 0 | 3 | 4 | No | X | |
| 12 | 4 | 2 | 1 | 3 | 4 | 1 | 2 | 3 | Yes | | X |
| 13 | 1 | 2 | 3 | 4 | - | - | - | - | Yes | | X |
| 14 | 4 | 1 | 2 | 3 | 2 | 1 | 4 | 3 | No | | X |
| 15 | 3 | 2 | 1 | 4 | 4 | 1 | 2 | 3 | No | X | |
| 16 | 2 | 1 | 3 | 4 | 3 | 1 | 4 | 2 | Yes | X | |
| 17 | 2 | 1 | 3 | 4 | 3 | 4 | 2 | 1 | Yes | | X |
| 18 | 3 | 1 | 2 | 4 | 2 | 1 | 3 | 4 | Yes | | |
| 19 | 3 | 1 | 2 | 4 | 3 | 1 | 2 | 4 | Yes | | X |
| 20 | 3 | 2 | 1 | 4 | 3 | 2 | 1 | 4 | No | | X |
| 21 | 3 | 2 | 1 | 4 | 4 | 1 | 3 | 2 | No | | X |
| 22 | 2 | 3 | 1 | 4 | 3 | 1 | 2 | 4 | Yes | X | |
| 23 | 1 | 1 | 1 | 4 | 1 | 1 | 1 | 4 | No | | X |
| 24 | 2 | 1 | 4 | 3 | 2 | 1 | 4 | 3 | No | | X |
| 25 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | No | | X |
| 26 | 2 | 1 | 3 | 4 | 2 | 4 | 1 | 3 | No | | X |
| 27 | 1 | 2 | 4 | 3 | 1 | 2 | 3 | 4 | No | X | |
| 28 | 1 | 4 | 4 | 4 | 1 | 3 | 2 | 4 | Yes | | |
| 29 | 2 | 3 | 1 | 4 | 3 | 1 | 2 | 4 | No | X | |
| 30 | 4 | 4 | 4 | 4 | 4 | 1 | 4 | 4 | No | | X |
| 31 | 3 | 2 | 1 | 4 | 2 | 1 | 3 | 4 | No | | X |
| 32 | 4 | 1 | 2 | 3 | 2 | 1 | 4 | 3 | Yes | | X |
| 33 | 2 | 1 | 4 | 3 | 2 | 1 | 3 | 4 | No | | X |
| 34 | 3 | 1 | 2 | 4 | 4 | 1 | 2 | 3 | No | | X |
| 35 | 3 | 1 | 2 | 4 | 1 | 2 | 3 | 4 | No | | X |
| 36 | 4 | 1 | 3 | 2 | - | - | - | 4 | No | X | |
| 37 | 1 | 4 | 3 | 2 | 3 | 4 | 1 | 2 | No | | X |
| 38 | 4 | 2 | 1 | 3 | 2 | 1 | 3 | 4 | No | X | |
| 39 | 2 | 1 | 3 | 4 | 3 | 1 | 2 | 4 | NO | X | |

RAW DATA FROM QUESTIONNAIRES
CONTINUED

| No. | 18 Size | 18 Dist. | 18 Industry |
|---|---|---|---|
| 1 | 3,000,000 | 0 mi. | Government |
| 2 | 10,000 | 5 mi. | Agriculture |
| 3 | 6,000 | 0 | Shipping |
| 4 | 275,000 | 0 | Commercial |
| 5 | 34,000 | 0 | Agriculture |
| 6 | 60,000 | 2 mi. | Commercial-Agriculture |
| 7 | 2,500,000 | 5 mi. | Commercial |
| 8 | 15,000 | 18 mi. | Commercial |
| 9 | 24,000 | 0 | Commercial-Agriculture |
| 10 | 15,000 | 0 | Agriculture |
| 11 | 25,000 | 2 mi. | Agriculture |
| 12 | 120,000 | 0 | Commercial |
| 13 | 10,000 | 3 mi. | Commercial |
| 14 | 3,000 | 18 mi. | Manufacturing-Commercial |
| 15 | 40,000 | 10 mi. | Commercial |
| 16 | 40,000 | 0 | Commercial |
| 17 | 450,000 | 1 mi. | Manufacturing-Commercial |
| 18 | 42,000 | 5 mi. | Manufacturing-Commercial-Agriculture |
| 19 | | 0 | Manufacturing-Commercial-Agriculture |
| 20 | 20,000 | 4 mi. | Commercial |
| 21 | 150,000 | 15 mi. | Commercial-Agriculture |
| 22 | 20,000 | 10 mi. | Agriculture |
| 23 | | | Agriculture |
| 24 | 55,000 | 15 mi. | Commercial |
| 25 | 30,000 | 10 mi. | Manufacturing |
| 26 | 200,000 | 9 mi. | Gambling |
| 27 | 30,000 | 8 mi. | Commercial-Agriculture |
| 28 | 16,000 | 0 | Tourism |
| 29 | 600,000 | 15 mi. | Commercial |
| 30 | 450,000 | 7 mi. | Mixed |
| 31 | 40,000 | 5 mi. | Agriculture |
| 32 | 150,000 | 12 mi. | Commercial |
| 33 | 500,000 | 20 mi. | Commercial |
| 34 | 30,000 | 1 mi. | Commercial |
| 35 | 100,000 | 5 mi. | Commercial-Agriculture |
| 36 | 650,000 | 16 mi. | Commercial |
| 37 | 550,000 | 0 | Manufacturing-Commercial |
| 38 | 600,000 | 7 mi. | Commercial |
| 39 | 3,000,000 | 15 mi. | Government |

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THE ROLE OF THE ENVIRONMENTAL

MANAGER IN THE AIR FORCE

by

Eugene M. Smith, Jr.

(ABSTRACT)

The Air Force, in response to the desires of the President and the Congress, began in 1970 to formulate policy to guide it in its pollution abatement program. In its search for methods to control Air Force caused pollution, the position of Pollution Abatement Specialist evolved. It would seem that the success or failure of the Air Force in its stated policy would be directly related to the role of the pollution abatement specialist, the Air Force's environmental manager.

This thesis attempts to define the role of the Air Force's environmental manager by exploring the current pollution laws as they apply to the Air Force. It explores the Air Force Regulations which establish Air Force policy relating to pollution abatement. A questionnaire was sent to the environmental managers of 73 continental Air Force bases to collect inofrmation which would indicate the degree of success the Air Force pollution abatement program enjoyed. Returns from the questionnaire indicated that there were many more planned pollution abatement projects than there were projects in the design, funded or under construction stages. The greatest delay in pollution abatement project occured at the funding stage.

Because many projects must compete for limited funds, a systems model was devised which would permit the environmental manager to compare various projects to each other from the standpoint of need, cost, seriousness of pollution, and local public opinion. With the systems model as a tool the environmental manager may allocate limited funds to the most efficacious projects.