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August 25, 1994

USFWS

Ms. Dianne G. Hall
U.S. Fish and Wildlife Service
Contracting and General Services
P.O. Box 25486 DFC
Denver, CO 80225-0486

Subject: Argonne National Laboratory Proposal P-94129 "Technical Support to the U.S. Fish and Wildlife Service at Rocky Mountain Arsenal"

Dear Ms. Hall:

In accordance with your request, Argonne National Laboratory is pleased to submit the subject proposal (enclosed). It is identified by our number P-94129. We would appreciate your use of this number on all correspondence, documents, or contracts related to the proposal.

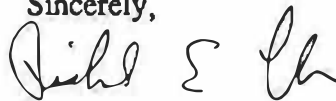
Argonne proposes to provide the U.S. Fish and Wildlife Service technical support in establishing a National Wildlife Refuge at the Rocky Mountain Arsenal. Gary Kaszynski, Robert Browne, and John Krummel will serve as principal investigators. The proposal has been prepared by the Laboratory's Environmental Assessment Division.

Funding support is requested in the amount of \$4,700,000 at the federal rate. The proposal covers work to be completed during the period of FY 1994-FY 1998, beginning on the contract execution date.

As you may know, U.S. Department of Energy (DOE) approval is required for the participation of Argonne staff and the use of Argonne equipment and facilities in work for other federal agencies. Accordingly, copies of this proposal have been sent to DOE for review and approval; this review will be completed soon, and you will be advised of the decision in writing. Should your review of this proposal be favorable, you can make funding arrangements with Luis A. Rivera, Argonne Area Office, U.S. Department of Energy, 9800 South Cass Avenue, Argonne, Illinois, 60439.

We appreciate the opportunity to prepare this proposal and look forward to conducting this work. Please contact me at the above number, or Richard E. Combs at (708) 252-6797, if you require additional administrative information. Direct any technical questions to Gary Kaszynski at (303) 986-1140, extension 245.

Sincerely,



Joseph G. Asbury
Deputy to the Laboratory Director

enclosure

cc: A. Taboas, U.S. Department of Energy

Proposal P-94129

**TECHNICAL SUPPORT TO THE U.S. FISH AND WILDLIFE
SERVICE AT ROCKY MOUNTAIN ARSENAL**

work proposed by:

Argonne National Laboratory
Environmental Assessment Division
Ecological and Social Sciences Group

Principal Investigators:
Gary Kaszynski, Robert Browne, and John Krummel

August 1994

Submitted to:

U.S. Fish and Wildlife Service
Rocky Mountain Arsenal
National Wildlife Area

Proposal P-94129

TECHNICAL SUPPORT TO THE U.S. FISH AND WILDLIFE SERVICE AT ROCKY MOUNTAIN ARSENAL

1 INTRODUCTION

The Rocky Mountain Arsenal (Arsenal) property was purchased by the federal government during World War II to construct facilities to manufacture chemical weapons. After the war, Arsenal facilities were used to manufacture pesticides and rocket propellant. Waste products from all of these chemical operations were deposited in shallow basins within the Arsenal. The disposal of these wastes has resulted in the Arsenal's being designated as a National Priorities List (NPL) site under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In 1988, the Secretary of the Army announced that the sole mission of the Arsenal was restoration and remediation of contaminated media. In 1989, five federal agencies, plus Shell Oil Company, signed an agreement outlining the objectives of the cleanup activities. The U.S. Fish and Wildlife Service (USFWS) of the U.S. Department of the Interior was one of the five federal agencies involved in the facility agreement. The USFWS's role was defined as being to protect and manage biological resources as the restoration and remediation activities occur on the Arsenal. The transformation of the Arsenal from a chemical weapons production facility to an urban wildlife refuge brings many technical challenges as the USFWS works with the Army and other federal agencies to protect and enhance natural resources.

In 1992, the President signed the Rocky Mountain Arsenal Wildlife Refuge Act to establish the Arsenal as a national wildlife refuge. This law defines the USFWS's principal management objectives at the Arsenal as follows:

- Conserve and enhance natural diversity for fish, wildlife, and plant populations, with particular emphasis on threatened and endangered species and enhancement of wetlands;
- Maximize public use that is compatible with enhancement and conservation of fish and wildlife habitats; and
- Monitor the effects of contamination on wildlife and provide research and technical assistance during the cleanup activities to avoid or limit impacts to fish and wildlife populations and habitats.

2 OBJECTIVE

Argonne National Laboratory (ANL) will provide technical assistance and expertise in (1) habitat evaluations for species of concern; (2) evaluation of remedial investigation/feasibility study (RI/FS) activities proposed by the U.S. Army and Shell Oil Company and development and implementation of natural resource damage assessments (NRDA); (3) review and application of ecosystem and landscape dynamic models that project future conditions unique to the Arsenal; (4) investigation of topics in soil ecology, especially as it relates to the effects of contamination, bioremediation, risk assessment, and borrow materials; (5) oversight and/or performance of NEPA assessments and development of master plans; and (6) implementation of an information management system that combines a geographic information system (GIS) and relational databases with user-friendly graphical interfaces.

The USFWS has requested that ANL, as a nonprofit, scientific organization, provide a proposal for technical assistance and expertise to produce and review results and findings within this proposals work scope based on scientific procedures and methods. Technical assessments will result in informed and objective decisions that assist the USFWS in meeting the goals of the Rocky Mountain Arsenal Wildlife Refuge Act for the transformation of the Superfund federal facility into an urban wildlife refuge. Since this transformation will set a nationwide example for federal facility land use planning, the technical issues inherent in the conversion require expertise in the remediation of chemical contamination, CERCLA compliance issues, and wildlife and ecosystem science. ANL, as a multidisciplinary research, development, and assessment organization, provides professional staff expertise and experience in each of these areas and has the ability to provide teams of scientists focused on the needs of the USFWS. In addition, since many ANL staff members have several years of experience with the cleanup activities at the Arsenal, ANL can immediately provide the USFWS with knowledge and useful information gained from past work. It is also understood by ANL that no actual information regarding specific situations at the Arsenal will be released to other agencies or personnel involved in the CERCLA and wildlife management activities without expressed written authority from the USFWS.

3 SCOPE OF WORK

The scope of work for technical support to the USFWS at the Arsenal includes six principal elements or tasks:

- Task 1: Habitat Evaluation
- Task 2: CERCLA and Natural Resource Damage Assessments Development and Review
- Task 3: Ecosystem and Landscape Models
- Task 4: Soil Ecosystem Studies and Land Restoration/Reclamation
- Task 5: NEPA and Master Planning
- Task 6: Information Management Systems

3.1 Task 1: Habitat Evaluation

Habitat evaluations are an integral part of analyzing a landscape for specific wildlife management goals, as well as an important input to any consideration of ecosystem changes over time. Likewise, quantitative evaluations of habitat are applied to CERCLA natural resource damage assessments when the loss of wildlife resources or habitat as a result of past contaminant releases must be determined in order to place a monetary value on compensation and remedial efforts.

An important technique used to establish baseline conditions and track changes over time is the Habitat Evaluation Procedures (HEP) system developed by the USFWS. HEP is a quantitative method for establishing the current value of a habitat area. This value can then be compared with results of future determinations to map changes in the habitat and compare to specific goals. Goals at the Arsenal might include minimizing the effect of residual contamination on particular species or enhancing specific resident, migratory, or endangered species. HEP could also be used to determine appropriate compensation for habitat loss due to residual contamination as recommended by the USFWS and to model the outcome of modifying

the use of a habitat area to enhance one use at the cost of another use. For instance, HEP could be applied to determine the suitability of the Arsenal to support a population of black-footed ferrets or other rare prairie species and to define what, if any, wildlife resource trade-offs would have to occur in order to support that species, as well as to determine if residual contamination would be a threat to its existence.

HEP is conducted in a series of discrete steps starting with a determination that HEP is a suitable method for the task at hand, defining the study limits, defining the baseline habitat units under evaluation, assigning species-specific habitat suitability indices (HSIs) to each habitat type, and conducting change-over-time evaluations. Depending upon the habitat and species selected for evaluation, a local HSI model may have to be produced by using data collected at the site or from regionally/ecologically similar study areas. An HSI is developed as an index representing positive relationships between habitat variables and carrying capacity. ANL has used HEP and HSI models and has recommended their use in quantitative cumulative effects analyses. Data collection and analyses for work at the Arsenal may take the form of quantitative field data collection and modeling, or adapting existing studies using professional judgment.

ANL will use HEP to develop habitat evaluations to support decisions regarding management of the Arsenal (e.g., contaminant remediation). Habitat evaluations will then be used to evaluate the effect of alternative land use management schemes on future habitat condition and to track the course of recovery of habitat adversely affected by past contamination. Emphasis will be placed on meeting species-specific goals as defined in the master plan and the Rocky Mountain Arsenal Wildlife Refuge Act of 1992.

The Arsenal is currently utilized by over-wintering bald eagles and may be suitable habitat for reintroducing endangered prairie species, such as the black-footed ferret. Using HEP, ANL will evaluate the suitability of the Arsenal habitats to support endangered or rare species, determine the effect of residual contamination on endangered species population dynamics, and prioritize habitat variables influencing the success of endangered species adapted to Arsenal habitats.

3.2 Task 2: CERCLA and Natural Resource Damage Assessments Development and Review

Because the Arsenal is a National Priorities List (NPL) site, remediation activities are carried out under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Under CERCLA, the remediation of contaminated areas follows a two-stage process. The first stage, remedial investigation (RI), includes characterization of existing conditions to identify contaminant sources, environmental concentrations and distribution, and contaminant pathways. A baseline risk assessment (BRA) is performed in parallel with the RI and includes evaluations of human and ecological risk posed by the site under existing conditions. The second stage is the feasibility study (FS), which evaluates remedial alternatives for site cleanup on the basis of the information collected during the RI and BRA. Although the Army is responsible for the RI/FS activities at the Arsenal, the USFWS is a CERCLA-designated Natural Resource Trustee for the site and has oversight responsibilities with regard to the Army RI/FA activities.

As a Natural Resource Trustee for the Arsenal, the USFWS is authorized to pursue monetary compensation on behalf of the public for injury to natural resources under the USFWS's stewardship resulting from releases of hazardous substances or from CERCLA response actions. Sections 107(a) and 120(a) of CERCLA specify that federal agencies are liable for the restoration of natural resources lost or damaged. It is the USFWS's responsibility to evaluate the natural resource injuries incurred to the USFWS's resources at the Arsenal from both the contamination and from remedial actions. Injuries are quantified in terms of the loss or reduction of natural

resource services (e.g., habitat, food, recreation, aesthetic value, drinking water, flood control, etc.). For the USFWS's trust resources, injury quantification will take the form of an ecological risk assessment. Following injury quantification, an economic valuation will be performed to determine monetary damages to the lost services and residual damages from contamination and remedial actions.

3.2.1 Subtask 2.1: RI/FS Process Coordination and Review

ANL will provide technical assistance to the USFWS in evaluation of RI/FS activities proposed by the U.S. Army and Shell Oil Company. The primary goals of this task will be to (1) assist the USFWS in the review of RI/FS workplans, draft RI and BRA documents, annual environmental monitoring reports, and other related documents to ensure data needs are met for evaluating impact to natural resources; (2) provide technical review of and input to the FS in the selection and evaluation of remedial alternatives relative to natural resource concerns; and (3) integrate NRDA concerns into the RI/FS process to avoid impacts to natural resources and to address the data needs of the NRDA process in a cost-effective manner.

3.2.2 Subtask 2.2: Development and Implementation of NRDA at the Arsenal

ANL will provide the USFWS with expertise to scientifically document the natural resource losses from previous contamination at the Arsenal. ANL will assist the USFWS with the development of an NRDA approach for the Arsenal and will develop and conduct "Type B" assessments for the Arsenal. ANL will follow the NRDA implementing regulations (43 CFR Part 11) in the development of the NRDA approach for the Arsenal and will assist the USFWS in developing and conducting an ecological risk assessment for the site that meets the needs of the NRDA preassessment screen and assessment phase. ANL will assist the USFWS in reviewing the results of any preassessment screens performed by the principal responsible party (PRP) at the Arsenal and will conduct an independent preassessment screen for comparative purposes. Ecological risk assessment assistance will include identification of ecological contaminants of concern; determinations of contaminant sources, distribution, and fate and transport; and development of risk models for selected wildlife species at the Arsenal. ANL will also assist in reviewing natural resource assessment plans developed by the USFWS or other Natural Resource Trustees at the Arsenal to ensure that the assessments are technically sound, address the issues of concern, and were conducted in a systematic and scientific fashion. Finally, ANL will provide technical assistance in developing and/or reviewing restoration methodology plans, which identify the costs of (1) assessing the natural resource damage, (2) rehabilitation of the damaged resource, (3) restoration of the resource to precontamination conditions, and (4) acquisition of replacement resources.

3.3 Task 3: Ecosystem and Landscape Modeling

Restoration of large land areas requires the integration of knowledge of species life-histories, population dynamics, and ecosystem processes. Because these ecological processes cross spatial and temporal scales, a landscape-scale approach is a useful context for restoration activities. To ensure the greatest likelihood of success, habitat restoration plans, species-reintroduction programs, and education programs should explicitly consider the spatial arrangement of habitat patches across the landscape and the multiple links among complex systems. This landscape approach, as opposed to the traditional species approach, is ideally suited to natural resource management.

Landscape models that are integrated with a geographic information system (GIS) can provide the USFWS with alternative land use scenarios that are readily interpreted and compared. ANL staff have extensive research and applied experience in landscape ecology and restoration and are developing models linked, through a graphical interface, to GIS technology

and databases. This experience includes studies in prairies, savannas, temperate and tropical forests, and strip-mined land. ANL will provide technical assistance to the USFWS in applying a landscape ecological approach to restoration activities at the Arsenal. The aims of this effort are to reduce erosion (and thereby contaminant transport) and to optimize the spatial configuration and composition of habitat patches.

3.4 Task 4: Soil Ecosystem Studies and Land Restoration/Reclamation

ANL recognizes that past and ongoing studies being funded at the Arsenal by the U.S. Army and Shell Oil Company are directed at determining the extent to which chemical contamination will be reduced. The findings of these studies will be used to determine the area and amount of soil that must be treated, consolidated, and/or removed. However, it is likely that past contamination will not be reduced to natural background conditions (i.e., conditions before the use of the site for chemical production). Thus, the USFWS must develop monitoring programs and ecological risk criteria that can be used to develop further soil remediation efforts.

Surface soils at several locations at the Arsenal are contaminated with low-levels of aldrin, dieldrin, and endrin (organochlorine pesticides [OCPs]). These areas of low-level OCP contamination are wide spread across the site and include many diverse habitats. While these low levels of contamination exceed biological site evaluation criteria, the extent of soil ecosystem damage is difficult to determine from simple observation of a site, and chemical analysis of the soil does not provide adequate data to determine the actual impact on biota. ANL will assist the USFWS in developing measurable soil quality criteria (remediation guidelines) in order to determine (1) areas in need of restoration or reclamation, (2) areas that could be used to obtain clean borrow, and (3) areas that pose little risk to plant or wildlife populations.

3.4.1 Subtask 4.1: Soil Ecology and Ecological Risk

Three types of information will be gathered by ANL to establish a firm causal relationship between contaminants at the Arsenal and ecological effects: (1) chemical analysis of soil to establish the occurrence, spatial distributions, and concentrations of specific contaminants; (2) ecological surveys to help determine if adverse ecological effects have occurred; and (3) toxicity tests to establish links between any adverse ecological effects and contaminant levels.

The comprehensive bioassessment and monitoring program for soils at the Arsenal will emphasize the soil biologically mediated processes and soil community structure. The proposed plan involves (1) a field survey of soil biota, (2) laboratory and field toxicity tests on indicator species and functional groups, (3) laboratory and field tests on indicator processes, and (4) long-term monitoring of soil quality parameters.

Determining the biodiversity of soil organisms in a given soil ecosystem is a prerequisite to a comprehensive assessment program. Soil invertebrates, which are essential components of the decomposer food web, nutrient cycling, and environmental contaminant pathways, are important agents in the formation and maintenance of the biological, chemical, and physical character of soil ecosystems. The same community indexes used in studies of aboveground and aquatic systems, such as species richness and measurements of evenness, are applied to the soil community. In addition to establishing the biodiversity of the soil community, assessment of contaminated soils will provide analysis of changes in the functional (trophic) groups of soil invertebrates. Changes in these functional groups are directly related to potential bioaccumulation in the aboveground trophic structure.

Two types of tests will be used in laboratory toxicity tests: a single indicator species test and a multispecies test. A collembolan species (*Folsomia candida*) will be used in the single indicator species test. This soil microarthropod belongs to the fungal energy channel (all food

chains originating from fungi), which is more sensitive to disturbance than the bacterial or root energy channels. A multispecies microcosm, which offers a high resolution of the ecotoxicological effects of chemicals in complex soil systems, will be used to determine community and trophic-level effects of chemicals on the soil ecosystem at the Arsenal. Field-collected nematode and microarthropod communities will be used in these microcosms. It has been shown that soil nematodes and microarthropods are sensitive indicators of environmental contaminants. Analysis of both nematode and microarthropod communities will provide information on toxicology in different soil microsites -- nematodes inhabit the water film around soil particles, whereas microarthropods inhabit air-field soil pores.

Field studies that quantify indicator processes include field litter decomposition studies, field net nitrogen mineralization assays, laboratory incubation of soil samples to determine rates of CO₂ evolution, and laboratory assays for the determination of nitrification potential of contaminated and noncontaminated soils. These indicator processes have been selected for use at the Arsenal because they are easily measured and serve as an integrator of the combined activities of organisms within the soil ecosystem. Litter decomposition and mineralization of nutrients contained in it are critical processes affecting the availability of nutrients and the primary productivity of ecosystems. Nitrification potential will be determined by amending soils in microcosms with (NH₄)₂SO₄. Unlike carbon mineralization, nitrification is one of the most sensitive criteria related to soil function because conversion of ammonia to nitrate is carried out only by a limited number of bacterial genera (mostly *Nitrosomonas* and *Nitrobacter*), while carbon mineralization is carried out by all heterotrophic organisms in soil. These studies will be conducted in conjunction with the soil amendment work described in subtask 4.2 below.

After determination of baseline parameters of the structure and function of soil ecosystems at the Arsenal, a long-term monitoring program will be initiated to provide a reliable and cost-effective tool for overseeing the progress of soil restoration and reclamation efforts. Results obtained from the monitoring activities would be used in Task 3 (Ecosystem and Landscape Modeling) in order to estimate the fate and consequences of the low-level contaminants at the Arsenal. In addition, development of land treatability priorities can be enhanced, with potential cost savings, on the basis of findings of risk to the soil ecosystem.

3.4.2 Subtask 4.2: Land Treatability - Biodegradation and Nutrient/Water Enhancement

In-situ biodegradation is a potential method for reducing OCP concentrations in soils with minimum disturbance to existing ecosystems. All soils contain microbes that can degrade most organic compounds. The challenge is to develop environmental conditions that enhance microbial degradation of OCP contaminants. The goal of this investigation is to determine the optimal soil fertility level and moisture condition to promote in-situ biodegradation of OCPs with minimum disturbance to existing ecosystems at the Arsenal. Specific objectives of this investigation are to (1) assess the influence of nutrient additions on OCP degradation in Arsenal soils, (2) evaluate the effect of various soil moisture levels on OCP degradation, (3) investigate the potential for inoculating soils with OCP degrading microbes, and (4) assess the impacts of amendments (i.e., fertilization, irrigation, inoculation) on the existing ecosystem at the Arsenal.

The first phase will involve a number of controlled environment (greenhouse and/or growth chamber) studies to determine the optimal soil nutrient and moisture levels on OCP degradation and the effectiveness of soil inoculation to increase OCP degradation. These tests would be conducted in conjunction with the soil ecology studies described in the preceding subtasks. Results from this phase will provide information on optimal amendments required for in-situ biodegradation of OCPs at the Arsenal. The second phase of the study will involve the establishment and monitoring of small field plots at the Arsenal to assess in-situ biodegradation of OCPs under field conditions and the impacts of the amendments to the existing ecosystems.

A literature review will be conducted as part of phase one to determine relationships between OCP degradation and soil fertility and soil moisture status from published studies. This information will be used to develop a detailed experimental plan for the controlled environment studies. Information on areas contaminated with low-levels of OCPs at the Arsenal will be reviewed, and soil will be collected from a location with a typical low level of OCP contamination. At ANL, the chemical characteristics, physical properties, and levels of OCPs and their metabolites will be determined. A series of replicated pot studies will be conducted in a controlled environment (greenhouse or growth chamber) to determine the influence that soil amendments (e.g., N and P fertilizers, organic material) and soil moisture have on OCP degradation. Levels of OCPs and their metabolites will be monitored at regular intervals to determine the influence of each treatment. The controlled environment studies are expected to be completed in about one year.

For phase two, the most promising treatments from the controlled environment studies will be implemented for field evaluation. First, locations at the Arsenal with low-level OCP contamination will be surveyed, replicated small plots marked, and soil analyzed to determine soil characteristics and OCP contamination levels. Then soil amendments will be applied. Soil and vegetation samples will be collected each spring, summer, and fall for three years. Soil samples will be analyzed to determine changes in OCP and metabolite concentrations, and vegetation data will be analyzed to determine shifts in the composition of the vegetative community.

3.5 Task 5: NEPA and Master Planning

The National Fish and Wildlife Foundation in cooperation with the USFWS is preparing a master plan and environmental impact statement (EIS) for the Arsenal. ANL has been involved in preparing assessment documentation and providing technical oversight for federal agencies since the National Environmental Policy Act (NEPA) was enacted in 1970. ANL expertise is utilized when federal agencies are establishing major new or modified programs that are typified by:

- Programmatic actions or alternatives that are not determined in advance, but are dependent upon the outcome of technical analyses of environmental consequences conducted by ANL;
- Comprehensive analytical processes involving many integrated components that must present complex results in terms understandable to the public and policy makers; and
- Geographic areas of sufficient size or sensitivity to require unique analytical methods and scientific credibility.

3.5.1 Subtask 5.1: Technical Management Oversight Support

ANL will provide technical oversight support for the design, development, and completion of environmental assessment documentation as a component of the Rocky Mountain Arsenal National Wildlife Area master plan. This support will include defining the scope of work, identifying the various technical and scientific component required for analyses, identifying scientific and technical disciplines necessary for task performance, establishing standards and requirements for work performance, identifying the actions and activities necessary for technical project management, and establishing criteria against which technical performance will be measured. ANL will conduct quality assurance activities, including monitoring of technical activities and review of technical documentation. ANL will also assist the USFWS in all aspects

of public participation, including a determination of the need for additional analyses or technical responses to public or agency comments.

3.5.2 Subtask 5.2: NEPA Documentation

ANL will develop technical and scientific documentation in support of the environmental analysis process. Such documentation may include, but not be limited to, analytical components of environmental analyses and/or environmental impact statements, appendices providing detailed information to support findings or conclusions reached in environmental documentation produced for agency and public review, and technical reports or publications providing methods, data, and results used in support of analyses presented in NEPA documents.

3.6 Task 6: Information Systems Development and Technical Support

ANL will provide technical assistance to the USFWS for the development and support of an information management system that will provide analytical tools and data required for the management and operation of the refuge. A key framework to be used in developing such an information management system will be the analytical and data requirements and results produced from the refuge master plan and EIS. ANL will evaluate current information management systems used by the USFWS, U.S. Army, and others at the Arsenal to determine the applicability of these systems to potential USFWS requirements. In addition, ANL will assist the USFWS in determining how available data collected for the purpose of the CERCLA remediation and restoration activities can best be used to meet the short- and long-term needs of the USFWS. It is the intention of ANL to avoid duplication of current information management activities while at the same time developing solutions that meet the unique mission, goals, and objectives of the USFWS, especially those related to the long-term management and stewardship of refuge land and resident biological resources.

ANL proposes to develop a workstation system based on a set of interconnected and integrated computer databases that could be accessed through a common, user-friendly computer interface. Development of the system would involve two principal components: (1) analysis of existing databases and information systems at the refuge in the context of USFWS requirements and (2) implementation of an information management system using selected data and/or databases develop during preparation of the master plan and EIS.

The proposed information management system would allow access to both digital spatial data, through a GIS, and relational database information in numerical or narrative form. Although ANL staff cannot specifically identify at this time all databases that would be included in the information management system, we anticipate that they would include selected existing databases on soils, contaminants, animal populations and habitats, and infrastructure, as well as new information derived from ongoing USFWS activities. These new activities include HEP analyses, possible NRDA activities, the refuge master plan, and mitigation actions developed under the EIS process. The determination of which databases would be incorporated into the information management system would be made in cooperation with USFWS staff. This determination would also take into account practical restrictions imposed by available funds and time, as well as technical feasibility. The following benefits would result from a centralized information management system:

- Immediate knowledge of the baseline environment at any location on the refuge at any point in time,
- Increased support of planning operations,
- Increased verifiability of reports,

- Decreased regeneration of baseline data for reports, and
- Increased support for the long-term planning and budgeting of fiscal resources.

The GIS component of the centralized information management system can aid in managing ecosystem and landscape dynamics at the refuge by:

- Maintaining updated spatial locations of environmental attributes (e.g., soils, vegetation communities, animal population, habitats);
- Maintaining updated baseline information on features and infrastructure such as roads, restricted areas, utilities, buildings, and recreational areas;
- Providing tracking information for monitoring activities, (e.g., date of monitor reading, monitor reading level, and monitor station number);
- Maintaining the results of the HEP models analyses to manage landscape interactions (e.g., habitat fragmentation, animal movement, restoration activities);
- Providing visual (terminal) and hard-copy (paper) maps of current conditions, as needed;
- Maintaining a historical record of activities and/or projects at the refuge,
- Providing spatial information on surrounding land uses and potential conflicts, and;
- Providing public access to information and educational materials through user-friendly terminals located at information centers.

3.6.1 Subtask 6.1: Survey and Review of Information Requirements

ANL will review, evaluate, and summarize USFWS and U.S. Army activities that develop and/or use information management systems and recommend specifications for an information management system that could meet USFWS program, project, and management needs. ANL will document the results of the survey and on the basis of results and recommendations of this task in order to assist in the design of an information management system.

3.6.2 Subtask 6.2: Environmental Baseline Data Evaluation

ANL will review, evaluate, and summarize all environmental baseline data available through various media, formats, and sources; provide a systematic approach of data consolidation and centralization based on USFWS program requirements; and define standardized protocols for future data collection efforts in order to support long-term information system requirements. An example of a protocol would be the development of locational standards for spatial data that assures information is accurately georeferenced. ANL will also assist in the development of uniform standards for data collection through controlled and structured data formats. In the development of task specifications, ANL will consider existing data, data formats, electronic platforms, and systems currently employed throughout the USFWS and Army to ensure that an information management system avoids duplication of effort, recognizes instances where USFWS requirements may be unique, and provides commonality and ease of use for all organizations.

3.6.3 Subtask 6.3: System Architecture and Design

ANL will design an information management system architecture to accommodate existing needs and future requirements of the USFWS. The proposed system would be compatible with current USFWS and Army data systems and would have electronic data transfer linkages to the software structures of those systems.

3.6.4 Subtask 6.4: Development of Automated Decision-Making Tools

ANL will develop specific applications for the information system designed in Subtask 6.3 above. The system applications will be designed for specified areas identified by the USFWS on the basis of the program, project, and management needs assessment. ANL's past and current experience will be of significant benefit in cost and time savings related to such effort. One such example of an application is a system developed for a current ANL sponsor that uses a database/GIS/query system to combine disparate environmental data and integrate that data into dynamic models to project future conditions, especially for ecosystem and landscape functions.

4 SCHEDULE AND COST

Based on the scope of work developed in Section 3, the deliverables, schedule and cost follow (assume a start date of August 1994). The total preliminary cost for the project during FY 1994 is estimated at \$700,000. The total tentative cost for the project is estimated at \$4,700,000 over a five-year period. Table 1 presents a breakdown of estimated cost and effort by fiscal year. Detailed costs and schedules will be developed on a task basis.

5 QUALITY ASSURANCE

The purpose of the Argonne National Laboratory Quality Assurance (QA) program is to establish procedures for performing high-quality work on projects and to ensure that the planned procedures are being followed during the course of the work. Quality assurance procedures are followed with regard to project planning, field activities, laboratory analysis, data analysis, review of reports, documentation, and records retention. The ANL quality assurance program conforms with good management practices of DOE Order 5700.6C Quality Assurance, and both ANL and subcontractors will consider this document as guidance for selected QA work plans.

5.1 Organization

Although quality assurance is the responsibility of all project staff members, it is the responsibility of the project leader to ensure that the appropriate QA procedures are carried out by specific members of the project team. The typical project organization includes the following key staff:

- Project leader
- Task investigators (in specific technical disciplines as necessary)
- Field staff
- Laboratory staff
- Subcontractors (as needed).

5.2 Project Plan

The tasks outlined in this proposal address a wide array of environmental research activities. The scope of each of the tasks is broad; this allows flexibility between the sponsor and

ANL to address environmental research opportunities over the course of the period of performance specified in this proposal. Following receipt of specific task orders from the sponsor referencing this proposal (P-94129), ANL will prepare a statement of work and a project plan for completion of the work outlined in the task order. The project plan will present, in simple and direct terms, the purpose of the project, the scope of data collection activities, the project schedule, staff organization and responsibilities, and methods for data collection and analysis. The project plan will contain QA procedures that will be used by ANL staff members throughout the duration of the task. The project plan will be prepared by the project leader, with assistance from the principal investigators. The plan will include the names and phone numbers of all key ANL project personnel and facility personnel and will be available for reference during all field and office activities.

5.3 Role of Subcontractors

ANL uses carefully selected subcontractors to supplement its services and meet the needs of the assigned work. ANL has extensive experience in evaluating and selecting subcontractors and reviewing and interpreting the data generated. ANL maintains responsibility for the work of its subcontractors. A formal QA program will be undertaken by all subcontractors to ensure that the results of any work are fit to be used by ANL, that the results are valid and reproducible, and that the results are adequately documented. All activities will be conducted in a manner such that they will withstand the scrutiny of a formal audit. ANL will review and approve any contractor's QA plan, and ANL reserves the right to inspect the contractor's documentation for compliance with the QA plan.

6 PROJECT MANAGEMENT

Argonne's Environmental Assessment Division (EAD) will be responsible for completion of the tasks specified in this proposal. As the primary principal investigator, Gary M. Kaszynski will have program management responsibility and will report to Robert Browne, Section Manager for the Natural Resource Sciences Section. Robert Browne will ensure that the scope of the program is coordinated with other programs similar in nature and will report to John Krummel, Group Leader for the Ecological and Social Sciences Group. Other ANL scientists and engineers from the Environmental Assessment Division will provide assistance according to their discipline and experience.

TABLE 1 Cost and Effort Estimate for FY 1994 through FY 1998

Category	FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		Totals	
	Person-Months	\$1000	Person-Months	\$1000	Person-Months	\$1000	Person-Months	\$1000	Person-Months	\$1000	Person-Months	\$1000
Scientific direct	42.6	370.4	46.1	431.7	48.7	483.0	51.7	538.3	63.8	697.4	252.9	2520.9
Salary direct	4.6	27.1	4.6	29.5	5.1	34.4	5.2	36.9	6.5	48.2	25.9	176.1
Secretarial/clerical direct	4.0	20.9	4.1	23.5	4.6	27.6	5.1	31.9	6.3	41.9	24.2	145.9
Total effort		418.5		484.7		545.0		607.1		787.5		2842.8
Materials and services												
Travel		0.0		0.0		0.0		0.0		0.0		0.0
Subcontracts		0.0		0.0		0.0		0.0		0.0		0.0
Computer cost		0.0		0.0		0.0		0.0		0.0		0.0
Other		96.4		108.9		124.1		133.6		180.2		643.2
Total materials and services		96.4		108.9		124.1		133.6		180.2		643.2
Total direct cost		514.9		593.6		669.1		740.7		967.7		3486.0
General and administrative		153.4		158.4		178.9		198.1		258.7		947.4
Equipment		10.0		15.0		15.0		20.0		20.0		80.0
DOE added factor 3.20%*		21.7		33.0		37.1		41.2		53.6		186.6
OFA recovery federal rate		700.0		800.0		900.0		1000.0		1300.0		4700.0

*Starting in FY 1995 the DOE added factor will be 4.3%