GEOHERMAL PLAN JUSTIFICATION

OFFICE OF BIOLOGICAL SERVICES

GEOHERMAL PROJECT

1976

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**U. S. Fish and Wildlife Service
Geothermal Project**

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GEOHERMAL PLAN JUSTIFICATION

Introduction

This document provides additional information to support the five-year plan and summarizes the plan. It includes an overall summary of the potential effects of geothermal development on fish and wildlife to demonstrate the urgent need for implementation of the plan. It summarizes appropriate legislative authorization, guidance and the role of the U. S. Fish and Wildlife Service to date in geothermal development activities. Finally, it provides additional detailed information on timing, scope and magnitude for each of the plan's six program elements.

Effects of Geothermal Activities and the Need for a National Plan

Geothermal resources are already being utilized in the United States. These resources at The Geysers, California, produce 500 megawatts of power and provide commercial space heating in Klamath Falls, Oregon and Boise, Idaho. Imperial Valley, California, Raft River, Idaho, Valles Caldera, New Mexico -- these places and more are the sites of extensive geothermal research or exploration. About 70 percent of the nation's geothermal potential is on over 55 million acres of federal lands in 13 western states and is not currently used.

To meet the national geothermal energy goal of 10-15,000 megawatts of electric and thermal power by 1985, 15 million acres or more of federal land must be leased by 1979. Most of this land is remote and contains significant fish and wildlife resources which may be adversely affected by geothermal development.

These areas include significant proportions of the nation's elk, bighorn sheep and large populations of many other wildlife species, as well as many of the presently listed or proposed endangered or threatened species. Nearly 50 percent of the cold and warmwater fisheries west of the Mississippi are on the federal lands involved.

Even though utilization of geothermal energy has the potential to cause fewer adverse impacts than emissions from refineries and fossil fuel or nuclear power plants, the surface disturbance resulting from geothermal activities may be

equivalent in magnitude to the threats resulting from surface mining of coal or oil shale, and may occur over a far larger geographical area.

Geothermal development has so far demonstrated that there may be direct land disturbance of as high as 20 to 30 percent of the leased area, as well as blowouts, subsidence, loss of surface water flows, and impairment of water quality. Noxious gases, noise and construction activities may exert further impacts upon the environment.

There have been court cases because of these effects and more may be expected. The National Environmental Policy Act (NEPA) provides that prior to leasing or issuing licenses or permits on federal lands, the effect of the proposed action -- both short and long term -- must be considered: the adverse impacts identified, mitigation and enhancement measures proposed along with those which are unavoidable, with alternatives and quantification of irreversible and irretrievable commitments of resources, including fish and wildlife and their habitats. However, generally the lands upon which geothermal development will occur have not been studied in the detail necessary to provide satisfactory ecological guidance, and as a result the Service has sometimes tended to react both negatively and after the fact to geothermal development programs and has taken a conservative posture in preparing recommendations for the conduct of geothermal activities. This stems in part from an inadequate knowledge of geothermal technology and procedures and their resulting impacts upon fish and wildlife.

To correct any negative or resistant approach, the Service must strengthen its leadership role in providing industry and regulatory agencies with practical recommendations based upon sound ecological evaluations, so that geothermal development may proceed within the framework of environmental integrity. The Service recognizes that a balanced approach is required.

It is crucial that the Service develop and maintain its capability to predict and identify impacts resulting from proposed geothermal resource development and that there is an opportunity to provide an early input to the federal regulatory and land management agencies regarding recommendations for impact mitigation measures or land withdrawals needed to properly manage these lands which are a public trust.

Role of the Service and Related Legislation

The Service began in 1871 with the establishment of the Bureau of Fisheries, which had a limited concern for commercial fishing only. By 1934, gradually broadened activities and a national concern for fish, wildlife and their habitat was expressed in the passage of the Fish and Wildlife Coordination Act. Public Law 85-624 of 1958 amended this act:

"For the purpose of recognizing the vital contribution of our wildlife resources to the nation, the increasing public interest and significance thereof due to expansion of our national economy and other factors, and to provide that wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs through the effectual and harmonious planning, development, maintenance, and coordination of wildlife conservation and rehabilitation..."

The Endangered Species Act of 1973 contains a declaration of purposes and policy. These include:

"...purposes of this chapter are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species..." and it is "the policy of Congress that all federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this chapter."

The Wildlife and Scenic Rivers Act states:

(it is) "the policy of the United States that certain selected rivers of the Nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations."

The objectives of the Service have thus expanded to assure maximum opportunity for the American people to benefit from fish and wildlife resources as part of their natural environment. A record of effective maintenance of these objectives has provided the Service with a strong tradition of leadership in maintaining a national environmental ethic.

The Energy Reorganization Act of 1974 and the Federal Non-Nuclear Energy Research and Development Act of 1974 assigned primary responsibility for stimulating energy resource development to the Energy Research and Development Administration (ERDA). Geothermal resources are treated in the Geothermal Development and Demonstration Act of 1974. To implement this legislation, ERDA has presented A National Plan for Energy Research, Development and Demonstration: Creating Energy Choices for the Future (ERDA-48), which outlines a comprehensive approach to energy resource development, and includes a program dealing specifically with geothermal resources.

The coordination of expertise from disparate federal agencies is necessary for the efficient development of geothermal resources and necessary to ERDA's national plan. Several pieces of legislation are pertinent in defining the role of the Service. Section 665 of the Fish and Wildlife Coordination Act explicitly refers to industrial development.

"The Secretary of the Interior, through the Fish and Wildlife Service and the Bureau of Mines, is authorized to make such investigations as he deems necessary to determine the effects of domestic sewage, mine, petroleum, and industrial wastes, erosion silt, and other polluting substances on wildlife, and to make reports to the Congress concerning such investigations and or recommendations for alleviating dangerous and undesirable effects of such pollution."

The National Environmental Policy Act of 1969 further emphasizes the firm national commitment to environmental quality, including fish and wildlife preservation. Measures to implement this commitment are incorporated in the legislation mentioned above, and are an important component of the national plan presented by ERDA. Additional selected legislative authorities are listed in Appendix I.

The dual objectives of geothermal energy development and preservation of environmental quality make a strong demand on the unique expertise of the Service. Intelligent development of geothermal fields must take cognizance of impacts on fish and wildlife resources, and must be compatible with sound wildlife management programs. The Service's primary role is to develop, analyze and disseminate basic biological data which can be used to guide the conservation, development and management of the nation's Geothermal Resource Program.

The Fish and Wildlife Act of 1956 further delineated the duties and refined the personnel structure of the Service. Command flows from the Service director through the Regional Directors in the several Service regions. Regional offices are the field operation units of the Service, and either directly or through coordination with state, local and private agencies and supporting elements in Service headquarters, provide services to the regions. Of these is the Office of Biological Services, which has the responsibility of coordinating the geothermal project.

The Service has been involved in the Department of the Interior's geothermal program since its inception and has been active in the development and implementation of the Geothermal Steam Act of 1970 and related federal rules and regulations.

The Service has also been on the interagency Geothermal Environmental Advisory Panel (GEAP) from its beginning. With the creation of the geothermal project, the Service established a leadership role and continued its effort to assure ecological input to the federal leasing programs. The Service is directing several biologically-oriented studies on new areas and areas under development to provide a better scientific basis for future decisions, and has conducted three National workshops for its staff and other federal and state fish and wildlife personnel involved in geothermal development. Other cooperative studies are underway with ERDA, EPA and state fish and game departments. A brief summary of other activities to date is included in Appendix II.

A great deal of national effort is being devoted to bringing geothermal energy into production quickly in order to regain energy self-sufficiency, and there must be a proportional increase in the biological program designed to provide for balanced resource utilization. This will accelerate and provide for environmentally sound development on a national basis.

The recent signing of a memorandum of understanding for the geothermal program by the Directors of the Service, BLM and USGS, formalizes cooperative procedures in the geothermal program.

To effectively utilize the funds available for fish and wildlife planning, the role of the Service must be clearly defined. Smooth coordination of the federal leasing program with the local, state and regional wildlife management plans should receive the most attention; information gathering activities must be designed to obtain and disseminate only material useful in planning and management programs dealing with wildlife

resources; and research must be strictly limited to studies vitally needed to increase the effectiveness of the Service and the state fish and game agencies with respect to geothermal development.

The program elements which follow provide the opportunity for the Service to carry out its role and responsibilities.

In order to achieve the objectives of the Fish and Wildlife Service and to ensure that environmentally sound geothermal energy development takes place, six program elements have been formulated to guide the Service within the Department of Interior's geothermal program.

These elements which follow cover effort required in the areas of legal and institutional activities; geothermal leasing increment; technical assistance; research and development; national assessment; and geothermal program management. The material presented provides the background for the Service's National Geothermal Plan.

Program Element I - Legal and Institutional

Legal

Because western lands overlying geothermal reservoirs are relatively remote and undisturbed, rapid geothermal development, by its nature, poses a unique and serious threat to the nation's fish and wildlife resources. Though pertinent legislation is generally adequate, an initial review of laws and regulations has revealed the weaknesses identified below, and as experience in interpreting and implementing present legislation and policies is gained, there will almost certainly be a demonstrated need for further changes.

The Service must establish a program to review at least periodically the status of existing and proposed geothermal legislation and prepare amendments or alternatives to ensure that there will be no unnecessary interference with the attainment of fish and wildlife objectives.

Such a program element probably would not require additional staffing, but rather can be carried out as part of regular or only slightly expanded administrative duties at the Geothermal Energy Advisor (GEA) level.

As an example of the possible role of this program element in carrying out the Service's responsibilities, certain problems have been identified, and several small but important amendments to existing legislation have been prepared.

✓ The Geothermal Steam Act of 1970 (PL 91-681). The Geothermal Steam Act of 1970 is the basic enabling legislation for the federal geothermal leasing program. As such, it gives extensive guidance for size limits on leaseholds, conservation of geothermal resources, and procedures for the leasing process. Very little is offered for the expressed protection of fish and wildlife resources, except for the implicit condition that as a federal activity, geothermal leasing is subject to the National Environmental Policy Act (PL 91-190). Specific provisions for the protection of environmental or ecological resources are limited to "water quality and other environmental qualities".

The following amendment is recommended.

Delete Section 24(i). Section 24 reads:

"The Secretary shall prescribe such rules and regulations as he may deem appropriate to carry out the provisions of this act. Such provisions include...(i) protection of water quality and other environmental qualities."

Add a new section, 24.1, to follow Section 24, to read:

"Protection of physical and biological resources from undesirable impacts resulting from geothermal resource exploration, development, and utilization shall be a major concern of the department. The Secretary shall provide for this protection by ensuring coordination and cooperation between those departmental agencies responsible for leasing and lease supervision, and those involved in biological resource conservation."

✓ Geothermal Energy Research, Development and Demonstration Act of 1974 (30 U.S.C. 11-1-1164). This act is to further the conduct of research, development and demonstrations in geothermal energy technologies; it ignores environmental concerns. The following amendments are suggested.

Amend Subchapter I, Section 1121(d) (1) (A) to read:

"A) The Department of the Interior, the responsibilities of which shall include evaluation and assessment of the resource base, including development of exploration technologies, and technical assistance to support environmental impact assessments and provide mitigation and enhancement recommendations; ..."

Amend Subchapter I, Section 1125(a), by adding subparagraph (8) to read:

"(8) The development of environmental protection systems, and the design of ecological management plans to reduce the effects of undesirable impacts resulting from geothermal resource exploration, development, and utilization of physical and biological resources."

Amend Subchapter III, Section 1161 to read:

"In the conduct of its activities, the project and any participating public or private persons or agencies shall place particular emphasis upon the objective of assuring that 1) the environment, including all physical and biological resources, and 2) the safety of persons or property are effectively protected; and the program under subchapter I of this chapter shall include such special research and development as may be necessary for the achievement of that objective."

✓ Regulations of the U. S. Geological Survey. Paragraph 270-34(k) of Part 270, Chapter II, Title 30 of U. S. Geological Survey regulations contains requirements for the lessee to collect environmental baseline data. It is a very important paragraph, but nevertheless it is confusing and misleading. Paragraphs (a) through (j) of this section address what is required of the operator in submitting a Plan of Operation. Paragraph (k) requires a one-year environmental baseline data program prior to the submission of a "plan for production". This is the only reference to a plan for production in the entire set of geothermal laws and regulations and is therefore unrelated to the rest of the section.

The present interpretation of this is that baseline data are only required prior to full-scale operations. This may sometimes be appropriate, but usually much of the ecological impact expected from geothermal resource development will occur during construction, and continue throughout production. Collecting ecological baseline data after major impacts have occurred is futile, if the purpose of the baseline data is to assess the impacts of the development.

The following amendment is recommended.

Section 270.34...

"Such plan shall include (k) a requirement program for the collection of data concerning the existing air and water quality, noise, seismic and land subsidence activities, and ecological system of the leased lands covering a period of at least one year prior to the submission of a plan for projection: including 1) establishment of baseline information covering a period of at least one year prior to drilling more than four wells, 2) monitoring during the life of the project to determine changes in baseline environmental conditions caused by the project.

Institutional

Geothermal activities on federal land require permit and leasing arrangements which involve the U. S. Bureau of Land Management, U. S. Geological Survey and at times other surface management agencies such as the U. S. Forest Service.

With several agencies involved in leasing and regulation, there were problems in coordinating effort and the timing of effort. Difficulties the Service encountered were:

- imp. difficulties
- In advance notice on lease sales, information on lead time and specific site location had not been adequate.
 - Coordination procedures for preparation and review of the Environmental Analysis Record (EAR) had not been satisfactory.
 - Information concerning the detailed scheduling and results of lease sales had not been adequate.
 - Post-lease participation in geothermal development activities, especially the U. S. Geological Survey Environment Assessment preparation and review had not been adequate.

To solve these and other problems, a memorandum of understanding for the geothermal program was signed in June 1976, by the USGS, BLM and the Service. This was a major step in ensuring adequate and timely notice of lease-related events which require Service input. By signing this agreement, the Director has committed the Service to technical input to, and review of, Environmental Assessments of the geothermal leasing processes. This scientific contribution will depend upon the availability of expert qualified personnel, and upon information which in many cases may only be developed through continuing field studies and research programs.

Initially, this agreement must be implemented at the operational level by developing detailed in-service procedure which should include time factors, reporting methods and

specific assignments. Even though many of the former problems have been eliminated, an annual review of cooperative procedures will assure continued appropriate Service involvement in federal geothermal leasing and regulation. A system to monitor the effectiveness of the agreement should be devised as part of the annual review.

Once the cooperative procedure is established costs of the program element will be reduced considerably. The first year will be essentially devoted to legal and institutional system studies, and the subsequent two years to review and modifications of the procedure. The fourth and fifth years will be routine review, with probably little effort to modify existing procedures.

Program Element II - Geothermal Leasing Involvement

During the normal sequence of geothermal exploration, leasing and operation on federal lands, several environmental assessments are conducted. Each represents a decision on the location or mode of geothermal operations within the constraints and sensitivities of the natural environment. The Service is responsible for the adequacies of the fish and wildlife element for each of these assessments.

Information on possible impacts to fish and wildlife resources is reviewed to make assessment efforts as efficient as possible. The Service's research programs, recommended in Program Element IV, are directly related and necessary to provide this information and improve the accuracy and efficiency of the assessment process.

✓ Subelement: Notice of Intent Review

The relatively small investment required to deal with geothermal development at the outset will establish an intelligent direction for the geothermal industry and prevent economic losses over the next several decades from delays, lawsuits and unnecessary environmental degradation. As industry identifies areas of promise, exploration becomes intensive. If analysis for more intensive exploration includes ecological considerations, then areas which are not ecologically appropriate for geothermal development may be identified at an early stage. With alternatives and options identified, including necessary remedial actions, this will save industry from wasted investment.

It is difficult to estimate the number of Notices of Intent (NOI) which may be submitted for review during the 1977-81 budget period. However, if the national 1985 geothermal energy goals are to be met, some 16.75 million acres of federal land must be leased in the next few years. Therefore, if all lease sales are maximum legal size (4.5 square miles) a minimum of 5,816 leases will be purchased. This number could be much higher if leaseholds average less than the maximum size limit. It is likely that several NOIs will be received for each leasehold.

Except in limited areas of considerable potential, the federal lease sale schedule required to lease 17 million acres will be far ahead of industrial exploration. It seems likely that at that leasing rate much, if not the vast majority, of land will be leased without prior intensive exploration. In this case the Environmental Analysis Record (EAR) will be the first environmental assessment of an area, and will be the significant assessment in directing appropriate geothermal resources development.

The NOI involvement by the Service will have two characteristics: 1) the response to NOIs submitted prior to leasing, representing an initial environmental analysis of the area and requiring a substantial degree of effort, and 2) the response to NOIs submitted after leasing, primarily a check for compliance with EAR and rehabilitation requirements.

As leasing occurs, pre-lease NOIs may be received at a high rate during the early and middle years of the five-year period with post-lease NOIs predominant in the later years. This would result in a decrease in the Service's NOI review effort in 1979, 1980 and 1981. However, if federal leasing should proceed at a slower pace, pre-lease NOIs may predominate further into the five-year period. Technology improvements and changes in tax laws on geothermal exploration activities could accelerate the process.

The most favorable resources will already be under lease after the current projected five-year budget period. Marginal areas will be leased only as improvements are made in technology or as increases occur in the net economic value of geothermal energy. This implies that with static economic and technological conditions, the involvement with NOIs will decrease after the national 1985 goals are realized. However, if there are charges in the situation which favor increased geothermal development, the Service's involvement with NOIs would increase drastically because the remaining resources become more difficult to identify.

Subelement: Environmental Analysis Record (EAR)

The EAR provides pre-lease environmental assessment of lands for their possible sensitivity to geothermal development activity, and is a federal decision point at which fish and wildlife can be provided for or through the identification of ecologically important areas to be withdrawn from lease sale or receive appropriate protective stipulations in the lease.

The Service's role in the EAR process is the active participation in the fish and wildlife assessment, which includes the identification of important species and their habitats requirements. This EAR therefore is a very important decision point.

It is difficult to predict the number and scheduling of EARs. EARs are pre-lease sale environmental assessments of KGRAs, and frequently cover 10,000 to 100,000 acres and sometimes more and will cover non-competitive as well as competitive lease applications. EARs conducted on non-competitive lease areas will generally cover less than 3,000 acres and only one lease. As the rate of federal leasing increases, it will become more common for EARs to be prepared for KGRAs with very few prior NOI submissions. These EARs will require a greater initial effort, since there will not be a set of previously completed NOI reviews to use as an information base and they will cover much larger land areas.

If the national goals for 1985 are to be met, the required federal lands must be leased by 1978. Since an EAR must be completed before a lease sale, there must be a major effort to prepare EARs during the next two years. The Service must correspondingly expend a major effort to provide the necessary biological advice and assistance and appropriate lease stipulations to facilitate the federal program under BLM's leadership.

Subelement: Environmental Analyses

Environmental Analyses are conducted by USGS at various post-lease development stages to determine the potential environmental impacts of a proposed geothermal development activity. The Geothermal Resource Operational Orders (GROs), which at present guide the USGS in the regulation of geothermal activities upon federal land, provide broad guidelines for maintenance of environmental quality. The general nature of these guidelines, however, is of no value for specific mitigation measures. USGS is provided with a great deal of authority, but should have available detailed, ecologically sound methodologies and techniques to be used in the overseeing of geothermal

development. The Service must provide input to and review of these EAs and will apply information gained from earlier participation (NOI and EAR) as well as other Service activities, including research into special species and/or ecosystem problems.

The important EA process occurs at the development stage of the first deep hole application. This assessment covers the leasehold and any nearby sensitive resources.

The normal sequence of geothermal development involves the drilling of deep exploratory wells for several years after significant surface exploration. The expected number of EAs will thus rise slowly through the major portion of the five-year period and peak some years after the EAR effort. With the maximum leasing rate, the EARs will be completed prior to extensive surface exploration; the lag time between the EAR and the EA in this situation should therefore be greater. If leasing occurs at a slower pace, the EAs should follow the EAR by two to three years.

* Of the leaseholds which are currently being purchased by operators, only about 40 percent are found to offer the resource potential warranting deep well exploration. EAs should therefore be conducted on about 40 percent of the 5,800 lease sales needed for 1985 energy goals -- roughly estimated to represent 2,350 areas.

Subelement: Baseline and Monitoring Design

Of those leaseholds which show potential warranting deep hole exploration, some portion (<1 out of 4) will actually have economical geothermal resources. As development continues on these, the operator may decide to expand the operation to four deep wells to test production field parameters. If these tests indicate economic potential, the operator may decide to go to full field operation. In applying for a permit to expand drilling in a field to more than four deep wells, the operator at this time should conduct a year-long environmental baseline data collection program designed to establish environmental conditions prior to major geothermal resources development. During full field development and operation, a monitoring data program designed to determine the change in environmental conditions caused by the operations is carried out.

To ensure that the chosen data elements and parameters will best assess the biological and physical conditions, the Service must be involved in the design process. Involvement may be in the form of a set of recommendations made to the USGS of elements which were earlier identified in the EA as

being in possible conflict with geothermal development. The level of effort will not be high in comparison with other subelements because of the use of information already available on the site.

The involvement in baseline and monitoring design will follow the EAs by some years and will only begin to be a significant factor in later years of the current plan.

Subelement: Baseline and Monitoring Assessment

Data received from the operator's baseline and monitoring programs must be reviewed to ensure that the conduct of the program itself is satisfactory and to determine if geothermal exploration development is adversely impacting fish and wildlife resources. If there are indications that operational stipulations are not appropriate or have not been followed by the operator, the Service will make recommendations to the USGS for operation modifications.

It is expected that the level of effort for this subelement will be intensive, since it requires the interpretation and storage of data.

Although the primary purpose of this subelement is to assess the impact of development on fish and wildlife resources on specific leaseholds and to recommend ways to minimize adverse impacts, a secondary function is to provide the basic information required for a national assessment of the effects of geothermal development on fish and wildlife resources. This is part of Program Element V.

Program Element III - Technical Assistance

The Service has the broad responsibility for providing technical support, upon request, to any of the federal agencies that may be involved with geothermal development possibly affecting the nation's fish and wildlife resources. In addition, the Service is in a position to provide information to any public or private entity needing technical support. In order to provide this support, the Service must be prepared to act in certain capacities. These include:

- Participating in or supporting environmental data acquisition projects associated with geothermal developments.
- Providing reports on both general and specific aspects of environmental impacts resulting from geothermal development.
- Providing information and advice on the abilities of the Service to provide technical support to public and private entities.

The support requirements of other agencies fluctuate with changing economic and technological considerations and cannot always be anticipated. Accordingly, the Service must continually maintain the capability to respond to requests for technical assistance based upon constant coordination with other agencies and an ongoing review of geothermal energy development needs. As geothermal resource exploration and development proceeds, a number of federal, state and local agencies will become involved as new areas are entered and as the necessary assessments, reviews and evaluations needed for licenses and permits are carried out.

Industry and the public should be kept advised of the problems which geothermal resource development may cause to fish and wildlife, and should be provided as early in the development process as possible with guidance and advice concerning areas to avoid, alternatives and methods to mitigate impacts.

Technical assistance will not include financial support from the Service, but rather will be a direct participation of Service personnel -- either as technical advisors or as participants in ongoing cooperative studies of problem areas.

The Service is the federal agency charged with protecting and managing the fish and wildlife of the nation and is the agency with the most complete biological staffing and experience to carry out this responsibility.

A basic contribution of the Service will be the identification of fish and wildlife requirements and the management possibilities of geothermal resource development and development of new techniques and methodologies for use by other agencies and industry. This will be particularly important for large blocks of western lands under the jurisdiction of agencies such as BLM or the Forest Service, which in turn have the power to establish and enforce management techniques. Since much leasing will be on private lands not directly subject to federal regulation, state and local agencies will require guidance to ensure that their regulatory requirements are consistent with those applied to federal lands.

The Service thus must acquire biological information to an unprecedented extent. Many of the lands which must be leased by 1979 will include areas where little if anything is known about the fish and wildlife resources, other than perhaps what might be identified and described from a casual road inspection.

Items affecting endangered and threatened species must be investigated -- including distribution, requirements for critical habitat zones, life history, special requirements, etc., and this information must be analyzed in the light of what is known about the nature of proposed geothermal resource development.

The Service will be the federal focal point for systematic collection of information on fish and wildlife on the lands in question, and will also be the principal agency responsible for identifying and describing mitigation and enhancement measures.

Industry must be guided in conducting baseline and monitoring programs, especially in obtaining ecological information required on federal leases. The Service will not collect this data but must be prepared to guide industry in this important task, which probably will be contracted.

One of the most important and efficient methods of ensuring that ecological information is made available is through the medium of workshops, at which biologists both within and without the Service will be trained in specific methods pertaining to the geothermal resource development program. These workshops will also provide an opportunity for non-biologists, such as geologists, engineers, planners, etc., to become informed about ecological matters.

Handbooks covering specific problem areas will be needed, and will assist administrators and planners at various governmental levels to make decisions concerning geothermal resource development.

This technical assistance must depend upon existing knowledge to a great extent. The widespread leasing of federal lands throughout the United States will require either significant staff increases in Regions I, II and VI or reprogramming of effort to provide services to the entities involved.

As ERDA and EPA become involved with their respective programs of energy development and of environmental protection, the Service will inevitably have to provide the ecological information upon which these agencies will in turn base their procedures and permit requirements. This will require additional involvement by biologists in each region at the start of the program for 1977. Each succeeding year will bring an increased demand for technical information as new areas are explored and as new geothermal resource technology is developed. By 1981, several additional ecologists may be required for each region in order to keep pace with the intensive geothermal resource development demanded to meet national 1985 energy goals.

This program element will probably require less from the Service as more entities are educated in the ecological impact of geothermal development. After state agencies and others have acquired sufficient background, the main effort of the element will be in assisting federal agencies in the leasing process. Assistance to other entities could increase again if significantly new situations arise, such as changes in technology, or the spread of resource development into new areas with differing biomes and physical systems.

Program Element IV - Research, Development and Demonstration

Geothermal resource development will have both adverse and beneficial impacts upon fish and wildlife resources. To predict adverse impacts, to institute measures to prevent damage, and to take advantage of possible beneficial effects, the Service will need specific information on the reaction of selected species to physical and chemical factors associated with geothermal activities. These factors may include noise, heat, trace elements, toxic gases, direct ground or vegetation modification, etc., as well as ecosystems analyses. While this problem-solving research is directed at geothermal resource development impacts, the information derived will be transferable to many other forms of human disturbance in the West.

Many specific items of biological information are needed for the development of effective fish and wildlife management plans to cope with geothermal impacts. In many cases the Service can most effectively direct specific studies to solve data deficiencies critical to fish and wildlife management. It has a structure which, with additional personnel, lends itself to conducting ecosystem research and/or directing the research of consultant groups, and has the laboratory facilities to carry out specific research. The Service will also be able to supply biological information to all concerned entities through Program Element III, Technical Assistance, thus reducing duplication of effort.

A federal agency may initiate a research program and request the Service for assistance. Cooperative research programs may tend to reflect problems of a different nature, including the priority concept of the cooperating agency rather than that of the Service.

Cooperative research programs should be drawn at least one year in advance, and, of course, reflect to the greatest possible extent the specific needs of the Service in order to avoid duplication of effort. From a practical viewpoint, a geothermal research program should provide information which may be used as a basis for problem-solving decisions concerning 1) land withdrawal, 2) size and nature of buffer zones, and 3) mitigation/rehabilitation/enhancement measures.

The information needed is in three major categories:

1. The Toxicity of Effluents to Plant and Animal Life. The major toxicants to be studied include hydrogen sulfide, ammonia, mercury and trace elements such as cadmium, radon, and arsenic, which may be in geothermal effluents. Other substances may be sources of trouble and are derived from industrial compounds or materials; e.g., chromium, copper, zinc and lead, in addition to possible herbicides, insecticides, algicides, etc. Aquatic life is especially sensitive to these water soluble substances. On a priority basis, hydrogen sulfide, ammonia and possibly mercury, should receive study. Drilling compounds should at least be tested in toxicity studies in order to determine if any real problems exist. Studies may be conducted in the laboratory or field, and primarily be concerned with uptake by plants and animals, including possible concentrations of undesirable elements.

2. Activities Impacts. Very little is known quantitatively about how animals are affected by man's activities -- including noise, movement, colors, etc. Research projects are recommended to determine as quantitatively as possible what the effects of the physical presence of geothermal operations

and man may be upon distribution patterns, breeding habitats, etc. Significant species, such as those important in the food web, endangered or threatened, or economically or recreationally used, should be identified, and a test animal (or animals) selected to study. For example, the sage grouse -- determine what geothermal activities, if any, disturb the bird. Look for information which would enable a satisfactory buffer zone to be established. Information based upon non-geothermal activities, such as construction, mining, etc., may be gathered from other areas and applied in a geothermal area, e.g., reaction to bulldozers, trucks, humans walking about, etc.

3. Habitat -- Maintenance, Rehabilitation or Enhancement. Information is needed on the tolerance of plant species for certain geothermal-related substances, e.g., dust, fog, ammonia, hydrogen sulfide, etc. Study programs to identify proper species and sources for revegetation should be conducted, as well as environmental manipulation using water, fertilizer, etc. The major concern here is the habitat -- if it remains undamaged, then usually the associated animal life will also be maintained. Thermal pools, alpine meadows or riparian habitats may be adversely affected through changes in hydrological patterns and research in this area will be needed, probably in cooperation with USGS.

Geothermal activities may benefit as well as degrade fish and wildlife and their habitats. The heat and, in some cases the water which is brought to the surface, may be used to encourage vegetative growth or to provide animals with water and a moderate microenvironment. Research will determine the features of geothermal activities which may have value and should be followed by programs to develop the methodology needed to utilize such values. In some cases research findings or methodologies may warrant a further project to demonstrate the usefulness of the results, using a pilot or full-scale geothermal operation. Research needs may vary from area to area. Accordingly, a specific research project should be designed to acquire information useful in a priority area, and should be conducted either in the area of concern or in an area whose environmental elements are representative of the problem areas. Pilot projects are needed both to assess impacts from specific activities, and to test mitigation and enhancement measures on a long-term basis.

The accompanying map locates 22 sites which have received enough industrial interest to make deep well exploration or development possible during the current budget period. The table in Appendix III demonstrates a suggested method of screening each of these sites in order to establish priority for locations of pilot projects.

The evaluation of these 22 sites as possible pilot projects should be directed toward the identification of several areas which represent a group of similar geothermal resource areas. As there are many parameters on which to base similarity and variation, it is recommended that the three major physiographic units be used as the prime unit of similarity. Thus, it would be advantageous to identify the general biotic, geologic, hydrologic and resource and utilization characteristics of the Basin and Range geothermal resource areas, and select one or two which will result in the transferability of ecosystem understanding and impact of development to the majority of geothermal areas in that physiographic unit. This should be repeated for the Snake River Plateau and the Cascade Mountains.

Based on current geothermal resources, development information and an initial analysis of the biological and physical condition of the area's Roosevelt Hot Springs, Utah, Brady-Hazen and Soda Lake, Nevada, Long Valley, California, Cove Fort, New Mexico and Valles Caldera, New Mexico suggest themselves as pilot projects for the Basin and Range province. The Raft River area may be a good location for the Snake River Plateau province. In the future, as geothermal development occurs in other areas, pilot project areas should be chosen in the Cascade Mountains, the western portion of the Snake River Plateau, and in the Gulf Coast area for geopressured development.

Once the appropriate sites have been identified, ecosystem level studies designed to analyze the biological and physical response to geothermal development, and to identify sensitive areas requiring various levels of protection, should begin. Also to be conducted are experiments with mitigation and rehabilitation techniques to be applied in areas of similar character. In conjunction with these ecosystem level studies, as many specifically identified special research studies as possible should be conducted. Additionally, specific assessment methodologies should be developed so that the Service can efficiently apply, at the operational level of geothermal development, the information derived from pilot and special studies.

Figure 1 ✓

GEOHERMAL RESOURCES DEVELOPMENT

Areas of Significant New Development by 1981

- 1 Brawley, CA
- 2 East Mesa, CA
- 3 The Geysers, CA
- 4 Heber, CA
- 5 Long Valley, CA
- 6 Niland, CA
- 7 Surprise Valley, CA
- 8 Grand View-Oreana, ID
- 9 Raft River, ID
- 10 Reowawe, NV
- 11 Brady-Hazen, NV
- 12 Dixie Valley, NV
- 13 Ruby Valley, NV
- 14 Soda Lake, NV
- 15 Steamboat Springs, NV
- 16 Animas Valley, NM
- 17 Valles Caldera, NM
- 18 Alvord Desert, OR
- 19 Beryl, UT
- 20 Cove Fort, UT
- 21 Roosevelt Hot Springs, UT
- 22 Thermo, UT

- Areas with deep drilling and significant development by 1981 (numbers are for location purposes; do not indicate priority).
- Areas with significant surface exploration and deep drilling by 1985.
- Areas with current production, areas with past drilling and no current activity, and areas which have not had activity.

A commitment of Service resources appropriate to the research needs over the next five years must be made. Although the prospects for geothermal development activity are limited primarily to two main physiographic units, leasing (and thus the important ecosystem protection stipulations) will occur throughout the West. Early pilot projects will provide answers to questions on impacts so that intelligent decisions can be made at the operational level. Initial resource demands should be high as pilot projects start, but should taper off after development is well underway. In areas with leasing pressure but little development activity, the pilot project can be at a low level until development pressure increases; then the Service's commitment should rise.

Program Element V - National Assessment

One of the most important tasks in the administration of the geothermal program will be constant evaluation and periodic summarization of the results of geothermal resource development program activities. Most of these activities will be in the remote, rugged areas of the West, which have significant national fish and wildlife resources and on federal lands.

Geothermal operations use heavy equipment. Land and vegetation are significantly modified for road construction, and the placement of structure and equipment.

As drilling proceeds and subsequent steps are taken to achieve full field development, effects on the environment will result from the geothermal resource per se. Toxic vapors and liquids may be produced, and factors such as noise and activity may influence plant and animal life over large areas.

Congress has mandated that information be gathered, and that the geothermal resource development be evaluated as it proceeds. In order to comply with this mandate, the Service will review its entire geothermal program annually, including such elements as: 1) number and location of leases predicted the previous year vs. the number and location of leases actually let; 2) EAR participation, anticipated vs. actual; 3) status of suggested organizational changes -- recommended vs. actual; 4) new predictions -- changes in the geothermal situation; 5) new technological problems; and 6) anticipated and actual surface area disturbance and habitat loss.

It is essential that information concerning all of this activity be pulled together in one place. Unless there is a central coordinated evaluation program, there will be no basis upon which to identify costs of a geothermal resource

development project. Problems encountered with an accurate plan review involve information accuracy and availability. Assistance of the geothermal project staff is anticipated to carry out the review process.

This national assessment will require that a system be established the first year to identify the nature of data required, data sources, procedures for obtaining and storing data, organization, etc. At the end of the first year, the information which has been obtained must be analyzed and reported. It will be imperative that adverse impacts be identified, and that methods of investigation and their effectiveness be evaluated so that early changes in effort either by the Service, other agencies or industry may be instituted. (The system itself must be evaluated as soon as possible, and the second year will be devoted to this and to necessary revision.) Some changes may be required in response to changes in geothermal development technology, accelerated rates of leasing, or new drilling locations. There must be a constant review and evaluation of these factors. The data reporting system must also keep up with advancing stages of exploration and development. The Service must ensure that useful and correct information is obtained, evaluated and disseminated.

This information, even though not obtained under this program element, will depend upon very close coordination among the Geothermal Environmental Advisor (GEA), the Western Energy Land Use Team (WELUT), and the Regional Activity Leader (RAL).

This program element must be designed to keep in very close touch not only with industry and geophysical advisory agencies, such as USGS, but also with the ERDA and other agencies which may influence or reflect national energy needs.

During the process of evaluation, information gaps and problems will be identified. This is the point at which specific research needs will be identified, and at which the first attempt at setting research priorities will be made.

This national assessment will require a strong initial effort in designing the system, followed by increasing effort for the next four years in the evaluation of geothermal resource development activities per se, with some decrease in system redesign as the initial "bugs" are identified and worked out.

Program Element VI - Geothermal Program Management

The Office of Biological Services (OBS) has established the geothermal project in order to devote special staff and research effort to geothermal development and its attendant impacts upon fish and wildlife. This effort is directed at determining, developing and implementing techniques and programs through which the Service can participate in effectively guiding geothermal development.

The following Figure 2 outlines the OBS organizational structure.

The Service's geothermal project has the overall objective: "To coordinate the Service's mission and programs with the orderly exploration, development and management of the nation's geothermal resources".

Major sub-objectives include:

- Providing technical support to other federal agencies and state, local and private entities to ensure the unification of public and private efforts toward the orderly development of geothermal resources.
- Ensuring a flexible organization within the Service capable of responding to the rapid and constantly changing technology of geothermal exploration.
- Providing for research in specific subject areas especially pertinent to critical wildlife problems associated with geothermal development.

To accomplish these objectives, OBS has devised five major strategies:

1. Define specific impacts upon fish and wildlife resulting from geothermal resource exploration and development.
2. Improve approaches, tools and methodologies for assessment of environmental impacts.
3. Analyze selected regions and ecosystems under stress from geothermal resource development.
4. Develop information systems and management strategies aimed at minimizing environmental damage.
5. Effectively focus Service teams, including regional and research personnel, in resource development decisions.

Figure 2

Office of Biological Services: Organization Chart¹

¹ Does not include Biological Services functions assigned to Fish and Wildlife Service regional offices or national wildlife research centers.

The geothermal project should be viewed in an overall Service perspective. It must be a unified, cohesive effort directed at solving the specially-selected problems of geothermal resources development. The project extends far beyond the OBS organizational structure, since it includes the regional Ecological Services and other Service entities (endangered species, research, etc.).

The geothermal project contains three basic organizational elements:

1. Geothermal Environmental Advisor (GEA)
2. Western Energy Land Use Team (WELUT)
3. Regional Activity Leaders (RAL)

Appendix IV contains a list of the key administrators and the location of their offices.

A suggested delineation of their roles and responsibilities follows.

Geothermal Environmental Advisor (GEA)

The GEA advises the Service Director on the policy of the geothermal project. He directs the coordination of the project, providing a unified Service effort in solving problems and taking advantage of opportunities afforded by geothermal resource development.

The GEA must possess a broad knowledge of geothermal resources development activities, and be able to recommend policy and provide Service coordination capability on a national level. He must also guide OBS activities relating to geothermal development so that they most effectively support regional operations. Specific responsibilities include but are not limited to:

- Serving as Project Leader, recommending allocation of resources and initiation of projects, maintaining cognizance of accomplishments.
- Representing the Service geothermal project to external agencies (GEAP, ERDA, etc.).
- Establishing initial contacts for and defining the role and extent of WELUT participation in extra-Service activities.

- Developing and approving research projects with the technical assistance of WELUT. This includes establishing the role of WELUT participation on specific regional problems on a project-by-project basis.
- Providing national overview and direction to the Service.
- Disseminating information to WELUT and regions concerning new geothermal project policies, new national trends in geothermal resource utilization, technology, etc., and other pertinent materials obtained from his activities.
- Coordinating development of methodology to solve problems.
- Participating with advisory panels.
- Participating with multidisciplinary Department of Interior teams to provide assistance to other countries and to exchange information. This work will be through the State Department and in conjunction with the United Nations.

Western Energy Land Use Team (WELUT)

The WELUT contributes research support and contract initiation and management capabilities to the geothermal project. In discharging its geothermal responsibility, the WELUT will be guided by the geothermal project's policy. Direct contacts with Service regions and extra-Service entities will be within the purview of the project policy and under the cognizance of the GEA. Specific responsibilities include but are not limited to:

- Advising the GEA on research project designs, feasibility, etc.
- Initiating and supervising contract work.
- Synthesizing research data.
- Disseminating research information to regions.
- Working on specific regional problems (e.g., pilot project basis).
- Providing technical support to Service regions, states, and other federal agencies.
- Providing technical support to the GEA's activities.
- Developing and designing research projects.

Regional Activity Leader (RAL)

RALs provide the three western Service Regional Directors with staff expertise in matters concerning geothermal resource development. In addition, they are the Regional Directors' interface with the OBS portion of the geothermal project. The RALs constitute the mechanism by which OBS technical expertise is delivered to the regions and transformed into operational capability. They thus provide regional guidance and support to geothermal operations. Specific responsibilities include but are not limited to:

- Facilitating information flow from the field and area offices to aid in problem identification at field level, and to provide regional views and research perspectives of the GEA and WELUT.
- Coordinating geothermal activities, e.g., arrange (for Regional Director) such things as where data will be stored (i.e., USFS, BLM, Service) for specific geothermal areas, budget and work plan preparation for geothermal activities, etc.
- Coordinating regional input to federal leasing program.
- Coordinating (with Regional Director and the GEA) response of regions to requests for operational support.
- Providing for the GEA information pertaining to the overall impact of geothermal development on fish and wildlife resources within the region.
- Recommending allocation of regional resources, funds and manpower.
- Tracking and reporting on regional progress toward achieving regional geothermal program objectives.
- Developing regional programs.
- Providing advice to meet regional objectives.

Subelement - Coordination

Coordination of the internal activities of the geothermal project will take place at several points within the organization. Whereas the GEA provides overall coordination and advises the Director on policy, the WELUT will be directly concerned with coordination of research projects. The RALs will be active in coordination through the region, with the working groups of industry, the public and other federal, state and local agencies whenever there is a requirement for operational support. Regions provide the operational component of the geothermal project.

It will be through this program subelement that the actual implementation of the geothermal project will be conducted, and thus effort during 1977 and 1978 will be somewhat proportional to the number of programs which will be started, but by 1979, 1980 and 1981, maximum effort will be needed.

Subelement - Participation with Advisory Groups and Panels

This will be a continuing effort for the five-year budget period and will be primarily a function of the GEA office, although as special technical or organizational problems arise, appropriate representatives of WELUT and the regions may participate.

Subelement - Assess Effectiveness of the Geothermal Plan

This subelement represents the summation of the assessments provided through Program Element V, National Assessment, and relates primarily to the administrative effort required to ensure that information is obtained, collected, evaluated and forwarded to the GEA for final transmittal to the Director. This will be ongoing, but the effort will increase somewhat proportionally to the increase in the number of implemented program elements. The assessment is highly important, because only in this way can the national objectives of the geothermal project be documented based upon factual, quantitative descriptions of the extent to which objectives of the geothermal plan are being realized.

Subelement - Preparation of Annual Program Document

This responsibility will be primarily in the GEA's office, and will follow the determination of needs identified in the preceding assessment of geothermal development plan effectiveness in meeting Service's and national objectives.

It will be at this point that research needs in particular will be identified and costs estimated, personnel reassignments may be recommended and changes in program emphasis proposed as necessary. The annual program budget will be developed cooperatively, and it will be the GEA's responsibility to assemble and submit the final budget. This will be an annual event, more or less at the same level of effort for the five-year budget period, but will be subject to increased effort as more programs are implemented.

Subelement - Ensure that Objectives of the Department and the Service are Met

This effort will be directly tied to the subelement assessing effectiveness of the national geothermal plan described above. It will require a periodic review of the Service's overall objectives and a close look at what is being accomplished in the geothermal area. At this point it will be appropriate to evaluate the entire hierarchy of national and regional objectives and ensure that they remain satisfactory. Revisions may be proposed based upon program evaluations by the region, the RALs and the GEA taking into account the needs of agencies outside the Service, and reflecting national needs as they may be changed by Congress and the Executive Branch.

This will generally be at least an annual event; however, this analysis may be required at anytime, and in fact should be a constant guiding force for all parties in the geothermal development program. This effort will vary as emphasis changes in the energy-related fields.

Subelement - Analyze the Services' Role in Geothermal Development

This is a continuation of the subelement above, and will reflect the GEA's, RAL's and WELUT's efforts to determine the effectiveness of ongoing activities and the needs for program changes as they are identified.

Subelement - Develop Interagency Agreements

This effort will be a major task for the GEA. His office must ensure that coordination between the Service and other agencies proceeds smoothly. He will be guided by directives from OBS and by his own contacts and knowledge of activities in other agencies. The region through RALs in particular will provide an important input and recommendation, since it will be at that level where problems of coordination will become most apparent.

The level of effort will be relatively constant -- although it may be expected to increase somewhat with increased geothermal exploration and development. Some major increase will result as research programs are implemented.

APPENDIX I

SELECTED LEGISLATIVE AUTHORITIES OF THE FISH AND WILDLIFE SERVICE

Anadromous Fish Conservation Act
Bald Eagle Protection Act
Black Bass Act
Dingell-Johnson Sport Fish Restoration Act
Endangered Species Act of 1973
Fish and Wildlife Act of 1956
Fish and Wildlife Coordination Act
Lacey Act
Land and Water Conservation Act of 1965
Lea Act
Marine Mammal Act
Migratory Bird Conservation Act
Migratory Bird Hunting Stamp Act
Migratory Bird Treaty Act
National Environmental Policy Act of 1969
National Wildlife Refuge System Administration
Act of 1966
Pittman-Robertson Wildlife Restoration Act
Predatory Animal Control Program-Act of 1931
Refuge Revenue-Sharing Act
Recreational Use of Conservation Areas Act
Wetlands Acquisition Act
Wilderness Act

*Significant
Activities*

APPENDIX II

SERVICE ECOLOGICAL STUDIES RELATED TO GEOTHERMAL DEVELOPMENT

- a. Ecological Effects of Geothermal Development — Contract: Jones & Stokes Associates, Inc. Products: National Plan and Geothermal Handbook.
- b. Identification of the Ecological Implications of Development of Geothermal Energy from the Gulf Coast Geopressured Zone.
- c. Special Revegetation Requirements of Geothermal Development Sites in Arid Areas.
- d. Development of Techniques for Predicting Probable Effects of Commercial-Scale Geothermal Development on Fish and Wildlife Resources in the Western United States.
- e. Cooperative Study — Fish and Wildlife Service and the California Department of Fish and Game. Analysis of the effects of geothermal exploration and development on fish and wildlife — in progress.
- f. Cooperative Study — Fish and Wildlife Service and the Nevada Department of Fish and Game. Identification and distribution of raptors in Known Geothermal Resource Area (KGRA), northern Washoe County, Nevada — completed.
- g. National Geothermal Workshops — Fish and Wildlife Service and state fish and game departments, July 1975, September 1975 and March 1976. Three completed and more planned — a continuing effort.
- h. Environmental Baseline Data Collection Requirements for Geothermal Development and Monitoring Requirements for Federal Leases — In-house and completed.
- i. Imperial Valley Environmental Baseline and Monitoring Program — Assisted in cooperative study design with ERDA on Lawrence Livermore Lab project.
- j. Cooperative Development of Aquatic and Terrestrial Baseline Studies for Geysers KGRA, California — ongoing with California Department of Fish and Game, Union Oil Company and PG&E.
- k. Cooperative Sage Grouse Study Design for Republic Geothermal Corporation, Mono-Long Valley, California — Fish and Wildlife Service, California Department of Fish and Game and Republic Geothermal.

Appendix II (Continued)

- l. Establishment of Recommended Critical Habitat Zones for Yuma Clapper Rail, California Cooperative Study -- California Department of Fish and Game, Fish and Wildlife Service and ERDA (Lawrence Livermore Lab).
- m. Color Infra-red Photography for Potential Geothermal Areas, Wyoming and Montana -- Fish and Wildlife Service Contract 1975 -- completed.
- n. Recommended Peregrine Falcon Critical Habitat Zones for Four Counties in California -- Cooperative Study -- California Department of Fish and Game and the Fish and Wildlife Service and BIM -- completed 1976.

The Service is continuing its cooperative research and development (R&D) studies with BIM on all federal leasing programs in the 13 western states. A great deal of the biological inventory work is R&D because it has never been done for most of the geothermal areas. Service operations are by priority, oriented at endangered and threatened species and related critical habitat zones. The aforementioned projects highlight part of the Service's efforts for the last three years.

APPENDIX III

The following is a suggested screening methodology for the selection of pilot project sites. It is felt that the 17 parameters which are used are important considerations; however, they may be of unequal value. Before significant effort in research is invested, careful consideration must be made using a system similar to the one found herein to ensure that the results will be valid and have the widest range of applicability possible.

Column 1. For pilot projects, time must be available before development so that baseline conditions can be established. Therefore the sites for pilot projects are limited to those which are projected to receive exploration and development during the next five years. While they may not all be appropriate as pilot project sites, they may provide possible sites for special studies. Sites with further development scheduled are listed with a number designation, while those with current production and no further development forecast for the next five years are listed without numbers.

Column 2. Current deep well exploration or production. In order to assess the relative level of current activity at the various sites, this column should be marked with a (+) if there is current activity, a (-) if there is not, and (UN) if this is unknown. This column also includes areas with current production but without the prospect for significant further development in the next five years. Each area should be assessed individually to determine if the level of activity is too great for before-and-after analysis of the specific study under consideration.

Column 3. ERDA test area. If the site is one on which significant geothermal resource recovery research is to be carried out by ERDA, there is an opportunity for the integration of other federal agencies environmental impact research needs with those of the Service. If the USGS can coordinate geological and hydrological research with the Service's ecosystem research, the total understanding and benefit to the Service will be much greater. If the area is an ERDA test site, a (+) should be used; a (-) if not.

Column 4. Current ecosystem impact research. If private grant research or individually-funded ecosystem research is being conducted, the Service should not duplicate it; such research, however, should be carefully evaluated for its applicability to similar geothermal areas. On the other hand, special studies of the Service may be well adapted to these outside ecosystem studies. As this matrix is designed to evaluate the prospective area's suitability for ecosystem studies, a (-) should denote ongoing ecosystem studies, and a (+) if there are none.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Current deep well exploration or production	ERDA test area	Current ecosystem impact research	Current special study impact research	Resource type	Unusual resource features	Probable utilization techniques	Delineation of possible development area	Timing of future development allowing baseline data validity	Size of area appropriate for economic ecosystems study	Area representative of regional geology and hydrology	Area representative of regional floral composition	Area representative of regional faunal composition	Area provides opportunity for special problem studies	Unusual fish, wildlife or habitat values	Amount of federal lands involved
1	Brawley, CA															
2	East Mesa, CA															
3	The Geysers, CA															
4	Heber, CA															
5	Long Valley, CA															
6	Niland, CA															
7	Surprise Valley, CA															
8	Grand View-Oreana, ID															
9	Raft River, ID															
10	Beowawe, NV															
11	Brady-Hazen, NV															
12	Dixie Valley, NV															
13	Ruby Valley, NV															
14	Soda Lake, NV															
15	Steamboat Springs, NV															
16	Animas Valley, NM															
17	Valles Caldera, NM															
18	Alvord Desert, OR															
19	Beryl, UT															
20	Cove Fort, UT															
21	Roosevelt Hot Springs, UT															
22	Thermo, UT															
	Klamath Lake, NV															
	Boise, ID															

Column 5. Current special study impact research. Special biological, geological or hydrological studies are conducted in an area when the possibility exists that a Service ecosystems study will result in a more complete understanding of the total biological and physical system and its response to geothermal development. A (+) should be used to indicate special studies are being conducted, a (-) to indicate no special studies, and (UN) if it is unknown.

Column 6. Resource type. Impacts on an ecosystem level are likely to be different due to basic variations in geothermal resource systems. (VD) should be used for vapor-dominated systems; (HHW) (high enthalpy hot water) should be used to designate liquid-dominated systems which can flash to steam on release of pressure; (LHW) (low enthalpy hot water) should be used to designate liquid-dominated systems which may be used for process or space heating; (GP) should be used to designate geopressured systems; and (HDR) to designate hot dry rock systems; (UN) should indicate an unknown.

Column 7. Unusual resource features. It can be argued that each geothermal resource area has unique features, but the attempt is to designate those which may be significant to ecosystem impacts, such as higher salinity than surrounding areas, unusual concentrations of boron or mercury, etc. In the identification of potential pilot projects, areas should be sought which would have the widest possible applications. Therefore, those geothermal resource areas which are least unusual would be best as pilot projects, while those which have unusual features may be well-suited for special studies. A (+) should designate areas without unusual features, and a (-) those with unique features; (UN) should indicate an unknown.

Column 8. Probable utilization. Related to both the resource type and unusual features of the resources, the mode of utilization can also create various alterations in ecosystems and should be a consideration in evaluating possible pilot project area. (DSE) (dry steam electrical conversion) should be used to designate electrical conversion in vapor-dominated fields; (WSE) (wet steam electrical conversion) to designate flash steam plants; (BE) (binary electrical conversion for binary electrical plants; (DS) (desalination) for desalination facilities; (AG) (agriculture) for agricultural use and greenhousing; (SH) (space heating) for space heating; (ID) (industrial) for industrial processing; and (BA) (balneology) for mineral baths, health spas, and resort facilities; (UN) should indicate an unknown.

Column 9. Delineation of possible development areas. To establish a good pre-development baseline data net, the specific areas to be studied should be relatively well-delineated. This reduces both the expense and the risk of pre- and post-development ecosystem studies. For delineated areas, a (+) should be used; and a (-) if boundaries are uncertain.

Column 10. Timing of future development allowing baseline data. A reasonable period of time prior to significant development is needed so that baseline data results can describe the ecosystem with validity prior to development impacts. A parameter of the time frame should also account for natural variability of ecological systems. If the lead time seems appropriate, a (+) should be used, and if not, a (-) should be used; (UN) should indicate an unknown.

Column 11. Size of area appropriate for economic ecosystems. Areas of possible development may be so large that an ecosystem analysis encompassing the area could be costly and the results inconclusive. If only a portion of a large development area is studied, there is a chance for inaccurate results because of interference from impacts of activities outside the study area. The area should also be large enough so that large-scale ecosystem impacts can be identified and be transferable to other areas. A (+) should be used to designate areas of appropriate size, and a (-) should be used to designate areas of appropriate size, and a (-) should designate those that are not; (UN) should indicate an unknown.

Column 12. Area representative of regional geology and hydrology.

Column 13. Area representative of regional floral composition.

Column 14. Area representative of regional faunal composition.

In columns 12, 13 and 14 the possible pilot project area should be evaluated for their ability to provide transferable results to other geothermal development areas. A (+) should indicate the areas which have features representative of other development areas, and a (-) should indicate areas which have non-representative features.

Column 15. Opportunity for special studies. Many specialized biological impact research needs which do not have ecosystem orientations may be identified. If these can be conducted in pilot project areas, both research elements should benefit. A (+) should indicate areas with special study possibilities, and a (-) should indicate those without; (UN) should indicate an unknown.

Column 16. Unusual fish, wildlife or habitat values. In some areas endangered or threatened species may exist. An ecosystem study of these areas would not significantly invalidate the transferability of the results to areas without the particular species. The opportunity to gain valuable information and to protect an endangered or threatened species from impact is important. This parameter should not be confused with columns 13 and 14, where the

composition is evaluated for representativeness. A (+) should indicate unusual biotic values, while a (0) should indicate the absence of unusual values; (UN) should indicate an unknown.

Column 17. Amount of federal lands involved. In general, the greater the proportion of federal lands involved the easier an ecosystem study should be, because of greater accessibility and freedom of sampling. An abundance of federal lands should be designated by (A), a moderate amount by an (M), and a little by an (L).

APPENDIX IV

KEY ADMINISTRATORS AND OFFICES OF THE SERVICE'S GEOTHERMAL PROGRAM

1. Key Administrators

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919 NE., 19th Avenue
Portland, Oregon 97232

CALIFORNIA/NEVADA

Field Supervisor (8-468-4731)
Ecological Services
Fish and Wildlife Service
2800 Cottage Way, Room E-2727
Sacramento, California 95825

HAWAII/AMERICAN SAMOA/GUAM/TRUST TERRITORY OF THE PACIFIC

Field Supervisor (546-5602)
Ecological Services
Fish and Wildlife Service
821 Mililani Street
Honolulu, Hawaii 97208

Regional Director, Region 2 (8-474-2321)
Fish and Wildlife Service
Post Office Box 1306
Albuquerque, New Mexico 87103

ARIZONA

Field Supervisor (8-261-3603)
Ecological Services
Fish and Wildlife Service
Downtown Post Office Bldg., Room 247A
522 N. Central Avenue
Phoenix, Arizona 85004

NEW MEXICO

Field Supervisor (8-474-2914)
Ecological Services
Fish and Wildlife Service
Post Office Box 1306
Albuquerque, NM 87103

TEXAS

Field Supervisor (8-527-2961)
Ecological Services
Fish and Wildlife Service
U.S. Customs House, Room 327/328
Galveston, Texas 77550

Regional Director, Region 6 (8-234-2209)
Fish and Wildlife Service
Denver Federal Center
Post Office Box 25486
Denver, Colorado 80225

MONTANA/WYOMING

Area Manager (8-585-6115)
Fish and Wildlife Service
711 Central Avenue
Billings, Montana 59102

NORTH DAKOTA

Area Manager (8-783-4401)
Fish and Wildlife Service
Post Office Box 1897
Bismarck, North Dakota 58501

COLORADO/UTAH

Area Manager (8-588-5631)
Fish and Wildlife Service
Federal Building, Room 2215
125 S. State Street
Salt Lake City, Utah 84138

IOWA/KANSAS/MISSOURI

Area Manager (8-758-5951)
Fish and Wildlife Service
Federal Building, Room 1748
601 East 12th Street
Kansas City, Missouri 64106

SOUTH DAKOTA

Area Manager (8-782-8226)
Fish and Wildlife Service
439 Federal Building
Post Office Box 250
Pierre, South Dakota 57501